JBA consulting

South Gloucestershire Council Level 2 Strategic Flood Risk Assessment for Oldbury on Severn

Final Report

September 2017

South Gloucestershire Council

JBA Project Manager

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Contract

This report describes work commissioned by South Gloucestershire Council. The council's representative for the contract was Jessica Bett. Sophie Dusting and Claire Gardner of JBA Consulting carried out this work.

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Purpose

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Executive Summary

Introduction

This Strategic Flood Risk Assessment (SFRA) has been produced to provide further evidence to support South Gloucestershire Council's Local Plan and help inform matters relating to development and flood risk in Oldbury on Severn. The study will also support the development of the Oldbury on Severn Neighbourhood Plan.

SFRA objectives

The objectives of this SFRA are to enable South Gloucestershire Council and Oldbury on Severn Parish Council to

- apply the Sequential and, where necessary, Exception Tests in determining land use allocations for less than 20 homes in Oldbury on Severn;
- fully understand flood risk from all sources within the study area;
- inform the sustainability appraisal so that flood risk is fully taken account of when considering options for housing sites at Oldbury on Severn;
- prepare appropriate policies on the management of flood risk;
- determine the acceptability of flood risk in relation to emergency planning;
- identify flood protection measures (if required) to address the effects of proposed development;
- provide the evidence which will assist with making decisions on individual planning applications; and
- consider the impact of development, identified in the Core Strategy and through planning applications, further up the Pickedmoor Brook.

Modelling

Tidal and fluvial

The Environment Agency's Somerset North Coast Flood Warning Improvements project developed extensive tidal TUFLOW 2D flood models along the Severn Estuary. The model from Aust to Sharpness that contains the Oldbury on Severn study area has formed the basis of the tidal flood modelling for the SFRA. Some minor amendments have been made to the model.

The Pickedmoor Brook was modelled for the previous SFRA using Jflow+ software. However, for this study it was decided to model the Brook in TUFLOW, as it enabled it to be combined into a single model with the tidal modelling.

Residual

Asset failure assessments were undertaken by the Environment Agency in 2013 as part of the Wessex Tidal Procedures study. The results of this modelling were used to assess the consequences of flood risk management infrastructure failure for Oldbury on Severn.

Summary

Sources of flood risk

- The historic flood record shows the village has been subject to both fluvial and tidal flood risk in the past, the most recent being the event of 9 March 2016
- Fluvial flood risk to the village is predominantly from the Oldbury Naite Rhine when it exceeds its capacity and overtops its banks and defences. Levels in the Rhine are exacerbated at times of high tide when the tidal outfalls at the penstock are closed. Additionally, flap values between ordinary and designated watercourses may also fail, allowing more water down the Rhine towards the village
- Tidal flood risk to the village is low due to the tidal defences. However, these defences are shown to overtop in some locations in the present day 0.5% AEP scenario, although no properties are at risk. Under a present day 0.1% AEP and future scenarios, the defences are overtopped causing considerable flooding to parts of the village

- Modelled scenarios show residual risk to parts of the village is high. Under the modelled coastal defence failure scenarios, much of the village is at risk. Those areas not at risk are still affected because of flood waters cutting off the village
- Surface water flood risk mapping shows the risk in the village is relatively low, mainly affecting the roads. However, historical information shows that surface runoff from surrounding agricultural land and down roads acting as flow paths is a significant source of flooding in the village

Climate change

- Much of the village and proposed development sites are unaffected by fluvial flooding in the future.
- Tidal climate change modelling has highlighted that the tidal defences will be overtopped in the future without investment to maintain the current standard of protection afforded to the village. Much of the village is shown to be at risk in the future as well as the proposed development sites

Access and egress

- Safe access and egress during floods is a key issue for the village. In the event of a fluvial flood, the two routes in and out of the village are flooded, potentially cutting off the village in the undefended fluvial scenario. Further work should be undertaken by developers to determine the level of risk when the fluvial defences are considered.
- The coastal defences ensure safe access and egress is available for events up to the 0.5% AEP event. Above a 0.5% AEP event, the roads are at significant risk.
- Under the coastal defence failure scenarios modelled, the village may potentially be cut off within 1.5 – 3 hours of the defence failure.

Key policies and strategies

There are several relevant regional and local key policies and strategies which have been considered within the SFRA, such as the Catchment Flood Management Plan, River Basin Flood Risk Management Plan, the Preliminary Flood Risk Assessment and Local Flood Risk Management Strategy. Other policy considerations have also been incorporated, such as sustainable development principles, climate change and flood risk management.

Development and flood risk

South Gloucestershire Council and Oldbury on Severn Parish Council provided boundaries of potential sites for development around the existing settlement boundary for the detailed Level 2 assessment. The sites were initially screened against flood risk information to remove the sites that were at greatest risk of flooding. Detailed site summary tables were produced for the remaining sites. Flood risk from all the modelled scenarios and other additional information has been summarised for each site and the sites ranked in order of level of risk.

RANK	SITE NUMBER
1	8
2	2
3	9
4	13
5	7
6	1
7	14
8	12
9	4
10	5
11	6

Recommendations

- The modelling and assessments included within this SFRA should be used when allocating sites for development to steer the development to those sites with the lowest risk. The mapping and assessments should also be used to direct development to the lowest risk area within the site
- Site-specific Flood Risk Assessments (FRAs) are required by developers to provide a greater level of detail on flood risk and any protection provided by defences and, where necessary, demonstrate the development passes part b of the Exception Test
- Developers should, where required, undertake more detailed hydrological and hydraulic assessments of the Rhine system, to account for channel and structure geometry. Survey of the fluvial defences in the village should also be undertaken to understand the actual risk of flooding, taking the defences into account, as well as the residual risk should the defences fail. This will allow them to verify flood extent (including latest climate change allowances), inform development zoning within the site and prove, if required, whether the Exception Test can be passed
- Sites will be required to pass the Sequential and, where necessary, Exception Tests in accordance with the NPPF. The council should use the information in this SFRA when deciding which development sites to take forward in their Local Plan
- Developers should consult with the council, the Environment Agency and the Lower Severn Internal Drainage Board, at an early stage to discuss flood risk including requirements for site-specific FRAs, detailed hydraulic modelling, and drainage assessment and design
- The council should consult the Environment Agency's 'Flood Risk Standing Advice (FRSA) for Local Planning Authorities', last updated 15 April 2015, when reviewing planning applications for proposed developments at risk of flooding
- Developers should ensure drainage from sites will not exacerbate the level of fluvial flood risk. Wherever possible, SuDS should be promoted
    - It should be demonstrated through a Surface Water Drainage Strategy, that the proposed drainage scheme, and site layout and design, will prevent properties from flooding from surface water. A detailed site-specific assessment of SuDS would be needed to incorporate SuDS successfully into the development proposals. All development should adopt source control SuDS techniques to reduce the risk of frequent low impact flooding due to post-development runoff
    - For proposed developments, it is imperative that a site-specific infiltration test is conducted early on as part of the design of the development, to confirm whether the water table is low enough to allow for SuDS techniques that are designed to encourage infiltration
    - Consideration must also be given to residual risk and maintenance of sustainable drainage and surface water systems
    - SuDS proposals should contain an adequate number of treatments stages to ensure any pollutants are dealt with on site and do not have a detrimental impact on receiving waterbodies
    - The promotion and adoption of water-efficient practices in new development will help to manage water resources and work towards sustainable development and will help to reduce any increase in pressure on existing water and wastewater infrastructure
- Developers will need to consider the residual risk of flooding, should the defences fail
- Developers should look to reduce residual risk by avoiding single storey buildings through use of multiple storey construction and raised areas that provide an escape route
- Safe access routes should, ideally, be located 300mm above design flood levels and avoid flow paths. Waterproof construction techniques should be used. Where this is unavoidable, limited depths of flooding may be acceptable providing the proposed access is designed with appropriate signage etc. to make it safe. The maximum flood hazard on access and egress routes to a place of safety should not exceed depths and velocity combinations associated with a 'very low hazard'. Additionally, it should not have any service covers that could be removed, or other underwater hazards.

- The long-term maintenance and standard of protection of the defences should be considered, including the potential requirement for improvements to maintain the current standard of protection into the future

Potential modelling limitations and improvements

- The combined tidal and fluvial hydraulic model developed for this study is represented in 2D-only. This could be upgraded in future to a 1D-2D hydraulic model if channel and structure survey becomes available. This type of model would provide a greater level of flood risk information as it would better represent the channel geometry. It could also be used to model various influences on flood risk for example, blockage of structures or failure of flap valves
- No information was available from the Severn Valley Internal Drainage Board for the fluvial flood defences in Oldbury on Severn. Due to the 2D nature of the modelling and lack of survey information available of any structures, structures and defences were not represented in the model. Therefore, only an undefended fluvial scenario was simulated.

  Survey of the fluvial defences in the village and inclusion in the model would allow the actual risk of fluvial flooding to be modelled, taking the defences into account, as well as the residual risk should the defences fail.
- If a watercourse or drain is shown on OS mapping but is not covered by a Flood Zone, this does not mean there is no potential flood risk. A hydraulic model would likely be required at detailed site-specific level to confirm the flood risk to the site

Contents

Contents

JBA consulting

List of Figures

List of Tables

Using this document

Hyperlinks

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

Appendix A: Detailed site summary tables

These are a series of interactive maps for each potential development site in Oldbury on Severn and correspond to the matching site summary table

Abbreviations and Glossary of Terms

Term	Definition
2D model	Two-dimensional hydraulic model
AEP	Annual Exceedance Probability
CC	Climate change - Long term variations in global temperature and weather patterns caused by natural and human actions.
CFMP	Catchment Flood Management Plan- A high-level planning strategy through which the Environment Agency works with their key decision makers within a river catchment to identify and agree policies to secure the long-term sustainable management of flood risk.
CIRIA	Construction Industry Research and Information Association
Defra	Department for Environment, Food and Rural Affairs
DTM	Digital Terrain Model
EA	Environment Agency
EU	European Union
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 Risk Area	An area determined as having a significant risk of flooding in accordance with guidance published by Defra and WAG (Welsh Assembly Government).
Flood Risk Regulations	Transposition of the EU Floods Directive into UK law. The EU Floods Directive is a piece of European Community (EC) legislation to specifically address flood risk by prescribing a common framework for its measurement and management.
Floods and Water Management Act	Part of the UK Government's response to Sir Michael Pitt's Report on the Summer 2007 floods, the aim of which is to clarify the legislative framework for managing surface water flood risk in England.
Fluvial Flooding	Flooding resulting from water levels exceeding the bank level of a watercourse.
Preliminary Flood Risk Assessment (PFRA)	PFRAs report on significant past and future flooding from all sources except from Main Rivers, reservoirs and sub-standard performance of the adopted sewer network. PFRAs are a high-level screening exercise and consider floods which have significant harmful consequences for human health, economic activity, the environment and cultural heritage
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.
FWMA	Flood and Water Management Act
Ha	Hectare
JBA	Jeremy Benn Associates
LFRMS	Local Flood Risk Management Strategy
LIDAR	Light Detection and Ranging
LLFA	Lead Local Flood Authority - Local Authority responsible for taking the lead on local flood risk management
mAOD	metres Above Ordnance Datum
Main River	A watercourse shown as such on the Main River Map, and for which the Environment Agency has responsibilities and powers
Major development	Residential development: 10 dwellings or more, or site area of 0.5 hectares or more is dwelling numbers are unknown. Non-residential development: provision of a building or buildings where the total floor space to be created is 1,000 square metres or more, or where the flood area is not yet known, a site area of one hectare or more.
NPPF	National Planning Policy Framework

Term	Definition
NPPG	National Planning Policy 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 of maintenance.
OS NGR	Ordnance Survey National Grid Reference
PFRA	Preliminary Flood Risk Assessment
Pitt Review	Comprehensive independent review of the 2007 summer floods by Sir Michael Pitt, which provided recommendations to improve flood risk management in England.
Pluvial flooding	Flooding because 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.
Resilience Measures	Measures designed to reduce the impact of water that enters property and businesses; could include measures such as raising electrical appliances.
Resistance Measures	Measures designed to keep flood water out of properties and businesses; could include flood guards for example.
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.
River Basin Flood Risk Management Plan (RBMP)	Under the Regulations the Environment Agency exercised an 'Exception' and did not prepare a PFRA for risk from rivers, reservoirs and the sea. Instead they had to prepare and publish a FRMP. The FRMP summarises the flooding affecting the area and describes the measures to be taken to address the risk in accordance with the Flood Risk Regulations
Return Period	Is an estimate of the interval of time between events of a certain intensity or size, in this instance it refers to flood events. It is a statistical measurement denoting the average recurrence interval over an extended period of time.
RoFfSW	Risk of Flooding from Surface Water dataset (previously known as the updated Flood Map for Surface Water)
Sewer flooding	Flooding caused by a blockage or overflowing in a sewer or urban drainage system.
SFRA	Strategic Flood Risk Assessment
SoP	Standard of Protection - Defences are provided to reduce the risk of flooding from a river and within the flood and defence field standards are usually described in terms of a flood event return period. For example, a flood embankment could be described as providing a 1 in 100-year standard of protection.
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 because of surface water runoff because 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.

1 Introduction

1.1 Purpose of the Strategic Flood Risk Assessment

This Strategic Flood Risk Assessment (SFRA) has been produced to provide further evidence to support South Gloucestershire Council's Local Plan and help inform matters relating to development and flood risk in Oldbury on Severn. The study will also support the development of the Oldbury on Severn Neighbourhood Plan.

1.2 Study background

1.2.1 Previous Strategic Flood Risk Assessments

South Gloucestershire Council published a Level 1 SFRA in February 2009. The Level 1 SFRA was primarily a desk-based study, using existing flood risk datasets, to assess the risk of flooding from all sources across South Gloucestershire. The Level 1 SFRA was used to inform the application of the Sequential Test.

A Level 2 SFRA report was published in December 2011 which supported the Core Strategy growth locations.

1.2.2 Requirement for a Level 2 Strategic Flood Risk Assessment

The South Gloucestershire Core Strategy (adopted 2013) forms part of the South Gloucestershire Local Plan. Under the Core Strategy, Policies CS5 - Location of Development and CS34 - Rural Areas, rural communities could identify the need for additional housing through the PSP Plan or Neighbourhood Plans. Through this process, Oldbury on Severn Parish Council, in partnership with the wider community, identified the need for approximately 14 new dwellings for the long-term sustainability of the village.

South Gloucestershire Council subsequently assessed potential housing sites in Oldbury on Severn to identify significant constraints / issues relating to flood risk. The council identified that all potential development sites in Oldbury on Severn were affected by flood risk and that there were no reasonably available sites in areas with a lower probability of flooding (i.e. applying the Sequential Test).

As all potential development sites are affected by flood risk, the application of the Exception Test is required. This Level 2 SFRA considers the detailed nature of the flood characteristics within Oldbury on Severn and will be used to inform the application of the Exception Test as well as inform future planning decisions within the village.

1.3 SFRA objectives

The objectives of this SFRA are to enable South Gloucestershire Council and Oldbury on Severn Parish Council to

- apply the Sequential and, where necessary, Exception Tests in determining land use allocations for less than 20 homes in Oldbury on Severn;
- fully understand flood risk from all sources within the study area;
- inform the sustainability appraisal so that flood risk is fully taken account of when considering options for housing sites at Oldbury on Severn;
- prepare appropriate policies on the management of flood risk;
- determine the acceptability of flood risk in relation to emergency planning;
- identify flood protection measures (if required) to address the effects of proposed development;
- provide the evidence which will assist with making decisions on individual planning applications; and
- consider the impact of development, identified in the Core Strategy and through planning applications, further up the Pickedmoor Brook.

2 The sequential risk-based approach

2.1 The sequential, risk-based approach

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

It is often the case that it is not possible for all new development to be allocated on land that is not at risk. The Flood Zone maps (that show the extent of inundation if there are no defences) are a starting point for a site-specific Flood Risk Assessment (FRA). For fluvial flood risk, these maps are only available where the watercourse has been modelled (where the upstream catchment is greater than 3km^2). In un-modelled parts of the catchments and areas where the flood zone maps are believed to inadequately represent the local detail, further assessment which could include modelling might be required to create a better understanding of the scale and nature of the risks.

2.1.1 Flood Zones

The NPPF Guidance identifies the following Flood Zones (see Table 2-1). These apply to both Main River and Ordinary Watercourses.

Table 2-1: Flood Zone descriptions

Zone	Probability	Description
Zone 1	Low	This zone comprises land assessed as having a less than 1 in 1000 annual probability of river or sea flooding in any year (<0.1%).
		All land uses are appropriate in this zone from a fluvial flooding perspective.
		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 from a fluvial flooding perspective. Highly vulnerable land uses are allowed as long as they pass the Exception Test. Development should only be permitted if it has passed the Sequential 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.
		From a fluvial flooding perspective, water compatible and less vulnerable land uses are permitted in this zone whilst highly vulnerable land uses are not permitted. More vulnerable and essential infrastructure are only permitted if they pass the Exception Test. Development should only be permitted if it has passed the Sequential 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. The identification of functional floodplain should take account of local circumstances.
		From a fluvial flooding perspective, 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. Development should only be permitted if it has passed the Sequential Test.
		All developments in this zone require an FRA.

The sequential approach can be applied both between and within Flood Zones. Between Flood Zones, the sequential approach should be used to direct development to the zone of lowest risk. Within Flood Zones, the sequential approach to the location of development should also consider surface water and other sources of flooding, such as groundwater, to direct development to locations of lowest risk.

2.1.2 Surface water flood risk information

In 2013, the Environment Agency, working with LLFAs, produced the Risk of Flooding from Surface Water map (RoFfSW)). The RoFfSW is a national scale map and assesses flooding scenarios as a result of rainfall with the following chance of occurring in any given year.

Risk	Definition
High	Probability of flooding greater than 1 in 30 (3.3%) each year.
Medium	Probability of flooding between 1 in 100 (0.1%) and 1 in 30 (3.3%) each year.
Low	Probability of flooding between 1 in 1,000 (0.1%) and 1 in 100 (1%) each year.
Very Low	Probability of flooding of less than 1 in 1,000 (0.1%) each year

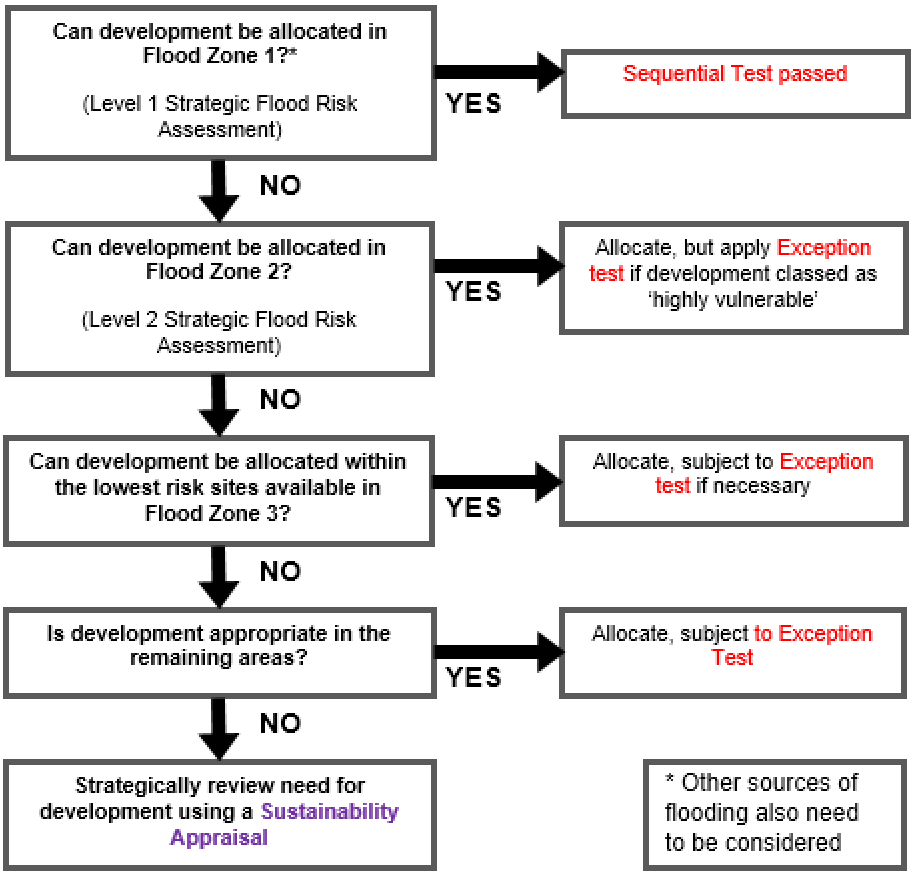
The surface water map is available via the Long-Term Flood Risk Information page on the government's website. In addition to showing the extent of surface water flooding, there are depth and velocity maps for each risk category. These maps should be used when considering other sources of flooding when applying the Sequential and Exception Tests.

2.2 Applying the Sequential Test and Exception Test in the preparation of a Local Plan / Neighbourhood Plan

When preparing a Local Plan or Neighbourhood Plan, it should be demonstrated that a range of site allocations have been considered, using the SFRA to apply the Sequential and Exception Tests where necessary.

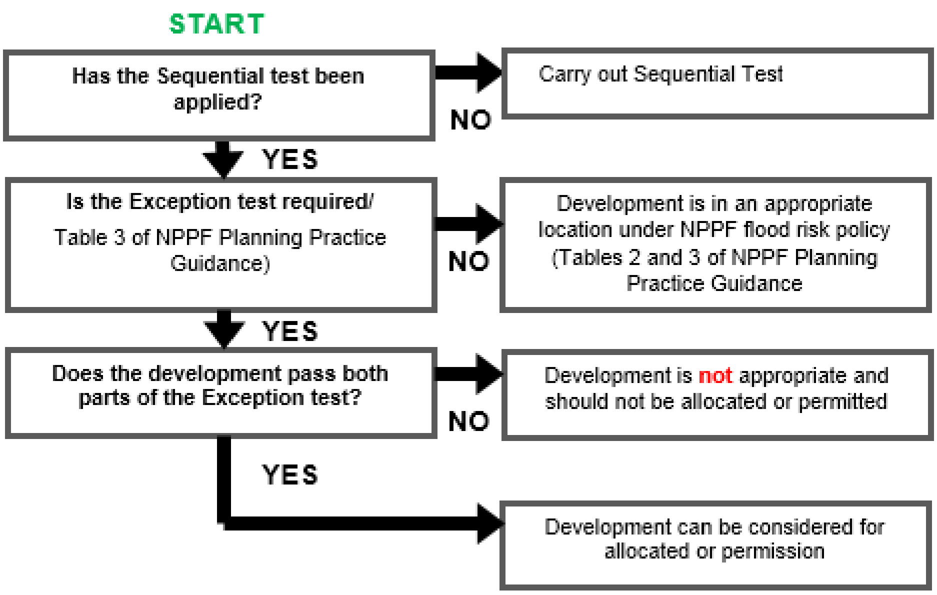
The Sequential Test should be applied to the whole Local Planning Authority or Neighbourhood Plan area to increase the likelihood of allocating development in areas not at risk of flooding. NPPF Planning Practice Guidance for Flood Risk and Coastal Change describes how the Sequential Test should be applied in the preparation of a Local Plan / Neighbourhood Plan (Figure 2-1).

Figure 2-1: Applying the Sequential Test in the preparation of a Local Plan / Neighbourhood Plan



The Exception Test should only be applied following the application of the Sequential Test and as set out in Table 3 of the NPPF Planning Practice Guidance: Flood Risk and Coastal Change. The NPPF PPG describes how the Exception Test should be applied in the preparation of a Local Plan / Neighbourhood Plan (Figure 2-2).

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



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

2.3.1 Sequential Test

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

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

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

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

2.3.2 Exception Text

If, following application of the Sequential Test, it is not possible for the development to be in areas with a lower probability of flooding, the Exception Test must then be applied if deemed appropriate. The aim of the Exception Test is to ensure that more vulnerable property types, such as residential development can be implemented safely and are not located in areas where the hazards and consequences of flooding are inappropriate. For the Test to be satisfied, both of the following elements have to be accepted for development to be allocated or permitted:

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

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[1] .

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

The site-specific Flood Risk Assessment should demonstrate that the site will be safe and the people will not be exposed to hazardous flooding from any source. The following should be considered[2]:

- 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
- Any funding arrangements required for implementing measures

The NPPF and Planning Practice Guidance provide detailed information on how the Test can be applied.

1 NPPF Planning Practice Guidance: Flood Risk and Coastal Change (paragraph 037, Reference ID: 7-056-20140306) March 2014
2 NPPF Planning Practice Guidance: Flood Risk and Coastal Change (paragraph 038, Reference ID: 7-056-20140306) March 2014

2.4 Actual flood risk

Where development cannot be accommodated in Flood Zone 1, a more detailed assessment is needed to understand the implications of locating proposed development in Zones 2 or 3. This is accomplished by considering information on the "actual risk" of flooding. The assessment of actual risk takes account of the presence of flood defences and provides a picture of the safety of existing and proposed development. The assessment of the actual risk should take the following issues into account:

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

This SFRA includes information on the actual risk of flooding, taking account of defences, their current standard of protection, future flood risk and residual flood risk.

3 Sources of information used in preparing this SFRA

3.1 Tidal and fluvial flood risk

The Environment Agency's Somerset North Coast Flood Warning Improvements project developed extensive tidal TUFLOW 2D flood models along the Severn Estuary.

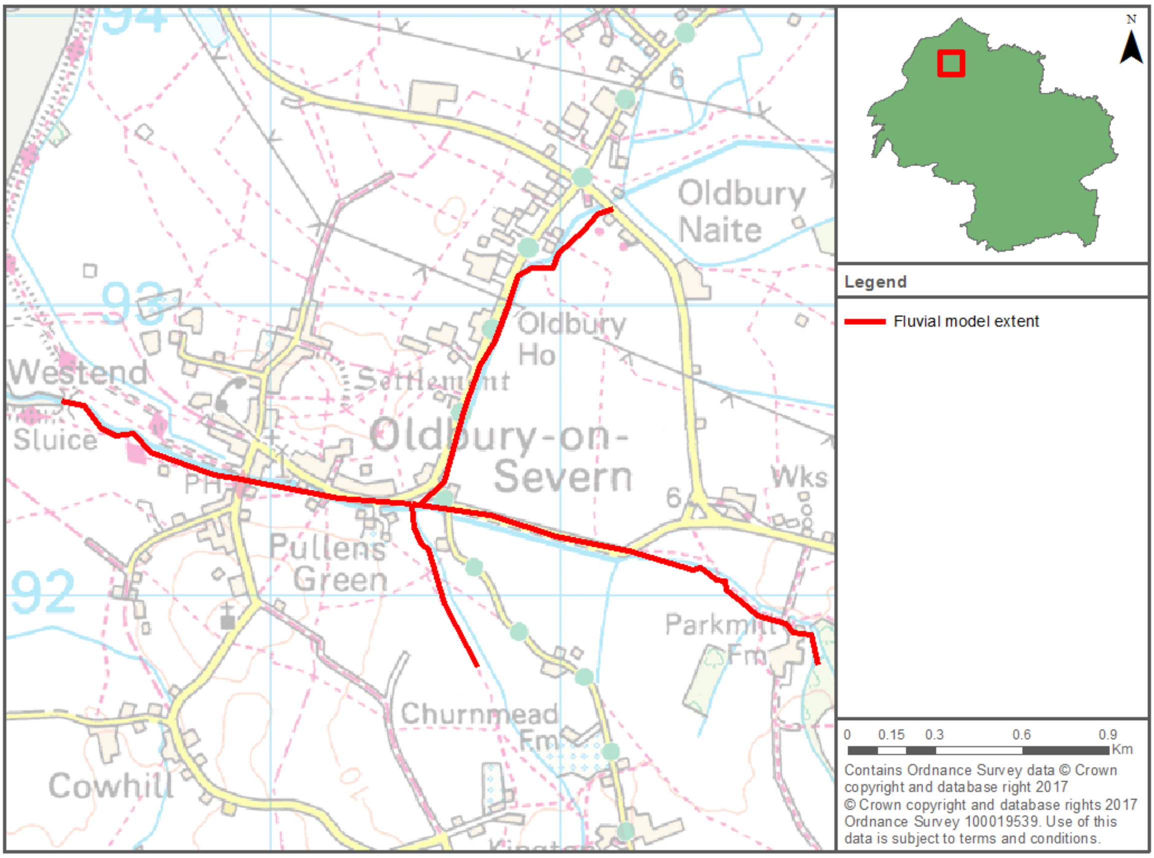
One of the models for this project extends from Aust to Sharpness and therefore contains the Oldbury on Severn study area. This model has formed the basis of the tidal flood modelling for the SFRA. Some minor amendments have been made to the model including

- updating the underlying digital terrain model (DTM) using more up to date LIDAR;
- updating tidal levels; and
- integration of a fluvial element with the inclusion of the Pickedmoor Brook.

The Pickedmoor Brook was modelled for the previous SFRA using Jflow+ software. However, for this study it was decided to model the Brook in TUFLOW, as it enabled it to be combined into a single model with the tidal modelling. This allows different combinations of scenarios to be modelled. It also provides greater flexibility for future amendments and improvements should channel or structure survey become available. The extent of the fluvial model was agreed at project inception and is shown in Figure 3-1.

A Model User Report has been prepared alongside the model, which documents the amendments to the model as well as the scenarios run as part of the SFRA.

Figure 3-1: Extent of fluvial model



Modelling limitations

- Due to the 2D nature of the modelling and lack of survey information available, structures and defences are not represented in the model. The channel geometry is also not fully represented.

- No information was available from the IDB for the fluvial flood defences in Oldbury on Severn. Therefore, only an undefended fluvial scenario was simulated.

3.1.1 Residual flood risk

Overtopping

Wave overtopping modelling for the present-day scenario was undertaken for the Somerset North Coast Flood Warning Improvements project. However, the 2012 study did not determine overtopping risk with the addition of climate change.

Existing crest levels of the local coastal defences have been inspected and compared against the estimated 2117 0.5% AEP tide level. From this comparison, it was concluded that the predicted peak water level is likely to be approximately 600mm above the defences, in which case waves will not be a major contributing factor to flood risk in Oldbury on Severn. Therefore, modelling of waves in relation to climate change has not been undertaken for this study.

Defence failure

Asset failure assessments were undertaken by the Environment Agency in 2013 as part of the Wessex Tidal Procedures study; the results of this modelling were used to assess the consequences of flood risk management infrastructure failure for Oldbury on Severn.

3.2 Surface Water

Mapping of surface water flood risk in Oldbury on Severn has been taken from the Risk of Flooding from Surface Water (RoFfSW) mapping (formally known as the updated Flood Map for Surface Water).

3.3 Groundwater

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

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

3.4 Sewers

Historical incidents of flooding are detailed by Wessex Water through their Sewer Flooding Risk Register. The register records incidents of flooding relating to public foul, combined or surface water sewers and displays which properties suffered flooding.

3.5 Reservoirs

The Environment Agency's Long-Term Flood Risk Information website was used to identify if there is any risk to Oldbury on Severn in the event of reservoir inundation. The mapping showed there is no risk to Oldbury on Severn from reservoirs.

3.6 Climate change

The government advises that SFRAs assess the risk to an area from flooding, now and in the future, including consideration of the impacts of climate change[3]. By making an allowance for climate change, it will help reduce the vulnerability of the development and provide resilience to flooding in the future.

The Environment Agency published climate change guidance on 19 February 2016, which supports the NPPF and must now be considered in all new developments and planning

3 Planning and Flood Risk, Paragraph: 009 Reference ID: 7-009-20140306 https://www.gov.uk/guidance/flood-risk-and-coastal-change

applications. The document contains guidance on how climate change should be accounted for when considering development, specifically how allowances for climate change should be included with FRAs.

The 2016 climate change guidance includes climate change predictions of anticipated change for peak river flow and peak rainfall intensity. The allowances are based on climate change projections and difference scenarios of carbon dioxide emissions to the atmosphere.

The effect of climate change on fluvial flooding in Oldbury on Severn has been modelled using the 2080s period for all three allowance categories for the River Severn basin set out in the 2016 guidance, i.e. 25%, 35% and 70% increase in the 1% AEP event.

The effect of climate change on tidal flooding has been modelled to 2117 using the sea level rise allowances set out in the 2016 guidance.

3.7 Flood risk policy and guidance

Since the previous SFRA, there have been several changes to the planning legislation and policy, including the Localism Act (2011) and the March 2012 National Planning Policy Framework (NPPF)[4] with supporting Planning Practice Guidance (March 2014)[5]. In addition, the provisions of the Flood and Water Management Act (2010) have been substantially commenced under a programme that was initiated by Defra in April 2010 and the Flood Risk Regulations came into force in December 2009 (these regulations transposed the EU 'Floods Directive' into UK law).

South Gloucestershire Council has also published the South Gloucestershire Local Plan, comprising the Joint Waste Core Strategy, the Core Strategy (2013) and the emerging South Gloucestershire Local Plan: Policies, Sites and Places Plan.

An overview of national and local planning policy and guidance is contained in Appendix E.

4 National Planning Policy Framework (Department for Communities and Local Government, March 2012)

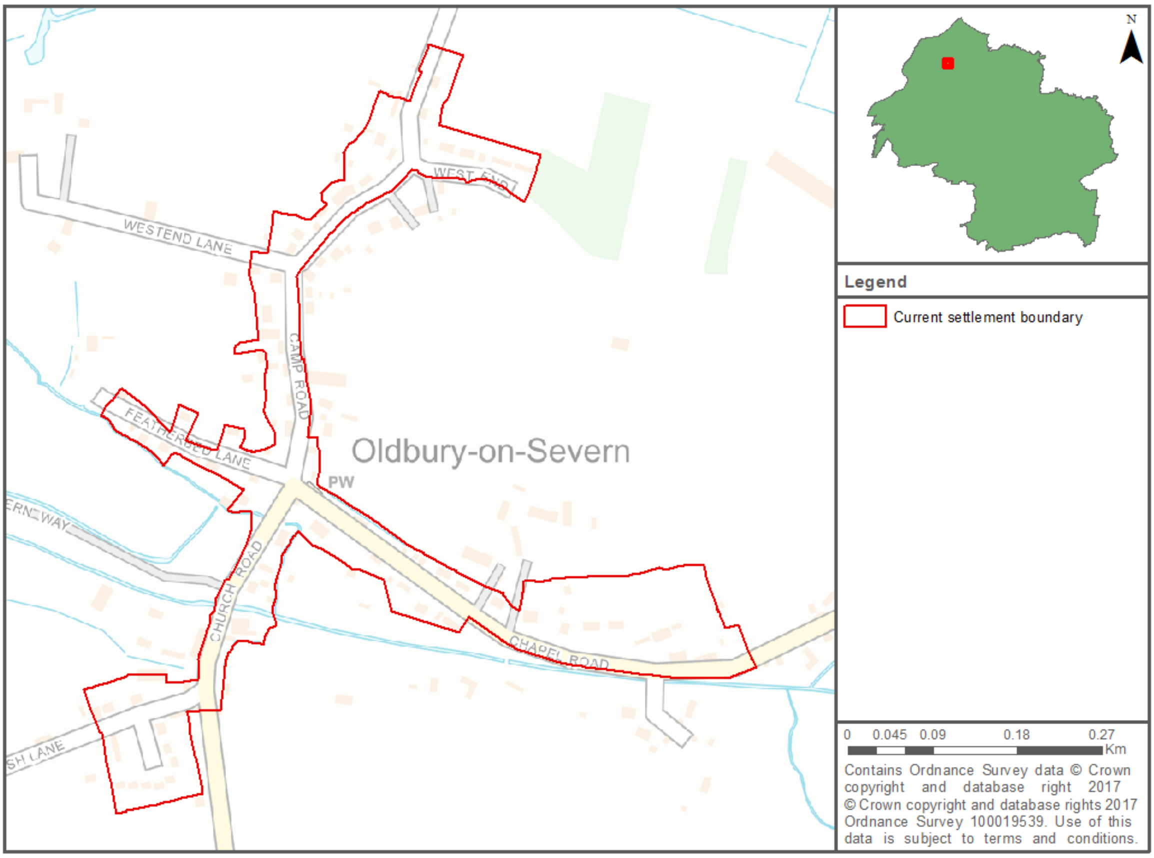
5 National Planning Policy Framework Planning Practice Guidance: Flood Risk and Coastal Change (Department for Communities and Local Government, March 2014)

4 Oldbury on Severn

4.1 Overview of study area

Oldbury on Severn is a small village located in South Gloucestershire, adjacent to the River Severn estuary. The main village extends from Ham Lane in the north, to Church Hill in the south, to Featherbed Lane in the west and Chapel Road in the east. Parts of Oldbury on Severn date back to Roman times; the Romans constructed the original flood defences in the village, to protect against high tides and inland flooding. The current settlement boundary is shown in Figure 4-1.

Figure 4-1: Oldbury on Severn settlement boundary



4.2 Flood history

There are several recorded flood events which are known to have affected Oldbury on Severn; these are shown in Table 4-1.

The most recent flooding event was on 9 March 2016 when properties, roads, gardens and open fields were flooded by a combination of tidal, fluvial and surface sources. A Flood Report for this event has been published by South Gloucestershire Council in May 2017. Oldbury on Severn Parish Council also provided a detailed account of the event in a report prepared in August 2016.

4.2.1 9 March 2016 flood event

- Between the hours of 0600 and 0930, parts of Oldbury on Severn were flooded
- Properties, roads and gardens were flooded on Church Hill, Featherbed Lane, Church Road, Chapel Road and Pickedmoor Lane
- Preceding months were wetter than average. There was sustained rainfall over a nine-hour period but the rainfall was not extreme
- The South Gloucestershire Council report suggests a peak flow rate of 10.9m^3/s.

- The peak flow event coincided with the high tide. The flaps at the penstock were closed due to high water tide conditions, as they are designed to do, which leads to raised water levels in the Rhine and increased volume of water in the Rhine system
- Non-return valves (flaps) where ordinary watercourses meet designated watercourses are not fully functioning, with some leakage through the structures

Table 4-1: Historical flooding in Oldbury on Severn

Date	Source of flooding	Location affected	Source of data
01 July 1968	Fluvial - from several ordinary watercourses	Predominantly undeveloped land west of Ham Lane and The Nate road.	Environment Agency Historic Flood Map
01 - 13 December 1981	Tidal - from the River Severn	Around Featherbed Lane, Camp Road, Chapel Road, Church Road and the Severn Way.	Environment Agency Historic Flood Map
25 November 2012	Surface water flowing down Church Hill and adjacent agricultural land	The Anchor Inn	Environment Agency Historic Flood Map
22 - 23 December 2013	Surface water flowing down Church Hill and adjacent agricultural land	The Anchor Inn	Environment Agency Historic Flood Map
9 March 2016	Surface water / fluvial: reported to be a combination of high tides (causing a "tide-lock" scenario) and designated (or adopted) watercourses exceeding channel capacity.	Property flooding recorded at the following post-codes: BS35 1QJ, BS35 1QA and BS35 1PL. The event caused flooding of local roads, gardens and open fields.	Parish Council report on flooding in Oldbury on Severn on 9th March 2016

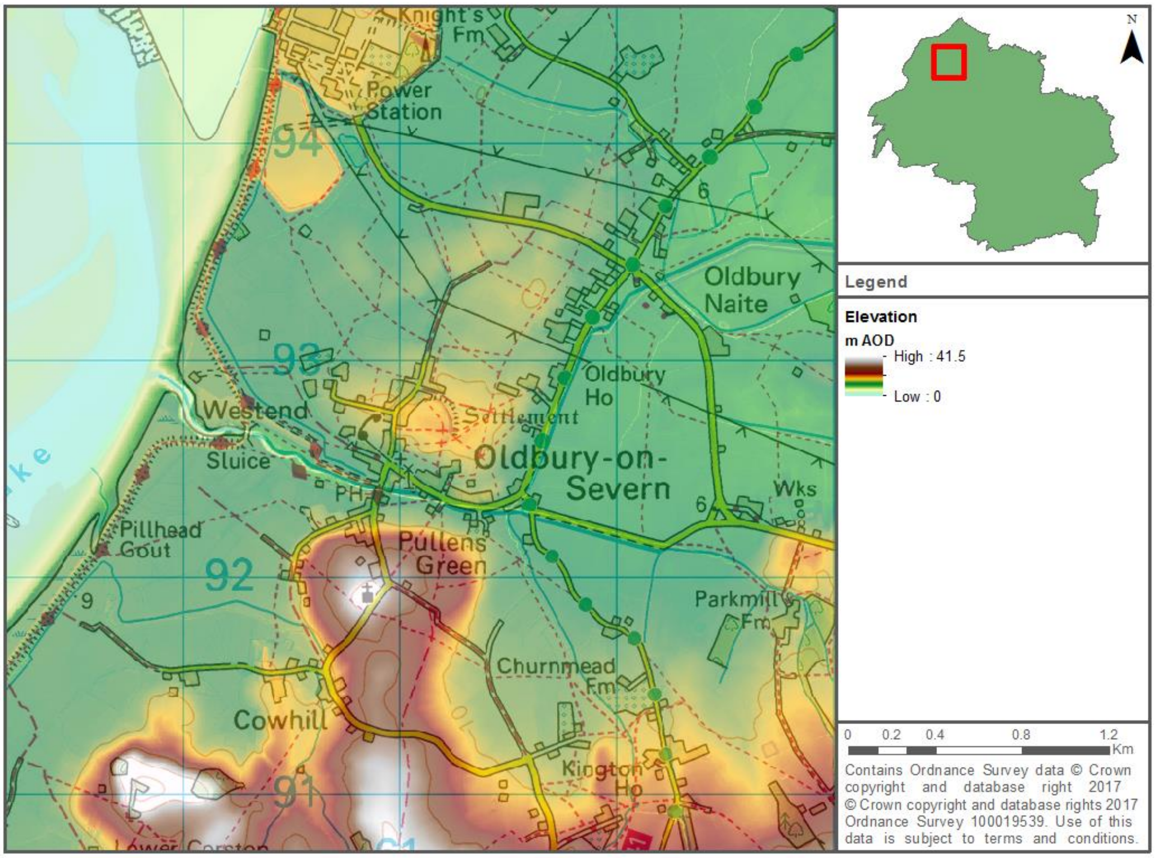
4.3 Topography, geology and soils

Topography, geology and soil are all important in influencing the way the catchment responds to a rainfall event. The degree to which a material allows water to percolate through it, the permeability, affects the extent of overland flow and therefore the amount of run-off reaching the watercourse. Steep slopes or clay rich (low permeability) soils will promote rapid surface runoff, whereas more permeable rock such as limestone and sandstone may result in a more subdued response.

4.3.1 Topography

The topography of Oldbury on Severn is dominated by the valley of the Oldbury Naite Rhine which flows south of the village centre. Towards the north of the village is an area of high ground, associated with the "Toot" hill fort. Elevations here reach approximately 13.6m AOD. South of the village, towards Cowhill, is another area of high ground. The highest elevations of around 39.7m AOD, can be found at St. Arilda Church. Areas with the lowest elevations can be found towards the base of the Oldbury Naite Rhine valley, where levels vary between approximately 6m AOD and 7m AOD. The surrounding low-lying topography exacerbates flood risk in the village as the main access and egress routes are at risk of flooding and potentially cutting off the village in a time of flood. An overview of the topography in Oldbury on Severn is shown in Figure 4-2.

Figure 4-2: Topography of Oldbury on Severn



4.3.2 Geology and soils

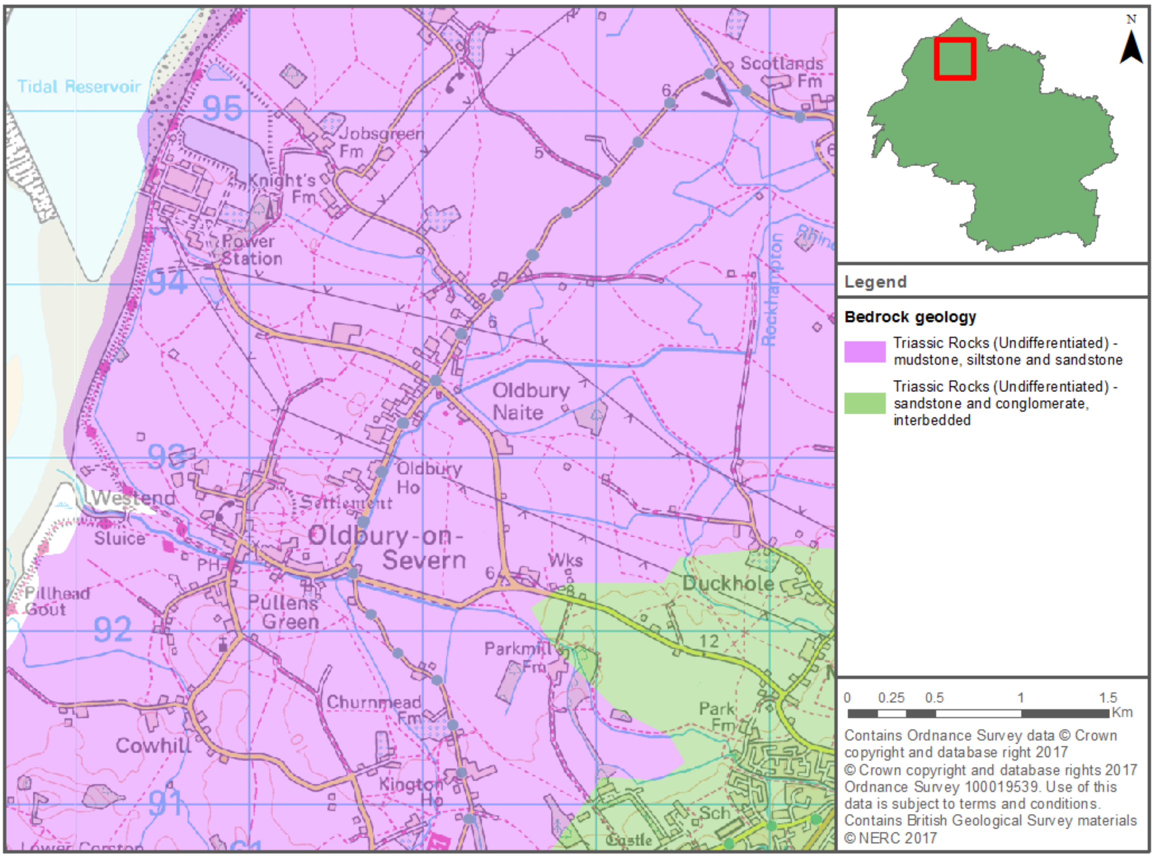
The geology of the catchment can be an important influencing factor on the way that water runs off the ground surface. This is primarily due to variations in the permeability of the surface material and bedrock stratigraphy.

The bedrock geology underlying Oldbury on Severn is mudstone, siltstone and sandstone bedrock associated with Triassic rocks (Figure 4-3). This, combined with the overlying loamy and clayey soils in the areas of higher elevation, means permeability is slow in these areas and will produce high levels of runoff. The lower-lying areas to the west and east of Oldbury on Severn and along the course of the Rhines are underlain by loamy and clayey floodplain or coastal flats with naturally high groundwater which limits infiltration.

The underlying geology and aquifer designation has implications for what sustainable drainage solutions may be suitable for a site. For example, infiltration SuDS will be dependent on the permeability of the underlying deposits. Further information on geology can be found via the British Geological Society's Geology of Britain website.

The British Geological Society have also produced an Infiltration SuDS map which gives a preliminary indication of the suitability of the ground for infiltration SuDS.

Figure 4-3: Bedrock geology



4.4 Fluvial and tidal risk

The principle watercourse flowing through Oldbury on Severn is the Oldbury Naite Rhine which is fed by the rhine network, managed by the Lower Severn Internal Drainage Board (IDB), to the north east of the village, and Pickedmoor Brook which flows through Thornbury before joining the Oldbury Naite Rhine just downstream of Kington Road. The Westend Rhine rises to the north of the village near the end of Ham Lane. It flows around the western boundary of the village before joining the Oldbury Naite Rhine just upstream of Church Road. The Rhine network is shown in Figure 4-4.

The Oldbury Naite Rhine discharges into the tidal River Severn through a penstock at Oldbury Pill. The tide flaps are designed to close once the rising tide exceeds the level within the Rhine, and reopen as soon as the tide level drops below the level in the Rhine. This means that during high tide conditions, the flaps of the penstock are closed and water from the Rhine is unable to discharge into the Severn, causing backing up of water and flooding upstream in the village.

Oldbury on Severn is protected by a flood wall running along the bank of the Oldbury Naite Rhine. Since this defence scheme was built, there has been no flooding from overtopping of the Oldbury Naite Rhine Banks[6]. Flooding is a result of backing up when the penstock and flap valves are closed.

The Lower Severn IDB seeks to maintain a general standard capable of providing flood protection to agricultural land and developed areas of 5% AEP and 1% AEP respectively[7].

Tidal flooding is caused by extreme tide levels exceeding ground and/or defence levels. Flood Zones 1, 2 and 3 delineate areas at low risk, medium risk and high risk respectively from both tidal and fluvial flooding. Flood Zones do not consider the effects of flood defences, and as such provides a worst-case assessment of flood risk. Flood Zone 3 and 2 represent the area that

[6] South Gloucestershire Council: Drainage team

[7] http://www.lowersevernidb.org.uk/downloads/Signed%20LSIDB%20Policy%20Statement.pdf

would be flooded in the 0.5% AEP and 0.1% AEP tidal event in the absence of defences, respectively.

Environment Agency Flood Zones show Oldbury on Severn to be at risk of flooding in a 1% AEP (Flood Zone 3) and higher. The main areas that are the exception to this is a dry island at The Toot and Westend Lane, and land along Church Road south of the junction with Westmarsh Lane. The Flood Zones are shown in Figure 4-5.

Oldbury on Severn is protected from tidal flooding by a series of earth embankments (Figure 4-6). The embankments provide a standard of protection up to a 0.5% AEP tidal event. The probability of a failure of the sea defences occurring is reduced by the actions of the defence owners in maintaining the defences, but there remains a residual risk from tidal flooding if the defences do fail or are overtopped.

To assess the potential for development in Oldbury on Severn, the risk of tidal and fluvial flooding needs to be considered in greater detail, including the actual flood risk when taking the defences into account and the residual risk in the event of defence failure. The results of this analysis are provided in Sections 5, 6 and 7 and in the individual site summary tables for each potential location for development (Appendix A).

Figure 4-4: Rhines and other watercourses

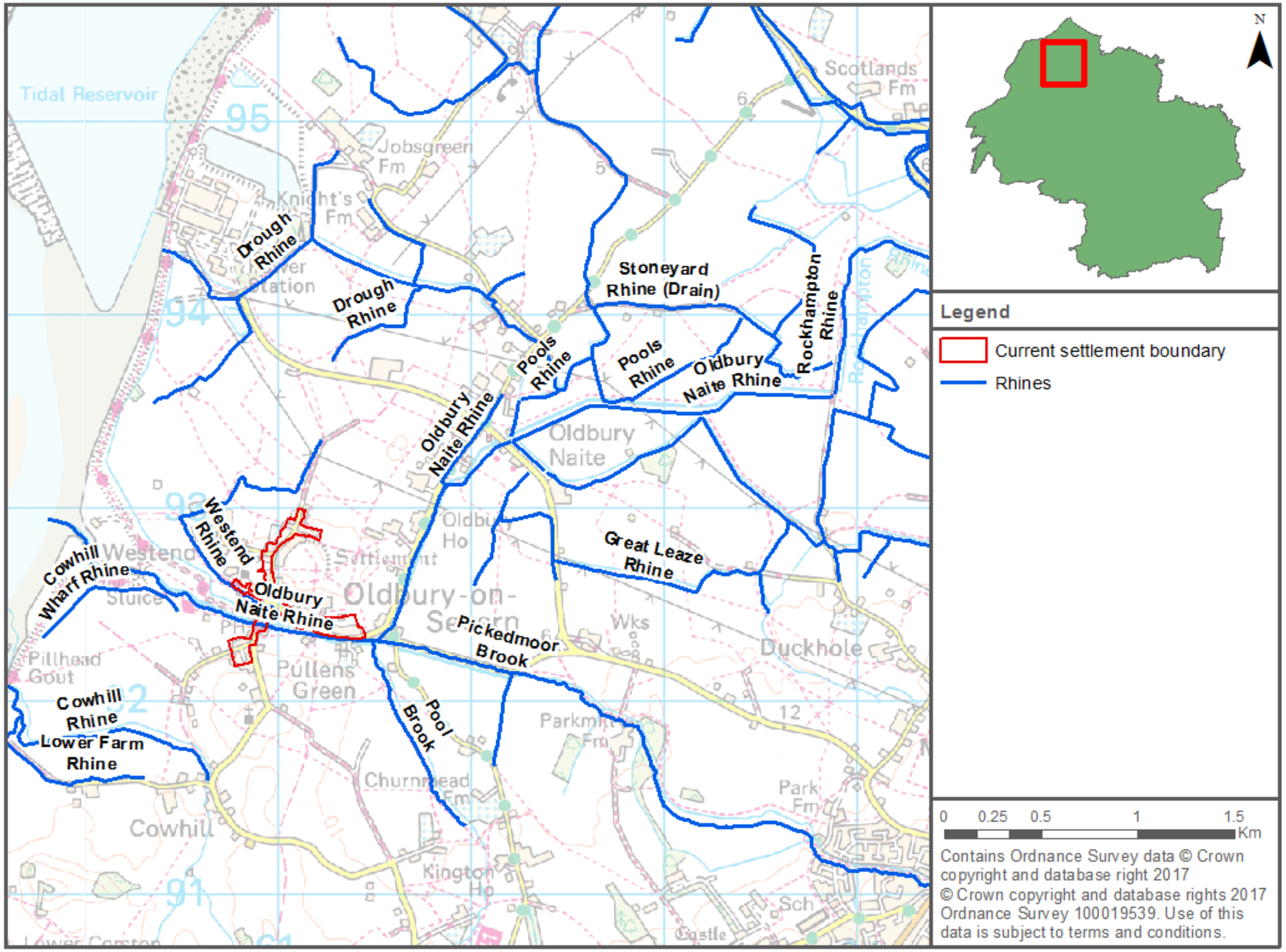


Figure 4-5: Flood Zones

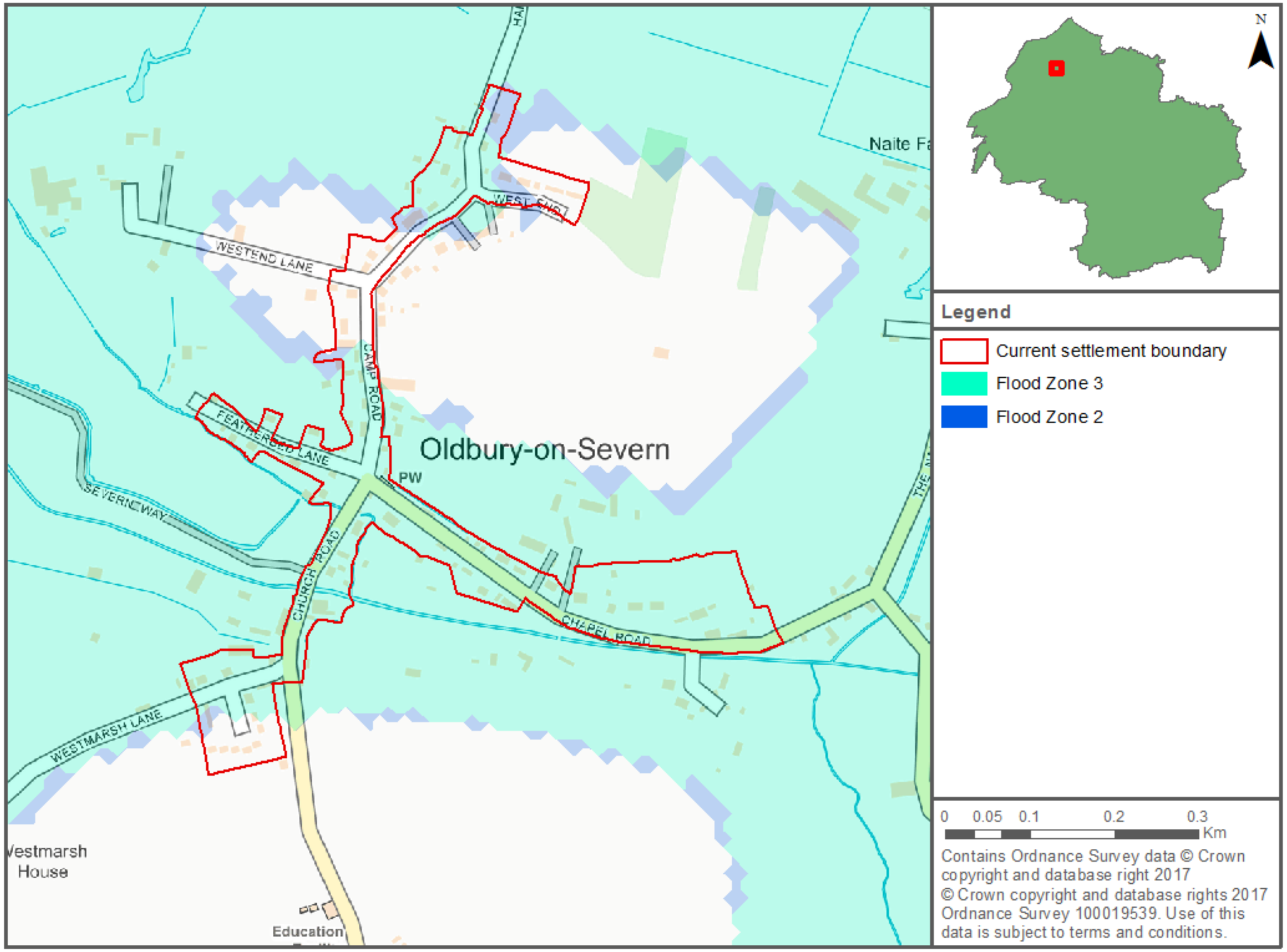
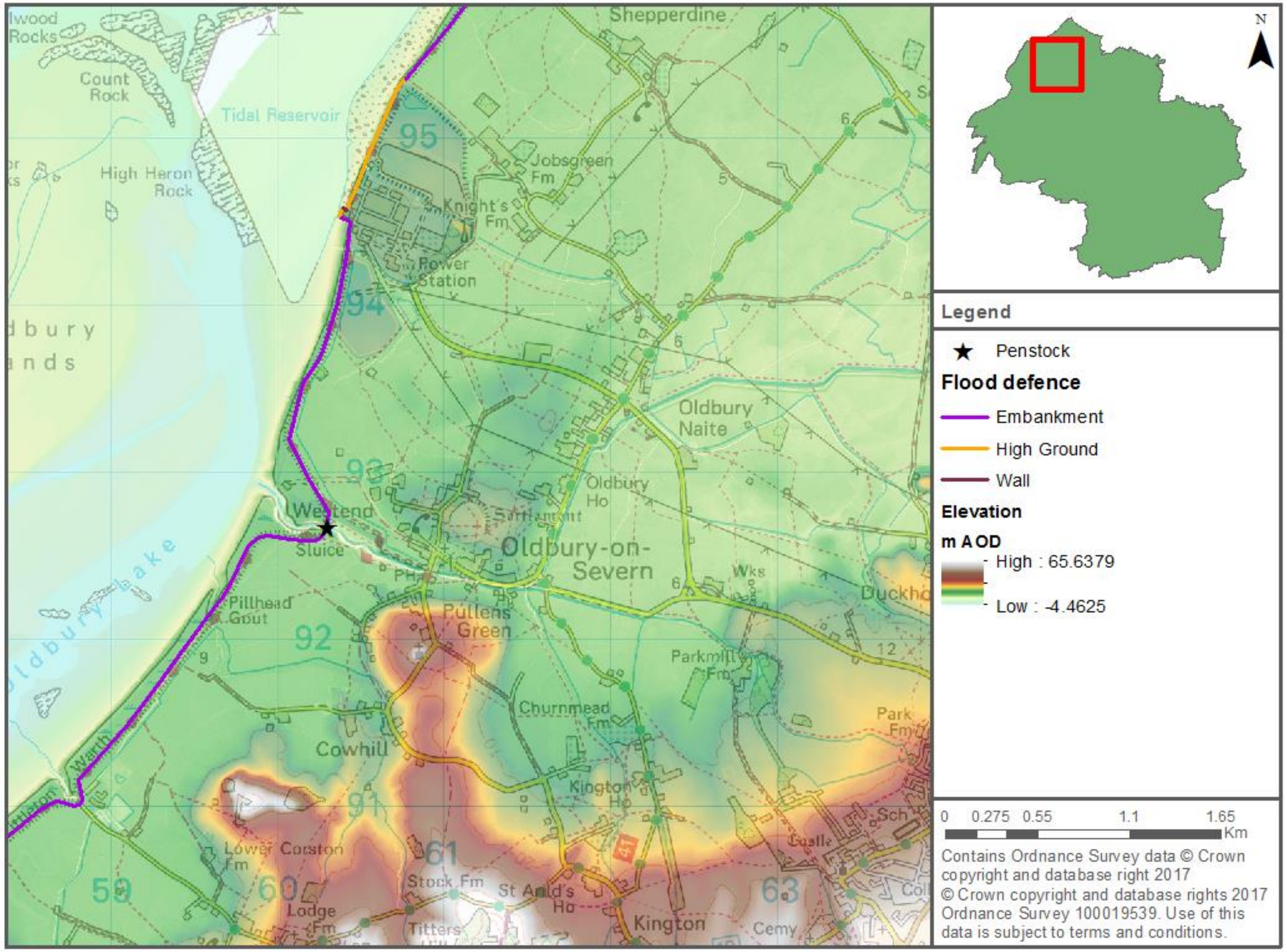


Figure 4-6: Coastal flood defences



4.5 Surface Water flood risk

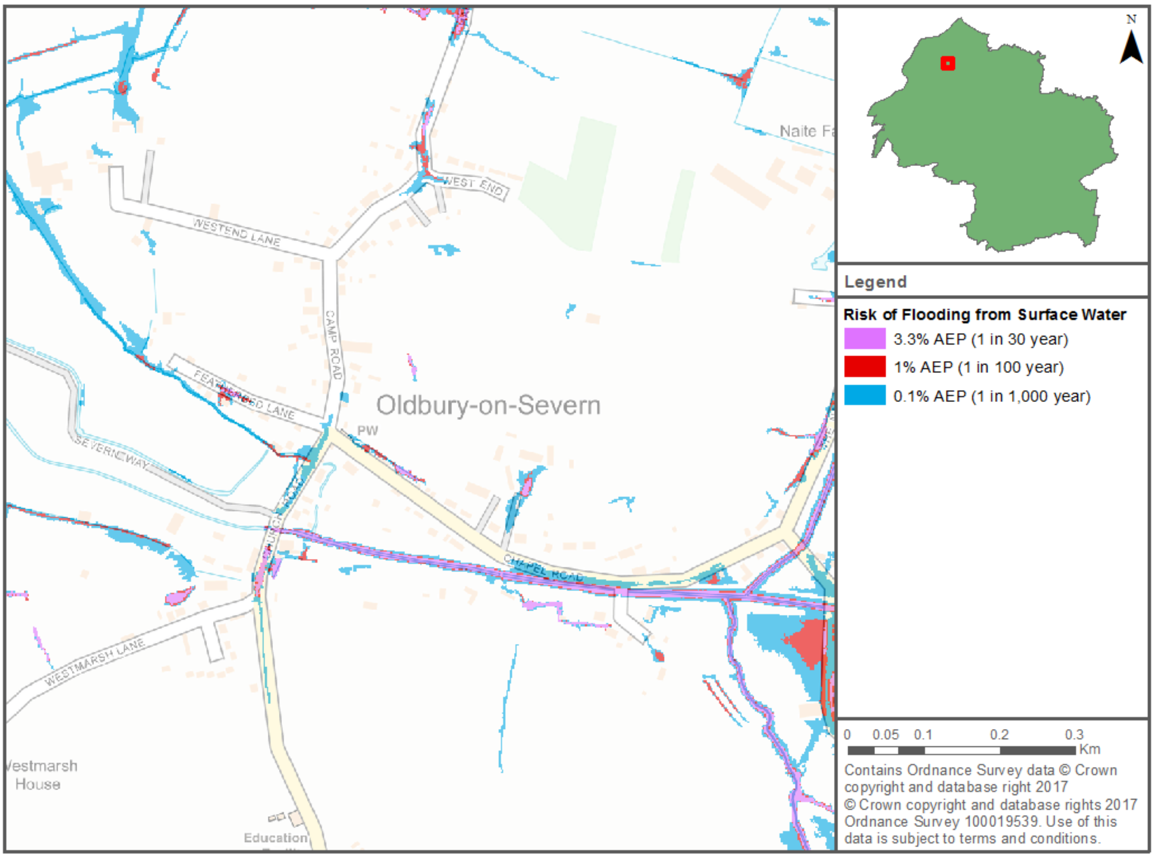
The Risk of Flooding from Surface Water maps (Figure 4-7) show surface water risk predominantly affects the roads in the immediate vicinity of the village, with potential risk of ponding on Chapel Road and The Naite. Elsewhere in the village, the surface water risk tends to correspond to the location of field drains and smaller watercourses.

Further out from the village, surface water mapping shows the low-lying rural land of the rhine system as well as Pickedmoor Lane near the junction with Foss Lane is at risk from surface water flooding.

Roads in and around the village are not shown to be at risk until a 0.1% AEP surface water event.

However, historical flooding information, suggests the risk is greater than that shown on the Risk of Flooding from Surface Water maps, with surface water flowing off surrounding land as well as using roads as flow paths, resulting in flooding of property.

Figure 4-7: Surface Water flood risk



4.6 Groundwater flood risk

In comparison to fluvial flooding, current understanding of the risks posed by groundwater flooding is limited and mapping of flood risk from groundwater sources is in its infancy. Under the Flood and Water Management Act (2010), LLFAs have powers to undertake risk management functions in relation to groundwater flood risk. Groundwater level monitoring records are available for areas on Major Aquifers. However, for lower lying valley areas, which can be susceptible to groundwater flooding caused by a high water table in mudstones, clays and superficial alluvial deposits, very few records are available. The AStGWf mapping shows no susceptibility to groundwater flooding in Oldbury on Severn.

4.7 Flood warning service

Flood warnings supplied by the Environment Agency's Floodline Warnings Direct service can be provided to homes and businesses within Flood Zones 2 and 3. Developers should encourage those owning or occupying developments, where flood warnings can be provided, to sign up to receive them. This applies even if the development is defended to a high standard.

The village is covered by the following Flood Alerts and Flood Warning Areas:

- Flood Alert
  - Severn Estuary at Oldbury-on-Severn, Northwick and Avonmouth
- Flood Warning
  - Severn Estuary at Oldbury-on-Severn, Oldbury Naite and Littleton Warth areas
  - Severn Estuary at Oldbury-on-Severn, Chapel Road and Olveston Common areas
  - Severn Estuary at Oldbury-on-Severn, Westend, Cowhill and Olveston areas

The extent of the flood warning coverage is displayed in Figure 4-8 and Figure 4-9.

Figure 4-8: Flood Alert coverage

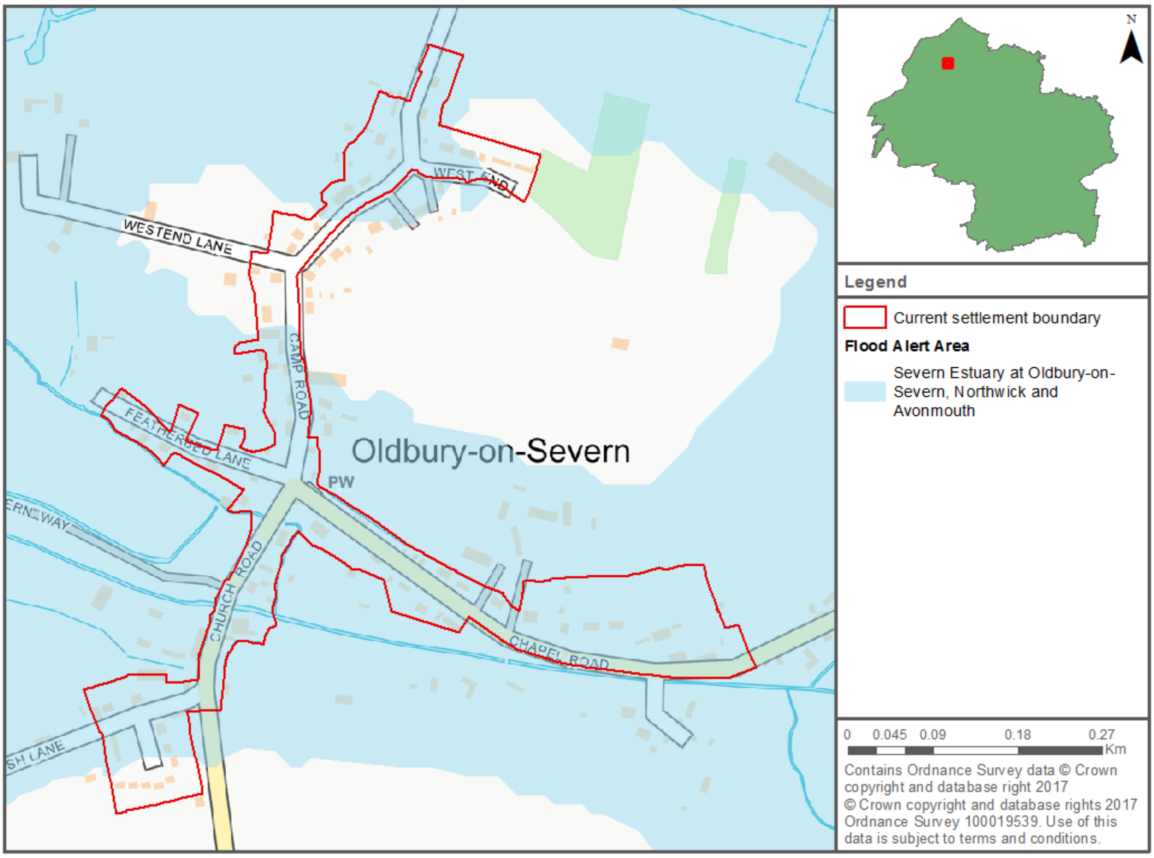
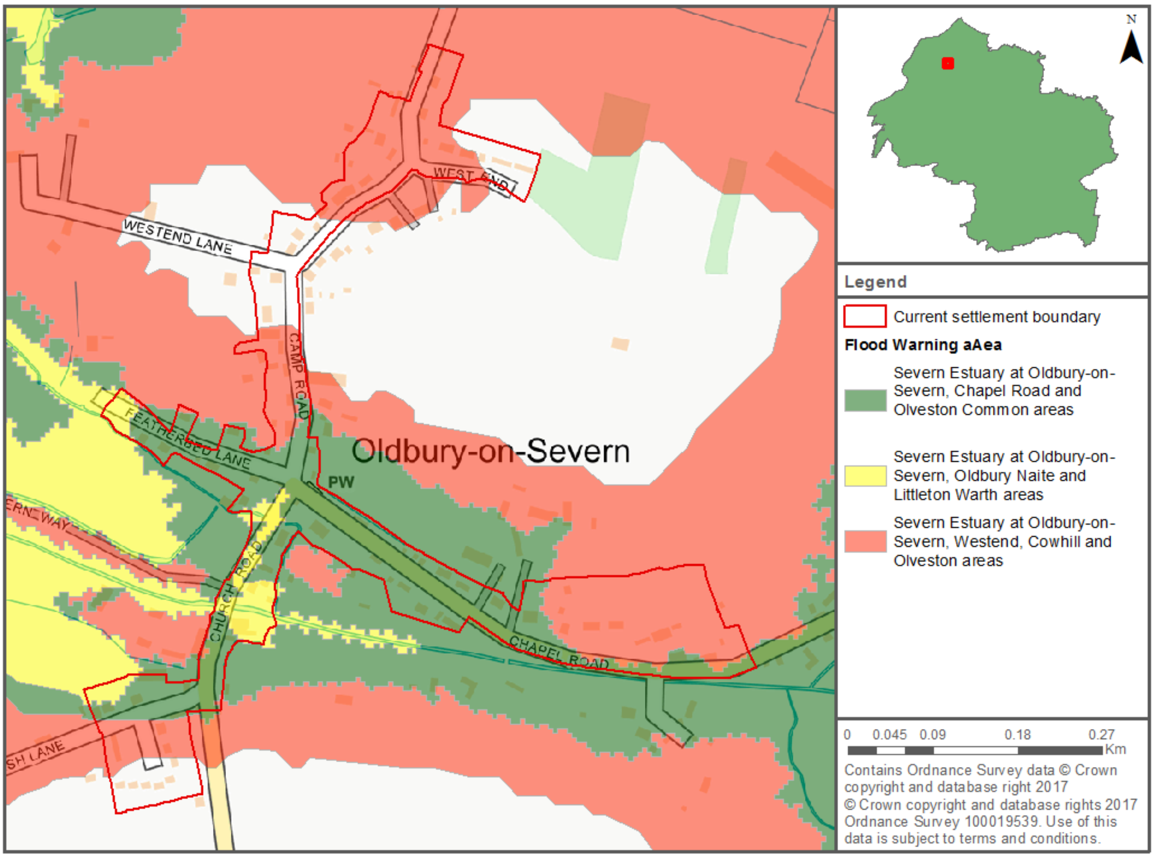


Figure 4-9: Flood Warning coverage



5 Fluvial flood risks in Oldbury on Severn

5.1 Current day

The model was run for the undefended 5%, 1% and 0.1% AEP fluvial event. Tide level was set at the present day Mean High Water Spring (MHWS). The results are mapped in Appendix B – Map B-1.

Modelling note: No information was available from the IDB for the fluvial flood defences in Oldbury on Severn. Due to the 2D nature of the modelling and lack of survey information available of any structures, structures and defences were not represented in the model. Therefore, only an undefended fluvial scenario was simulated.

The modelling results show flood extents to be similar for all three undefended modelled scenarios. Water is shown to get out of bank from a 5% AEP event, affected properties along Church Road and Chapel Road. The 1% and 0.1% AEP events have similar flood extent as the 5% AEP event, with some notable exceptions. The Westend Rhine is shown to get out of bank upstream of Featherbed Lane and farmland to the west of The Naite (road) is also shown to be affected.

Flood depths do not vary significantly between event magnitudes, with just several centimetres' difference in depths between the 5% and 0.1% AEP (Appendix B – Map B-3 to Map B-5). The relatively small difference in flood depths means flood hazard is very similar for all three modelled scenarios (Appendix B – Map B-6 to Map B-8).

5.2 Future

The model was also run for the for the 1% AEP undefended fluvial event with allowances for climate change. The allowances run was for the 2080s epoch and the Central (+25%), Higher Central (+35%) and Upper End (+70%) allowances. The results are mapped in Appendix B – Map B-2.

When compared to the present-day undefended risk from a 1% AEP event, future flood risk tends to cover a similar flood extent with several noticeable exceptions.

Under all three climate change scenarios, farmland to the west of The Naite (road) is shown to be at risk. Water gets out of bank at more locations along Chapel Road with the Higher Central and Upper End climate change allowances, with the entrance route to Rook Farm and neighbouring properties shown to be at risk. A longer length of Chapel Road is at risk of flooding in the future.

Flood risk along Church Road is broadly the same as the present-day scenario with depths increasing by several centimetres with each scenario (Appendix B – Maps B-9 to B-11). However, the increase in flood depths mean a longer length of the road falls within the hazard category 'Danger for Some' compared to the present day 1% AEP scenario (Appendix B – Maps B-12 to B-14).

5.3 Implication for development

Fluvial flood risk mostly affects the existing developed areas of the village, both now and in the future. Of the currently undeveloped areas, land to the south of the Rhine and east of Church Road as well as farmland to the west of The Naite sees an increase in fluvial flood risk in the future. Developers should apply the sequential approach to development and seek to place development outside of the fluvial flood risk zones.

Under a defended scenario, it is unlikely the defences would be overtopped in a 5% AEP scenario or lower[8]. The presence of the defences may also reduce flood extents in the 1% and 0.1% AEP. To fully understand the implications of the defences on flood risk, developers should undertake survey of the defence and include it within a hydraulic model. Failure of the defence should also be considered to understand potential residual risk to development.

Although much of the undeveloped land in the village is not at risk from fluvial flooding, the main access and egress routes for the village (Church Road and Chapel Road) are shown to flood in all scenarios, both now and in the future, with potential to cut off the village in times of flood. Flood depths on these roads range from a few millimetres to half a metre in all scenarios. Developers

[8] South Gloucestershire Council: Drainage department

will need to consider the requirements for safe access and egress when planning any future development in the village.

Table 5-1 summarises which of the potential development sites have some risk from fluvial flooding. It should be noted that, except for Site 6, only a small area of the sites is at risk from undefended fluvial flooding. Table 8-2 provides full details on the proportion of the site affected by each scenario.

Table 5-1: Potential development sites at risk from fluvial flooding

Fluvial scenario	**Potential development site**										
	1	**2**	**4**	**5**	**6**	**7**	**8**	**9**	**12**	**13**	**14**
5% AEP	No	No	No	Yes	Yes	No	No	No	No	No	No
1% AEP	No	No	No	Yes	Yes	No	No	No	No	No	No
0.1% AEP	No	No	No	Yes	Yes	No	No	No	No	No	No
1% AEP plus 2080s Central climate change allowance	No	No	Yes	Yes	Yes	No	No	No	No	No	No
1% AEP plus 2080s Higher Central climate change allowance	No	No	Yes	Yes	Yes	No	No	No	No	No	No
1% AEP plus 2080s Upper End climate change allowance	No	No	Yes	Yes	Yes	No	No	No	No	No	No

(green)	No	(red)	Yes

6 Tidal flood risks in Oldbury on Severn

6.1 Current day

The model was run for the 5%, 0.5% and 0.1% AEP tidal events. Flow in the watercourse was set at the 5% AEP event. The modelling was undertaken for both the defended and undefended scenarios, i.e. the undefended with the earth embankments along the coast removed. The defended and undefended scenarios are presented in Appendix C – Map C-1 and C-2.

5% AEP event

Map C-1 compares the present day defended and undefended 5% AEP event flood extents and shows how the earth embankments provide considerable protection to Oldbury on Severn at higher probability, lower magnitude events. In the defended scenario, only the land south of the Oldbury Naite Rhine as it flows past Severn Way is flooded. In the undefended scenario, much of the village is a risk.

0.5% AEP event

Map C-2 compares the present day defended and undefended 0.5% AEP event flood extents and shows how the earth embankments provide considerable protection to Oldbury on Severn. In the defended scenario, most of the village is protected with only the land south of Severn Way and north of Westmarsh Lane at risk. In the undefended scenario, much of the village is at risk except for the higher land at The Toot, Westend Lane and Church Road (south of junction with Westmarsh Lane).

Depths in the defended 0.5% AEP event reach 1–1.5 metres in the at-risk areas in the village. However, in the undefended scenario, these same areas reach depths of 3–3.5 metres.

The design standard of the earth embankments is for a 0.5% AEP event. The modelling shows the embankments are overtopped in the 0.5% AEP defended event. Although properties in the village are not at risk in the defended scenario, the overtopping suggests that the actual protection provided by the defences is less than a 0.5% AEP standard of protection.

0.1% AEP event

Map C-3 compares the present day defended and undefended 0.1% AEP event flood extents. In the defended scenario, a larger extent of the village is at risk compared to the 0.5% AEP defended event, particularly around the Featherbed Lane, Church Road and Chapel Road area. The design standard of the earth embankments is for a 0.5% AEP event, therefore overtopping in a 0.1% AEP event is to be expected. However, the defences still provide a degree of protection as, when compared to the undefended scenario flood extent, the area of the village at risk is much smaller. In the undefended scenario, properties along Camp Road and West End are at risk from flooding, in addition to those areas that flood in the defended scenario.

6.2 Future

Defended scenario

The embankments are shown to overtop in the present-day 0.5% AEP event but no property is at risk. When the climate change allowance is applied (Appendix C Map C-4). a longer length of the embankment is overtopped resulting in extensive flooding in the village, affecting many properties. This indicates that work may be required to the defences in the future to sustain the current level of protection to the village.

Large areas of the village are already at risk in the present-day 0.1% AEP defended event (Appendix C Map C-5). When the allowance for climate change is applied, it shows most of the village becomes at risk in the future.

Undefended scenario

The increase in flood risk because of climate change is very similar for both the 0.5% and 0.1% AEP undefended scenarios (Appendix C Map C-6 and Map C-7). Without the presence of defences, climate change results in the whole of West End Lane becoming at risk of flooding. Flood risk also encroaches further into the area around The Toot. To the south of the village the increase in flood extent due to climate change is marginal due to the higher topography acting as a natural barrier to any inundation further south.

Whilst climate change may not have a significant impact on flood extents in the undefended scenario, flood depths in the at-risk areas increase significantly with flood depths in the village (apart from West End Lane) ranging from 3.5 to 4 metres and in some places reaching over 4 metres in depth. Flood depths in West End Lane range from 0.1 to 1.5 metres.

6.3 Implications for development

The defences provide considerable protection to the village, protecting against property flooding from a 5% AEP and 0.5% AEP event. The presence of the defences also affords some protection to parts of the village in the event of a 0.1% AEP. Despite this protection, developers will need to consider the residual risk of flooding, should the defences fail.

Modelling suggests the standard of protection provided by the earth embankments is less than the design standard of 0.5% AEP. Although no property is presently at risk from a 0.5% AEP, if no measures are taken to maintain the current standard of protection, many more properties within the village will be at risk from a 0.5% AEP event in the future. The long-term maintenance and standard of protection of the defences should be considered, including the potential requirement for improvements to maintain the current standard of protection into the future.

Table 6-1 summarises which of the potential development sites have some risk from tidal flooding. Of the sites, only site 8 is unaffected in all modelled scenarios. Site 2 is unaffected in all but the undefended climate change scenarios. It should be noted that under some scenarios, the proportion of the site at risk may be quite small. Table 8-2 provides full details on the proportion of the site affected by each scenario.

Table 6-1: Potential development sites at risk from tidal flooding

Tidal scenario	**Potential development site**										
	1	**2**	**4**	**5**	**6**	**7**	**8**	**9**	**12**	**13**	**14**
5% defended – present day	No	No	No	No	No	No	No	No	No	No	No
0.5% defended – present day	No	No	No	No	No	No	No	No	No	No	No
0.1% defended – present day	No	No	Yes	Yes	Yes	No	No	No	Yes	No	Yes
0.5% defended – climate change to 2117	Yes	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
0.1% defended – climate change to 2117	Yes	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
5% undefended – present day	Yes	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
0.5% undefended – present day	Yes	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
0.1% undefended – present day	Yes	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
0.5% undefended – climate change to 2117	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
0.1% undefended – climate change to 2117	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes

(green)	No	(red)	Yes

7 Residual risk

7.1 Introduction

Residual risks are those remaining after applying the sequential approach and taking mitigating actions. It is the responsibility of the developer to fully assess flood risk, propose measures to mitigate it and demonstrate that any residual risks can be safely managed.

This SFRA does not assess the probability of failure other than noting that such events are very rare. However, in accordance with NPPF, all sources of flooding need to be considered. If a breach or overtopping event were to occur, then the consequences to people and property could be high. Developers should be aware that any site that is at or below defence level may be subject to flooding if an event occurs that exceeds the design capacity of the defences, or the defences fail and this should be considered when building resilience into low level properties.

The residual risk can be

- the effects of a flood with a magnitude greater than that for which the defences or management measures have been designed to alleviate (the 'design flood' – 0.5% annual exceedance probability). This can result in overtopping of flood banks, failure of flood gates to cope with the level of flow or failure of pumping systems to cope with the incoming discharges; or
- failure of the defences or flood risk management measures to perform their intended duty. This could be breach failure of flood embankments, failure of flood gates to operate in the intended manner or failure of pumping stations.

7.2 Residual risk assessment

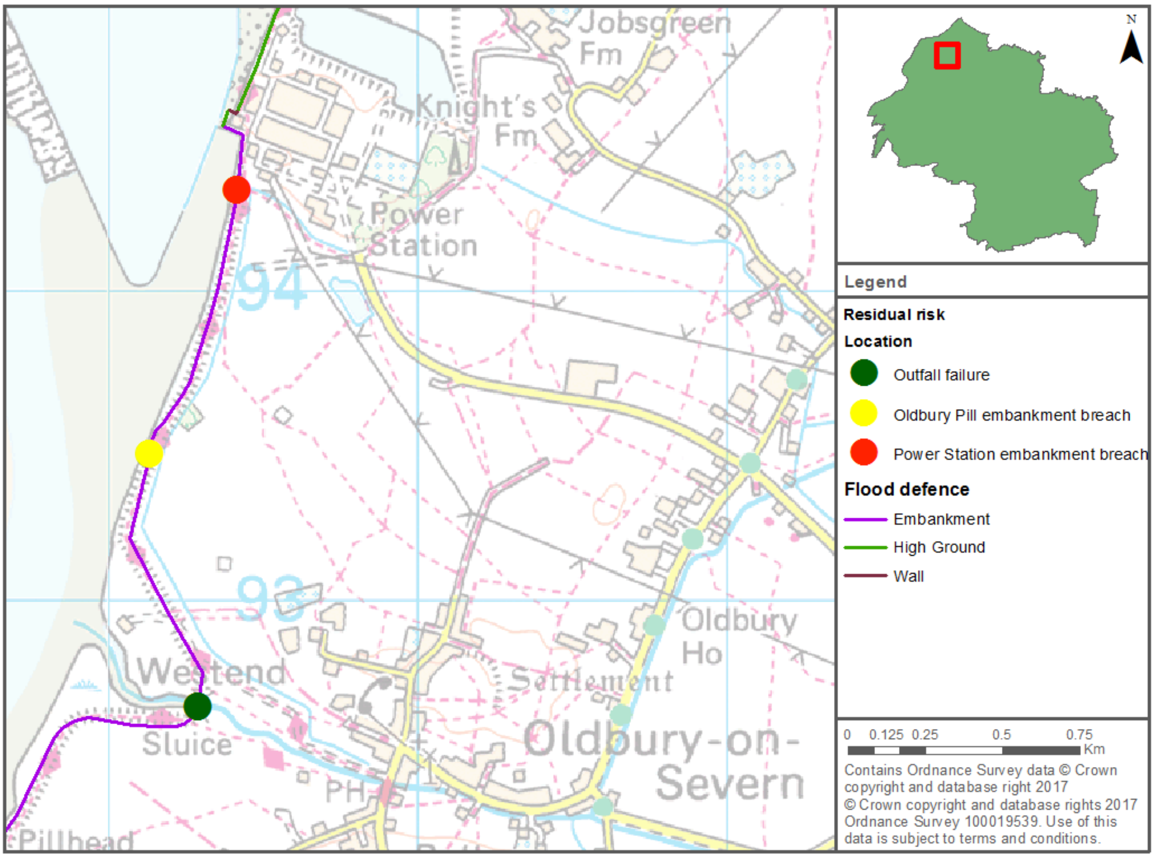
The assessment of residual risk demands that attention be given to the vulnerability of the receptors and the response to managing the resultant flood emergency.

The Environment Agency undertook breach modelling as part of the Wessex Tidal Procedures Asset Failure Analysis study in 2013. This analysis used the Somerset North Coast flood models. The outputs from this study have been used to assess the residual risk to Oldbury on Severn because of breach or defence failure. The analysis relevant to Oldbury on Severn include

- failure of the outfall (penstock);
- breach of Oldbury Pill embankment; and
- breach of Oldbury Power Station embankment.

The locations of the asset failures are provided in Figure 7-1. Animations of the scenarios have also been provided to show the time to inundation.

Figure 7-1: Asset failure locations



7.2.1 Outfall failure

This scenario simulated failure of the outfall (penstock) at Oldbury Pill over one tidal cycle.

Under this scenario, water flows up the Oldbury Naite Rhine, getting out of bank at Church Road and flooding properties within one hour of the failure. Water also gets out of bank onto Chapel Road. Within 1.5 hours, large sections of Church Road and Chapel Road are flooded, cutting off access to and from the village. Two hours after the failure, properties at Featherbed Lane also start to flood. Although properties at Camp Road, Westend Lane and West End are unaffected by flooding, the inundation of water to other areas of the village following the breach leave these areas cut off.

Unlike other scenarios, Chapel Road is completely inundated along its whole length, with depths reaching 1.5 metres in places at the height of the event. The flood hazard is classed as 'Danger for Most' along much of the length. Similarly, Church Road to its junction with Westmarsh Lane is also classed as 'Danger for Most' with depths reaching over 1.5 metres.

7.2.2 Breach of Oldbury Pill embankment

This scenario simulated a breach to a 50m width of the defence to the level of the land in front over a period of 72 hours.

Under this scenario, flood waters flow in two directions – north east and south east avoiding the higher elevated areas. Within one hour of the breach, the flood water flowing to the south east has reached Church Road bridge and is flooding properties at Church Road and Featherbed Lane. At the same time, the water flowing to the north east has reached Ham Lane. Half an hour later, properties at Chapel Road are flooded and the road is impassable. 70 hours later there is still water on low lying ground in the Rhine system and to the west of the village. Flood water still affects the roads; however, the depth of flooding on the roads is less.

At the height of the event, the flood hazard is classed as 'Danger for Most' in the Featherbed Lane and Church Road area.

The village becomes cut off within 1.5 hours on the breach, with depths on Featherbed Lane and Church Road reaching 1.5 metres in places. Depths on Chapel Road reach 0.5 metres.

7.2.3 Breach of Oldbury Power Station embankment

This scenario simulated a breach to a 50m width of the defence to the level of the land in front over a period of 72 hours.

Within two hours of the breach, inundation flows southwards around the higher ground in the centre of the village to inundate properties at Featherbed Lane. Flood waters also reach Ham Lane within two hours of the breach. Church Road floods half an hour later (within 2.5 hours of the breach) and Chapel Road floods another half hour later. 67 hours later there is still water on low lying land in the Rhine system and to the west and north of the village. Flood water still affects the roads, although the depth of flooding is less.

Depths in village range from 0.1 to 0.5m. Hazard ranges from 'Danger to Some' to 'Danger to Most'. The higher elevated areas of the village at Westend Lane, West End and Camp Road are unaffected by flooding in this scenario; however, these areas are at risk of being cut off.

Depths on the main routes out of the village range from 0.1 to 0.5 metres. All routes are cut off within three hours of the breach.

7.3 Implications for development

Although Oldbury on Severn is defended, there is a residual risk to the village should a section of defence fail or breach. The structural safety of dwellings or structures that could be adversely affected by significant flood flows or depths is an important consideration for development. Single storey buildings such as ground floor flats or bungalows are especially vulnerable to rapid rise of water, such as that experienced during a breach. <u>Developers should look to reduce this risk by use of multiple storey construction and raised areas that provide an escape route.</u>

In the event of defence failure, access and egress routes become inundated rapidly. The duration that these routes are flooded will depend on tide cycles and length of time taken to repair a breach. <u>Safe access routes should be located above design flood levels and avoid flow paths. Where this is unavoidable, limited depths of flooding may be acceptable providing the proposed access is designed with appropriate signage etc. to make it safe.</u>

Table 7-1 summarises which potential development sites are at risk under the three different residual risk scenarios. The residual risk to Sites 4 and 6 is high with large proportions of the sites at risk in the event of failure at the outfall or breach of the Oldbury Pill embankment. The risk to Sites 5, 12 and 14 is relatively low with the risk limited to the northern, southern and eastern boundaries respectively. Table 8-2 provides full details on the proportion of the site affected by each scenario.

Table 7-1: Potential development sites at risk in residual risk scenarios

Breach scenario	Potential development site										
	1	2	4	5	6	7	8	9	12	13	14
Outfall	No	No	Yes	Yes	Yes	No	No	No	Yes	No	No
Oldbury Pill embankment	No	No	Yes	Yes	Yes	No	No	No	Yes	No	Yes
Power station embankment	No	No	No	No	Yes	No	No	No	Yes	No	Yes

(green)	No	(red)	Yes

8 Site assessment

8.1 Introduction

South Gloucestershire Council and Oldbury on Severn Parish Council provided boundaries of potential sites for development around the existing settlement boundary for the detailed Level 2 assessment. Stage One of the assessment involved screening the sites against flood risk information to remove the sites that were at greatest risk of flooding. The remaining sites were then taken forward to Stage Two of the detailed Level 2 SFRA assessment.

8.2 Stage One: site screening

Table 8-1 documents the results of the site screening. The sites were screened against the following flood risk information:

- Flood Zones 2 and 3 as shown in the Environment Agency's Flood Map for Planning
- Fluvial Flood Zone 3b, 3a and 2 (defended scenario)
- Tidal Flood Zones 2 and 3 (defended scenario)
- Environment Agency's historic flood map
- Environment Agency's Areas Benefitting from Defences

Table 8-1: Site screening results

Site	Site Area	Flood Map for Planning		Fluvial (defended scenario)			Tidal (defended scenario)		Historic Flood Map	Area benefiting from defences?
		FZ3	FZ2	FZ3b	FZ3a	FZ2	FZ3	FZ2		
1	2.39	47%	66%	0%	0%	0%	0%	<1%	0%	100%
2	0.51	0%	0%	0%	0%	0%	0%	0%	0%	100%
3	7.02	7%	25%	<1%	<1%	<1%	0%	1%	<1%	99%
4	3.95	84%	124%	0%	<1%	1%	0%	48%	6%	58%
5	2.86	95%	99%	3%	3%	6%	0%	19%	24%	72%
6	4.8	100%	100%	26%	27%	30%	12%	91%	39%	19%
7	2.01	32%	36%	0%	0%	0%	0%	<1%	0%	38%
8	0.48	0%	0%	0%	0%	0%	0%	0%	0%	0%
9	3.52	10%	15%	0%	0%	0%	0%	0%	0%	17%
10	7.26	100%	100%	8%	8%	8%	26%	76%	77%	20%
11	4.6	100%	100%	5%	6%	6%	1%	75%	41%	14%
12	1.83	70%	88%	<1%	<1%	<1%	0%	13%	<1%	91%
13	4.69	49%	61%	0%	0%	0%	0%	<1%	0%	100%
14	2.23	90%	96%	0%	0%	0%	0%	6%	2%	98%

Following the screening, sites 3, 10 and 11 were excluded from the detailed assessment:

- Site 3 is a Scheduled Ancient Monument and was removed by the council
- Sites 10 and 11 are completely within the Flood Map for Planning (the undefended scenario)
- Sites 10 and 11 have high residual risk from tidal flooding with large proportions of the sites at risk in the defended scenarios
- The proportion of the site that benefits from defences is less than a fifth for all three sites

8.3 Stage Two: detailed site assessments

Detailed site summary tables were produced for the remaining sites. These summary tables and associated interactive maps are provided in Appendix A.

The detailed site summary tables set out the following information:

- Site area, location description, drainage features
- Fluvial flood risk (undefended)
  - 5% AEP, 1% AEP, 0.1% AEP
    - Proportion of site at risk
    - Range of depths
    - Range of hazard
- Tidal flood risk
  - Defended
    - 5% AEP, 0.5% AEP, 0.1% AEP
    - Proportion of site at risk
    - Range of depths
    - Range of hazard
  - Undefended
    - 5% AEP, 0.5% AEP, 0.1% AEP
    - Proportion of site at risk
    - Range of depths
    - Range of hazard
- Surface water flood risk
- Climate change
  - Fluvial
    - Increase in 1% AEP with 2080s climate change allowances
  - Tidal
    - Increase in defended 0.5% and 0.1% AEP with climate change to 2117
- Flood history
- Defence
  - Type, standard of protection, condition)
  - Residual risk
    - Proportion of site at risk
    - Range of depths
    - Range of hazard
- Emergency planning
  - Flood warning coverage
  - Access and egress issues
- Planning and development implications
- Guidance for developers

8.4 Summary of site flood risk information

Table 8-2 summarises the flood risk to the site from each of the modelled scenarios as well as other flood risk information. Note: hazard mapping is not available for the undefended tidal flood risk.

The sites have subsequently been ranked by considering present day fluvial and tidal flood risk, the increase in risk due to climate change and, finally, the remaining residual risk. The ranking is in descending order with a rank of 1 indicating the site with the lowest flood risk and a rank of 11 indicating the site with the highest flood risk. Figure 8-1 shows the ranking for each site. From the mapping, it is easily seen that the highest-ranking sites are in areas of higher elevation, away from the watercourses, and are mostly at risk from flooding in the future (if defences are not improved with time to maintain the current standard of protection) or from failure of the defences. Conversely, the lowest ranking sites are those adjacent to the Oldbury Naite Rhine and in the areas of lower elevation. These sites tend to be at risk from present day fluvial flooding and tidal flooding, which is exacerbated by climate change in the future. These sites are also a greater risk in the event of defence failure.

Figure 8-1: Potential development site ranking

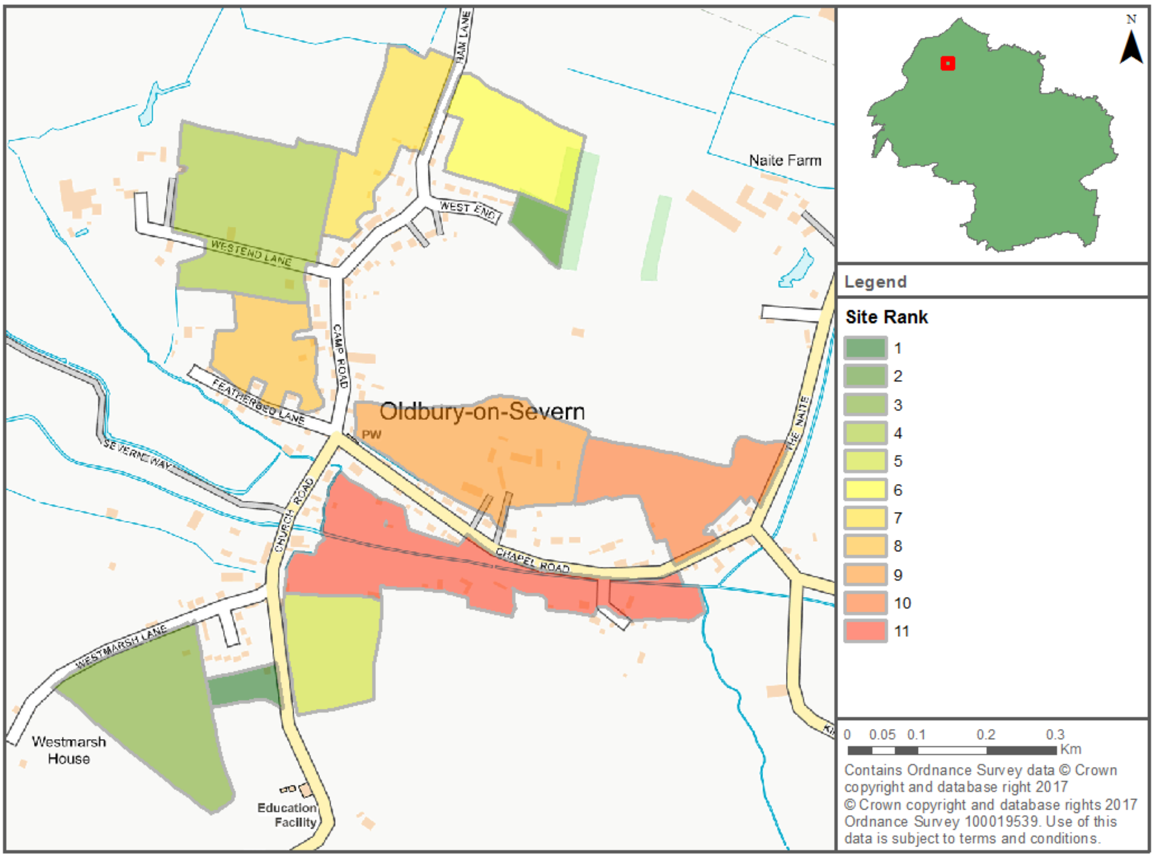


Table 8-2: Summary of site flood risk information

Scenario	Flood risk information	Potential development site										
		1	2	4	5	6	7	8	9	12	13	14
FLUVIAL - UNDEFENDED												
5% AEP	Proportion of site at risk (%)	No risk	No risk	No risk	3	26	No risk	No risk	No risk	No risk	No risk	No risk
	Range of depths (m)				0 – 0.5	0 – 1.0						
	Maximum hazard				Danger for Some	Danger for Some						
1% AEP	Proportion of site at risk (%)	No risk	No risk	No risk	3	27	No risk	No risk	No risk	No risk	No risk	No risk
	Range of depths (m)				0 – 0.5	0 – 1.0						
	Maximum hazard				Danger for Most	Danger for Some						
0.1% AEP	Proportion of site at risk (%)	No risk	No risk	1	6	30	No risk	No risk	No risk	No risk	No risk	No risk
	Range of depths (m)			0 – 0.1	0 – 1.0	0 – 1.0						
	Maximum hazard			Very Low	Danger for Most	Danger for Some						
1% AEP climate change (2080s Central allowance)	Proportion of site at risk (%)	No risk	No risk	1	9	30	No risk	No risk	No risk	No risk	No risk	No risk
	Range of depths (m)			0 – 0.1	0 – 0.5	0 – 1.0						
	Maximum hazard			Very Low	Danger for Most	Danger for Some						
1% AEP climate change (2080s Higher Central allowance)	Proportion of site at risk (%)	No risk	No risk	1	10	31	No risk	No risk	No risk	No risk	No risk	No risk
	Range of depths (m)			0 – 0.5	0 – 1.0	0 – 1.0						
	Maximum hazard			Very Low	Danger for Most	Danger for Some						
1% AEP climate change (2080s Upper End allowance)	Proportion of site at risk (%)	No risk	No risk	4	11	34	No risk	No risk	No risk	No risk	No risk	No risk
	Range of depths (m)			0 – 0.5	0 – 1.0	0 – 1.0						
	Maximum hazard			Danger for Some	Danger for Most	Danger for Some						
TIDAL - DEFENDED												
5% AEP	Proportion of site at risk (%)	No risk	No risk	No risk	No risk	No risk	No risk	No risk	No risk	No risk	No risk	No risk
	Range of depths (m)											
	Maximum hazard											
0.5% AEP	Proportion of site at risk (%)	No risk	No risk	No risk	No risk	No risk	No risk	No risk	No risk	No risk	No risk	No risk
	Range of depths (m)											
	Maximum hazard											
0.1% AEP	Proportion of site at risk (%)	No risk	No risk	48	19	91	No risk	No risk	No risk	13	No risk	6
	Range of depths (m)			0 – 1.5	0 – 1.5	0 – 1.5				0 – 0.5		0 – 0.5
	Maximum hazard			Danger for Most	Danger for Most	Danger for Most				Danger for Some		Danger for Some
0.5% AEP climate change (to 2117)	Proportion of site at risk (%)	47	No risk	87	81	100	36	No risk	15	83	53	90
	Range of depths (m)	0 – 1.5		0 – 4.0	0 – 2.0	0 – 3.5	0 – 2.5		0 – 0.1	0 – 2.5	0 – 2.5	0 – 2.5
	Maximum hazard	Danger for Most		Danger for All	Danger for Most	Danger for All	Danger for Most		Danger for Some	Danger for All	Danger for Most	Danger for Most

Scenario	Flood risk information	Potential development site										
		1	**2**	**4**	**5**	**6**	**7**	**8**	**9**	**12**	**13**	**14**
0.5% AEP climate change (to 2117)	Proportion of site at risk (%)	77	No risk	96	100	100	43	No risk	22	100	84	97
	Range of depths (m)	0 – 2.5		0 - >4.0	0 – 2.5	0 – >4.0	0 – 3.0		0 – 2.5	0 – 3.5	0 – 2.5	0 – 3.0
	Maximum hazard	Danger for All		Danger for All	Danger for All	Danger for All	Danger for All		Danger for All	Danger for All	Danger for All	Danger for All
TIDAL - UNDEFENDED												
5% AEP	Proportion of site at risk (%)	43	No risk	82	91	100	32	No risk	8	69	43	87
	Range of depths (m)	0 – 1.5		0 – 3.5	0 – 3.5	0 – 3.5	0 – 2.0		0 – 0.5	0 – 2.5	0 – 2.0	0 – 2.5
0.5% AEP	Proportion of site at risk (%)	66	No risk	88	97	100	38	No risk	15	84	60	93
	Range of depths (m)	0 – 2.5		0 – 4.0	0 – 4.0	0 – 4.0	0 – 2.5		0 – 1.0	0 – 2.5	0 – 2.5	0 – 3.0
0.1% AEP	Proportion of site at risk (%)	81	No risk	92	99	100	41	No risk	18	97	73	97
	Range of depths (m)	0 – 3.0		0 - >4.0	0 - > 4.0	0 - >4.0	0 – 3.0		0 – 1.5	0 – 3.0	0 – 2.5	0 – 3.0
0.5% AEP climate change (to 2117)	Proportion of site at risk (%)	100	43	100	100	100	47	No risk	23	100	99	100
	Range of depths (m)	0 – 3.0	0 – 0.5	0 - >4.0	0 - >4.0	0 - >4.0	0 – 3.5		0 – 2.5	0 – 4.0	0 – 3.5	0 – 4.0
0.5% AEP climate change (to 2117)	Proportion of site at risk (%)	100	92	100	100	100	50	No risk	25	100	100	100
	Range of depths (m)	0 – 3.5	0 – 1.0	0 - >4.0	0 - >4.0	0 - >4.0	0 – 4.0		0 – 2.5	0 - >4.0	0 – 3.5	0 – 4.0
RESIDUAL RISK												
0.5% AEP defended Failure of outfall	Proportion of site at risk (%)	No risk	No risk	1	1	12	No risk	No risk	No risk	1	No risk	No risk
	Range of depths (m)			0 – 1.5	0 – 0.5	0 – 1.0				0 – 0.5		
	Maximum hazard			Danger for Most	Danger for Some	Danger for Most				Very Low		
0.5% AEP defended (Breach of Oldbury Pill embankment)	Proportion of site at risk (%)	No risk	No risk	13	2	48	No risk	No risk	No risk	8	No risk	8
	Range of depths (m)			0 – 1.0	0 – 0.5	0 – 1.0				0 – 0.5		0 – 0.5
	Maximum hazard			Danger for Some	Danger for Some	Danger for Most				Danger for Some		Danger for Some
0.5% AEP defended (Breach of Power Station embankment)	Proportion of site at risk (%)	No risk	No risk	No risk	No risk	26	No risk	No risk	No risk	6	No risk	3
	Range of depths (m)					0 – 0.5				0 – 0.5		0 – 0.5
	Maximum hazard					Very Low				Very Low		Very Low
RISK OF FLOODING FROM SURFACE WATER												
3.3% AEP	Proportion of site at risk (%)	0	0	0	1	10	0	0	0	0	0	0
1% AEP	Proportion of site at risk (%)	0	0	1	1	12	0	0	0	0	0	1
0.1% AEP	Proportion of site at risk (%)	0	0	4	3	19	0	0	0	0	0	2
OTHER INFORMATION												
Historic Flood Map (HFM)	Proportion of site in HFM (%)	0	0	6	24	39	0	0%	0	<1	0	2
Areas Benefitting from Defences	Proportion of site benefitting	100	100	58	72	19	38	0%	17	91	100	98

SITE RANK	**6**	**2**	**9**	**10**	**11**	**5**	**1**	**3**	**8**	**4**	**7**

9 Guidance for planners and developers

9.1 Over-arching principles

This SFRA focuses on delivering a strategic assessment of flood risk for Oldbury on Severn. Prior to any construction or development, site-specific assessments will need to be undertaken so all forms of flood risk at a site are fully addressed. Some sites may additionally be put forward for the Exception Test following the Sequential Test, if the Sequential Test indicates that there are safety and sustainability issues to be addressed. These will require further work in a detailed Flood Risk Assessment (FRA). Any site that does not pass the Exception Test should not be allocated for development.

It is the responsibility of the developer to provide an FRA with an application.

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

9.2 Requirements for site-specific flood risk assessments

9.2.1 What are site specific FRAs?

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

Paragraph 068 of the NPPG Flood Risk and Coastal Change Planning Practice Guidance sets out a checklist for developers to assist with site specific flood risk assessments.

Site-specific FRAs are required in the following circumstances:

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

9.2.2 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 is likely to be affected by current or future flooding from any source;
- whether a proposed development will increase flood risk elsewhere;
- whether the measures proposed to deal with the effects and risks are appropriate;
- the evidence, if necessary, for the 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 South Gloucestershire Council. 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); and
- 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.

9.3 Flood risk management guidance – mitigation measures

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

The fact that mitigation measures are discussed in this SFRA should not be taken as a presumption that the Sequential Test is not necessarily satisfied. The mitigation measures are included to provide additional support and a more comprehensive picture of the implications of allocating land in Flood Zones 2 and 3. In circumstances where mitigation measures are required, it will be essential for submissions in support of proposed development to include assessments of flood depths and velocities during the preparation of detailed hydrological and hydraulic modelling carried out as part of a formal FRA. Development proposals should consider flood risk and safety issues at the site and the immediate surrounding area as well as the availability of safe access and egress to ensure the development remains safe should flooding occur. Further information on access and egress is provided in Section 11.1.

Often the determining factor in deciding whether a development is appropriate is the practical feasibility, financial viability and long-term maintenance implications of flood risk mitigation rather than technical limitations. Detailed technical assessments are required in the FRA to assess the practical feasibility, together with a commercial review by the developer of the cost of the mitigation works and how contributions will be made for their long-term maintenance.

9.3.1 Site layout and design

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

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

9.3.2 Raised floor levels

The raising of floor levels within a development avoids damage occurring to the interior, furnishings and electrics in times of flood. If it has been agreed with the Environment Agency that, in a particular instance, the raising of floor levels is acceptable, the floor levels should be raised to a minimum of 300mm above the maximum water level caused by a 1 in 100-year fluvial flood event including an appropriate allowance for climate change or 1 in 200-year tidal/coastal flood event plus an appropriate allowance for climate change[9]. However, if raised floor levels are proposed these should be agreed with South Gloucestershire Council. The minimum Finished Floor Level (FFL) may change depended on the vulnerability and flood risk of the development. Reference to the latest climate change guidance will be made when considering the FFL.

Many areas currently situated within Flood Zone 2 may become part of Flood Zone 3a in the future because of climate change, therefore it is essential that the potential risk of flooding in the future is considered when planning development.

[9] Environment Agency (2012): Flood risk assessment: standing advice. Available: https://www.gov.uk/guidance/flood-risk-assessment-standing-advice

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

Single storey buildings such as ground floor flats or bungalows are especially vulnerable to rapid rise of water (such as that experienced during a breach). This risk can be reduced by use of multiple storey construction and raised areas that provide an escape route. However, access and egress would still be an issue, particularly when flood duration covers many days. All sleeping accommodation in Flood Zone 2 and 3a should be located above the recommended flood level. No sleeping accommodation should be located in Flood Zone 3b.

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

9.3.3 Modification of ground levels

Modifying ground levels to raise the land above the required flood level is an effective way of reducing flood risk to a particular site in circumstances where the risk is entirely from tidal flooding and the land does not act as conveyance for flood waters. However, care must be taken at locations where raising ground levels could adversely affect existing communities and property.

In most areas of fluvial flood risk, conveyance or flood storage in flood cells would be reduced by raising land above the floodplain, adversely impacting on flood risk downstream or on neighbouring land. Compensatory flood storage should be provided, and would normally be on a level for level, volume for volume basis on land that does not currently flood but is adjacent to the floodplain (in order for it to fill and drain). It should be in the vicinity of the site and within the red line of the planning application boundary (unless the site is strategically allocated). Ground raising will change the localised characteristics of flooding, not just tidal but fluvial also. Raising ground levels can also deflect flood flows, so analyses should be performed to demonstrate that there are no adverse effects on third party land.

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

Impacts of ground raising on localised flood characteristics will need to be considered as part of the detailed site-specific Flood Risk Assessment to ensure there is no increase in flood risk to existing development.

Impacts of individual plot level raising, when considered in isolation, may appear to be relatively minor; however, the cumulative impact of plot level raising in the area may have more significant impacts. The Local Planning Authority should consider the impact of plot level raising, both in isolation and cumulatively, when assessing planning applications that propose ground raising as a mitigation measure, in relation to the flood risk in the area, to ensure the risk is not exacerbated.

9.3.4 Making space for water

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

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

9.3.5 Developer contributions

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

DEFRA's Flood and Coastal Risk Management Grant in Aid (FCRMGiA)[10] can be obtained by operating authorities to contribute towards the cost of a range of activities including flood risk management schemes that help reduce the risk of flooding and coastal erosion. Some schemes are only partly funded by FCRMGiA and therefore any shortfall in funds will need to be found from elsewhere when using Resilience Partnership Funding, for example local levy funding, local businesses or other parties benefitting from the scheme.

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

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

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

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

9.4 Flood risk management guidance – resistance measures

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

There may be instances where flood risk to a development remains despite implementation of such planning measures as those outlined above. For example, where the use is water compatible, where an existing building is being changed, where residual risk remains behind defences, or where floor levels have been raised but there is still a risk at the 1 in 1,000-year scenario. In these cases, (and for existing development in the floodplain), additional measures can be put in place to reduce damage in a flood and increase the speed of recovery. These measures should not normally be relied on for new development as an appropriate mitigation method. Most of the measures should be regarded as reducing the rate at which flood water can enter a property during an event and considered an improvement on what could be achieved with sand bags. They are often deployed with small-scale pumping equipment to control the flood water that does seep through these systems. The effectiveness of these forms of measures are often dependant on the availability of a reliable forecasting and warning system to user the measures are deployed in advance of an event. The following measures are often deployed:

Permanent barriers

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

Temporary barriers

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

Community resistance measures

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

10 Principles for implementing flood and coastal resilience funding partnerships (Environment Agency, 2012)

9.5 Flood risk management guidance – resilience measures

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

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

- electrical circuitry installed at a higher level with power cables being carried down from the ceiling rather than up from the floor level;
- water-resistant materials for floors, walls and fixtures; and
- non-return valves to prevent waste water from being forced up bathroom and kitchen plugs, or lavatories.

9.6 Reducing flood risk from other sources

9.6.1 Surface water and sewer flooding

Developers should discuss public sewerage capacity with the water utility company at the earliest possible stage. The development must improve the drainage infrastructure to reduce flood risk on site and the wider area. It is important that a drainage impact assessment shows that this will not increase flood risk elsewhere, and that the drainage requirements regarding runoff rates and SuDS for new development are met.

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

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

South Gloucestershire Council have applied for funding to make major resilience improvements to drainage facilities on the highway network, consisting of upgrades to key drainage infrastructure and introduction of methods to reduce need for reactive maintenance works. The bid includes work on Church Road, Chapel Road, and Camp Road.

9.6.2 Sustainable Drainage Systems

Sustainable Drainage Systems (SuDS) aim to mimic the natural processes of Greenfield surface water drainage by encouraging water to flow along natural flow routes and thereby reduce runoff rates and volumes during storm events while providing some water treatment benefits. SuDS also have the advantage of provided effective Blue and Green infrastructure and ecological and public amenity benefits when designed and maintained properly.

The inclusion of SuDS within developments should be an opportunity to enhance ecological and amenity value, and promote Green Infrastructure, incorporating above ground facilities into the development landscape strategy. SuDS must be considered at the outset, during preparation of the initial site conceptual layout to ensure that enough land is given to design spaces that will be an asset to the development rather than an after-thought. Advice on best practice is available from the Environment Agency and the Construction Industry Research and Information Association (CIRIA).

10 Surface water management and SuDS

10.1 What is meant by Surface Water Flooding?

For this SFRA, the definition of surface water flooding is that set out in the Defra SWMP guidance[11]. Surface water flooding describes flooding from sewers, drains and ditches that occurs during heavy rainfall in urban areas.

Surface water flooding includes:

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

10.2 Role of the LLFA and Local Planning Authority in surface water management

From April 2015, local planning policies and decisions on planning applications relating to major development or major commercial development should ensure that sustainable drainage systems for management of run-off are put in place. The approval of sustainable drainage solution lies with the Local Planning Authority.

In April 2015, South Gloucestershire Council was made a statutory consultee on the management of surface water and, as a result, will be required to provide technical advice on surface water drainage strategies and designs put forward for new major developments.

Major developments are defined as

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

The LLFA will also provide advice on minor development on a non-statutory basis.

When considering planning applications, local planning authorities should seek advice from the relevant flood risk management bodies, principally the LLFA on the management of surface water (including what sort of SuDS they would consider to be reasonably practicable), satisfy themselves that the proposed minimum standards of operation are appropriate and ensure, through the use of planning conditions or planning obligations, that there are clear arrangements for on-going maintenance over the development's lifetime. Judgement on what SuDS system would be reasonably practicable should be through reference to Defra's 'Non-statutory technical standards for SuDS' document and should take into account design and construction costs.

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

10.3 Sustainable Drainage Systems (SuDS)

Sustainable Drainage Systems (SuDS) are designed to maximise the opportunities and benefits that can be secured from surface water management practices.

[11] Defra, Surface Water Management Plan Technical Guidance (March 2010). https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69342/pb13546-swmp-guidance-100319.pdf

SuDS provide a means of dealing with the quantity and quality of surface water whilst offering additional benefits over traditional systems of improving amenity and biodiversity. The correct use of SuDS can also allow developments to counteract the negative impact that urbanisation has on the water cycle by promoting infiltration and replenishing ground water supplies. SuDS if properly designed can improve the quality of life within a development offering addition benefits such as

- improving air quality;
- regulating building temperatures;
- reducing noise;
- providing education opportunities; and
- cost benefits over underground piped systems.

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

10.3.1 Types of SuDS System

There are many different SuDS techniques that can be implemented in attempts to mimic pre-development drainage (

Table 10-1). The suitability of the techniques will be dictated in part by the development proposal and site conditions.

Table 10-1: Examples of SuDS techniques and potential benefits

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

10.3.2 Treatment

A key part of SuDS is to provide the maximum improvement to water quality through the use of the "SuDS management train". To maximise the treatment within SuDS, CIRIA recommends[12] the following good practice is implemented in the treatment process:

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

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

10.3.3 SuDS Management

SuDS should not be used individually but as a series of features in an interconnected system designed to capture water at the source and convey it to a discharge location. Collectively this concept is described as a SuDS Management Train. The number of treatment stages required within the Management Train depends primarily on the source of the runoff and the sensitivity of the receiving waterbody or groundwater. A drainage strategy will need to demonstrate that an appropriate number of treatment stages are delivered.

10.3.4 Overcoming SuDS constraints

The design of a SuDS system will be influenced by a number of physical and policy constraints. These should be taken into account and reflected upon during the conceptual, outline and detailed stages of SuDS design. Table 10-2 details some possible constraints and how they may be overcome.

Table 10-2: Example SuDS design constraints and possible solutions

Considerations	Solution
Land availability	SuDS can be designed to fit into small areas by utilising different systems. For example, features such as permeable paving and green roofs can be used in urban areas where space may be limited.
Contaminated soil or groundwater below site	SuDS can be placed and designed to overcome issues with contaminated groundwater or soil. Shallow surface SuDS can be used to minimise disturbance to the underlying soil. The use of infiltration should also be investigated as it may be possible in some locations within the site. If infiltration is not possible linings can be used with features to prevent infiltration.
High groundwater levels	Non-infiltrating features can be used. Features can be lined with an impermeable line or clay to prevent the egress of water into the feature. Additional, shallow features can be utilised which are above the groundwater table.
Steep slopes	Check dams can be used to slow flows. Additionally, features can form a terraced system with additional SuDS components such as ponds used to slow flows.

12 C753 CIRIA SuDS Manual (2015)

Considerations	Solution
Shallow slopes	Use of shallow surface features to allow a sufficient gradient. If the gradient is still too shallow pumped systems can be considered as a last resort.
Ground instability	Geotechnical site investigation should be done to determine the extent of unstable soil and dictate whether infiltration would be suitable or not.
Sites with deep backfill	Infiltration should be avoided unless the soil can be demonstrated to be sufficiently compacted. Some features such as swales are more adaptable to potential surface settlement.
Open space in floodplain zones	Design decisions should be done to take into consideration the likely high groundwater table and possible high flows and water levels. Features should also seek to not reduce the capacity of the floodplain and take into consideration the influence that a watercourse may have on a system. Facts such as siltation after a flood event should also be taken into account during the design phase.
Future adoption and maintenance	Local Planning Authority should ensure development proposals, through the use of planning conditions or planning obligations, have clear arrangements for on-going maintenance over the development's lifetime.

For SuDS techniques that are designed to encourage infiltration, it is imperative that the water table is low enough and a site-specific infiltration test is conducted early on as part of the design of the development. Infiltration should be considered with caution within areas of possible subsidence or sinkholes. Where sites lie within or close to Groundwater Source Protection Zones (GSPZs) or aquifers, further restrictions may be applicable and guidance should be sought from the LLFA.

10.4 Sources of SuDS guidance

10.4.1 C753 CIRIA SuDS Manual (2015)

The C753 CIRIA SuDS Manual (2015)[13] replaces and updates the previous version (C697) providing up to date guidance on planning, design, construction and maintenance of SuDS. The document is designed to help the implementation of these features into new and existing developments, whilst maximising the key benefits regarding flood risk and water quality. The manual is divided into five sections ranging from a high-level overview of SuDS, progressing to more detailed guidance with progression through the document. It is recommended that developers and the LPA utilise the information within the manual to help design SuDS which are appropriate for a development.

10.4.2 Non-Statutory Technical Guidance, Defra (March 2015)

Nom-Statutory Technical guidance has been developed by Defra to sit alongside PPG to provide non-statutory standards as to the expected design and performance for SuDS.

In March 2015, the latest guidance was released providing amendments as to what is expected by the LPA to meet the National standards. The guidance provides a valuable resource for developers and designers outlining peak flow control, volume control, structural integrity of the SuDS, and flood considerations both within and outside the development as well as maintenance and construction considerations. It considers the following: flood risk inside and outside the development, peak flow, volume control, structural integrity, designing for maintenance considerations and construction.

The Local Planning Authority will refer to these standards when determining whether proposed SuDS are considered reasonably practicable.

13 C753 CIRIA SuDS Manual (2015): http://www.ciria.org/Memberships/The_SuDs_Manual_C753_Chapters.aspx

11 Emergency planning

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

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

11.1 Access and egress

The NPPF Planning Practice Guidance outlines how developers can ensure safe access and egress to and from development to demonstrate that development satisfies the second part of the Exception Test[14]. Access considerations should include the voluntary and free movement of people during a 'design flood' as well as for the potential of evacuation before a more extreme flood. The access and egress must be functional for changing circumstances over the lifetime of the development.

The NPPF Planning Practice Guidance sets out that[14]

1. access routes should allow occupants to safely access and exit their dwellings in design flood conditions. Vehicular access to allow the emergency services to safely reach the development during design flood conditions will also normally be required
2. Wherever possible, safe access routes should be provided that are located above design flood levels and avoiding flow paths. Where this is not possible, limited depths of flooding may be acceptable, provided that the proposed access is designed with appropriate signage etc to make it safe. The acceptable flood depth for safe access will vary depending on flood velocities and the risk of debris within the flood water.

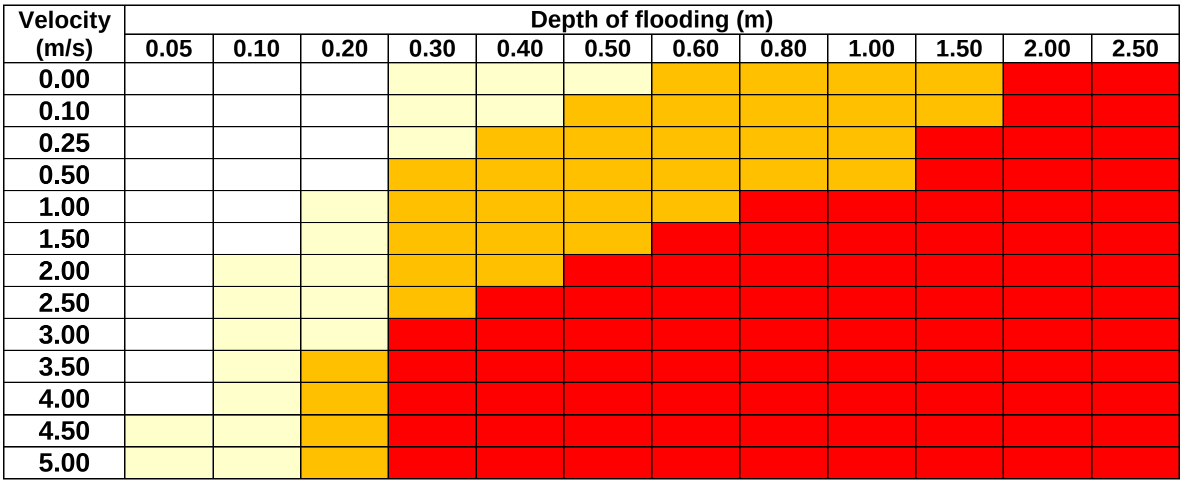
Ideally, access should be situated 300mm above the design flood level and waterproof construction techniques used.

If dry access routes cannot be provided, the Defra/EA Technical Report: FD2320: Flood Risk Assessment Guidance for New Development should be referred to, to determine the hazard to people posed along the access route. This can also be used to inform a Flood Warning and Evacuation Plan for the site. The maximum flood hazard on access and egress routes to a place of safety should not exceed depths and velocity combinations associated with a 'very low hazard' (Figure 11-1). Additionally, it should not have any service covers that could be removed, or other underwater hazards.

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

[14] NPPF Planning Practice Guidance: Flood Risk and Coastal Change (paragraph 039, Reference ID: 7-056-20140306) March 2014

Figure 11-1: Danger to people for different combinations of depth and velocity (taken from FD2320)



To achieve safe access the following may be required

- Raising of access routes
- Defending of access routes

Any proposals for the above would need to be accompanied by a suitable flood risk assessment, that not only demonstrates safe access and egress, but that any proposed measures do not result in obstruction of flow routes and that there is no loss of flood storage capacity.

The depth, velocity and hazard mapping and visualisations from this SFRA update should help inform the provision of safe access and egress routes.

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

11.2 Flood Warning and Evacuation Plans

A consideration for any new development is how to make it safe from flood risk over the developments lifetime (including the likely impacts of climate change). The NPPF Planning Practice Guidance outlines the main options and considerations for making a development safe; this includes flood warning and evacuation plans (these can also be referred to as flood plans or flood response plans etc)[15]. Flood warning and evacuation plans should detail actions to assist residents / building users in preparing and responding to the risk of flooding and remaining safe, as well as defining procedures in the event an evacuation is required.

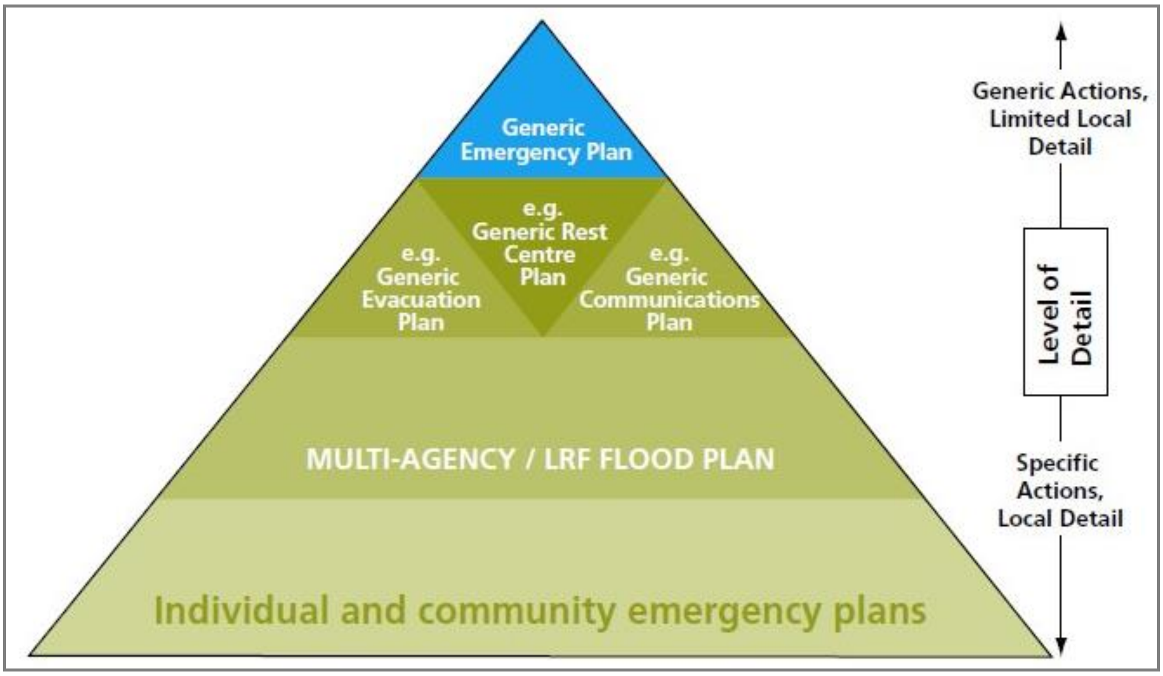
The practicality of safe evacuation from an area will depend on[16]

- the type of flood risk present, and the extent to which advance warning can be given in a flood event;
- the number of people that would require evacuation from the area potentially at risk;
- the adequacy of both evacuation routes and identified places that people could be evacuated to (and considering the length of time that the evacuation may need to last); and
- sufficiently detailed and up to date evacuation plans being in place for the locality that address these and related issues.

Flood warning and evacuation plans can be prepared at a personal, site specific, community/ group level (see Figure 11-2 types of emergency plans), in consultation with the Local Planning Authority and emergency services.

[15] NPPF Planning Practice Guidance: Flood Risk and Coastal Change (paragraph 056, Reference ID: 7-056-20140306) March 2014
[16] NPPF Planning Practice Guidance: Flood Risk and Coastal Change (paragraph 057, Reference ID: 7-057-20140306) March 2014

Figure 11-2: Types of emergency plans



Source: DEFRA (2011) Detailed Guidance on Developing Multi-Agency Flood Plans[17]

There are two main mitigating strategies to reduce risk to life in a major floor event; these are containment and evacuation. When preparing the flood response plans, the two mitigation strategies will need to be explored to see if they are suitable for the locations at risk of flooding.

Containment

Containment is where those within a building are moved to higher floors so that they are above of flood level and wait for food waters to recede. If rapid inundation of Oldbury on Severn was to occur and warnings were not issued in sufficient time, the only safe option for the members of public in the flood risk areas would be containment. This is where residents must move to the highest point of their homes. The emergency services can then be contacted to inform them of their location. When the tide recedes, it is expected a safer rescue can be undertaken, reducing risk to life.

Evacuation

Evacuation is where those in the building are moved out of the building that is at risk and relocated in temporary accommodation, for example rest centres set up by council emergency planners. A key factor in evacuation is the availability of a safe access and egress route.

11.3 Site and community level flood response plans

A Community Flood Response Plan is developed and owned by the community, using local knowledge and experience in flood risk management.

"Working together as a community or group to complete a plan will help you respond quickly when flooding happens. It can help you decide what practical actions to take before and during a flood, helping reduce the damage flooding can cause."[18]

Site-level Flood Response Plans can be prepared as part of a Flood Risk Assessment, following advice from the Environment Agency, local authorities or insurers. Individual property flood response plans can also be prepared more informally, by the discretion of the home owner/ resident. Site-level plans should also indicate what actions should not be taken without the approval of emergency services.

[17] DEFRA (2011) Detailed Guidance on Developing Multi-Agency Flood Plans, Figure 12.1 How a MAFP fits with other emergency plans, page 3.

[18] Environment Agency (2011) Flooding – minimising the risk, flood plan guidance for communities and groups, page 1.

12 Summary

12.1 Sources of flood risk

- The historic flood record shows the village has been subject to both fluvial and tidal flood risk in the past, the most recent being the event of 9 March 2016 because of fluvial flooding
- Fluvial flood risk to the village is predominantly from the Oldbury Naite Rhine when it exceeds its capacity and overtops its banks and defences. Levels in the Rhine are exacerbated at times of high tide when the tidal outfalls at the penstock are closed. Additionally, flap values between ordinary and designated watercourses may also fail, allowing more water down the Rhine towards the village
- Tidal flood risk to the village is low due to the tidal defences. However, these defences are shown to overtop in some locations in the present day 0.5% AEP scenario, although no properties are at risk. Under a present day 0.1% AEP and future scenarios, the defences are overtopped causing considerable flooding to parts of the village
- Modelled scenarios show residual risk to parts of the village is high. Under the modelled coastal defence failure scenarios, much of the village is at risk. Those areas not at risk are still affected because of flood waters cutting off the village
- Surface water flood risk mapping shows the risk in the village is relatively low, mainly affecting the roads. However, historical information shows that surface runoff from surrounding agricultural land and down roads acting as flow paths is a significant source of flooding in the village

12.2 Climate change

Climate change modelling for both fluvial and tidal sources has been undertaken based on the new climate change guidance, using the combined model developed for this SFRA.

Much of the village and proposed development sites are unaffected by fluvial flooding in the future.

However, the tidal climate change modelling has highlighted that the tidal defences will be overtopped in the future without investment to maintain the current standard of protection afforded to the village. Much of the village is shown to be at risk in the future, as well as the proposed development sites.

12.3 Access and egress

Safe access and egress during floods is a key issue for the village. In the event of a fluvial flood, the two routes in and out of the village are flooded, potentially cutting off the village in the undefended fluvial scenario. Further work should be undertaken by developers to determine the level of risk when the fluvial defences are considered.

The coastal defences ensure safe access and egress is available for events up to the 0.5% AEP event. Above a 0.5% AEP event, the roads are at significant risk.

Under the coastal defence failure scenarios modelled, the village may potentially be cut off within 1.5 – 3 hours of the defence failure.

12.4 Key policies

There are several relevant regional and local key policies which have been considered within the SFRA, such as the CFMP, RBMP, the PFRA and LFRMS. Other policy considerations have also been incorporated, such as sustainable development principles, climate change and flood risk management.

12.5 Development and flood risk

The Sequential and Exception Test procedures for both Local Plans and FRAs have been documented, along with guidance for planners and developers. Links have been provided for various guidance documents and policies published by other Risk Management Authorities, such as the LLFA and the Environment Agency.

13 Recommendations

A review of national and local policies has been conducted against the information collated on flood risk in this SFRA, along with assessment of flood risk to Oldbury on Severn village and the proposed sites brought forward into the Level 2 assessment. Following this, several recommendations have been made.

13.1 Development management

13.1.1 Sequential approach to development

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

The modelling and assessments included within this SFRA should be used when allocating sites for development to steer the development to those sites with the lowest risk. The mapping and assessments should also be used to direct development to the lowest risk area within the site.

13.1.2 Site-specific flood risk assessments

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

Developers should, where required, undertake more detailed hydrological and hydraulic assessments of the Rhine system, to account for channel and structure geometry, and fluvial flood defences. This will allow them to verify flood extent (including latest climate change allowances), inform development zoning within the site and prove, if required, whether the Exception Test can be passed. The assessment should also identify the risk of flooding to adjacent land and properties to establish whether there is a requirement to secure land to implement strategic flood risk management measures to alleviate existing and future flood risk. Any flood risk management measures should be consistent with the wider catchment policies set out in the CFMP, FRMP and LFRMS.

13.1.3 Sequential and Exception Tests

The SFRA has identified that areas of Oldbury on Severn are at high risk of flooding from tidal, fluvial and surface water sources. Most of the proposed development sites have an element of flood risk. Additionally, there is residual risk to development from overtopping or failure of the tidal defences and flood defence infrastructure. Sites will be required to pass the Sequential and, where necessary, Exception Tests in accordance with the NPPF. The council should use the information in this SFRA when deciding which development sites to take forward in their Local Plan.

Developers should consult with the council, the Environment Agency and the Lower Severn Internal Drainage Board, at an early stage to discuss flood risk including requirements for site-specific FRAs, detailed hydraulic modelling, and drainage assessment and design.

13.1.4 Council review of planning applications

The council should consult the Environment Agency's 'Flood Risk Standing Advice (FRSA) for Local Planning Authorities', last updated 15 April 2015, when reviewing planning applications for proposed developments at risk of flooding. When considering planning permission for developments, planners may wish to consider the following

- will the natural watercourse system which provides drainage of land be adversely affected?
- will a minimum 8m width access strip be provided adjacent to the top of both banks of any Main River for maintenance purposes and is appropriately landscaped for open space and biodiversity benefits?
- will the development ensure no loss of open water features through draining, culverting or enclosure by other means and will any culverts be opened up?
- have SuDS been given priority as a technique to manage surface water flood risk?

- will there be a betterment in the surface water runoff regime; with any residual risk of flooding, from drainage features either on or off site not placing people and property at unacceptable risk?
- is the application compliant with the conditions set out by the LLFA?

13.1.5 Drainage strategies and SuDS

Planners should be aware of the conditions set by the LLFA for surface water management and ensure development proposals and applications are compliant with the council's policy. Although risk from surface water flooding in Oldbury on Severn is relatively low, flooding from fluvial sources is higher. Therefore, developers should ensure drainage from sites will not exacerbate the level of fluvial flood risk. Wherever possible, SuDS should be promoted:

- It should be demonstrated through a Surface Water Drainage Strategy, that the proposed drainage scheme, and site layout and design, will prevent properties from flooding from surface water. A detailed site-specific assessment of SuDS would be needed to incorporate SuDS successfully into the development proposals. All development should adopt source control SuDS techniques to reduce the risk of frequent low impact flooding due to post-development runoff
- For proposed developments, it is imperative that a site-specific infiltration test is conducted early on as part of the design of the development, to confirm whether the water table is low enough to allow for SuDS techniques that are designed to encourage infiltration
- Consideration must also be given to residual risk and maintenance of sustainable drainage and surface water systems
- SuDS proposals should contain an adequate number of treatments stages to ensure any pollutants are dealt with on site and do not have a detrimental impact on receiving waterbodies
- The promotion and adoption of water efficient practices in new development will help to manage water resources and work towards sustainable development and will help to reduce any increase in pressure on existing water and wastewater infrastructure

13.1.6 Residual risk

- Developers will need to consider the residual risk of flooding, should the defences fail
- Developers should look to reduce residual risk by avoiding single storey buildings through use of multiple storey construction and raised areas that provide an escape route
- The long-term maintenance and standard of protection of the defences should be considered, including the potential requirement for improvements to maintain the current standard of protection into the future

13.1.7 Access and egress

- Safe access routes should be located above design flood levels and avoid flow paths. Where this is unavoidable, limited depths of flooding may be acceptable providing the proposed access is designed with appropriate signage to make it safe
- Ideally, access should be situated 300mm above the design flood level and waterproof construction techniques used.
- If dry access routes cannot be provided, the hazard to people posed along the access route should be determined and used to inform a Flood Warning and Evacuation Plan for the site. The maximum flood hazard on access and egress routes to a place of safety should not exceed depths and velocity combinations associated with a 'very low hazard'. Additionally, it should not have any service covers that could be removed, or other underwater hazards.
- Where development is located behind, or in an area benefitting from, defences, consideration should be given to the potential safety of the development, finished floor levels and the potential for safe access and egress in the event of rapid inundation of water due to a defence breach with little warning.

13.2 Technical recommendations

13.2.1 Potential modelling limitations and improvements

- The combined tidal and fluvial hydraulic model developed for this study is represented in 2D-only. This could be upgraded in future to a 1D-2D hydraulic model if channel and structure survey becomes available. This type of model would provide a greater level of flood risk information as it would better represent the channel geometry. It could also be used to model various influences on flood risk for example, blockage of structures or failure of flap valves
- No information was available from the Severn Valley Internal Drainage Board for the fluvial flood defences in Oldbury on Severn. Due to the 2D nature of the modelling and lack of survey information available of any structures, structures and defences were not represented in the model. Therefore, only an undefended fluvial scenario was simulated.

  Survey of the fluvial defences in the village and inclusion in the model would allow the actual risk of fluvial flooding to be modelled, taking the defences into account, as well as the residual risk should the defences fail.
- If a watercourse or drain is shown on OS mapping but is not covered by a Flood Zone, this does not mean there is no potential flood risk. A hydraulic model would likely be required at detailed site-specific level to confirm the flood risk to the site

13.2.2 Use of SFRA information

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

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 site-specific FRA.

Appendices

A Detailed site summary tables

B Fluvial flood risk mapping

C Tidal flood risk mapping

D Residual risk mapping

E Time to inundation animations

F Flood risk policy and strategic documents

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