

**Bristol City Council
South Gloucestershire Council
Lower Severn Drainage Board**



**Strategic Flood Risk Assessment – Level 2
Avonmouth / Severnside**

SUMMARY REPORT

March 2011

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About this document

This document is a summary of the outcome of the Level 2 SFRA of the Avonmouth / Severnside area. Reference should be made to accompanying the detailed technical reports if more precise information is sought on specific issues. A summary of the main conclusions of the study follows this section.

Technical studies for the Avonmouth / Severnside SFRA have been completed in several phases over the period 2005 – 2010 and commenced prior to the introduction of PPS25¹ and completion of the district-wide Strategic Flood Risk Assessments for Bristol City Council and South Gloucestershire Council. The Avonmouth / Severnside SFRA meets the requirements of a Level 2 SFRA and should be read in conjunction with the district-wide studies.

The Level 2 Strategic Flood Risk Assessment is prepared in order to support decision making on land use planning and development control. Future updates may therefore be necessary from time to time.

As new information and concepts become available, the technical reports will be updated as necessary so that decisions are made using the “best available” data. However, it is possible that the information in the summary document will not need to be updated so frequently. If reference is made to the detailed technical reports then the reader should ensure that the most up to date versions are used.

All revisions to this summary document to date are listed in Table D1.

Table D1 Document register

Version	Issue Date	Issued by	Issued to	Amendments from previous version
Draftv1	09/01/2007	Capita Symonds Ltd	Management Group	N/A
Finalv1	26/01/2007	Capita Symonds Ltd	January 2007 Final Issue	Comments from Management Group.
Draftv2	October 2010	Capita Symonds Ltd	Management Group	Updated with new results and guidance to form a Level 2 Strategic Flood Risk Assessment
Draft Final v2	November 2010	Capita Symonds Ltd	Management Group	Comments from Management Group
Final v3	February 2011	Capita Symonds Ltd	Management Group	Comments from Management Group

¹ Planning Policy Statement 25: Development & Flood Risk, CLG, March 2010

Summary of Main Conclusions

This section provides a brief summary of the main conclusions of the study and is structured to provide answers to typical queries that a user may have. References are provided to locations in the reports where further information may be found.

	Reference for further information:
<p>What are the main dangers now?</p> <ul style="list-style-type: none"> • Tidal flooding from the Severn Estuary presents the main risk to Avonmouth / Severnside. • Fluvial flooding from the rhine network also presents a flood risk – mainly in the vicinity of the M49 corridor & the area north of the Bristol to Cardiff railway line. • The majority of Avonmouth / Severnside is located within Flood Zone 3a. Only a reasonably small proportion of the study area around Avonmouth Village lies within Flood Zone 1. • Informal & defacto flood defences along the Avonmouth / Severnside frontage may prevent tidal flooding from occurring at the present time except for extreme events. However the condition and standard of these defences is uncertain in many locations, increasing the likelihood of breach. Should a defence breach occur land adjacent to the defences would be vulnerable to rapid inundation, high flood depths and velocities. The breach bandwidth identifies the area considered at highest risk. 	<p>Figure 7.2 TR Chapter 7</p> <p>Figure 7.1</p> <p>Figure 7.2 TR Figure 4.3 TR Chapter 4 Figure 7.6</p>
<p>What might happen with climate change?</p> <ul style="list-style-type: none"> • Climate change is expected to make a large difference to sea levels – around a 1m difference in sea levels is predicted over the next 100 years. Rainfall intensity and fluvial flooding is also expected to increase. • The increase in sea levels will reduce the standard of protection provided by many of the flood defences. Without an improvement to the flood defences tidal flooding is expected to affect a large proportion of Avonmouth / Severnside in the future. • The risk of defence failure may also increase as a result of higher sea levels and associated wind and wave action. 	<p>TR Chapter 5</p> <p>TR Figure 4.3 Figure 7.3, 7.5</p>

	Reference for further information:
<p>Which areas are at greatest risk?</p> <ul style="list-style-type: none"> • Land adjacent to the Severn estuary is most at risk from tidal flooding, particularly north of the M4. • Some inland areas east of Avonmouth village and north of the railway are most at risk of fluvial flooding from the rhine network. • With climate change the majority of Avonmouth / Severnside is at risk of tidal flooding, with the highest depths and hazard generally experienced west of the M49. • The breach hazard bandwidth encompasses the majority of Avonmouth and the western frontage of the study area – this area is particularly vulnerable to a breach in the defences. 	<p>Figures 7.2- Figures 7.6 TR Chapter 7</p>
<p>What is the scope for mitigation?</p> <ul style="list-style-type: none"> • The assessment of strategic mitigation measures has highlighted that improvements to the defences will be a key component of any measures across Avonmouth / Severnside. • The following measures may be appropriate to some extent across the majority of Avonmouth / Severnside: <ul style="list-style-type: none"> ○ Land raising (would need to consider the potential impact of loss of flood storage on existing development); ○ New / improved access routes; ○ Flood warning / event management ○ Improvements to the rhine network (north of Avonmouth) 	<p>TR Chapter 8 Section 9</p>
<p>What order of costs might be involved?</p> <ul style="list-style-type: none"> • Improvements to defences to achieve the target protection level are estimated to cost in the region of £57 million. Raising defences to prevent all flooding due to wave overtopping may cost in the region of £200 – 300 million. • The potential for developer contributions has been assessed and across much of the study area the scope for developer contributions to cover a significant proportion of the cost is considered low or medium. 	<p>TR Chapter 4</p>

	Reference for further information:
<p>What happens if we do nothing?</p> <ul style="list-style-type: none"> • If no action is taken to manage future flood risk across Avonmouth / Severnside it is expected that tidal flooding will become a significant issue across the majority of the study area. • The frequency of flooding, flood depths and hazards are likely to mean that existing and new development is no longer safe and viable across much of the area. 	Figure 7.3, 7.5 TR Chapter 7
<p>What actions / further studies are needed to address the key problems?</p> <ul style="list-style-type: none"> • Consider formalising responsibilities and maintenance regime for the existing defences to provide certainty in the level of protection provided • Develop a strategic approach to flood risk mitigation, particularly in light of the increased risks associated with climate change. Identifying funding sources will be a key factor. • Existing studies currently underway are likely to have a bearing on the strategy for Avonmouth / Severnside: <ul style="list-style-type: none"> ○ Severn Estuary Flood Risk Management Study (Environment Agency) ○ Avonmouth & Severnside Integrated Development, Infrastructure and Flood Risk Management Study 	Section 10

Glossary and notation

Actual risk	The risk that has been estimated based on a qualitative assessment of the performance capability of the existing flood defences
AEP	Annual probability of exceedence. The annual chance of experiencing a flood with the corresponding flood magnitude, i.e. a 1% AEP flood is a flood with a flow magnitude that has a 1% chance of occurring each year.
BCC	Bristol City Council
Breach or failure hazard	Hazards attributed to flooding caused by a breach or failure of flood defences or other infrastructure which is acting as a flood defence.
CFMP	Catchment Flood Management Plan
Climate Change	The global climate is changing and likely impacts include sea level rise and the potential increase in intensity, severity and frequency of coastal storms, and rainfall events affecting flooding in fluvial catchments and urban surface water systems. Current DEFRA predictions are outlined in Table B.1 of PPS 25.
DCLG	Department for Communities and Local Government.
DEFRA	Department for Environment, Food and Rural Affairs.
DG5	Register of properties at risk of flooding from sewers maintained by water companies. The register is regularly updated to take account of infrastructure improvements.
EA	Environment Agency
Flood defence	Natural or man-made infrastructure used to prevent flooding
Flood risk	Flood risk is a combination of two components: the chance (or probability) of a particular flood event and the impact (or consequence) that the event would cause if it occurred.
FRA	Flood risk assessment
Flood risk management	Flood risk management can reduce the probability of occurrence through the management of land, river systems and flood defences, and reduce the impact through influencing development in flood risk areas, flood warning and emergency response.
Flood Zones	This refers to the Flood Zones in accordance with Table D1 of PPS 25.
LDD	Local development documents
LDF	Local development framework

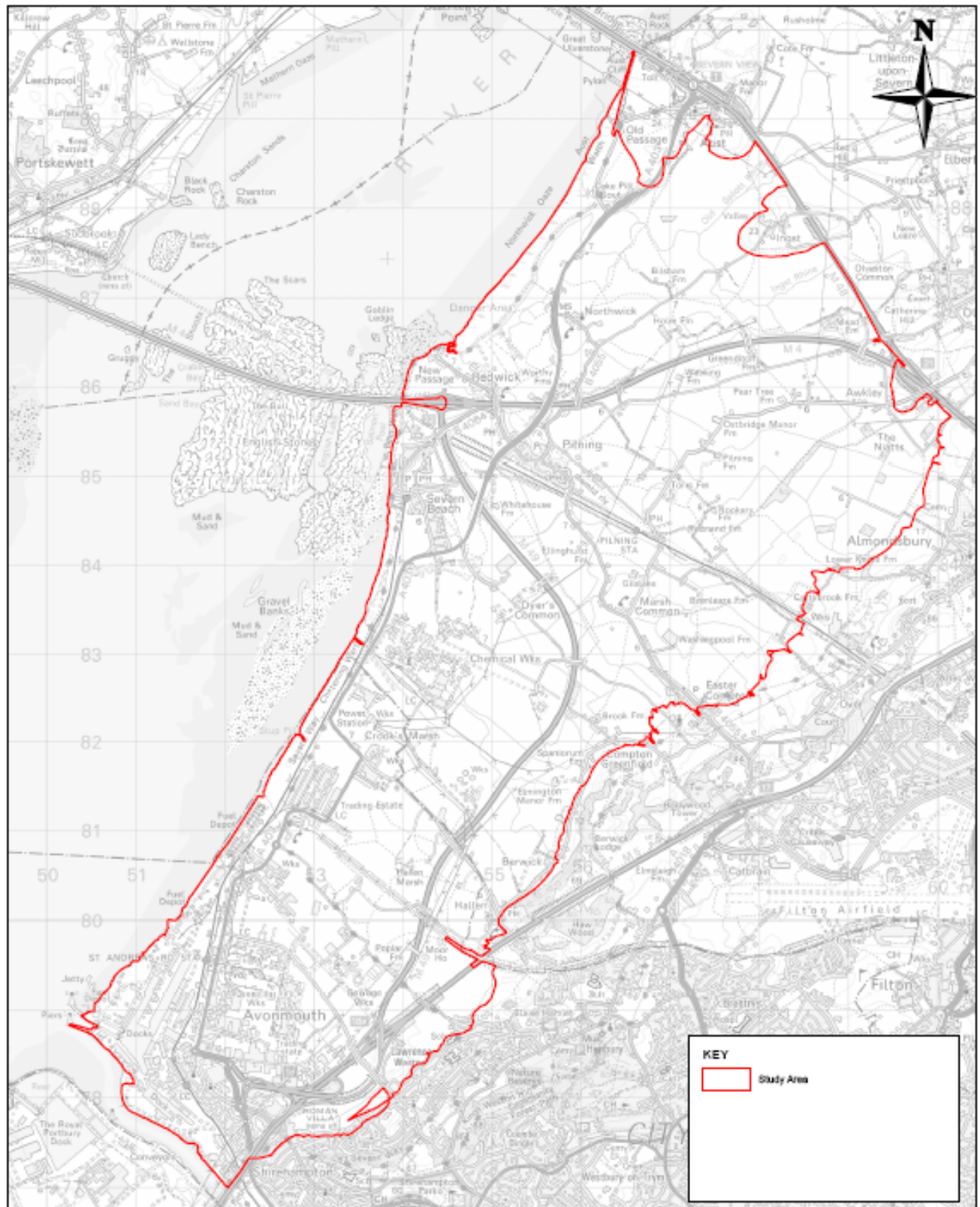
LSDB	Lower Severn Drainage Board
M	metres (measure of distance)
m/s	metres per second (measure of velocity)
NGR	National grid reference
ODPM	Office of the Deputy Prime Minister (ODPM). Former government body responsible for PPG25 and PPS25. DCLG is now the responsible Government body.
OS	Ordnance survey
PPG25	Policy Planning Guidance Note 25: Development and Flood Risk – Previous Guidance explaining how flood risk should be considered at all stages of the planning and development process in order to reduce future damage to property and loss of life.
PPS25	Planning Policy Statement Note 25: Development and Flood Risk. Current Government Guidance on Flood Risk.
Precautionary Principle	<i>“Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost effective measures to prevent environmental degradation”</i> . The Precautionary Principle was stated in the Rio Declaration in 1992. Its application in dealing with the hazard of flooding acknowledges the uncertainty inherent in flood estimation.
RBMP	River Basin Management Plan.
Residual risk	Flood risks resulting from an event more severe than for which particular flood defences have been designed to provide protection.
RFRA	Regional Flood Risk Appraisal
RSS	Regional Spatial Strategy (now rescinded by Government)
Sequential risk-based approach	Priority in allocating or permitting sites for development, in descending order to the flood zones set out in Table D1 of PPS25, including the sub divisions in Zone 3. Those responsible for land development plans or deciding applications for development would be expected to demonstrate that there are no reasonable options available in a lower-risk category subject to satisfying other sustainability objectives.
SFRA	Strategic Flood Risk Assessment
SFRM	Strategic Flood Risk Management. Current Environment Agency framework for commissioning flood mapping products (2003 - 2008).
SGC	South Gloucestershire Council
SMP	Shoreline Management Plan

SOP	Standard of Protection
SREP	Strategic Risk Evaluation Procedure
SWMP	Surface Water Management Plan – Prepared by local authorities and key stakeholders where deemed necessary to develop a coordinated strategic approach to managing surface water drainage and reducing flood risk.
S105	National Section 105 Framework Agreement (NATCON 257) (1998 to 2003). Previous Environment Agency framework for commissioning flood mapping products under Section 105 of the Water Resources Act (1991).
TUFLOW	A two-dimensional fully hydrodynamic modelling package developed by WBM Oceanics Australia. The TUFLOW model differs from the ISIS model in that it models the whole floodplain as 2D domains, providing a more complete description of flood behaviour where complex overland flows and backwater filling occur.
1D	1 Dimensional
2D	2 Dimensional
1 in 100 year return period flood event	<p>A flood with an average return period of 100 years. This term is not used in the SFRA as it can be misleading, in that it is possible that this size flood will not occur once in a 100 year period and likewise it is possible that it will occur more than once. It is a flood with a 1 in one hundred chance (or 1% chance) of happening in each year.</p> <p>The flood is also known as 1 per cent annual probability of exceedence (1% AEP) flood.</p>

1. Introduction

- 1.1. This document contains a summary of the Avonmouth / Severnside Level 2 Strategic Flood Risk Assessments (SFRA). The location is shown in Figure 1.1.
- 1.2. The information in the technical Level 2 SFRA report is intended to provide flood risk information to strategic planners during the land use allocation process, to assist with development control decisions and also inform the wider community in matters relating to development and flood risk in the Avonmouth / Severnside area. The information contained within this document describes how the Level 2 SFRA is used to inform the application of Planning Policy Statement 25 – Development and Flood Risk (DCLG, 2010).
- 1.3. This volume does not provide the full technical context of the Avonmouth / Severnside Level 2 SFRA. The full details are to be found in the following documentation:
 - Technical Report containing the outcome of the Phase 1 - 4 assessments and in particular describing -
 - Hydrology, drainage and groundwater assessments;
 - Flood defence assessment and advice on the implications and potential funding sources for improving defences at Avonmouth;
 - Review of relevant environmental sustainability policies that influence the feasibility of conceptual flood defence proposals;
 - 2D/1D hydraulic modelling of the study area;
 - Economic, social and environmental sustainability;
 - Study area Strategic Flood Risk Assessment;
 - Advice on possible strategic mitigation measures to reduce residual flood risk; and
 - Advice on procedures to enable continuous update of the flood modelling and mapping outputs.
 - Technical Report Volume 2 – Figures and drawings.

- 1.4. It should be noted that the outline information in this summary document will not necessarily match exactly the text and descriptions in the more detailed technical reports and accompanying figures. The reason for this is that amendments might be made to the detailed technical reports without it being necessary to change any of the information in this summary document. The decision to amend documentation is taken on the basis of a judgement that the technical modifications do not substantially change the outcome of the assessment and hence the summary of the outcome described. It is advised that a log of updates to the SFRA is maintained so that the consistency of the Summary Report and SFRA can be maintained.
- 1.5. The Level 2 SFRA is a “live” document that is updated as new information becomes available that could affect the outcome. The data underpinning the Avonmouth / Severnside Level 2 SFRA is based on the best available information at the issue date. This summary document has been prepared on the basis of information available up to the date shown in the front cover. The “Avonmouth / Severnside SFRA Management Group” has responsibility for the management of the documentation. The group is made up of parties with influence over flooding and land drainage in the Avonmouth / Severnside area – Bristol City Council, South Gloucestershire Council and Lower Severn Drainage Board.
- 1.6. The SFRA creates a strategic framework for making planning decisions. It has been developed with reference to the relevant Planning Policy Statement on Development and Flood Risk (as issued by DCLG) at the time of preparation. Additional guidance has been made available by the Bristol City Council, South Gloucestershire Council, Lower Severn Drainage Board and the Environment Agency.
- 1.7. Level 1 Strategic Flood Risk Assessments have been prepared by Bristol City Council and South Gloucestershire Council. These assess all sources of flooding throughout the whole of the respective administrative areas and identify Avonmouth / Severnside as a key area requiring further detailed assessment specifically due to the flood risks posed by river and tidal flooding.
- 1.8. The Level 2 Strategic Flood Risk Assessment summarised in this report provides a more detailed assessment of the key area at Avonmouth and Severnside that spans both councils areas of operation. This enables the councils to assess flood risk in increasing detail as they progress their local development framework.



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Figure 1.1 – Avonmouth / Severnside Location Plan (Figure 1.1 from Technical Report)

2. Principles behind the Level 2 SFRA

2.1. The following should be observed in the preparation of planning strategies:

- Local Authorities should adopt policies for land use allocation and development control that where possible avoid flood risk to people and property and if necessary manage it elsewhere;
- The impact of climate change (sea level rise and increased river flows) might make some locations particularly sensitive when making decisions on land use or development control. In such circumstances consideration should be given to opportunities to relocate proposed new development to locations that are not so badly affected by climate change impacts;
- Flood risk must be considered alongside other spatial planning issues and the contribution that avoidance and management of flood risk can make should be properly considered to deliver integrated solutions; and
- The sustainability appraisal process should include the outcome of the flood risk assessments undertaken at regional and local levels.

2.2. For the Avonmouth / Severnside area the requirements are best satisfied by using information contained in a Level 2 SFRA to provide greater understanding of the factors contributing to the probability of flooding in the potential development areas; provide guidance for LDF policy to ensure that the development would be safe from flooding, and would not increase flood risk elsewhere; and identify the need for additional more detailed assessment to reduce uncertainty. The SFRA was started in 2005 under the direction of a Steering Group made up of representatives from Bristol City Council, South Gloucestershire Council, Lower Severn Drainage Board, The Bristol Port Company and the Environment Agency.

2.3. The fundamental concepts that underpin the Level 2 SFRA are outlined in PPS 25 (March 2010) and expanded in the PPS25 Practice Guide (December 2009). The guidance provided requires local authorities and those responsible for development decisions to demonstrate that they have applied a risk based, sequential approach in preparing development plans and consideration of planning through the application of a sequential test. Failure to demonstrate that such a test has been undertaken

potentially leaves planning decisions and land allocations open to challenge during the planning process.

- 2.4. The underlying objective of the risk based sequential allocation of land is to reduce the exposure of new development to flooding and reduce the reliance on long-term maintenance of built flood defences. This is to respond to the challenge that the risk of flooding in low-lying areas will potentially increase in the future due to the impacts of climate change. Within areas at risk from flooding, it is expected that development proposals that are approved should contribute to a reduction of flood risk.
- 2.5. Information contained in the Level 2 SFRA is essential to enable a strategic and proactive approach to be applied to flood risk management. The assessment allows us to understand current flood risk on a wide-spatial scale and how this is likely to change in the future.
- 2.6. The main objectives of the Avonmouth / Severnside SFRA are to provide flood information:
- So that an evidence based and risk based sequential approach can be adopted when making planning decisions, in line with PPS 25;
 - That is strategic in that it covers a wide spatial area and looks at flood risk today and in the future;
 - That supports sustainability appraisals of local development frameworks;
 - That identifies what further investigations may be required in flood risk assessments for specific development proposals.
- 2.7. The Level 2 SFRA is structured to address the requirements of PPS25 and the Practice Guide and in doing so includes sections on sources of flood risk, managing flood risk, today, and in the future, and recommendations for implementing the Level 2 SFRA.

3. Links with other studies and plans

3.1. The Level 2 SFRA forms part of the wider SFRA process. Flood risk can be assessed to various degrees of detail, which should be proportionate to the nature and complexity of the flood risk within the administrative boundary. To ensure that an appropriate level is included, guidance in the PPS25 Practice Guide recommends two levels of detail:

- Level 1 (initial assessment) – should be carried out for all of the administrative area, as it is necessary for the LPA to understand comparative flood hazard across its administrative area in order to consider flooding on a risk basis;
- Level 2 (more detailed) – where the result of the Level 1 assessment indicates that there is an issue of flood risk, then it is necessary to undertake a more detailed assessment of flood risk to collect further information on the spatial distribution of flood hazard.

3.2. Level 1 SFRAs, investigating all sources of flooding, have been completed by Bristol City Council and South Gloucestershire Council for the whole of their administrative areas. These Level 1 SFRAs have identified Avonmouth / Severnside as a key area where it may be necessary to apply the Exception Test and thus requiring further detailed assessment of fluvial and tidal flood risk and hazard through a Level 2 SFRA.

3.3. There are a number of other plans and policies which influence, and are influenced, by the Avonmouth / Severnside Level 2 SFRA. Figure 3.1 shows the conceptual framework in which the Level 2 SFRA was developed and how it may fit into the wider planning framework in England and Wales.

3.4. The principal documents referred to in the Level 2 SFRA are:

- Shoreline Management Plan for the Severn Estuary (SMP)
- The relevant Catchment Flood Management Plans (CFMP)
- The Tidal Severn Flood Risk Management Strategy (TSS) and Severn Estuary Flood Risk Management Strategy (SEFRMS)

Other relevant documents reviewed included:

- The Avon Biodiversity Action Plan
- The 1994 Habitat Regulations;
- The Wildlife & Countryside Act 1981 (as amended);
- The CROW Act 2000; and
- Natural Environment & Rural Communities Act 2006.

- 3.5. Catchment Flood Management Plans and Shoreline Management Plans represent the first 'tier' in the strategic flood risk management process, providing the overall framework within which more detailed assessments, such as the Avonmouth / Severnside SFRA are undertaken. The SFRA covers a smaller area than the CFMPs and SMPs and is better able to address local issues, opportunities and constraints.
- 3.6. The SFRA's relationship with the land use (spatial) planning process is particularly important and operates at two levels, with a strong link to local development frameworks and a slightly weaker, but still important, link to regional land use planning. It provides information so that an evidence-based and risk-based sequential test may be carried out when making planning decisions.
- 3.7. The SFRA does not eliminate the need for more detailed flood risk assessments (FRAs) of individual proposed development sites. More detailed FRAs will still be required, as specified in Appendix E of PPS 25. Rather the SFRA will provide additional information for these FRAs to draw upon and identify more detailed issues associated with flood hazards and flood consequences. It is intended that all current and subsequent FRAs refer to the SFRA together with any generic guidance that can be assigned to development proposals in the Avonmouth / Severnside study area.

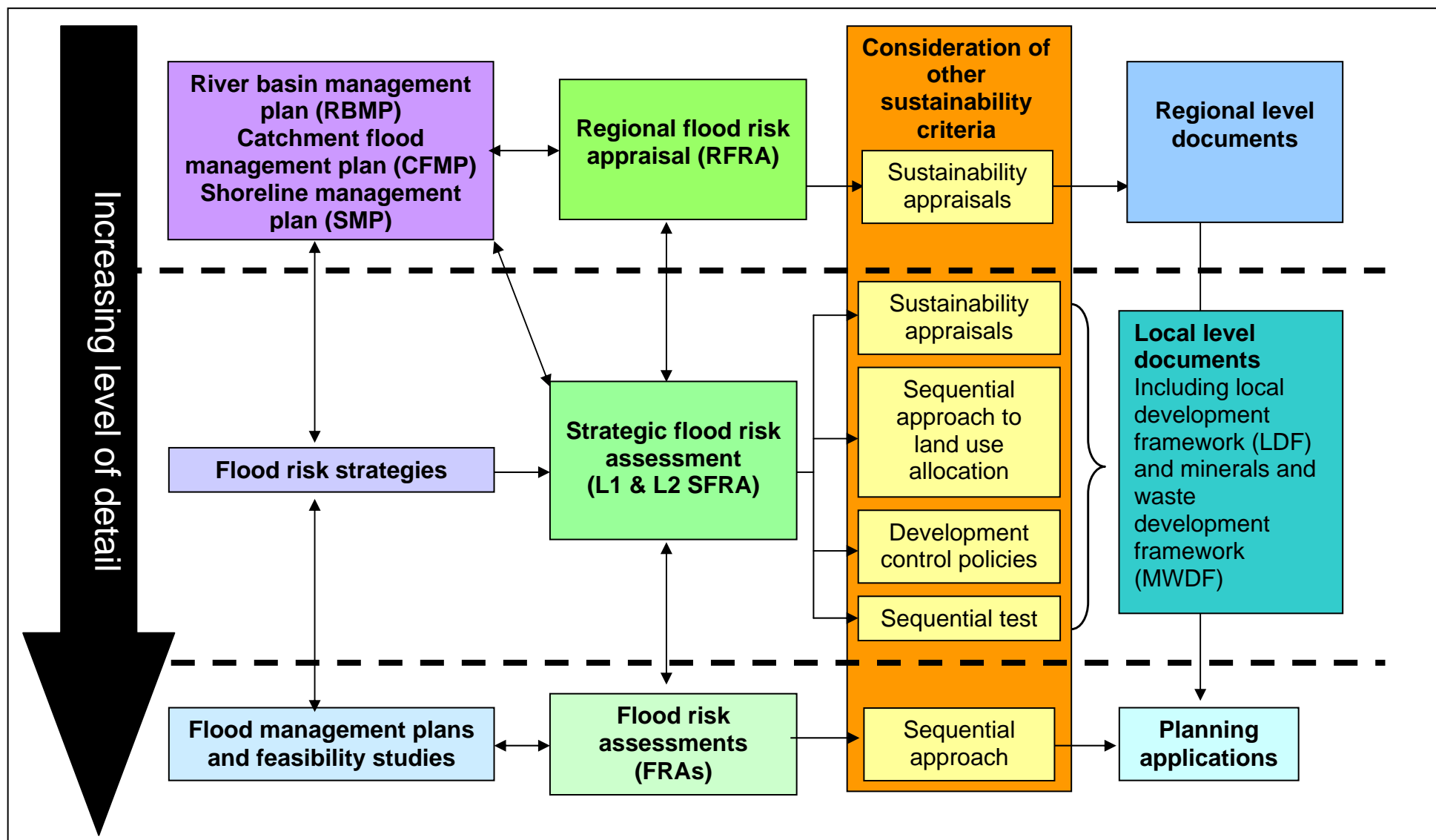


Figure 3.1 – How the level 2 SFRA may fit into the conceptual land use planning framework

4. Strategic risk evaluation procedure

4.1. The basis for the consideration of flooding is the risk based sequential approach as defined in PPS 25. To enable the risks to be assessed it is first necessary to define how flood risk will be defined. For the Avonmouth / Severnside SFRA the following definitions have been used:

Flood risk defined as a combination of two components, the:

(1) "**chance (or probability)** of a particular flood event and the

(2) **impact (or consequence)** that the event would cause if it occurred."

Secondly, the Government also wants flood risk to be investigated using the "source-pathway-receptor" concept. This means that when investigating flood risk, it is important to consider how flooding occurs, the characteristics of different types of flooding and the vulnerability of the "receptor" or development to flooding.

4.2. Considering both the definition of risk and the "source-pathway-receptor" model, it is beneficial to assess risk in terms of the components shown in Figure 4.1.

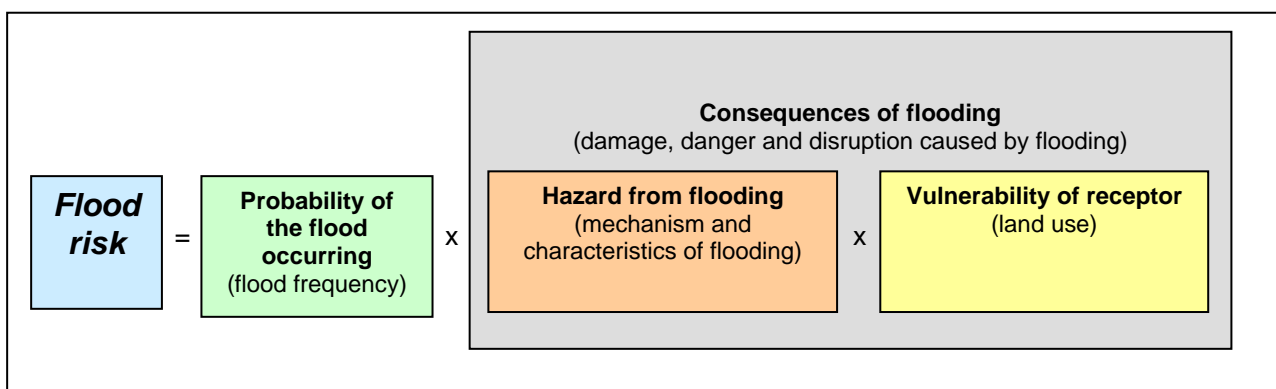


Figure 4.1 – Conceptual definition of flood risk

4.3. Accordingly the SFRA provides the following information:

- The probability (or chance) of flooding is defined using data and statistical analysis on river flows, tide levels and wave heights;
- The hazard from flooding is evaluated by using computer models to prepare estimates of the depth of floodwater, the velocity of flow, the speed of onset of

flooding and the rate of rise of floodwater (also the impact potential of the failure of defences is assessed using the computer model); and

- The vulnerability to flooding is assessed through analysis of the land use, property or people that would be affected by flooding.

By using published predictions on the impact of climate change the flood risk can also be assessed to see how it might change in the future. This enables the decisions taken today to account for the implications of changes that are predicted to occur as a consequence of sea level rise, increased storminess and increased winter rainfall.

- 4.4. There is inherent uncertainty in estimation of flood probability due to the need to simplify variability in rainfall, storm types, soil types, land cover and antecedent conditions into one design event. By separating flood risk into its three components, it is possible to gauge risk even if the exact probability of an event is uncertain. In this way a precautionary principle can be applied, as flood risk will be higher for floods with significant hazards and consequences, even when the probability of occurrence is uncertain.
- 4.5. To logically assemble and consider information on flood risk a standard procedure has been developed for the Avonmouth / Severnside study area. This is referred to as the Strategic Risk Evaluation Procedure (SREP) and uses the prescribed definition of flood risk to define flood zones, actual risk, residual risk and breach and/or failure hazards. Flood zones are described in Table D1 of PPS 25. Those using this information should be aware that there is no implied priority given to any of these specific kinds of risk. When performing the sequential test it will be important that all flood risks are considered.
- 4.6. This information can then be used to inform the Sequential Test. By including consideration of climate change the procedure is precautionary, in accordance with PPS 25.
- 4.7. It can be seen from the risk equation that by reducing the hazard or vulnerability of flooding, it is possible to reduce the risk. It follows that development proposals in the Avonmouth / Severnside area should be developed and assessed using a risk-based search sequence avoiding risk where possible and managing it elsewhere. It can also be seen that careful selection of the vulnerability of the development so that it is

compatible with the level of risk of inundation can also reduce the magnitude of the long-term consequences of flooding.

- 4.8. The SFRA should be used to provide high-level information for decisions on land use planning in the study area. This can be done on an “as required” basis, matching the needs of phased submission of applications. The strategic approach defined in this document will require that information supporting all planning applications in the study area make reference to the SFRA and clearly demonstrate adoption of a risk-based sequential approach.
- 4.9. The Strategic Risk Evaluation Procedure (SREP) is shown diagrammatically in Figure 4.2.

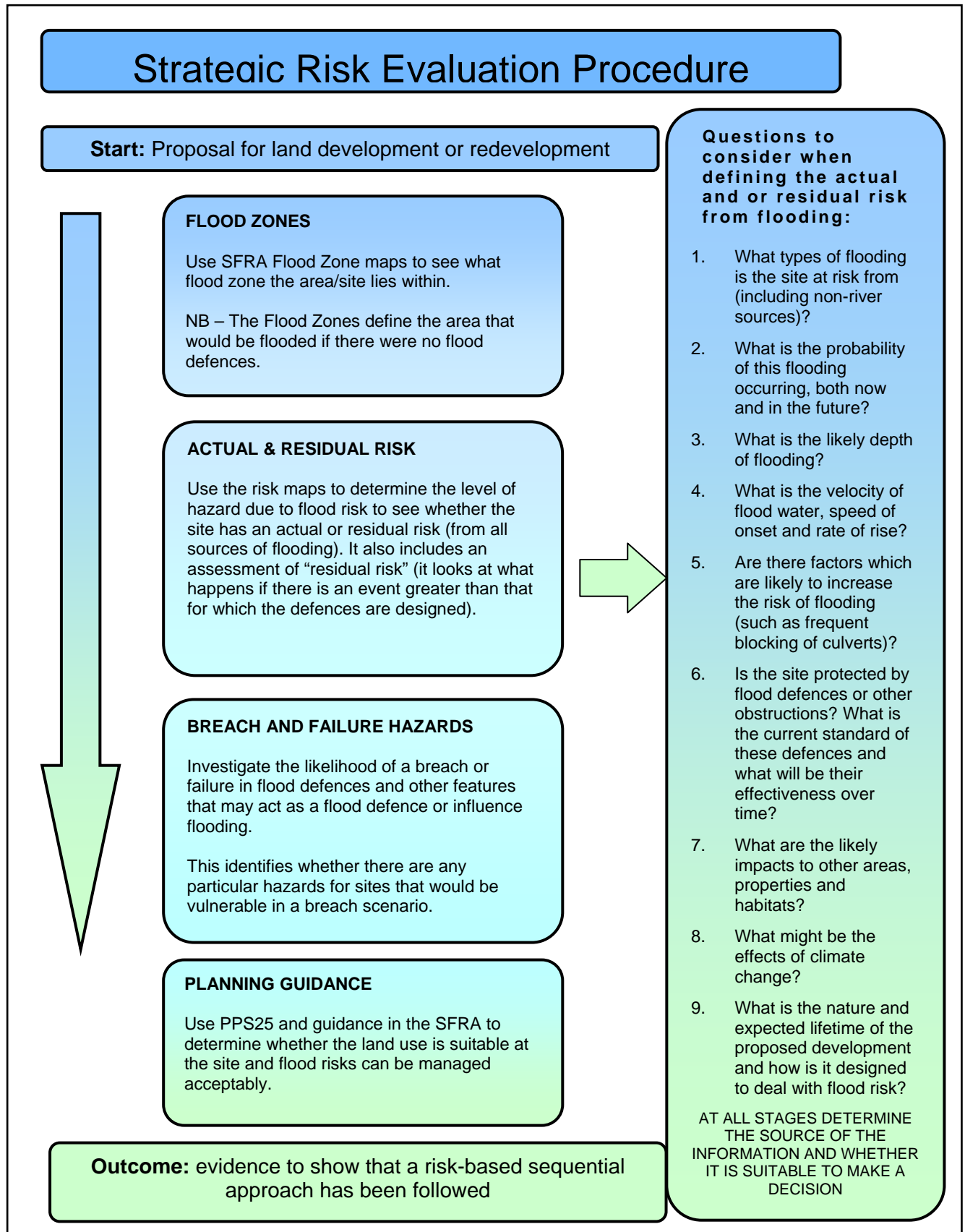


Figure 4.2 – The strategic risk evaluation procedure

5. The study area

- 5.1. The Avonmouth / Severnside area is a low lying area adjacent to the Severn Estuary extending northwards from the mouth of the River Avon and includes the Port of Bristol, Avonmouth village, the existing industrial area immediately to the north, Severn Beach and an extensive area of undeveloped land to the north and east of Severn Beach. Figure 5.1 shows the study extents of the SFRA and the principal features of the study area.
- 5.2. The SFRA study area was selected so that informed decisions, based on a robust knowledge of flood risks, could be made on the continued use of the Avonmouth / Severnside area as a regional employment resource. Furthermore, confident flood risk predictions in the existing built up areas of Avonmouth / Severnside are needed to inform development control activities.
- 5.3. As a starting point for assessment, the Environment Agency publishes mapping of flooding from rivers and the sea. These do not consider the benefit provided by defences and can therefore provide a conservative view of flooding in areas such as Avonmouth / Severnside. According to the Environment Agency flood mapping the Avonmouth / Severnside area lies wholly within the 1 in 200 year return period flood plain of the Severn Estuary. Current flood defences alongside the estuary offer a variety of standards of protection. Some locations (the Binn Wall – Severn Beach area) locally have defence heights that may provide protection during events with a probability of 1 in 200 years or greater. Other locations offer much less protection and the defences in some places are not formally maintained by the Environment Agency and consequently have no formal status (there is no obligation on the owners of these defences to maintain them). The Environment Agency has stated that the area is not considered to be fully defended to the desired 1 in 200 year tidal standard of protection. The Environment Agency does not maintain the ‘informal’ defences and where these are present the probability of breach is higher. Internal drainage of the low lying land behind the defences consists of a historic system of Rhines (ditches) that are regulated by the Lower Severn Drainage Board.
- 5.4. The Severn Estuary has been notified as a Site of Special Scientific Interest (SSSI) and is accordingly protected under the Wildlife and Countryside Act 1981 (as amended) and the Countryside and Rights of Way Act 2000. It is also designated as a Special

Protection Area (SPA) under EC Directive 79/409 and is a RAMSAR site under the Ramsar Convention on the Conservation of Wetlands of Importance. The Estuary is also a Special area of Conservation (SAC) under European Directive 92/43/EEC (the "Habitats Directive").

- 5.5. Over the years there has been extensive development in the area for industrial distribution and port related purposes along with a number of industrial installations using and storing potentially hazardous materials. Further large areas of land in the northern section of Avonmouth / Severnside either have planning permission for employment development or have been allocated in development plans for employment purposes.
- 5.6. Strategically the area has been examined for its development potential over many years. The assessments have identified that the area is a strategic location for the expansion of employment development to serve the South West. However, the Environment Agency has advised that any future development should take full account of flood risk and be based on the appropriate application of the risk-based sequential approach advocated in Government planning guidance (PPS 25).
- 5.7. Strategically the biggest factor influencing flood risk is the tide levels in the adjacent Severn Estuary. Climate change impacts will mean that there is a long term increase in the average sea levels in the adjacent estuary, the sea levels are predicted to gradually rise in years to come. The impact of this change is monitored by Defra and recent advice states that over 100 years the mean sea level in the estuary will increase by approximately 1m. This means that during very severe storm events the predicted flood levels in the Severn Estuary will be 1m greater in 100 years time than they are now. Assuming that no changes are made to the existing banks or walls that protect the land from flooding the long-term increase in sea levels means that the flooding in the future will be far worse than it could be today. Additionally the average rise in sea levels will mean that there will be an increased chance of significant flood events occurring more frequently.
- 5.8. The predicted increase in rainfall severity will also potentially affect the performance of the Rhine System that drains the low-lying land. The combination of local catchment fluvial and ground water flooding will continue to present a flood risk in the study area.

This will also be affected by sea level rise as the time available between high tides, during which the water can drain out from behind the tidal defences will be reduced.

- 5.9. Economic, commercial, flood risk and environmental factors will strongly influence decisions on land use in the Avonmouth / Severnside area. The SFRA provides information showing how the area is affected in the future so that the implications of decisions can be measured and their sustainability assessed.

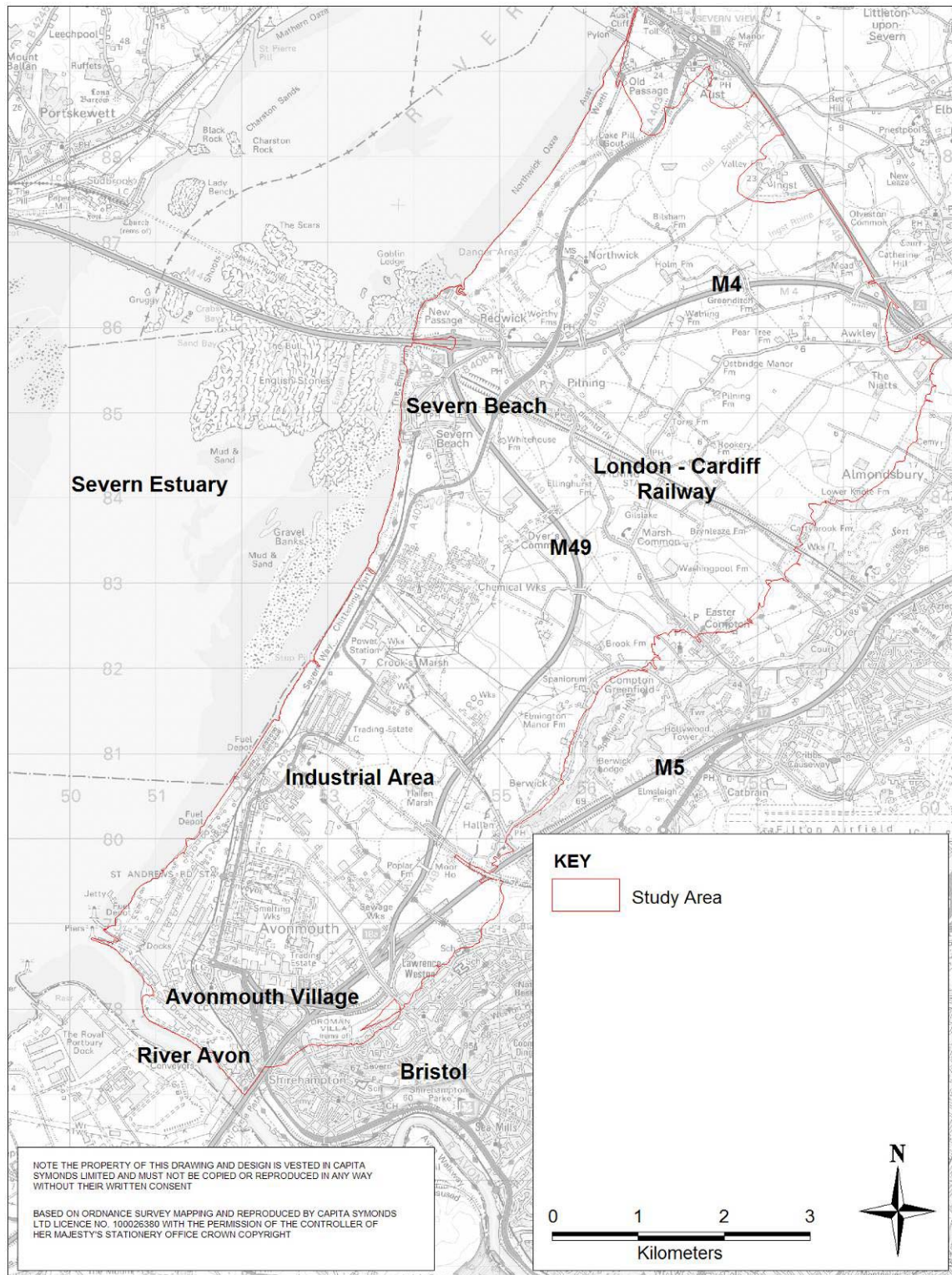


Figure 5.1 – Avonmouth / Severnside SFRA Study Extent

6. The approach

Baseline assessment

6.1. The first stage in developing the Avonmouth / Severnside Level 2 SFRA involved an assessment of flood risk for baseline conditions, now and in the future taking account of climate change (see Figure 6.1). This assessment provides the platform to prepare information that can be used to support planning decisions and investigate the implications of possible alternatives.

6.2. In accordance with the relevant Government guidance the baseline assessment was made up of three components as follows:

- Flood zones (Figure 7.1) – It is important to recognise that the zones defined in PPS 25 do not describe an actual level of flood risk as they 'ignore the presence of flood defences'. In some areas, this means that the flood zones show areas that are protected by existing flood defences. The flood zones only show areas at risk of flooding from the Severn Estuary or the overflowing of the Rhine system, not flooding from sewer flooding, surface water flooding (ponding – poor local land drainage) or groundwater flooding. Flood zones presented in Table D.1 of PPS 25 are:
 - Zone 1 Low Probability
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%).
 - Zone 2 Medium Probability
This zone comprises land assessed as having between 1 in 100 and 1 in 1000 annual probability of river flooding (1% - 0.1%) or between 1 in 200 and 1 in 1000 annual probability of sea flooding (0.5% - 0.1%) in any year.
 - Zone 3a High Probability
This zone comprises land assessed as having a 1 in 100 or greater annual probability of river flooding (>1%) or 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year.
 - Zone 3b Functional Floodplain
This zone comprises land where water has to flow or be stored in times of flood. PPS25 states that the identification of the Functional Floodplain should take account of local circumstances and not be defined solely on rigid probability parameters. But land which would flood with an annual probability of 1 in 20

(5% AEP) or greater in any given year or is designated to flood in an extreme (0.1%) flood, should provide a starting point for consideration. The impact of flood defences is considered when defining flood zone 3b.

- Actual risk and residual risk (Figures 7.2 – 7.5) - provides information on the actual & residual flood risk on the Avonmouth / Severnside area for the years 2010 and 2110, including the impact of existing flood defences (assuming that they operate as they are supposed to and assuming no improvements to existing crest levels). For the purposes of this study, actual risk of tidal flooding has been assessed for a flood with a 0.5% AEP. Actual risk also included an assessment of the fluvial flooding that might be expected from the Rhine system during floods with a 1% AEP. Residual risk has been assessed for a tidal flood with a 0.1% AEP; and
- Breach and/or failure hazards (Figure 7.6) - This involves the assessment of breach or failure of tidal and river defences or other features which may act as a defence. This assessment is important even where the probability of a breach may be low because the potential consequences are high. Breach and failure hazard can be site specific and should also be assessed in individual FRAs. Figure 7.6 shows the breach hazard bandwidth area where hazard from a breach or failure of the tidal defences is expected to be particularly high.

6.3. All the potential flood risk scenarios must be considered when making planning decisions and there is no set weight given to a particular component. The weight placed on each component will vary between development proposals according to the vulnerability of the development to specific types of flooding.

6.4. The three components of flooding are examined through use of the hydraulic modelling, hydrological assessments and historical data searches. The large tide range and dramatic sea level rise increases result in a system that is very much dominated by the performance of the existing tidal sea defence structures.

6.5. The hydraulic model developed for earlier phases of the Strategic Flood Risk Assessment has been updated with new survey and tide level data. The model is based on “best science” and “best available data”. It solves the full equations of unsteady flow in two dimensions, is fully hydrodynamic (TUFLOW) and is able to give more accurate predictions than conventional one dimensional analysis (e.g. iSIS) or raster based methods (the models previously deployed by the Environment Agency). The data makes use of the latest three-dimensional ground model (LiDAR data) and an

updated comprehensive ground survey of the flood defences, partial survey of the Rhine system and outfall structures. It also makes use of locally collected and updated data on wave and tide levels in the Severn Estuary. Full details of the model can be found in the Technical Report.

- 6.6. A detailed hydrological assessment has been undertaken by the Lower Severn Drainage Board and the results used to estimate inflows to the Rhine network in the hydraulic model. It was identified that flooding of the land during severe rainfall events was possibly also influenced significantly by groundwater levels. Accordingly it has been recognised there is a need to collect more data on groundwater levels and surface water levels in the Rhine system.

Decision support

- 6.7. Further work was undertaken to provide additional information and support for planning decisions in the Avonmouth / Severnside area. The baseline assessment has demonstrated that flood risk is likely to generate significantly worse conditions over the next 100 years and that there is a need to consider the implications of the potential responses to address the increased risk.
- 6.8. A review was undertaken to examine the condition of the existing tidal flood defences that provide some protection to the area from inundation during high tide and storm events in the Severn Estuary. The survey identified areas where the defences did not meet current standards and considered the crest level of the defences in relation to the predicted tide levels during severe events. The review considered not only the existing banks and bunds but also the gate structures, locks etc in Bristol Port. Additionally the likelihood of the failure of defences through breaching (failure or collapse of the bunds or banks) was examined. This information was then used to evaluate the consequences to the existing land if the defences were to fail during a severe high tide event. The computer model was used to simulate the outcome for scenarios where the defences had failed so that this information could also be used when making planning decisions.
- 6.9. Since the future extent of flooding is predicted to be significant, consideration was given to the likely cost of raising the level of the defences to reduce the future level of flooding to more acceptable limits. The outline estimates suggest that the cost of upgrading the defences to appropriate standards will be tens or hundreds of millions of

pounds (estimates ranged from 34.4 to 300 Million pounds). Increasing the level of the flood defences would need to be implemented in a strategic way along the whole of the study area and would be a major project. However, there is currently no provision in the Defra capital flood defence programme for an improvement scheme for flood defences at Avonmouth / Severnside.

- 6.10. Consideration was given to other possible sources of funding for defence improvements, particularly the scope for developer contributions. There is potential for some developer contribution to defence improvement costs in the Avonmouth / Severnside area however monies raised from contributions will only form a small proportion of the full costs required. A jointly funded Regional Development Agency economic assessment is currently underway. This will determine how funding strands can be used to implement the required strategic infrastructure.
- 6.11. Outline consideration was also given to the wider implications of raising the flood defences to identify what constraints existed, should such a response be contemplated. The review identified that Natural England would be very concerned that raising the defences could cause a loss of the inter-tidal habitat adjacent to designated conservation sites along the Severn Estuary. They advised that should such proposals be considered then detailed studies would need to be undertaken to demonstrate that there would be no negative impacts on the ecological environment. Additionally they were concerned that raising the level of the defences would have an adverse impact on the conditions required for bird feeding and breeding.
- 6.12. A review of strategic approaches to flood risk management in the Avonmouth / Severnside area has also been completed. This considered a range of responses and evaluated them on a number of criteria to identify those that were likely to be appropriate in the context of existing and future development. **The review identified that improvements to the tidal defences is a key component of the management of flood risk on the Avonmouth / Severnside area.**
- 6.13. The earlier phases of the study also initiated a process whereby the results and data could be updated and maintained so that the information was the best available at the time planning decisions are taken. A SFRA Management Group will be established to manage and maintain the information in the SFRA. It is expected that the Group will comprise of representatives from Bristol City Council, South Gloucestershire Council,

the Lower Severn Drainage Board, and the Environment Agency. The Lower Severn Drainage Board will have the additional responsibility of controlling and managing the computer model used to generate the results contained in the Level 2 SFRA.

- 6.14. Decision support guidance and recommendations are provided in chapters 8 and 9 of this report.

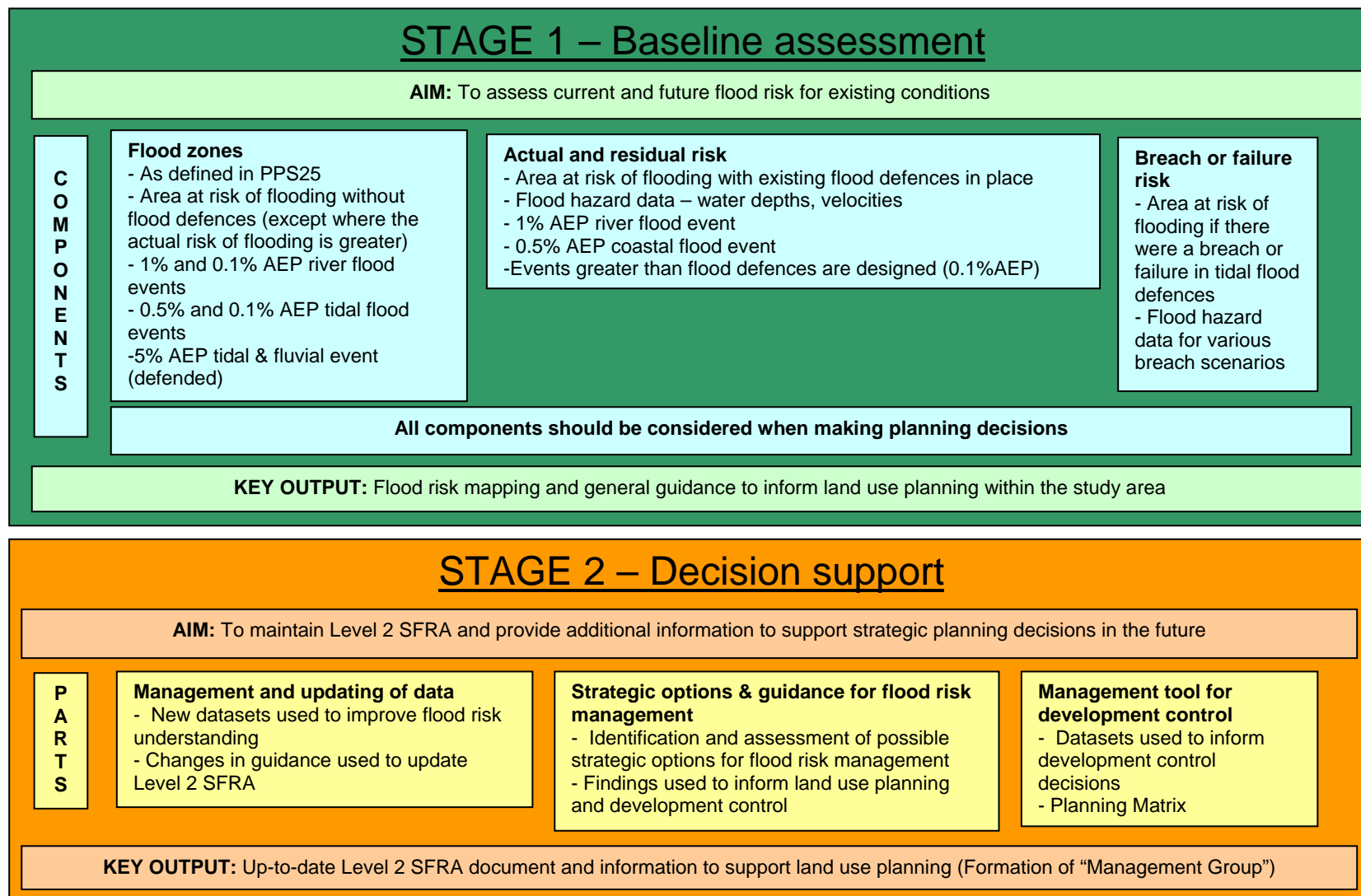


Figure 6.1 – Overview of the Avonmouth / Severnside Level 2 SFRA

7. Results

- 7.1. **Note:** The full suite of maps and detailed description of flooding mechanisms and impacts is presented in the Technical Report. The following is a summary highlighting the key issues.

Flood zones

- 7.2. Flood zones for the Avonmouth / Severnside SFRA are shown in *Figure 7.1*. The flood zones only show tidal flooding from the Severn Estuary and local catchment fluvial flooding from the Rhine system (not flooding from other sources such as surface water or ground water). Flood zones 2 and 3a represent the extent of flooding, ignoring the presences of the tidal defence and outfalls along the Severn Estuary frontage.
- 7.3. The majority of the Avonmouth / Severnside SFRA study area is considered at high probability of flooding (Flood zone 3a – 1% AEP river flooding or 0.5% coastal flooding). If there were no tidal defences it is predicted that there would be extensive flooding of the low lying land. The impact of the high tide storm condition (high tides and storms) dominate the flood zone 3a envelope in comparison to the fluvial dominated simulations.
- 7.4. Flood zone 2 (medium probability – 0.1% AEP river or coastal flooding) only includes a reasonably small additional area of land to that already included in flood zone 3, as a result of the extensive low lying land and the steep edges of the floodplain. Again, severe tidal/surge conditions completely dominate the extent of flood zone 2 in comparison to the predicted fluvial flooding that could be generated by the Rhine system.
- 7.5. In contrast, Flood Zone 3b (functional floodplain) is dominated by the predicted fluvial flooding that could be generated by the Rhine system in low lying land as the tidal defences prevent significant tidal flooding at the present time.
- 7.6. Only higher ground levels around Avonmouth village are outside flood zones 2 and 3. Some isolated “islands” are predicted. These areas would be classified as Flood Zone 1, at low probability of flooding.

Actual and Residual Risk

- 7.7. Actual risk and residual risk flood depth and hazard are shown in Figures 7.2 to 7.5. The actual and residual risk flood extents only show tidal flooding from the Severn

Estuary and local catchment fluvial flooding (not flooding from other sources such as surface water or ground water). These flood extents assume that existing flood defences are in place and functional (apart from sections of the defence that are considered sub-standard in the tidal defence review and have accordingly not been taken into account in the simulation). The hazard follows the Defra flood hazard rating developed in the Flood Risks to People study, which uses a relationship between flooding depth and velocity to predicted flood hazard. The study outlined the methodology for assessing Flood Risks to People, which is based on a multi-criteria assessment of factors that affect Flood Hazard, the chance of people in the floodplain being exposed to the hazard, and the likely consequence of those (people) affected to respond to flooding.

- 7.8. For the purposes of this Level 2 SFRA the actual risk flood extent is defined as what is likely to flood from 1% AEP river flooding events or 0.5% AEP tidal flooding events, with current flood defence systems in place as detailed above. The future actual risk maps have included an allowance for climate change over the next 100 years. Residual risk flood extent is defined as what is likely to flood from the 0.1% AEP tidal flood event, with current flood defence systems in place and with allowances for future climate change.
- 7.9. Defra (October 2006) guidance presented in Table B.1 of PPS 25 indicates the following allowances and sensitivities for climate change for the period up to 2110. This indicates that over 100 years the following changes can be expected:
- net sea level rise of 1.02m;
 - increase in extreme wave height of 10%; and
 - increase in rainfall intensity of 30%.
- 7.10. Both actual and residual risk flood extents are dominated by the effect of tidal flooding (flooding during severe storm events). It should be recognised that flooding from the Rhines (such as occurred in 2000) can also be extensive. Information on historical flood events in Avonmouth / Severnside, including photos of the 2000 floods, is included in Section 2 of the Technical Report. The standard of protection afforded by much of the existing tidal defences is significantly reduced by the impact of future climate change and sea level rise. Tidal flooding will occur today due to overtopping of defences and the risk increases in the future as a result of climate change.

- 7.11. The actual risk flood extent includes almost the entire area to the north of the M4 motorway and large areas of land in the vicinity of the M49, along the Severn frontage and to the north of the Cardiff / London Railway. In the future the actual flood risk extent is predicted to cover almost the entire study area.
- 7.12. The residual risk flood extent is noticeably larger west of the M49 motorway and north of the Cardiff / London Railway. Flood depths are also significantly higher. There is a smaller difference in actual and residual risk flood extents in the future, however flood residual risk flood depths are significantly higher.

Breach or Failure Risk

- 7.13. The impact of defence breach or failure was assessed at six locations along the Severn Estuary where the likely probability of failure of the tidal defence was estimated to be significant, or the consequence of failure was significant. Figure 7.6 presents a bandwidth along the tidal defence that would experience high flood hazard following defence breach or failure. Within this zone hazard is particularly high due to rapid inundation (<1.5 hours) and high velocities and is generally considered to present “danger for all”. Maps showing the extent and hazard resulting from a defence breach at each of the locations are provided in the Technical Report.
- 7.14. The impact of blockage of the M49 culverts on fluvial flooding from the Rhine network has been assessed at five locations. Maps showing the extent of flooding with the blockage are included in the Technical Report.

Flooding Mechanisms

- 7.15. The sequential risk-based approach is based on the concept that land use allocation decisions consider actual flood risk within the Avonmouth / Severnside area. To develop an understanding of actual risk, the following questions should be considered:
- what types of flooding is the site at risk from?
 - what is the probability of this flooding occurring, both now and in the future?
 - what is the likely depth of flooding, both now and in the future?
 - what is the velocity of flood water, speed of onset and rate of rise?
 - is the site protected by flood defences or other obstructions? What is the current standard of these defences and what will be their effectiveness over time?
 - what are the likely impacts to other areas, properties and habitats?
 - what might be the effects of climate change?

- what is the nature and expected lifetime of the proposed development and how is it designed to deal with flood risk?

7.16. In order to answer these questions, the Level 2 SFRA hydraulic model has been used to predict the depths and rates of flow for given flood events. Using these results conclusions may be drawn on the likely impacts of flooding to other areas, properties and habitats.

7.17. Maximum flood depths and flood hazard ratings for the actual and residual flood risk have been mapped in Figures 7.2 to 7.5. These maps illustrate the actual risk peak flood depth and hazard rating for 1% AEP river flooding and 0.5% AEP tidal flooding event. The “Hazard Rating” is a way of considering the effect of both flood depth and the velocity of the flood flow. It has been shown that shallower depths of water flowing at high velocities can pose hazards to humans and property and it is a useful way of showing that the level of hazard can be quite variable within areas that are predicted to flood.

7.18. From the maps it is possible to gain a greater understanding of the magnitude of flooding and likely consequences through analysing this data and considering it when making planning decisions. At present (2010) flood depths are generally less than 0.5m, however in the future it can be seen that defence overtopping results give considerable flooding, with depths greater than 1.0m for most of the area to the west of the M49, and greater than 1.5m north of the M4. The rapid flooding and deep floodwater suggest flooding in the area would be a danger for most or all people. Both the M49 and M4 alleviate flooding to the east, with depths less than 1.0m predicted in most places, and the flood hazard category suggests lower risk but danger for ‘some’ and ‘most’ in places.

7.19. Whilst flood mechanisms will vary significantly between sites, the following observations can be made regarding flood risk along the Avonmouth / Severnside area as a whole:

- The Avonmouth / Severnside area is very susceptible to tidal/surge flooding from overtopping of the tidal defences;
- In the future, the extent of tidal flooding is predicted to include much of the low lying land. Compared with the present day, the extent of flooding for more extreme events only increases slightly because of the steep edges of the floodplain. However flood depths are shown to increase significantly;

- Tidal flooding from overtopping of the tidal defence is the most serious type of flooding, when compared with flooding that could occur when the Rhines are full and flow over the land (though the hydraulic model was unable to reproduce historic fluvial flooding because of the likely ground water interaction);
- The likely consequence of defence breach or failure results in high flood hazard along the adjacent land. The probability of breach is higher for the informal defence sections due to the potential poor composition of some of the defences in the study area.

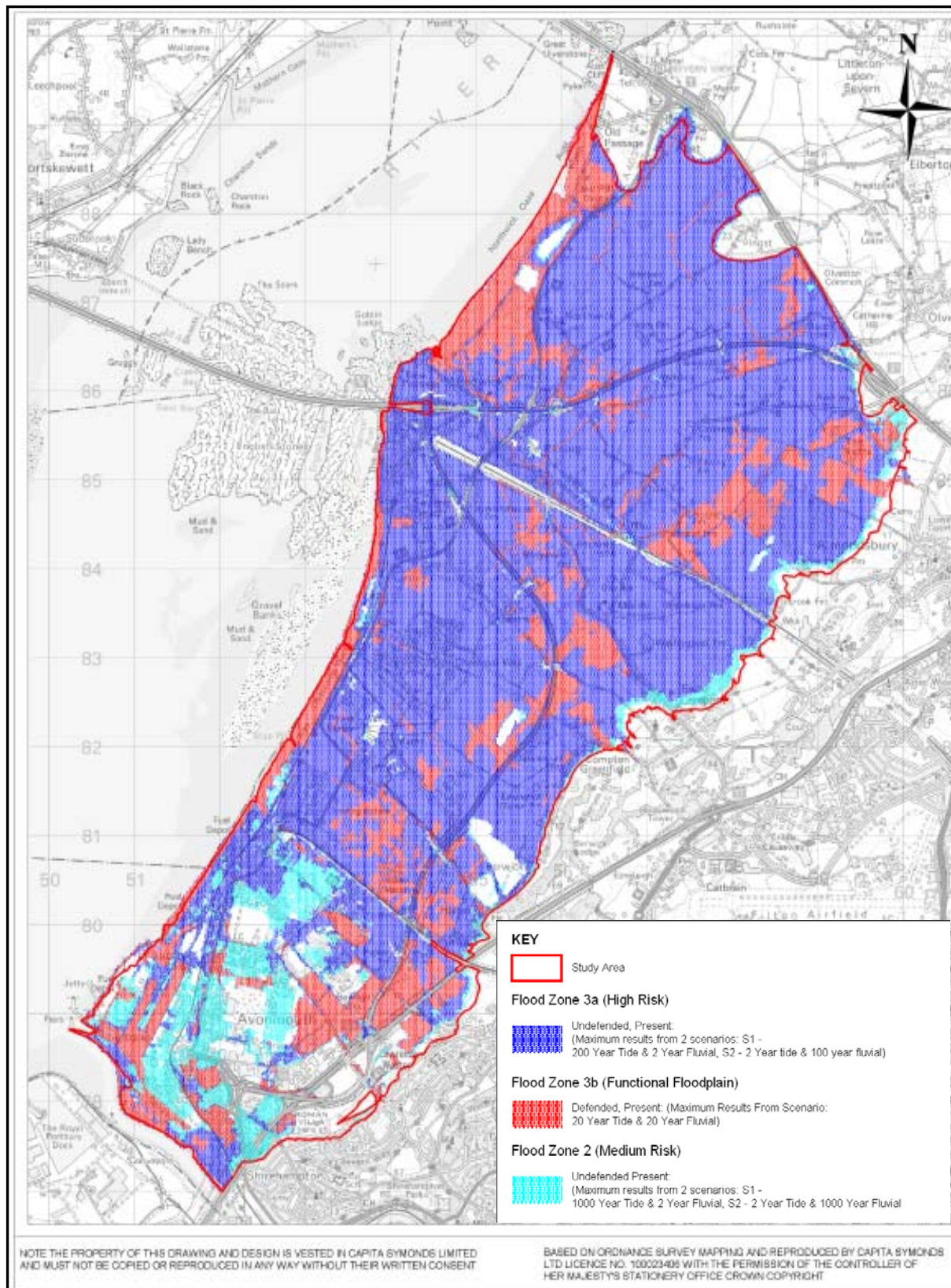


Figure 7.1 – Flood Zones (Figure 7.1 in Technical Report)

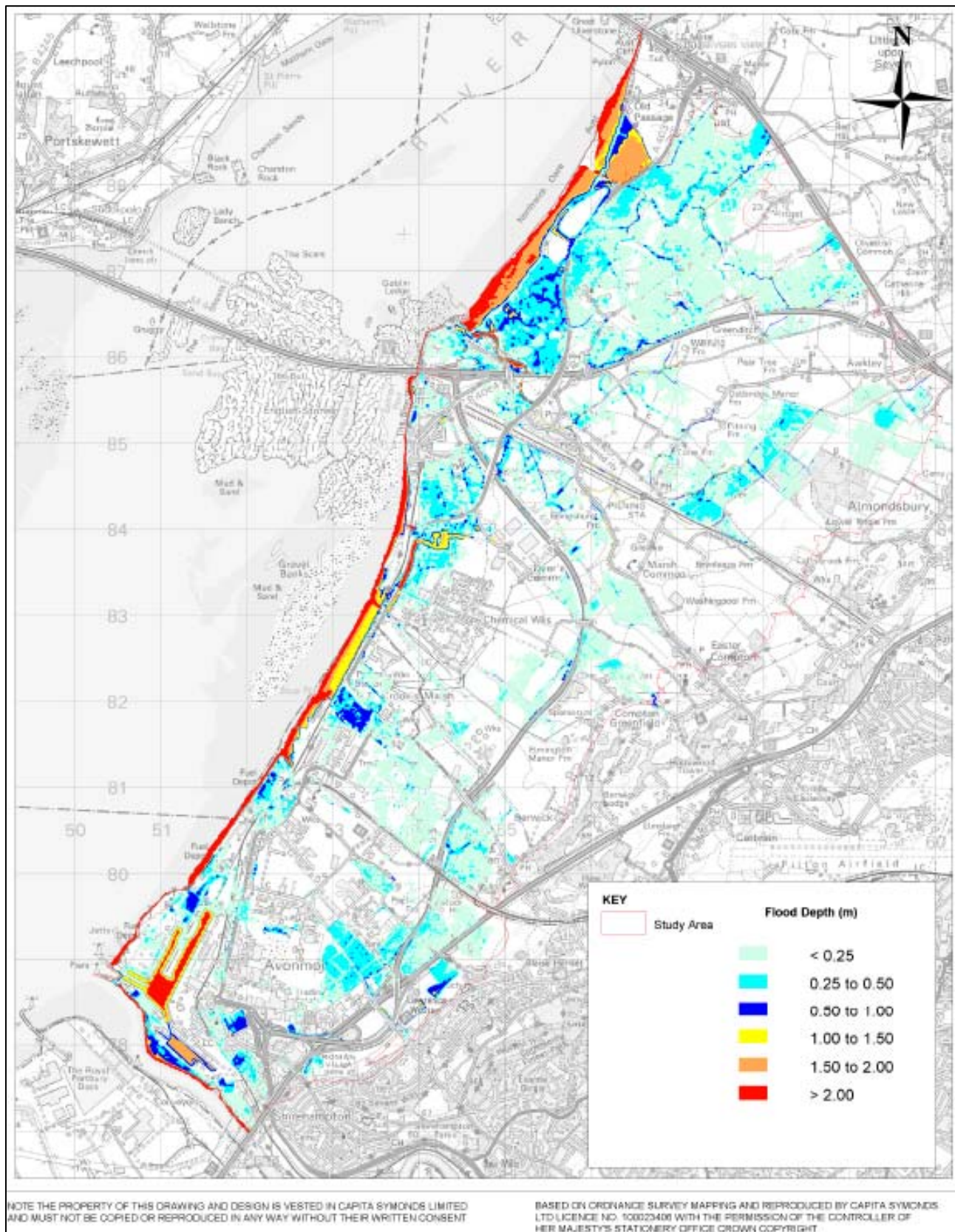


Figure 7.2a – Present Day Actual Flood Risk (Flood Depth) (Figure 7.19 in Technical Report)
(Maximum results from two scenarios 200 year tidal / 2 year fluvial and 100 year fluvial / 2 year tidal)

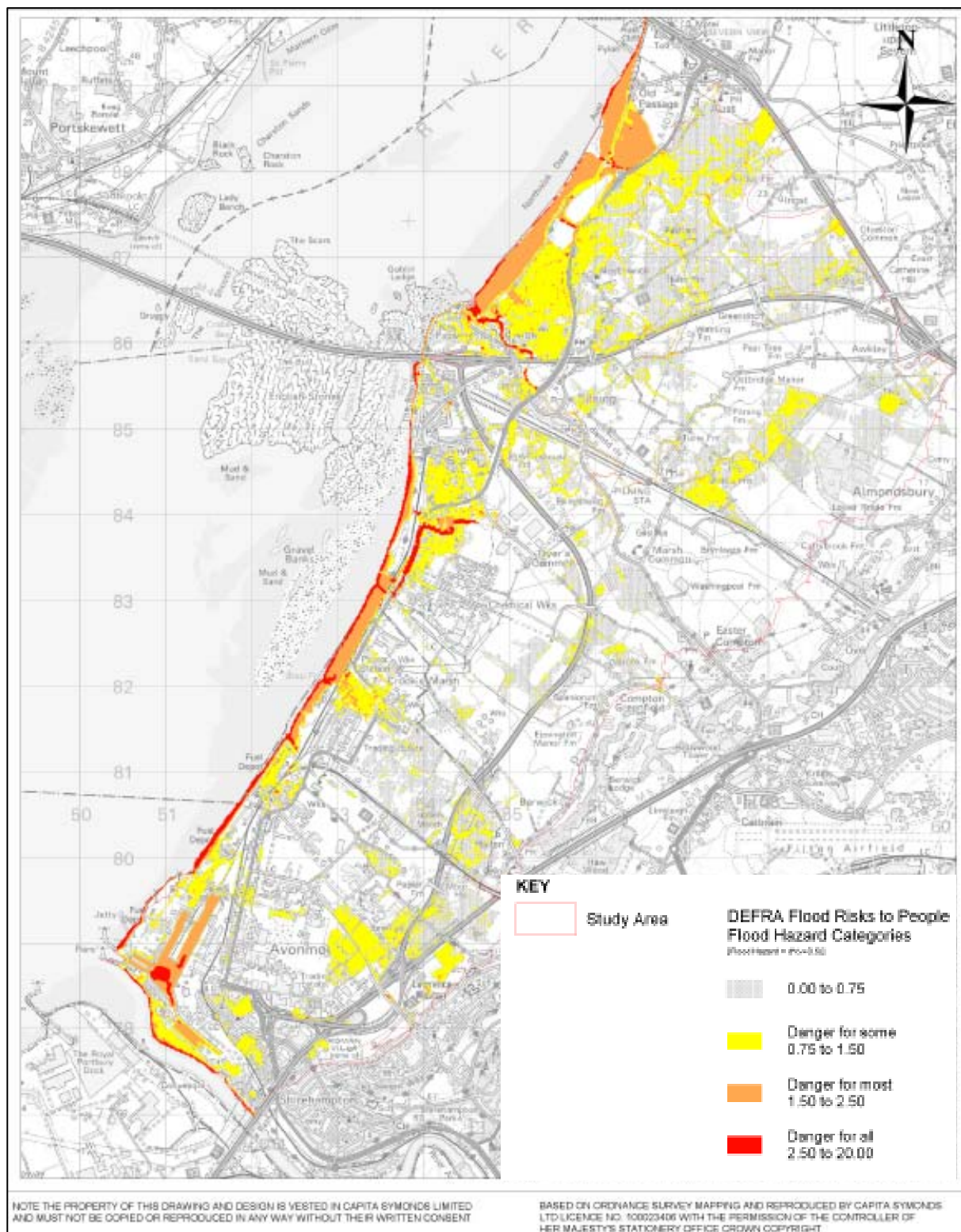


Figure 7.2b – Present Day Actual Flood Risk (Flood Hazard) (Figure 7.20 in Technical Report)
(Maximum results from two scenarios 200 year tidal / 2 year fluvial and 100 year fluvial / 2 year tidal)

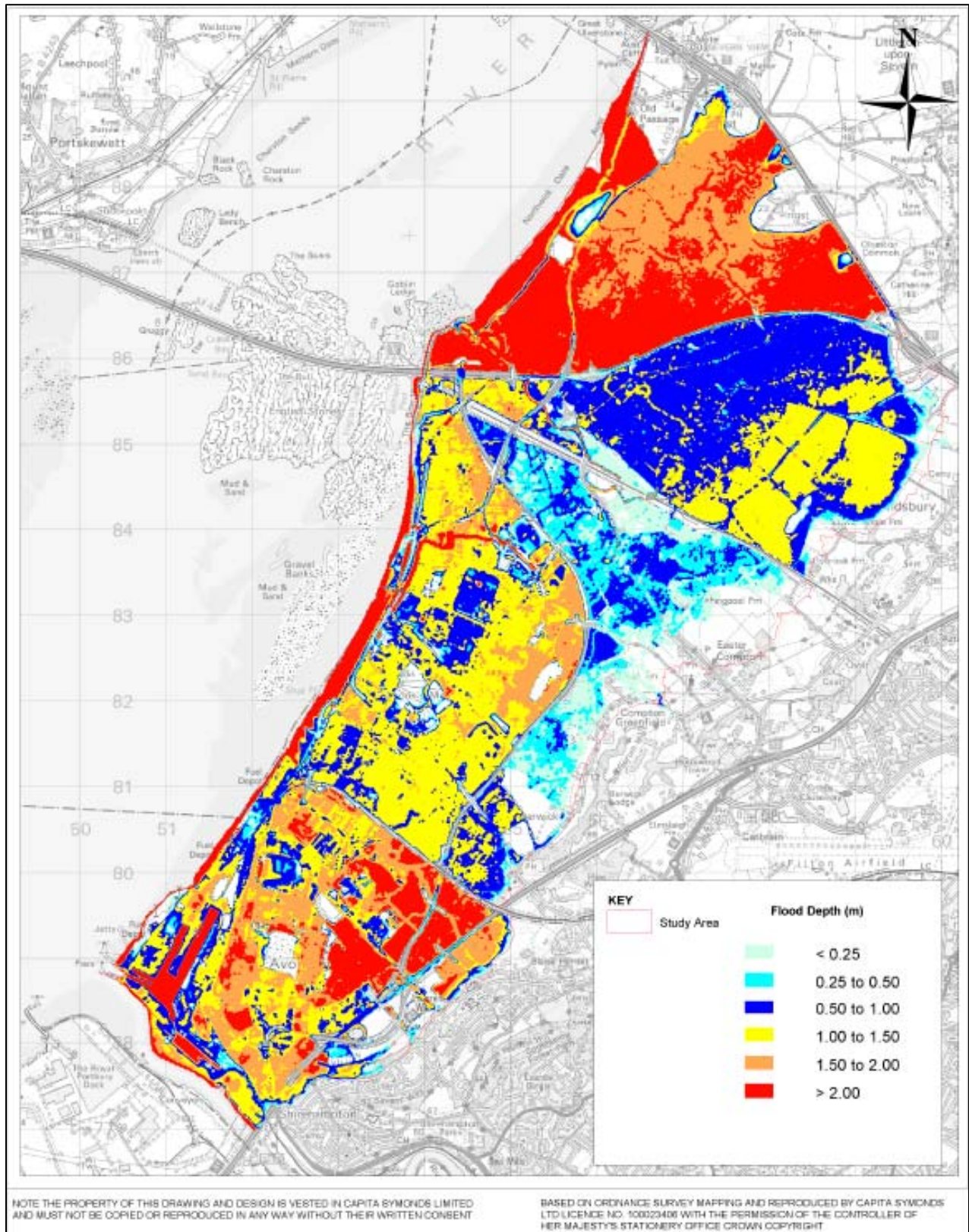


Figure 7.3a – Future (2110) Actual Flood Risk (Flood Depth) (Figure 7.3 in Technical Report)
(Maximum results from two scenarios 200 year tidal / 2 year fluvial and 100 year fluvial / 2 year tidal)

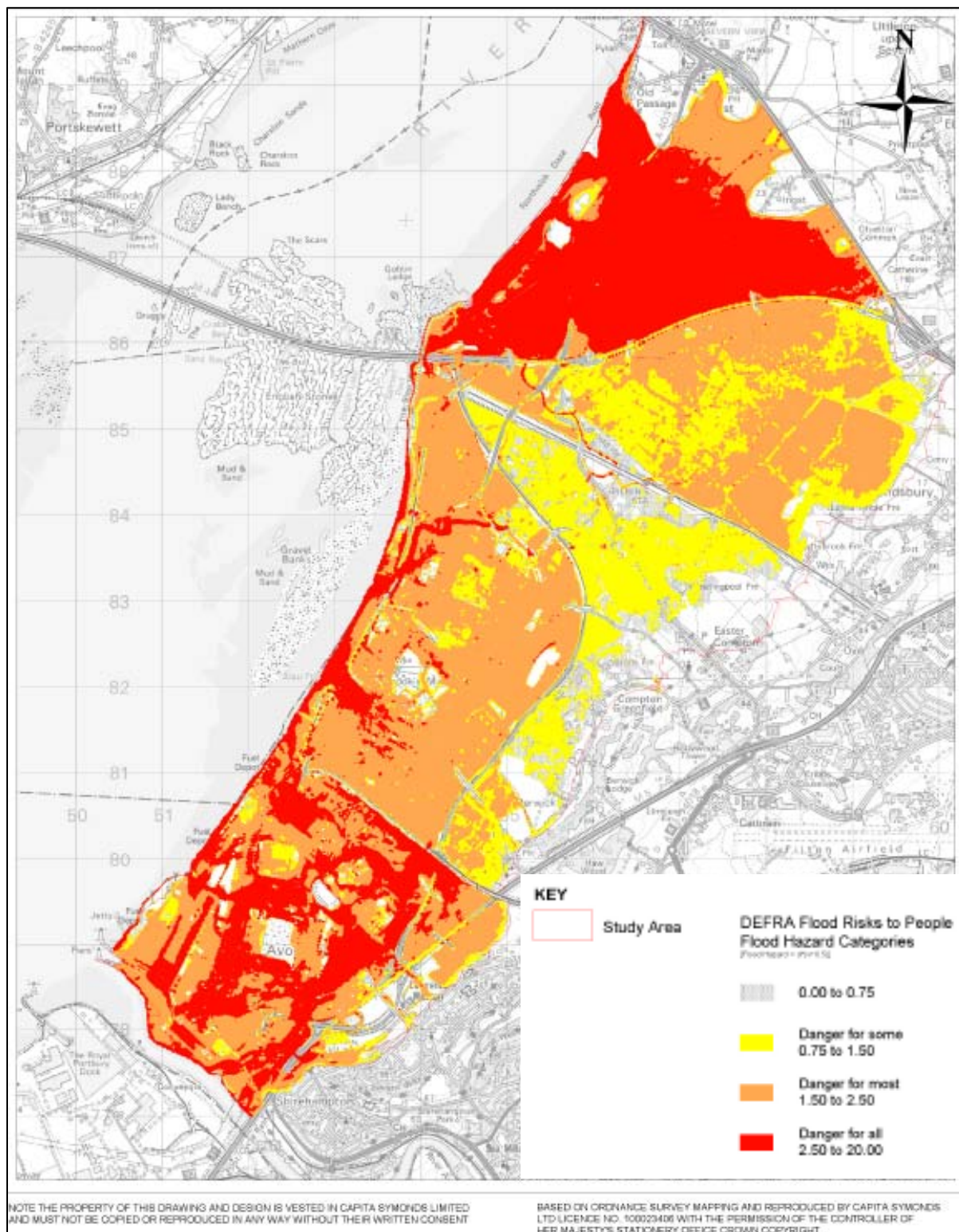


Figure 7.3b – Future (2110) Actual Flood Risk (Flood Hazard) (Figure 7.4 in Technical Report)

(Maximum results from two scenarios 200 year tidal / 2 year fluvial and 100 year fluvial / 2 year tidal)

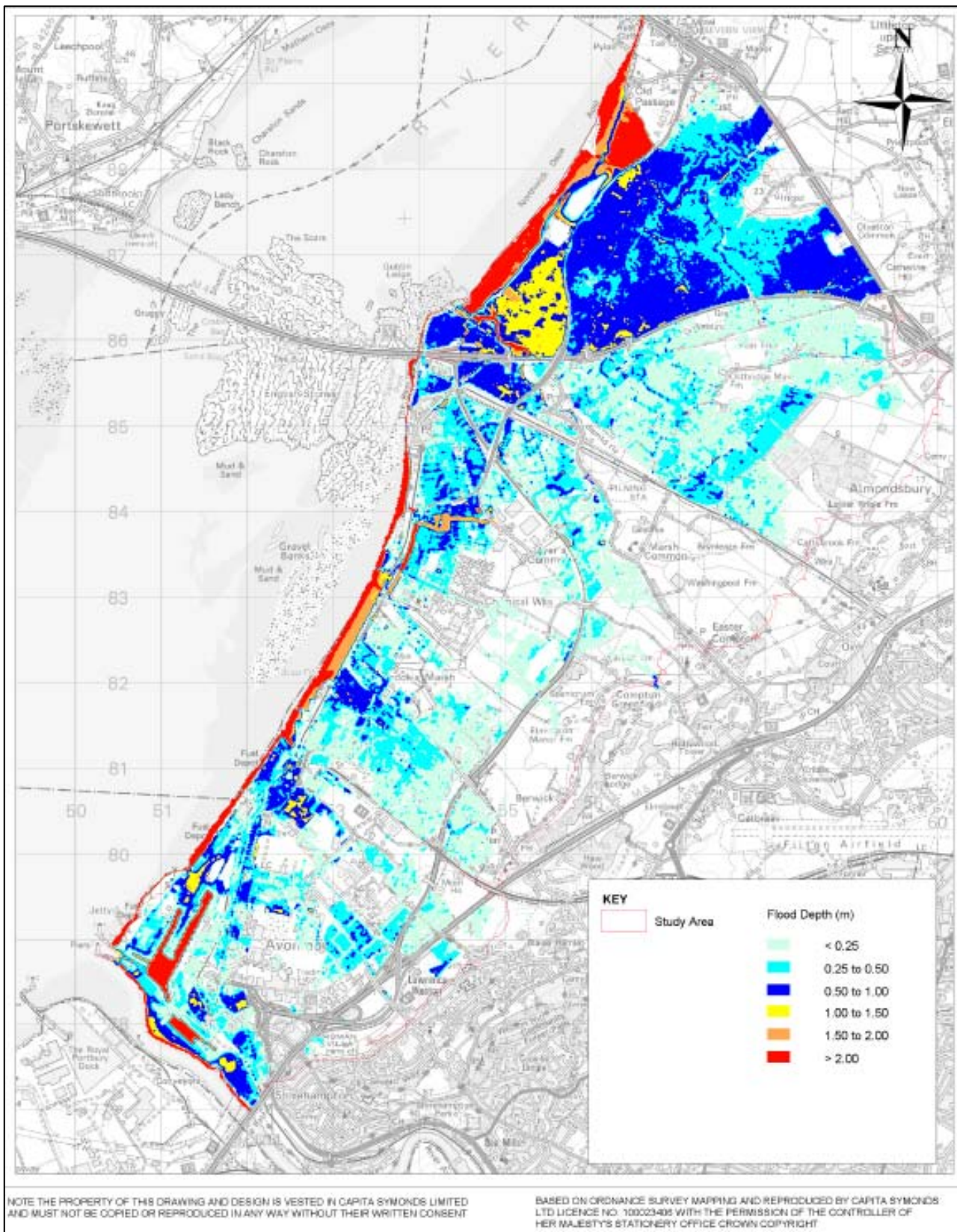


Figure 7.4a – Present Day Residual Flood Risk (0.1% AEP tidal event) (Flood Depth)
(Figure 7.21 in Technical Report)
(Maximum results from 1000 year tidal / 2 year fluvial event)

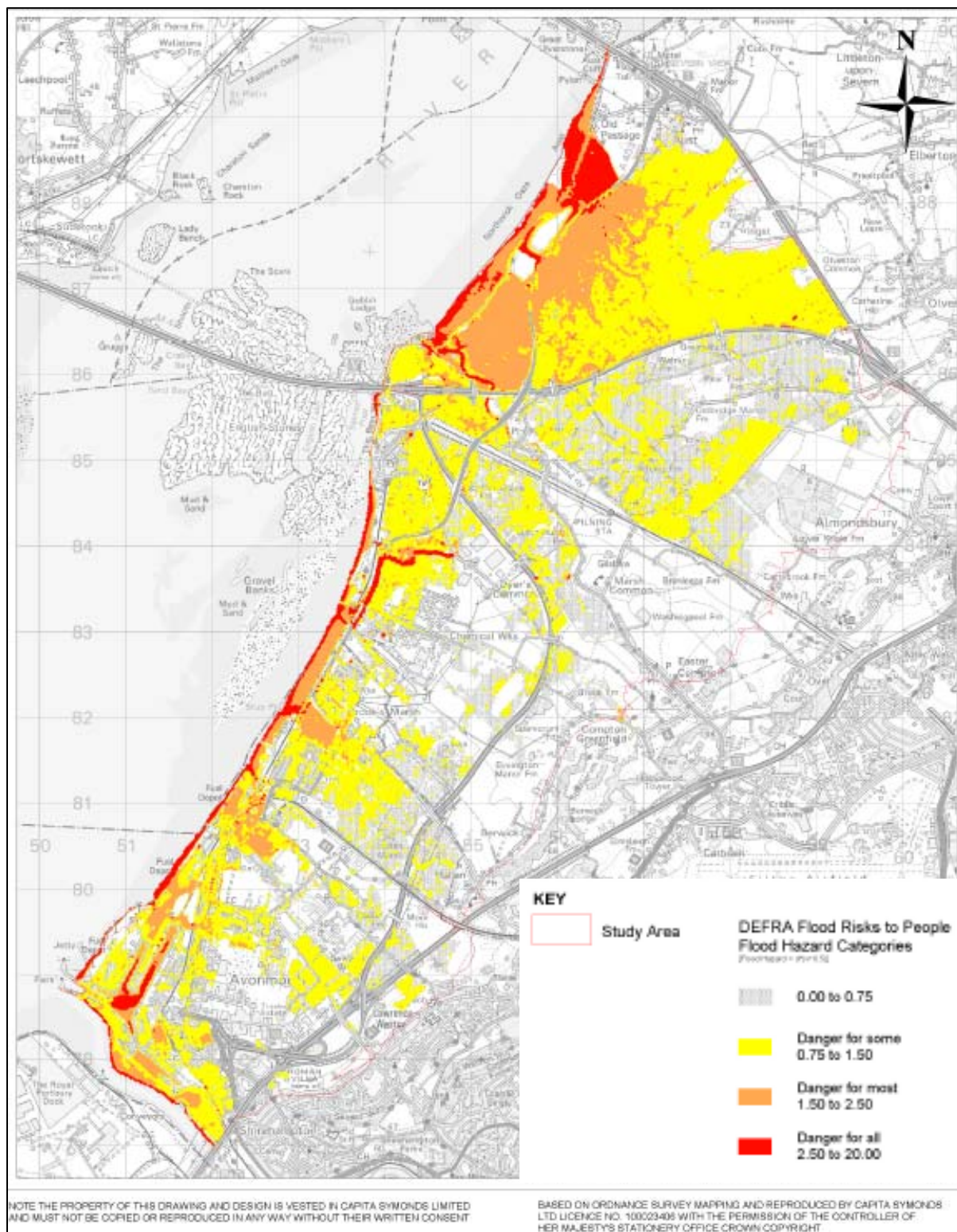


Figure 7.4b – Present Day Residual Flood Risk (0.1% AEP tidal event) (Flood Hazard)
(Figure 7.22 in Technical Report)

(Maximum results from 1000 year tidal / 2 year fluvial event)

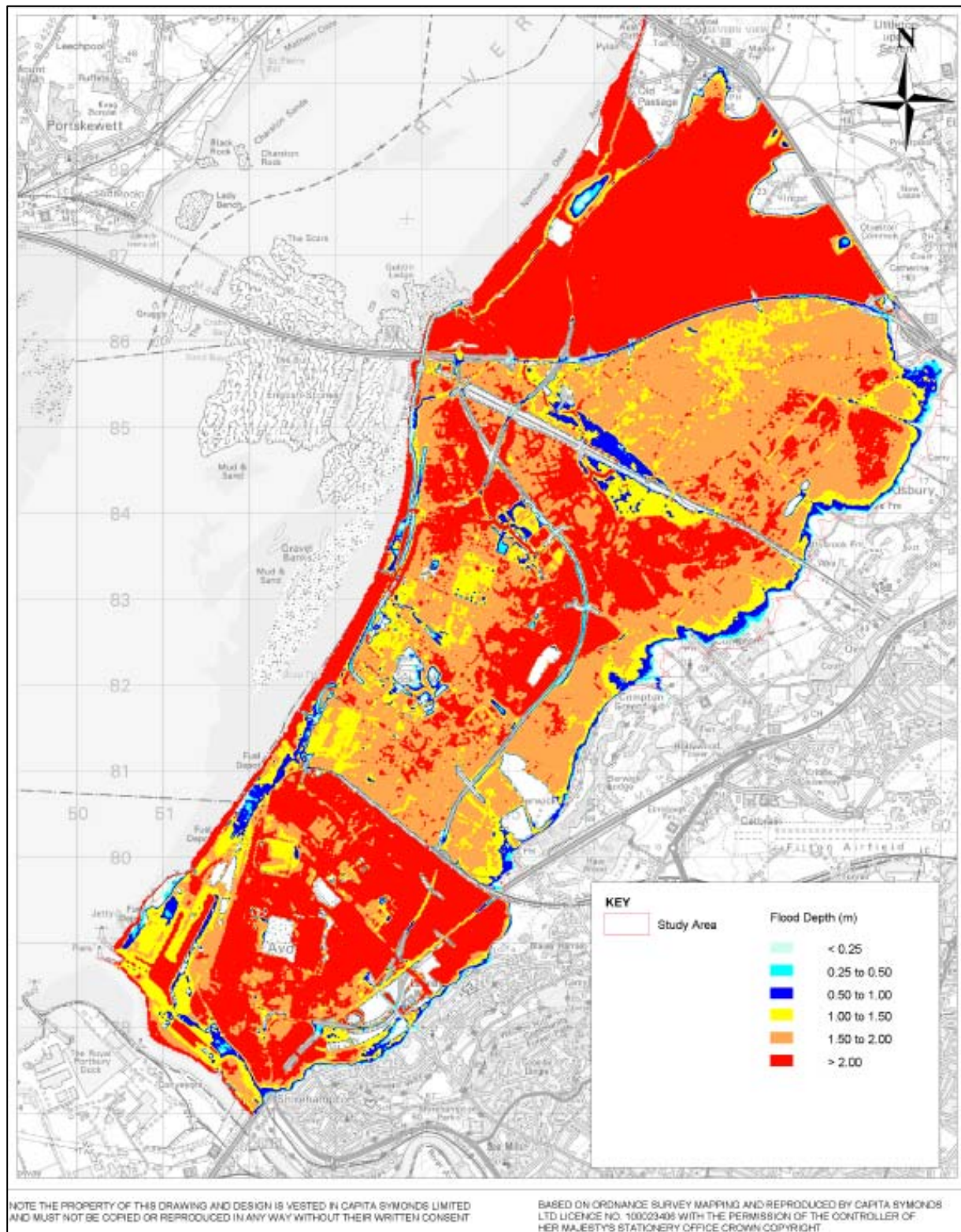


Figure 7.5a – Future (2110) Residual Flood Risk (0.1% AEP tidal event) (Flood Depth)
(Figure 7.3 in Technical Report)
(Maximum results from 1000 year tidal / 2 year fluvial event)

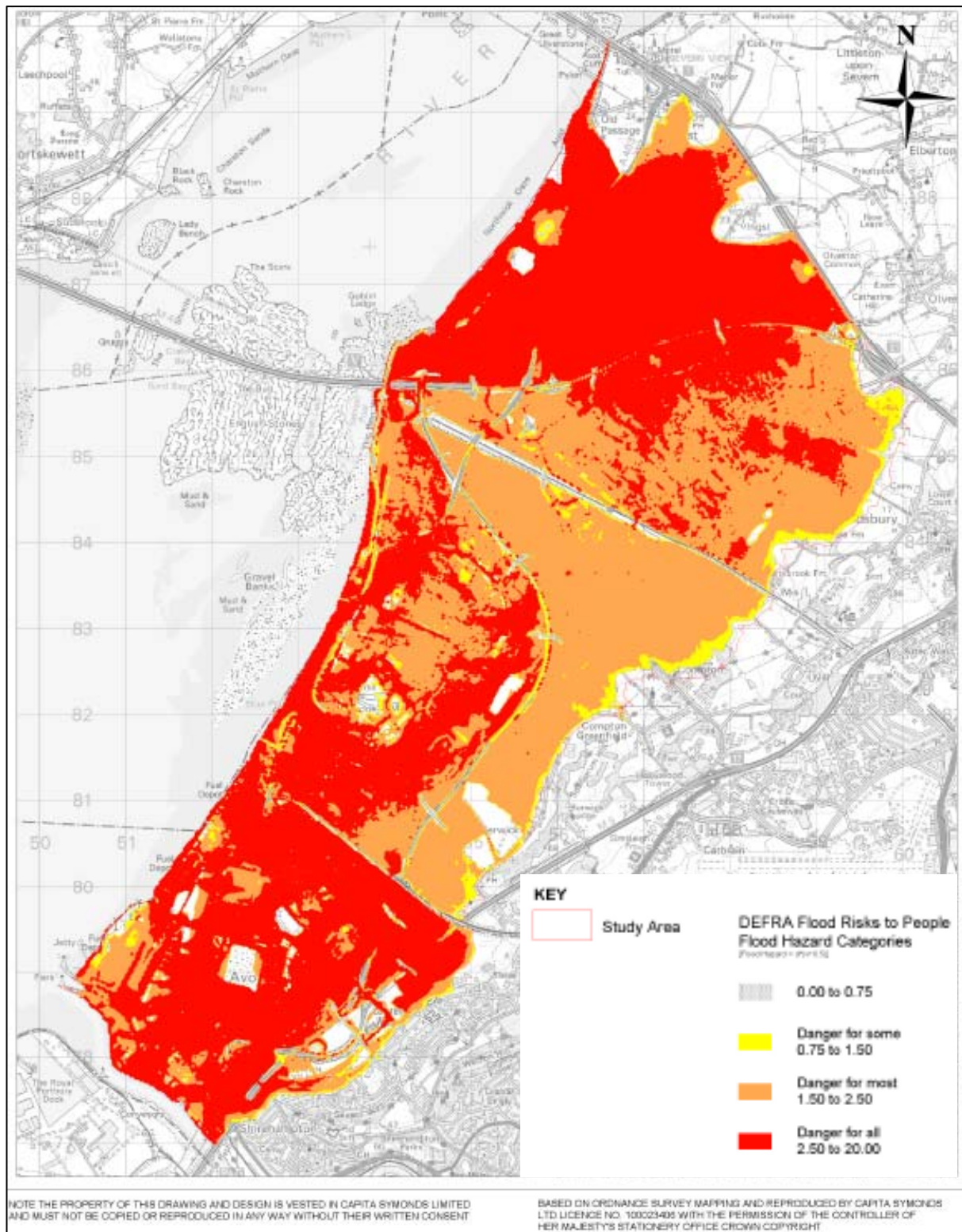
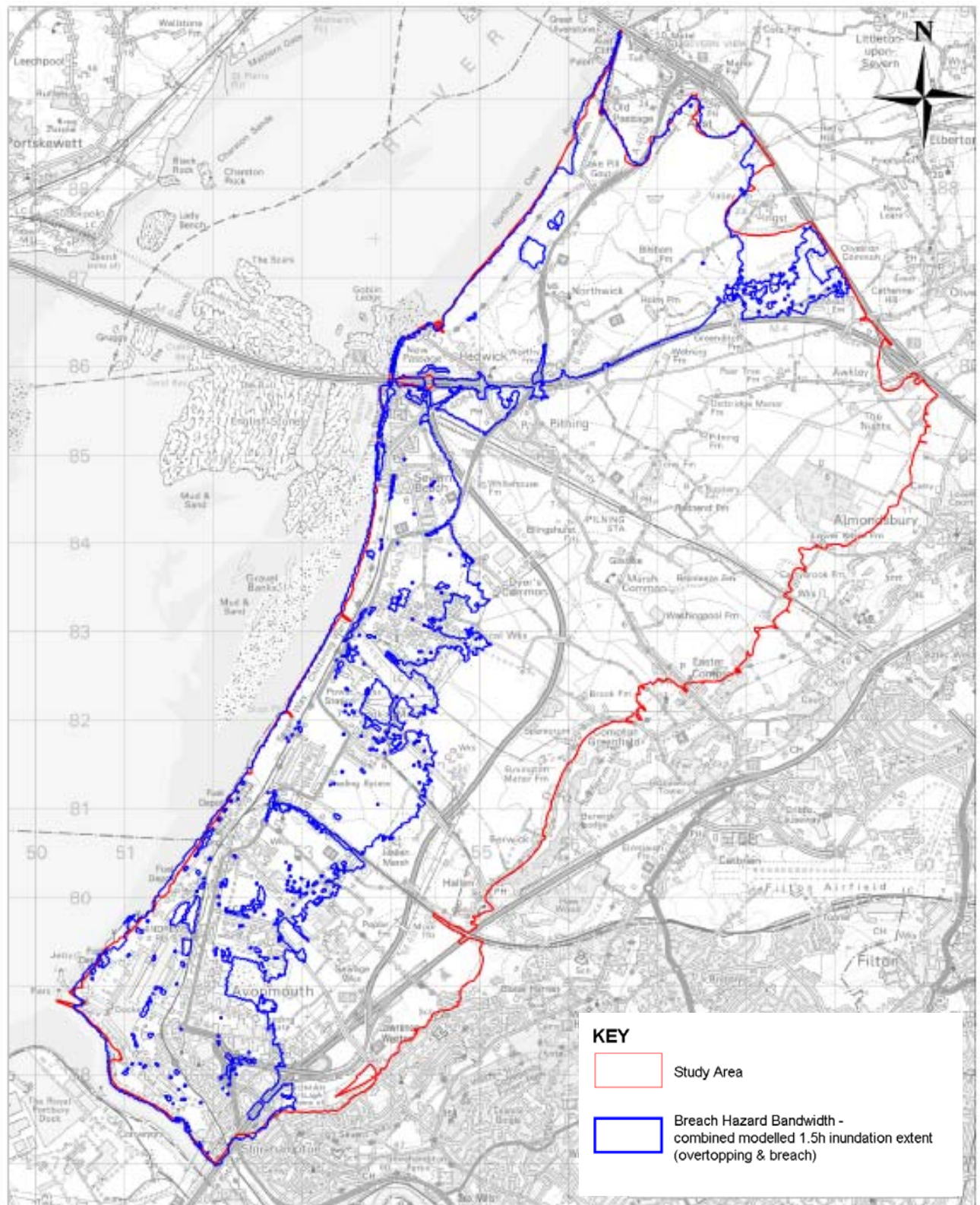


Figure 7.5b – Future (2110) Residual Flood Risk (0.1% AEP tidal event) (Flood Hazard)
(Figure 7.4 in Technical Report)
(Maximum results from 1000 year tidal / 2 year fluvial event)



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Figure 7.6 – Breach Hazard Bandwidth (Figure 7.12 from Technical Report)

8. General Guidance for using the SFRA

Land use planning

- 8.1. Table 8.1 illustrates the context for the use of flood risk information in the land use planning process. It should be noted that the guidance and information given in this Level 2 SFRA does not replace current Government Guidance, as described in PPS 25.
- 8.2. The Level 2 SFRA does not mean that FRAs are not required. It is intended that future FRAs will refer to the Level 2 SFRA data and relevant planning guidance.
- 8.3. The Level 2 SFRA will enable Bristol City Council and South Gloucestershire Council to assess their allocations for new development sites using the Sequential Test and Exception Test as required by PPS 25. The Level 2 SFRA should provide the necessary information for planners to be able to make strategic decisions that identify the amount and type of development that may be suitable, how runoff might be managed and possible options for flood management.
- 8.4. PPS 25 advocates a sequential approach to assessing flood risk. The approach is a decision making tool, which aims to develop sites at lowest risk in preference to sites at higher risk of flooding. The sequential approach should be applied at all levels of planning.

Sequential Test

- 8.5. It is recognised that flood risk information must be considered alongside other spatial planning issues. Allocations are thus “tested” on the basis of their flood risk attributes and the outcome used to inform decisions that include other spatial planning issues. This is the Sequential Test. Figure 8.1 illustrates the context for the application of the information in the Level 2 SFRA.

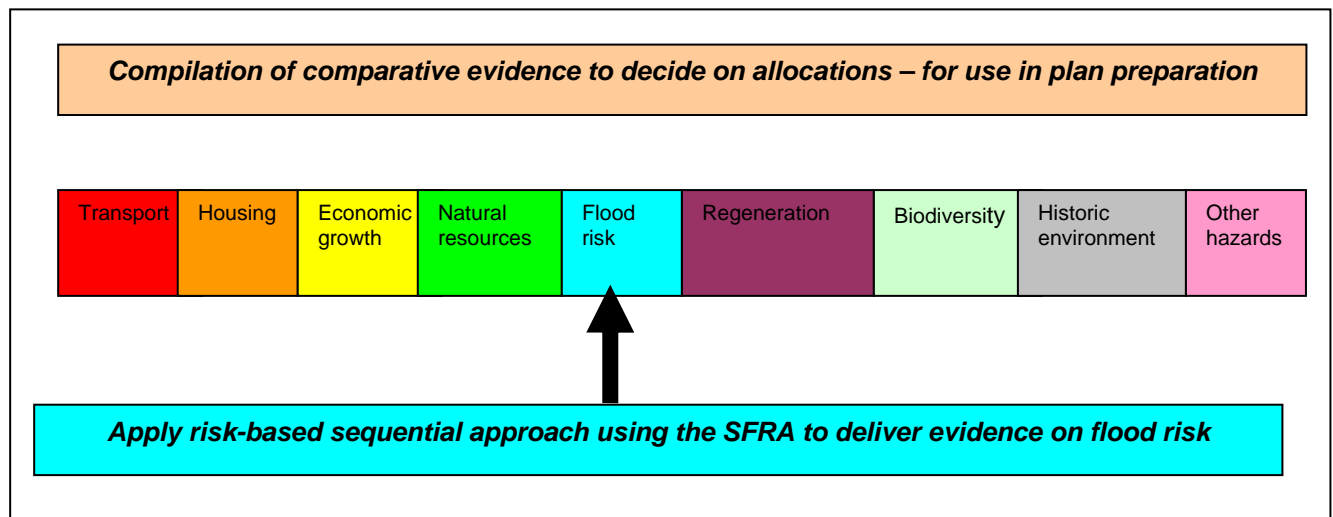
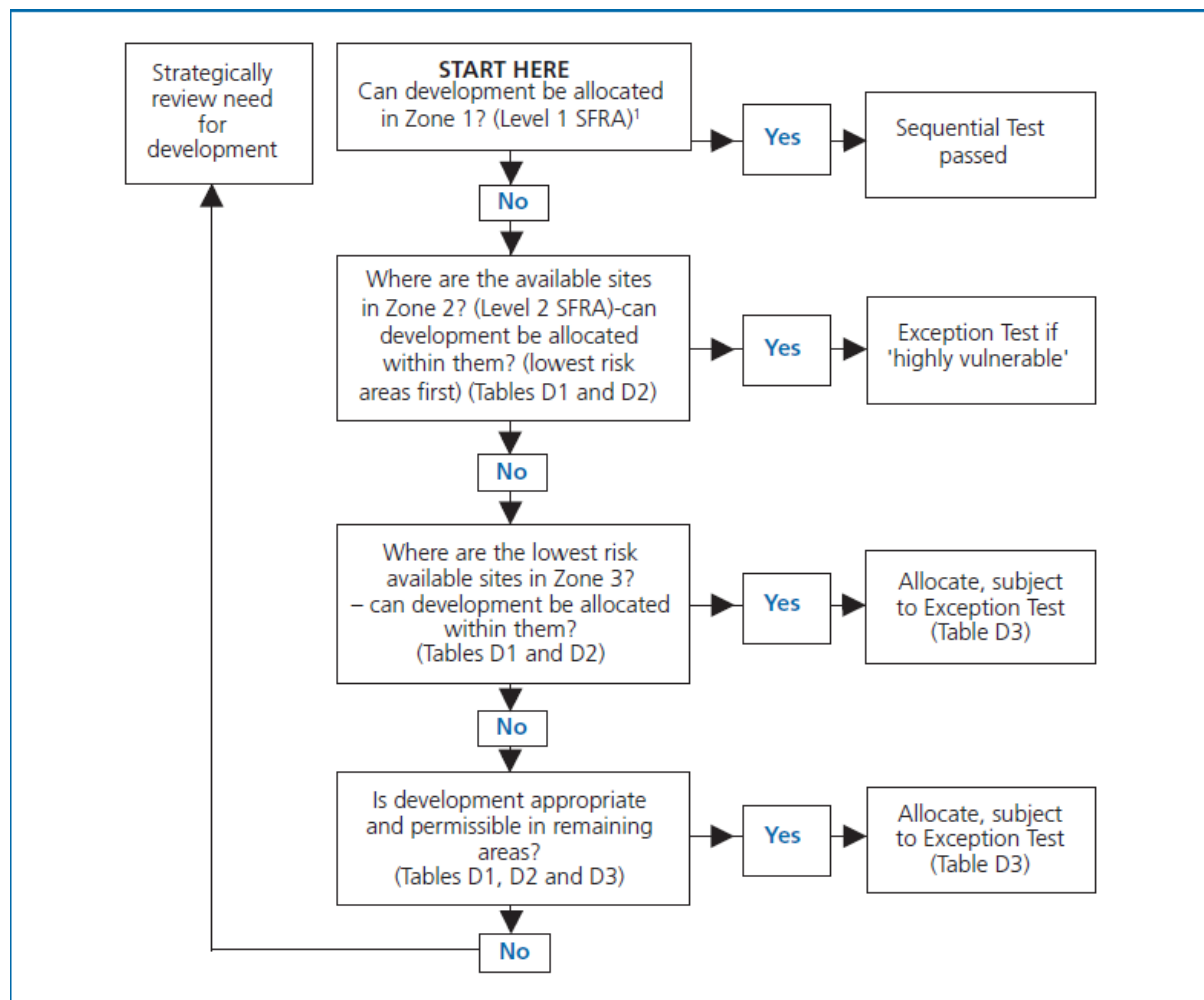


Figure 8.1 – How the risk based sequential approach informs decision-making

- 8.6. The Sequential Test should be applied when allocating land for development. The Test is applied to demonstrate that there are no reasonably available sites in areas with a lower probability of flooding, which would be appropriate to that type of development.
- 8.7. If there is no other reasonably available site within the lowest risk zone (from all sources of flooding), then the vulnerability of the proposed development can be taken into account. Proposed land uses in the Avonmouth / Severnside area mostly fall into the lower vulnerability classifications of land use as per Table D2 of PPS25. Although there may be times that proposed land use is considered that falls into one of the other vulnerability classes. For example, installations requiring hazardous substances consent are considered highly vulnerable.
- 8.8. Figure 8.2 provides a flow chart for applying the Sequential Test in determining an appropriate location for an intended landuse. This chart is supported by the Government through its inclusion in the 'Practice Guide to PPS25' (CLG 2009). It is a tool to help the decision-maker locate a proposed development in lower flood risk categories.
- 8.9. The guidance provided in these tools should ideally be agreed by the Environment Agency and BCC / SGC. It is important that the decision maker engages key stakeholders early in the decision making process. It is also important to consider uncertainty of information when making land use planning decisions.



Note

¹ Other sources of flooding need to be considered in Flood Zone 1

Figure 8.2 Application of the Sequential Test (Source: CLG 2009)

Exception Test

8.10. Following the application of the Sequential Test, if it is not possible for the development to be located in zones of lower risk, and it is consistent with wider sustainability objectives, the Exception Test can be applied in accordance with table D3 and paragraphs D9 to D14 of PPS 25. The Test provides a method of managing flood risk while still allowing necessary development to occur. It may not always be appropriate to apply the Exception Test, and if applied all three elements must be passed.

8.11. The three elements of the Exception Test are, in summary²;

- It must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk.
- The development must be on developable previously developed land or, if it is not on previously developed land, that there are no reasonably alternative sites on developable previously developed land (i.e. no reasonably alternative 'brownfield' sites exist).
- A site specific flood risk assessment must demonstrate that the development will be safe, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.

8.12. PPS25 requires all six forms of flooding (river, sea, land, groundwater, sewer and artificial sources) to be considered when making land planning decisions. The Level 2 SFRA technical report provides information on the primary sources of flooding at Avonmouth / Severnside (i.e. tidal and fluvial flooding). Tidal flooding poses the over-riding risk for the Avonmouth / Severnside area.

8.13. PPS25 also requires the vulnerability of different land uses to flooding to be considered when making land-planning decisions. The land uses in the Avonmouth / Severnside area will cover a range of vulnerability classifications of land use as per Table D2 of PPS25 (essential infrastructure, highly vulnerable, more vulnerable, less vulnerable and water compatible).

8.14. The Flood Risk Matrix shown in Table 8.1 provides generic decision support in relation to the two main sources of flooding and potential land uses for the Avonmouth / Severnside Level 2 SFRA. This expands upon Table D3 of PPS25 by providing additional guidance on the likely criteria for development in each combination of landuse and flood hazard.

8.15. The following generic steps must be undertaken when considering land-use allocation proposals:

- Assess the requirement with reference to the flood risk matrix and Figures 7.1 - 7.6;
- Consult with the Environment Agency;
- Determine where necessary the requirement for more detailed studies based on areas of high risk (where receptors must be located in higher probability flood

² Refer to PPS25 paragraph D9 – D14 for full details

zones) and where information is too uncertain for an effective land use planning decision to be made;

- Where land use is planned in areas of higher probability flood risk, use the SFRA to test the proposed application against the Exception Test (see PPS25 Table D1).
- Consult with the Environment Agency if necessary to discuss the appropriateness of development proposals and the adequacy of mitigation measures.

8.16. The advice given in the flood risk matrix table 8.1 should be considered as over arching guidance and it is important to note that there may be local circumstances that justify some deviation from the standard advice. In this instance consultation with the Environment Agency would be required to agree the planning considerations for individual developments.

Breach Hazard Bandwidth

8.17. Due to the potentially high flood hazard posed by a breach in defences at Avonmouth Severnside, the breach hazard bandwidth has been identified as an additional flood zone. This represents the area in which particularly high velocities and speed of inundation would be expected during a defence breach. The breach hazard bandwidth is shown in Figure 7.6.

8.18. An extended flood zone 3a policy is recommended for the breach hazard bandwidth. In addition to the standard flood zone 3a requirements the extended policy should require an Exception Test for all types of development within the breach hazard bandwidth and should also limit development to water compatible and less vulnerable development types only. At all locations at risk of breach (including those outside the defined bandwidth) FRAs will need to assess the risk of breach in more detail and also consider mitigation within the design of the building.

Existing allocations & Windfall Sites

8.19. Any currently allocated sites that have not been Sequentially tested by the LPA, together with any new (windfall) sites that developers bring forward will need to be sequentially tested by the developer. In all cases, the Sequential Test must be performed in an open and transparent manner, in advance of the Exception Test if

required. The LPA, along with the Environment Agency, will be responsible for overseeing the process, and for evaluation of the submission by the developer.

Flood Risk Matrix

8.20. The Flood Risk Matrix shown on the following pages provides generic decision support in relation to the two main sources of flooding and potential land uses for the Avonmouth / Severnside Level 2 SFRA. This expands upon Table D3 of PPS25 by providing additional guidance on the likely criteria for development in each combination of landuse and flood hazard.

8.21. The matrix is divided into the following sections:

8.22. *Flood Zones* – Use this section of the matrix to assess whether a proposed development is appropriate at a site (refer to Figure 7.1 to determine which flood zone the site lies within) OR to assess which types of development would be appropriate for a particular site. This section of the matrix also provides advice on the planning requirements for development, such as the need for FRAs and application of the Exception Test.

8.23. *Actual Risk* – This refers to flood risk taking into account the presence of defences assuming they work as they are supposed to. Use this section of the matrix to assess whether a proposed development will be safe in accordance with PPS25 requirements and to check who else should be consulted. This is particularly important when development is proposed subject to the Exception Test. Refer to Figures 7.2 – 7.5 in conjunction with the matrix. The assessment should consider flood risk for the lifetime of the development so it is important to consider the advice & maps for the present day and future scenarios. The ‘future’ scenario considered in the SFRA is for the year 2110.

8.24. *Residual Risk* – This refers to flood risk considering what would happen if defences fail. A major residual risk for Avonmouth / Severnside is a breach in the flood defences. The breach hazard bandwidth (refer to Figure 7.6) has been defined to show areas particularly vulnerable to rapid inundation (< 1.5 hours) due to a breach. Specific advice is provided in the matrix for development that lies within this bandwidth.

- 8.25. All the potential flood risk scenarios must be considered when making planning decisions and there is no set weight given to a particular component. The weight placed on each component will vary between development proposals according to the vulnerability of the development to specific types of flooding.
- 8.26. The Bristol City Council / South Gloucestershire Council SFRAs should be referred to for guidance related to other sources of flooding (surface water, groundwater, sewers and artificial sources).
- 8.27. FRAs are required for all developments in Flood Zone 2, 3a and 3b, and all developments larger than 1ha in Flood Zone 1. FRAs for development in Flood Zone 1 should assess the vulnerability to flooding from other sources and the potential to increase flooding through addition of hard surfaces. FRAs should conform with guidance in PPS25 Appendix E and the Practice Guide. FRAs should demonstrate no increase in runoff from existing levels / surface water management in accordance with IDb drainage strategy and appropriate use of SuDS. Particular items requiring consideration include: likelihood & consequence of defence failure; impact of M49 culvert blockage; safe access & egress; impact of ground raising / new access routes on flood risk to existing developments
- 8.28. Strategic mitigation solutions considered for Avonmouth / Severnside include: Defence improvements; new / improved access routes; property resilience / resistance measures / local defence schemes; flood warning / event management; land raising; and improvements to the rhine network.

Table 8.1 Flood Risk Matrix

Flood Zones - Use this section of the matrix to assess whether a proposed development is appropriate at a site (refer to Figure 7.1 to determine which flood zone the site lies within) OR to assess which types of development would be appropriate for a particular site. This section of the matrix also provides advice on the planning requirements for development, such as the need for FRAs and application of the Exception Test.

Description				Essential Infrastructure	Highly Vulnerable	More Vulnerable	Less Vulnerable	Water Compatible Development	Minor Development / Change of Use
Development Types				<ul style="list-style-type: none">Essential transport infrastructure and mass evacuation routes (which has to cross the area at risk);Essential utility infrastructure which has to be located in a flood risk area for operational reasons, including electricity generating power stations and grid and primary substations; and water treatment works that need to remain operational in times of flood;Wind Turbines.	<ul style="list-style-type: none">Police, Ambulance and Fire Stations, Command Centres and telecommunications installations required to be operational during flooding;Emergency dispersal points;Basement dwellings;Caravans, mobile and park homes intended for permanent residential use;Installations requiring hazardous substance consent (where there is a demonstrable need to locate such installations for bulk storage of materials with port or other similar facilities, or such installations with energy infrastructure or carbon capture and storage installations, that require coastal or water-side locations, or need to be located in other high flood risk areas, in these instances the facilities should be classified as Essential Infrastructure).	<ul style="list-style-type: none">Hospitals;Residential Institutions such a residential care homes, children’s homes, social services homes, prisons and hostels;Buildings used for: dwelling houses; student halls of residence; drinking establishments; nightclubs and hotels;Non-residential uses for health services, nurseries and educational establishments.Landfill and sites used for waste management facilities for hazardous waste;Sites used for holiday or short-let caravans and camping, subject to a specific warning and evacuation plan.	<ul style="list-style-type: none">Police, Ambulance and fire stations not required to be operational during flooding;Buildings used for: shops, financial, professional and other services; restaurants and cafes; hot food takeaways; offices; general industry; storage and distribution; non-residential institutions not included in ‘more vulnerable’; and assembly and leisure.Land and buildings used for agriculture and forestry;Waste treatment (except landfill and hazardous waste);Minerals working and processing (except sand and gravel working);Water treatment works which do not need to remain operational during times of flood;Sewage treatment works (if adequate measures to control pollution and manage sewage during flooding events are in place).	<ul style="list-style-type: none">Flood control infrastructure;Water transmission infrastructure and pumping stations;Sewage transmission infrastructure and pumping stations;Sand and gravel workings;Docks, marinas and wharfs;Navigation facilities;MOD defence installations;Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside locationWater based recreation (excluding sleeping accommodation);life / coastguard stations;amenity / open space, nature conservation and biodiversity, outdoor sports and recreation and essential facilities such as changing rooms;Essential ancillary sleeping or residential accommodation for staff required by uses in this category (subject to a specific flood warning and evacuation plan).	<ul style="list-style-type: none">Non residential extensions < 250m;Alterations with no increase in size;‘Householder’ developments e.g. extensions sheds, garages (EXCLUDES creating separate dwellings)
Flood Zone 1	<div>Frequency and Severity of Flooding</div> <div></div>	Risk based Sequential Test – new development should be directed first to sites at the lowest probability of flooding and the flood vulnerability of the intended use matched to the flood risk of the site.	Development is appropriate subject to the Sequential Test. FRA & Surface Water Management required for developments > 1ha in accordance with PPS25 (review other sources of flooding).						
Flood Zone 2			Development is appropriate subject to the Sequential Test. Opportunities should be sought to reduce overall risk by layout and form of development and management of surface water runoff. Must remain operational during an extreme flood event. Refer to FRA requirements and strategic options.	Development should only be considered subject to the Sequential & Exception Tests. Refer to FRA requirements and strategic mitigation options.	Development is appropriate subject to the Sequential Test. Opportunities should be sought to reduce overall risk by layout and form of development and management of surface water runoff. Must remain safe during an extreme flood event. Refer to FRA requirements and strategic options.	Development is appropriate subject to the Sequential Test. Opportunities should be sought to reduce overall risk by layout and form of development and management of surface water runoff. Must remain safe during an extreme flood event. Refer to FRA requirements and strategic options.	Development is appropriate subject to the Sequential Test. Opportunities should be sought to reduce overall risk by layout and form of development and management of surface water runoff. Must remain operational during an extreme flood event. Refer to FRA requirements and strategic options.	Development is appropriate subject to the sequential test. Refer to EA standing advice.	
Flood Zone 3a			Development should only be considered subject to the Sequential & Exception Tests. Refer to FRA requirements and strategic mitigation options.	Development should not be permitted.	Development should only be considered subject to the Sequential & Exception Tests. Refer to FRA requirements and strategic mitigation options.	Development is appropriate subject to the Sequential Test. Opportunities should be sought to reduce overall risk by layout and form of development; relocation of development to lower risk zones; and management of surface water runoff; and create space for flooding. Refer to FRA requirements & strategic mitigation options.	Development is appropriate subject to the Sequential Test. Opportunities should be sought to reduce overall risk by layout and form of development; relocation of development to lower risk zones; and management of surface water runoff; and create space for flooding. Refer to FRA requirements & strategic mitigation options.		
Flood Zone 3b			Development should only be considered subject to the Sequential & Exception Tests. Refer to FRA requirements and strategic mitigation options.	Development should not be permitted.	Development should not be permitted.	Development should not be permitted	Development may be appropriate subject to the Sequential Test. Refer to FRA requirements and strategic mitigation advice.		

Actual Risk – This refers to flood risk taking into account the presence of defences assuming they work as they are supposed to. Use this section of the matrix to assess whether a proposed development will be safe in accordance with PPS25 requirements and to check who else should be consulted. This is particularly important when development is proposed subject to the Exception Test. Refer to Figures 7.2 – 7.5 in conjunction with the matrix. The assessment should consider flood risk for the lifetime of the development so it is important to consider the advice & maps for the present day and future scenarios. The 'future' scenario considered in the SFRA is for the year 2110.

Description			Essential Infrastructure	Highly Vulnerable	More Vulnerable	Less Vulnerable	Water Compatible Development	Minor Development / Change of Use
Development Types			<ul style="list-style-type: none"> Essential transport infrastructure and mass evacuation routes (which has to be located in a flood risk area for operational reasons, including electricity generating power stations and grid and primary substations; and water treatment works that need to remain operational in times of flood; Wind Turbines. 	<ul style="list-style-type: none"> Police, Ambulance and Fire Stations, Command Centres and telecommunications installations required to be operational during flooding; Emergency dispersal points; Basement dwellings; Caravans, mobile and park homes intended for permanent residential use; Installations requiring hazardous substance consent (where there is a demonstrable need to locate such installations for bulk storage of materials with port or other similar facilities, or such installations with energy infrastructure or carbon capture and storage installations, that require coastal or water-side locations, or need to be located in other high flood risk areas, in these instances the facilities should be classified as Essential Infrastructure). 	<ul style="list-style-type: none"> Hospitals; Residential Institutions such a residential care homes, children's homes, social services homes, prisons and hostels; Buildings used for: dwelling houses; student halls of residence; drinking establishments; nightclubs and hotels; Non-residential uses for health services, nurseries and educational establishments. Landfill and sites used for waste management facilities for hazardous waste; Sites used for holiday or short-let caravans and camping, subject to a specific warning and evacuation plan. 	<ul style="list-style-type: none"> Police, Ambulance and fire stations not required to be operational during flooding; Buildings used for: shops, financial, professional and other services; restaurants and cafes; hot food takeaways; offices; general industry; storage and distribution; non-residential institutions not included in 'more vulnerable'; and assembly and leisure. Land and buildings used for agriculture and forestry; Waste treatment (except landfill and hazardous waste); Minerals working and processing (except sand and gravel working); Water treatment works which do not need to remain operational during times of flood; Sewage treatment works (if adequate measures to control pollution and manage sewage during flooding events are in place). 	<ul style="list-style-type: none"> Flood control infrastructure; Water transmission infrastructure and pumping stations; Sewage transmission infrastructure and pumping stations; Sand and gravel workings; Docks, marinas and wharfs; Navigation facilities; MOD defence installations; Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location Water based recreation (excluding sleeping accommodation); life / coastguard stations; amenity / open space, nature conservation and biodiversity, outdoor sports and recreation and essential facilities such as changing rooms; Essential ancillary sleeping or residential accommodation for staff required by uses in this category (subject to a specific flood warning and evacuation plan). 	<ul style="list-style-type: none"> Non residential extensions < 250m; Alterations with no increase in size; 'Householder' developments e.g. extensions sheds, garages (EXCLUDES creating separate dwellings)
Actual Risk	Present day flood depth & flood hazard.		Consult EA; Infrastructure company; Emergency Services & Emergency Planners. Development should remain operational during an extreme (1000 year flood event). Check climate change impacts.	<p>Development should remain safe in accordance with PPS25. Consult EA; Emergency Services & Emergency Planners. Check climate change impacts.</p> <p>In areas of hazard rating 'Danger for Some', Highly Vulnerable development for use by children, the elderly and infirm is not advised.</p> <p>In areas of hazard rating 'Danger for most', Highly Vulnerable development for use by the general public is not advised.</p> <p>In areas of hazard rating 'Danger for all', Highly Vulnerable development is not advised.</p>	<p>Development should remain safe in accordance with PPS25. Consult EA; Emergency Services & Emergency Planners. Check climate change impacts.</p> <p>In areas of hazard rating 'Danger for some', More vulnerable development for use by children, the elderly and infirm is not advised</p> <p>In areas of hazard rating 'Danger for most', More Vulnerable development for use by the general public is not advised.</p> <p>In areas of hazard rating 'Danger for all', More Vulnerable development is not advised</p>	<p>Development should remain safe in accordance with PPS25. Consult EA; Emergency Services & Emergency Planners. Check climate change impacts.</p> <p>In areas of hazard rating 'Danger for some' Less Vulnerable development for use by children, the elderly and infirm is not advised</p> <p>In areas of hazard rating 'Danger for most', Less Vulnerable development for use by the general public is not advised</p> <p>In areas of hazard rating 'Danger for all', Less Vulnerable development is not advised</p>	Consult EA; Emergency Services & Emergency Planners. Development should remain operational during an extreme (1000 year flood event). Check climate change impacts	Refer to EA Standing advice.
	Future flood depth & flood hazard.	NB: Does not account for future defence improvements.	Consult EA; Infrastructure company; Emergency Services & Emergency Planners. Development should remain operational during an extreme (1000 year) flood event for the lifetime of the development. Consult EA / LA to determine impact of future FRM strategies on actual risk.	<p>Development should remain safe in accordance with PPS25. Consult EA; Emergency Services & Emergency Planners.</p> <p>Consult EA / LA to determine impact of future FRM strategies on actual risk.</p> <p>In areas of hazard rating 'Danger for Some', Highly Vulnerable development for use by children, the elderly and infirm is not advised.</p> <p>In areas of hazard rating 'Danger for most', Highly Vulnerable development for use by the general public is not advised.</p> <p>In areas of hazard rating 'Danger for all', Highly Vulnerable development is not advised.</p>	<p>Development should remain safe in accordance with PPS25. Consult EA; Emergency Services & Emergency Planners.</p> <p>Consult EA / LA to determine impact of future FRM strategies on actual risk.</p> <p>In areas of hazard rating 'Danger for some', More vulnerable development for use by children, the elderly and infirm is not advised</p> <p>In areas of hazard rating 'Danger for most', More Vulnerable development for use by the general public is not advised.</p> <p>In areas of hazard rating 'Danger for all', More Vulnerable development is not advised</p>	<p>Consult EA; Emergency Services & Emergency Planners. Development should remain safe according to PPS25.</p> <p>Consult EA / LA to determine impact of future FRM strategies on actual risk.</p> <p>In areas of hazard rating 'Danger for some' Less Vulnerable development for use by children, the elderly and infirm is not advised</p> <p>In areas of hazard rating 'Danger for most', Less Vulnerable development for use by the general public is not advised</p> <p>In areas of hazard rating 'Danger for all', Less Vulnerable development is not advised</p>	Consult EA; Emergency Services & Emergency Planners. Development should remain operational during an extreme (1000 year) flood event for its lifetime.	Refer to EA Standing advice.

Residual Risk – This refers to flood risk considering what would happen if defences fail. A major residual risk for Avonmouth / Severnside is a breach in the flood defences. This assessment is important even where the probability of a breach may be low because the potential consequences are high. Breach and failure hazard can be site specific and should also be assessed in individual FRAs. The breach hazard bandwidth (refer to Figure 7.6) shows where hazard from a breach or failure of the tidal defences is expected to be particularly high and has been defined to show areas particularly vulnerable to rapid inundation (< 1.5 hours) due to a breach. Specific advice is provided in the matrix for development that lies within this bandwidth.

Description			Essential Infrastructure	Highly Vulnerable	More Vulnerable	Less Vulnerable	Water Compatible Development	Minor Development / Change of Use
Development Types			<ul style="list-style-type: none"> Essential transport infrastructure and mass evacuation routes (which has to cross the area at risk); Essential utility infrastructure which has to be located in a flood risk area for operational reasons, including electricity generating power stations and grid and primary substations; and water treatment works that need to remain operational in times of flood; Wind Turbines. 	<ul style="list-style-type: none"> Police, Ambulance and Fire Stations, Command Centres and telecommunications installations required to be operational during flooding; Emergency dispersal points; Basement dwellings; Caravans, mobile and park homes intended for permanent residential use; Installations requiring hazardous substance consent (where there is a demonstrable need to locate such installations for bulk storage of materials with port or other similar facilities, or such installations with energy infrastructure or carbon capture and storage installations, that require coastal or water-side locations, or need to be located in other high flood risk areas, in these instances the facilities should be classified as Essential Infrastructure). 	<ul style="list-style-type: none"> Hospitals; Residential Institutions such a residential care homes, children's homes, social services homes, prisons and hostels; Buildings used for: dwelling houses; student halls of residence; drinking establishments; nightclubs and hotels; Non-residential uses for health services, nurseries and educational establishments. Landfill and sites used for waste management facilities for hazardous waste; Sites used for holiday or short-let caravans and camping, subject to a specific warning and evacuation plan. 	<ul style="list-style-type: none"> Police, Ambulance and fire stations not required to be operational during flooding; Buildings used for: shops, financial, professional and other services; restaurants and cafes; hot food takeaways; offices; general industry; storage and distribution; non-residential institutions not included in 'more vulnerable'; and assembly and leisure. Land and buildings used for agriculture and forestry; Waste treatment (except landfill and hazardous waste); Minerals working and processing (except sand and gravel working); Water treatment works which do not need to remain operational during times of flood; Sewage treatment works (if adequate measures to control pollution and manage sewage during flooding events are in place). 	<ul style="list-style-type: none"> Flood control infrastructure; Water transmission infrastructure and pumping stations; Sewage transmission infrastructure and pumping stations; Sand and gravel workings; Docks, marinas and wharfs; Navigation facilities; MOD defence installations; Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location Water based recreation (excluding sleeping accommodation); life / coastguard stations; amenity / open space, nature conservation and biodiversity, outdoor sports and recreation and essential facilities such as changing rooms; Essential ancillary sleeping or residential accommodation for staff required by uses in this category (subject to a specific flood warning and evacuation plan). 	<ul style="list-style-type: none"> Non residential extensions < 250m; Alterations with no increase in size; 'Householder' developments e.g. extensions sheds, garages (EXCLUDES creating separate dwellings)
Residual Risk	Breach Hazard Bandwidth (1.5 hour inundation time)		<p>Consult EA; Infrastructure company; Emergency Services & Emergency Planners. Development should remain operational during an extreme (1000 year) flood event for the lifetime of the development. Consult EA / LA to determine impact of future FRM strategies on actual risk.</p>	<p>Land is particularly susceptible to high hazard from a breach in the defences.</p> <p>Development should not be permitted</p>	<p>Land is particularly susceptible to high hazard from a breach in the defences.</p> <p>Development should not be permitted</p>	<p>Land is particularly susceptible to high hazard from a breach in the defences.</p> <p>Development should only be considered subject to the Sequential & Exception Tests. Consult EA; Infrastructure company; Emergency Services & Emergency Planners. Development should remain safe in accordance with PPS25. Consult EA / LA to determine impact of future FRM strategies on actual risk.</p>		

Strategic responses to flood risk

8.29. The outcome of the SFRA identifies that there is a requirement for strategic responses to flood risk in the Avonmouth / Severnside area to enable new development in accordance with PPS25. The study has identified that over time and without improvements to the existing defences the extent and frequency of flooding will become much worse. Decisions taken on land use will need to recognise the potential severity of the consequences and the appropriate ways of responding to the risk. Strategic mitigation measures are discussed further in section 9.

Emergency planning

8.30. Government recognises that it is not possible to protect everyone, everywhere against every flooding eventuality. Extreme or unpredictable events can happen. While physical defences may provide a level of protection, they may be breached or overtopped. A necessary component of flood defence is flood warning, backed up by civil protection measures. In this context, the Environment Agency is the authority responsible for issuing forewarning of possible events to the public, local authorities and emergency services.

8.31. Structures and procedures for civil protection drawn up under the Civil Contingencies Act came into force in November 2004. The Act formalises the duties on Category 1 responders to emergencies by requiring risk assessment and contingency planning to deal with emergencies, and the giving of advice and information to the public about actual or likely emergencies.

8.32. Under the Act, risk assessment and planning is arranged through Local and Regional Resilience Forums. The Forums, which are currently led by the Regional Resilience Teams in the Government Offices of the Regions, seek to draw in all those bodies which may be exposed to risk or be required to respond to events, including flooding. This includes production of an emergency Flood Management Plan, which may then be incorporated into a local Emergency Plan or Major Incident Plan as judged appropriate. The Teams also assist local authorities and emergency services in responding to and recovering from events.

8.33. The Level 2 SFRA provides information on the spatial distribution of flood hazard, which can inform the production of emergency flood management plans. Emergency flood management plans should minimise risks to life and property, through, for

example, ensuring that evacuation procedures are adequate to the kinds of risks that a major flooding event may create.

8.34. Information held within the Level 2 SFRA can be used to:

- identify and develop emergency plans for Avonmouth and Severnside;
- identify and develop emergency plans for rapid inundation of properties due to failure of raised defences and structures;
- identify essential infrastructure at higher risk of flooding, such as power stations and public buildings;
- identify major transportation linkages at higher risk of flooding; and
- improve flood warning through further analysis of flood mechanisms.

8.35. Outcomes of the Level 2 SFRA can be used to inform emergency planning in the area.

It is expected that other professional partners including local authorities, fire service, police and health authority will contribute to the emergency plan.

8.36. It is likely the aims of the Emergency Plan will be to:

- identify the responsibilities of professional partners and others in the management of flood risk;
- identify the flood warning decision making and delivery process;
- identify the actions required during instigation of the plan;
- identify recovery actions following a flood event; and
- identify the most appropriate means of disseminating flood warning and flood information (i.e. internet, SMS messaging etc).

Development Control

8.37. Level 2 SFRAs set the context within which any planning application should be considered, by establishing:

- the category of Flood Zone within which the proposed site sits;
- the flood risk constraints in accordance with guidance in PPS25; and
- the basis of the policies of BCC and SGC regarding proposed development in each Flood Zone.

- 8.38. The SFRA should be used to provide high level flood risk information for decisions on land use planning. This can be done on an “as required” basis, matching the needs of phased submission of applications.
- 8.39. Developers should be referred to the Level 2 SFRA at the start of any pre-application consultation with the LPAs. Where developers promote development outside of the allocated areas identified in the LDDs and within flood risk areas defined by the Level 2 SFRA they are responsible for:
- demonstrating compliance with PPS25, notably the Sequential Test and if appropriate the Exception Test;
 - providing an assessment of the impact of flooding on the development and of the development on flood risk elsewhere; and
 - satisfying the LPA that flood risk to the development and the impact of the development on flood risk elsewhere will be appropriately managed.
- 8.40. This will require the preparation of site-specific Flood Risk Assessments (FRAs). The Level 2 SFRA provides advice on the likely scope of FRAs, and developers should demonstrate that these have been considered prior to consulting further with the LPA and Environment Agency.
- 8.41. The level of information in FRAs should be proportionate to the degree of flood risk and the scale, nature and location of the proposed development. The Level 2 SFRA provides information already available which should be considered in the production of site-specific FRAs. In these instances the Level 2 SFRA allows the LPA to identify the level of detail required for site-specific FRAs in particular locations.
- 8.42. The Level 2 SFRA should also be used to set planning constraints within development areas designated in the LDDs and where relevant in the case of windfall planning applications.

Site Specific Flood Risk Assessments

- 8.43. The outcomes of the Level 2 SFRA do not replace the requirement for an appropriate Flood Risk Assessment (FRA) to be undertaken at the planning application stage.
- 8.44. The FRA will be required to demonstrate that flood risk to the development can be managed now and in the future, and that the development will not increase the risk of

flooding elsewhere. The requirement for site-specific FRAs is detailed in PPS25. Planning applications for development proposals of 1 hectare or greater in Flood Zone 1 and all proposals for new development located in Flood Zones 2 and 3 require a FRA. Further guidance on FRAs is provided in section 9.

9. Managing flood risk now and in the future

Flood Defences

- 9.1. Flood defences are currently present along the Avonmouth / Severnside frontage with the River Severn and River Avon. These are a mix of Environment Agency and privately owned flood defences that provide a varied standard of protection, and are a variety of construction types and condition.
- 9.2. The defence assessment completed as part of the SFRA highlighted that some defence sections are of unknown or non-standard construction, and therefore may have a high chance of breach or failure. The SFRA model results show that failure of defences could lead to severe flooding consequences across much of the area.
- 9.3. It is recommended that BCC / SGC, with the Environment Agency, consider formalising the responsibilities and maintenance regime for the defences that provide protection to Avonmouth / Severnside. This should provide improved certainty in the level of protection provided now and in the future.
- 9.4. The SFRA results indicate that the level of protection provided by the defences is likely to reduce significantly in the future due to the effects of climate change, principally increases in sea level and increased 'storminess' and wave overtopping. If defences are not improved, the frequency and severity of flooding in the future is such that existing and planned development is unlikely to be sustainable. The SFRA findings demonstrate that there is a need to upgrade the defences (both condition and design standard) to sustain proposed development.
- 9.5. The draft Severn Estuary Shoreline Management Plan (SMP2) states that the short term (0-20 years) policy adopted in relation to the defences is Hold the Line (HTL). This may mean repairing or replacing defences in the same place as they currently exist. There are two ways in which HTL may be implemented:
- Maintaining the same standard of protection (SoP) as today;
 - Not increasing the height of defences so that the SoP gradually decreases.
- 9.6. Whether or not a HTL policy means increasing the height of built defences or not is not considered at an SMP2 level. The decision on how a HTL policy will be implemented

will be considered in more detail by the Severn Estuary Flood Risk Management Strategy (SEFRMS).

9.7. The study area spans two Catchment Flood Management Plans (CFMPs). The adopted CFMP policy for the study area is: 'Areas of low, moderate or high flood risk where we are already managing flood risk effectively but where we may need to take action to keep pace with climate change'. Whilst CFMPs are primarily aimed at management of fluvial flooding, the drivers behind selection of the policy will also apply to tidal flooding. Identified actions, relevant to the study area, to implement CFMP policies include:

- "Carry out a multi-agency review of flood risk management led by the Environment Agency and involving South Gloucestershire Council and the Internal Drainage Board" (Severn Tidal Tributaries CFMP);
- "Maintain flood warning systems and explore opportunities to improve how effective they are and increase the number in place" (Severn Tidal Tributaries CFMP);
- "Improve the public's awareness of the risk of flooding and what to do when they receive a flood warning" (Bristol Avon CFMP); and
- "Review maintenance operations to make sure they are proportionate to flood risk" (Severn Tidal Tributaries CFMP).

9.8. In accordance with current best practice future development potential within the flood zones is dependent upon the defences providing protection to the 1 in 200 year return period event with an allowance for climate change.

9.9. The defence review carried out as part of this Level 2 SFRA identifies that in order to maintain the minimum 1 in 200 year standard of protection into the future the defences need significant improvement. Details of the defence breach assessment and improvement requirements for each defence section can be found in section 4 of the Level 2 SFRA technical report.

9.10. It has been estimated that to raise the existing defences to a minimum level of 10.24m AOD (the 'average' 200 year return period event, with climate change to 2110, flood level) could potentially cost £34.4M, and to include standard freeboard allowances could potentially cost £49.4M (both cost estimates have contingencies added). Further information is included in the accompanying Technical Report.

- 9.11. It has been demonstrated through hydraulic modelling that the area benefiting from the minimum defence upgrade may be insufficient to justify the expenditure if benefit is considered to be no residual flood risk. The model results indicate that the areas benefiting from raising the defences a further 500mm to 10.74m AOD are more notable, but these areas are located generally in marginal rural locations at the back of the floodplain. It should be noted that a more detailed assessment of residual risk associated with wave overtopping is required to fully assess the areas benefitting from defences. A more realistic assessment of benefits would need to consider the reduction rather than the removal of residual flood risk, recognising that this cannot be removed completely. A reduction in the frequency and severity of flooding to the study area, as might otherwise occur due to climate change would improve the sustainability of existing and proposed development.
- 9.12. The implications of raising the defences in the Avonmouth/Sevenside area against overtopping from extreme tidal waves in the Severn Estuary have been examined. These estimates indicate that the defences may need to be raised to levels up to 12.4mAOD and would cost in the region of £200 – 300 million. The environmental impact of such significant works would probably preclude their implementation and the information provided in the SFRA Level 2 technical report in this regard should only be used for guidance in this context. Further assessment of residual flood risk due to wave overtopping is required considering joint probability of extreme tide levels and waves. It is likely that a detailed assessment would demonstrate that residual wave overtopping is less than considered in the SFRA.
- 9.13. A HTL policy does not guarantee funding for defence maintenance and / or capital works along these sections of the shoreline but it is expected there will be a commitment to implementation of SMP policy.
- 9.14. A preliminary assessment of the scope for developer contributions to the funding of defence improvements has been carried out as part of the Level 2 SFRA. Details of this assessment can be found in section 4 of the technical report. Although there would potentially be some scope for developer contributions in the Avonmouth / Sevenside area, this is limited and would only provide partial funding proportionate to the benefit provided to the new development. Further funding would therefore be required to raise defences to the required minimum standard.

- 9.15. Defra provide central government funding in the form of grant in aid for large flood and coastal defence works that meet the required cost benefit scores. Scheme assessments and allocation of funds are carried out by the Environment Agency.
- 9.16. Scheme selection is based on a priority score system, embracing a strong cost- benefit analysis approach. Schemes are formally assessed, normally through a project Appraisal Report (PAR) which provides information on the associated costs, benefits (monetary and non-monetary) and risks associated with the preferred scheme and rejected options.
- 9.17. The potential impact of increased flooding on existing development in the vicinity of Avonmouth, Avonmouth Docks and Severn Beach is such that Defra funding for defence improvements may be available, even in the absence of significant new development or developer contributions. This would be subject to the assessment procedures set out in the Defra Policy Statement: Appraisal of Flood and Coastal Erosion Risk Management (FCERM). Grant in aid funding is less likely to be available for less developed areas where damages are subsequently lower and funding of improvements may not be justified on economic grounds.
- 9.18. Funds can be raised for flood defence schemes which do not attract Defra grant in aid through levies imposed by the Environment Agency on Local Authorities, and by the Local Authorities themselves. Similar to grant in aid, schemes will normally be subject to scrutiny and assessed based on a cost-benefit analysis. As described above, due to the level of existing development, local levy funding is more likely to be available in the vicinity of Avonmouth, Avonmouth Docks and Severn Beach due to the level of existing development increasing the likelihood of schemes achieving higher priority scores.
- 9.19. The Community Infrastructure Levy was introduced in April 2010 and was intended to replace tariff based Section 106 obligations. At the time of issue of this report the coalition government had confirmed that this will introduced through the Localism Bill & subsequent Act.
- 9.20. Funding of defence improvements will therefore be a key factor to consider for development plans in Avonmouth / Severnside. Various potential funding sources have been identified but there is little certainty that sufficient funding will be made available in the short to medium term. It is recommended that this is given early consideration,

exploring a variety of funding sources, and seeking to optimise the level of protection and spend.

9.21. The Level 2 SFRA study has highlighted several areas that would benefit from further investigation. It is recommended that the following points are addressed in the development of a Flood Management Strategy for Avonmouth / Severnside:

- A review of target crest levels / standard of protection to identify the optimum standard of protection provided (against a multi criteria assessment (economic, engineering, environmental and social factors)). This should include assessment of residual wave overtopping;
- A review of the conceptual defence improvement designs and re-design to the appropriate target crest levels;
- An investigation and assessment of the permissions and consents required to implement the improvements;
- Environmental Appraisal (a full Environmental Impact Assessment and associated studies are likely to be required for many of the improvement works);
- Consideration of how proposed improvement works relate to the wider Severn Estuary Flood Risk Management Strategy;
- Timescales for improvements and phasing taking into consideration when funding may be available and timescales for developments to come forward;
- The assessment criteria for grant funding and likelihood of achieving successful applications;
- The feasibility of bringing forward 'quick wins' and associated timescales; and
- The feasibility of any improvements for raising of the railway embankment, particularly for defence section E-F, where there are significant difficulties associated with alternative improvements.

Surface Water Management and Sustainable Drainage Systems (SuDS)

Introduction to SuDS

9.22. Flooding from rivers, sewers, and surface water is likely to increase throughout Avonmouth / Severnside in the future as a result of climate change. However, in addition to this, the impact of new development on flood risk needs to be considered, both at the new development site and for existing developments within the catchment. The impact of development on flood risk within the catchment should be considered

even where the development itself is not at risk of flooding. For example intense development in the catchment could result in increased run off if not managed appropriately, and result in increased fluvial flooding within and downstream of the study area. In addition future development may reduce the capacity of the Rhine network in Avonmouth / Severnside to provide the necessary storage to manage the effects of tide locking of outfalls.

- 9.23. New developments can also increase pressure on sewer systems and urban drainage. Consequently, it is important to manage the impact of developments in a sustainable manner. PPS25 provides an opportunity for all those with responsibility for the drainage of new development to contribute to managing flood risk, improving amenity and biodiversity, and improving water quality. As a minimum the negative impacts of development on surface water runoff should be mitigated.
- 9.24. In addition to the concerns over flood risk, there is increasing pressure for efficient and sustainable use of water resources. This can be helped by incorporating Sustainable Drainage Systems (SuDS) and grey water reuse systems into new developments (as per PPS25 and the Building Regulations, Part H).
- 9.25. SuDS aim to control surface water runoff as close to its origin as possible, before it is discharged to a watercourse or sewer. This involves moving away from traditional piped drainage systems towards softer engineering solutions which seek to mimic natural drainage regimes. SuDS can have many benefits such as reducing flood risk, improving water quality, encouraging groundwater recharge and providing amenity and wildlife benefits. Sustainable urban drainage systems should seek to meet the three criteria depicted Figure 9.1.
- 9.26. All three criteria should be considered when designing a drainage scheme. Table 9.1 depicts a hierarchical approach to the selection of SuDS techniques with the most sustainable techniques located at the top of the table. The most sustainable techniques meet all three SuDS criteria.

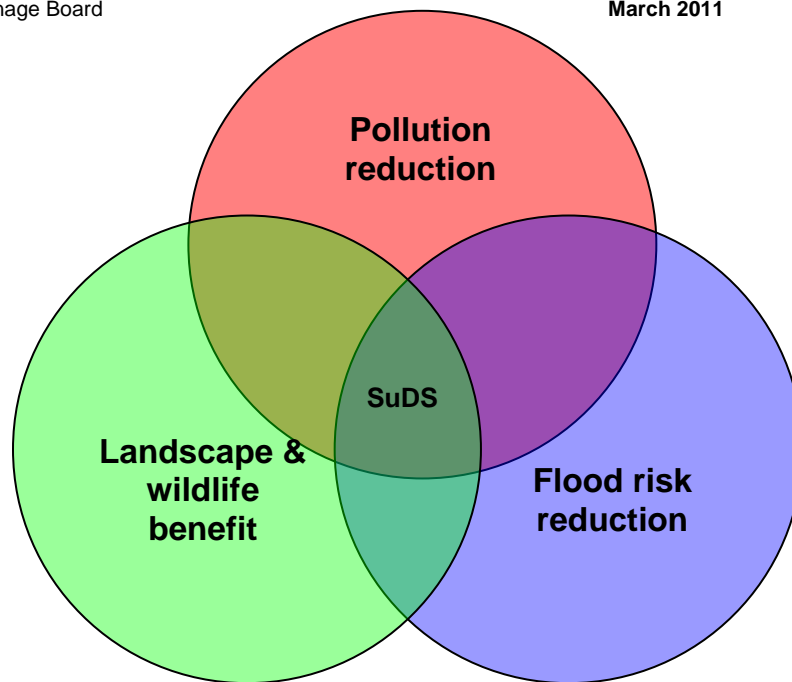
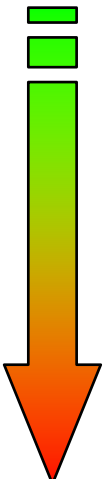


Figure 9.1 Broad criteria of Sustainable Urban Drainage Systems

9.27. The feasibility of SuDS options should be established as part of a site investigation. Before the site layout is decided, it is important that land is first allocated to accommodate these SuDS requirements. A drainage design can consist of a range of SuDS techniques. SuDS systems need to be carefully designed to ensure that they provide habitat for flora and fauna as well as reducing flood risk and improving water quality and their future maintenance should be considered and secured.

Table.9.1 The SuDS hierarchy

<div> <div>Most Sustainable</div>  <div>Least Sustainable</div> </div>	SuDS technique	Flood reduction	Pollution reduction	Landscape & wildlife benefit
	Basins and ponds <ul style="list-style-type: none"> - Constructed wetlands - Balancing ponds - Detention basins - Retention ponds 	✓	✓	✓
	Filter strips and swales*	✓	✓	✓
	Infiltration devices* <ul style="list-style-type: none"> - soakaways - infiltration trenches and basins 	✓	✓	✓
	Source control <ul style="list-style-type: none"> - rainwater harvesting - green roofs 	✓		✓
	Permeable surfaces and filter drains <ul style="list-style-type: none"> - gravelled areas - solid paving blocks - porous paving 	✓	✓	
	Tanked systems <ul style="list-style-type: none"> - over-sized pipes/tanks - storms cells 	✓		

9.30. Whereas conventional piped networks can be accurately sized using scientific and empirical calculations, SuDS sizing and design is often more challenging due to the many 'natural' variables that exist, such as soil permeability, the effect of vegetation, irregular channel shapes, etc. There are no definitive design codes or standards for SuDS although design guidance is available. CIRIA offers the following design documents:

- C522 – Sustainable Urban Drainage Systems – design manual for England and Wales;
- C523 – Sustainable Urban Drainage Systems – best practise for England, Scotland, Wales and Northern Ireland
- C609 – Sustainable Drainage Systems – Hydraulic, structural and water quality advise
- CIRIA 697 - The SuDS manual.
- CIRIA C635 - Designing for exceedance in urban drainage – good practice

- 9.31. Under the Floods & Water Management Act 2010 Lead Local Flood Authorities (in this case Bristol City and South Gloucestershire councils) will be responsible for the approval, adoption and subsequent maintenance of SuDS systems. It is also expected that national guidance relating to SuDS standards will be issued shortly.

Guidance on Surface Water Management within Avonmouth / Severnside

- 9.32. Land falling within the Avonmouth / Severnside administrative area is generally low lying and at risk of tidal flooding. The soils are generally of marine alluvium origin and the underlying geology is Triassic mudstone which is poorly draining. Consequently, controlling surface water runoff is a key consideration for the area.
- 9.33. A large proportion of the area is controlled by a network of drainage ditches, pumps and control structures, such as sluices. This infrastructure is the responsibility of the Lower Severn Drainage Board (LSDB) and is managed to protect against flooding and maintain the necessary conditions to allow agriculture. Within these areas the LSDB is the principal body responsible for surface water drainage. Outside these areas the responsibility lies with the appropriate Lead Local Flood Authority.

Internal Drainage Board controlled areas

- 9.34. A large proportion of the Avonmouth / Severnside administrative area falls under the jurisdiction of the Lower Severn Drainage Board (LSDB). Within the areas controlled by LSDB (shown on Figure 9.2), they have an important role in the planning process for development. This usually involves assessing the effect of proposed development, where it involves land use change or affects local watercourses.
- 9.35. The LSDB have produced a draft strategy for the area, which outlines their general approach to assessing developments and the mitigating actions which are likely. This document is currently being updated and a revised version is due to be issued in early 2011. Any development that falls within LSDB area should consult this document as the starting point for any SuDS design.
- 9.36. Details of the LSDB drainage strategy were not available for this SFRA. It is understood that the current LSDB drainage strategy has been developed to accommodate the restrictions on surface water discharge due to the tidal cycle and tide locking of outfalls and that the underlying principles of the strategy are to:

- Provide sufficient capacity in the Rhine (drainage ditch) network to discharge runoff from existing & proposed developments and undeveloped land to the Severn Estuary when tide levels allow, without increasing flood risk to third parties and areas downstream. Thus retaining storage capacity for periods of tide locking;
- Provide sufficient storage capacity within the Rhine network and strategic storage ponds to accommodate runoff from existing & proposed developments when tide levels prevent discharge to the Severn Estuary, without increasing flood risk to third parties and areas downstream.

9.37. Details of the LSDB drainage provision and its design criteria were not available at the time of writing this SFRA. It is recommended that this information is sought as part of future assessments to establish that the requirements of PPS25 are met. This would include information such as the event magnitude / return period used for design and testing of the drainage provision, climate change allowance / planning horizon incorporated in the design and the allowance for tide locking.

9.38. The LSDB own a comprehensive surface water drainage model of the Avonmouth/Severnside Draft Strategy Area which allows them to assess changes such as an increase in the runoff from a site and determine necessary mitigation works to make such changes acceptable. The network of Rhines and storage ponds throughout the area provides a large proportion of the storage of surface water which is discharged to the Severn Estuary by gravity at low tides. Increasing the capacity of this is currently the general approach to managing additional surface water runoff from landuse changes.

9.39. Within the LSDB area, promoters of developments would normally be required to submit details and obtain consent from the LSDB to discharge surface water runoff to the local Rhine network. Developers may be required to contribute to upgrades to the Rhine network to accommodate development. Early consultation with the LSDB is recommended.

Local Authority areas

9.40. As can be seen from Figure 9.2, only a small area within Avonmouth /Severnside is not controlled by the LSDB. It roughly coincides with the land seaward of the railway line.

- 9.41. In the north this land forms a strip of shoreline approximately 50m wide with no existing development and seaward of the flood defences. This area is expected to remain undeveloped.
- 9.42. In the south this area is heavily developed. It includes a fuel depot, Avonmouth Docks and part of Avonmouth village, which is predominantly residential. It is also very low-lying, under 10mAOD almost without exception, and flat.
- 9.43. The land is heavily urbanised. Where the land is still undisturbed it is expected to comprise marine alluvium which is a mixture of clay, silt and sand and Triassic mudstone, so infiltration rates are expected to be poor. Groundwater levels are also expected to be reasonably high.
- 9.44. DG5 information provided by Wessex Water shows flooding from sewers in three locations to the west of Avonmouth railway station: Gloucester Road; Meadow Street; and Clayton Street. BCC confirmed that the drainage in Avonmouth Village is mainly on a combined system, with some tank sewers. The foul base flows are pumped to a Sewage Treatment works and the rest overflow into the River Avon. This data suggests that the capacity for additional surface water runoff within the system is limited and particular care should be taken when considering options for surface water discharge in this area.
- 9.45. Contained within CIRIA 697, The SuDS Manual, is a site characteristics selection matrix (CIRIA 697 Table 5.4). This along with the land-use selection matrix (CIRIA697 Table 5.2) should be referred to as a first point of reference when screening options for a specific site. Based on the information above and these matrices, it is unlikely that infiltration, open channel or filtration based techniques will be appropriate in the non-LSDB controlled area of Avonmouth.
- 9.46. Strategic SuDS options, which receive runoff from a number of areas generally require large land take and benefit from gravity drainage, so there is little opportunity for such techniques in the non-IDB controlled Avonmouth / Severnside area. For the same reasons basins and ponds are unlikely to be achievable. The design of such features would also need to include appropriate measures to manage the risks arising from potential ground contamination.

- 9.47. For the majority of sites in this area the SuDS options may be limited to source control (rainwater harvesting, green roofs) and sub-surface storage (oversized pipes, tanks) and should be designed to restrict runoff from developments to at least existing levels (in accordance with PPS25). Opportunities to reduce runoff from sites entering the local sewer system should also be considered.
- 9.48. Bristol City Council is currently preparing a Surface Water Management Plan (SWMP) for their administrative area, which includes the majority of the Avonmouth / Severnside falling outside the LSDB controlled area. The findings and recommendations of the SWMP should also be considered for development.

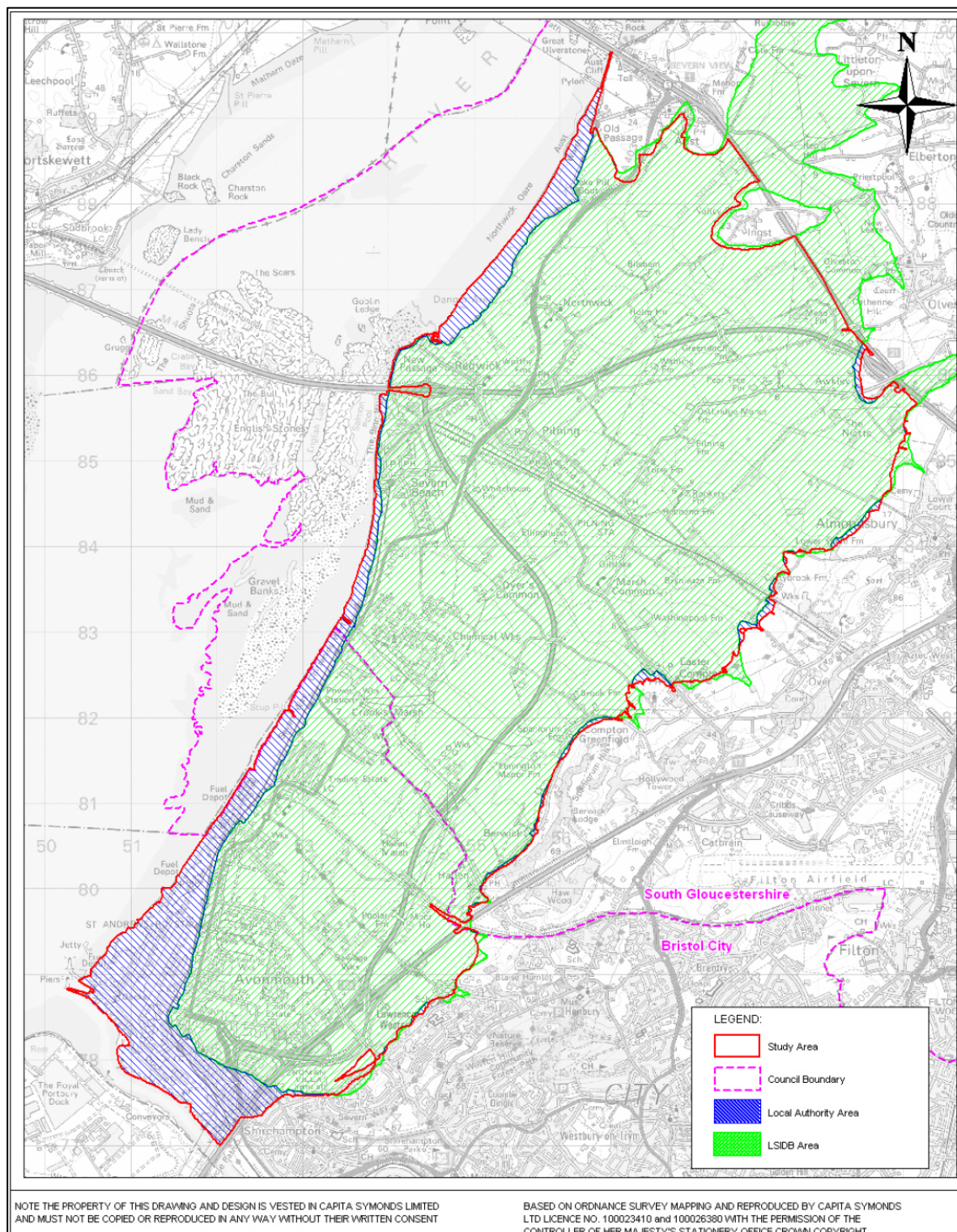


Figure 9.2 Surface Water Management Responsibility

Strategic Flood Risk Mitigation

9.49. Although the Avonmouth / Severnside area is offered some protection from flooding by defences, (defence improvements are recommended to increase the standard of protection now and in the future taking account of climate change), a residual risk of tidal flooding will still be present due to overtopping or failure of defence systems. Although much less significant to the area, the fluvial flood risk from the rhine network must also be considered for existing and future development in the area.

9.50. Response to flood risk will require consideration of the following:

- selection of development solutions that complement least risk options in accordance with the flood zones, actual risk areas, residual risk areas and breach and/or failure hazards;
- commitment to provision, management and maintenance of the standard of protection afforded by existing flood defences (improvements to defences are considered essential for the Avonmouth / Severnside area to remain viable in the future given the scale of future flooding expected due to climate change);
- where necessary, identification and implementation of strategic solutions that offer a sustainable means of addressing long-term flood risk and hazard, and complement catchment wide solutions;
- where necessary the provision of development forms in areas at actual risk from river or tidal flooding that include appropriate management measures, that limit the consequences, are safe and preferably complement strategic solutions;
- use of sustainable drainage systems in new developments and redevelopments and / or surface water management in accordance with strategies appropriate to Avonmouth / Severnside ;and
- preparation of an emergency flood management plan or updating of existing plans for incorporation in local emergency plans and/or major incident plans.

9.51. Potential strategic mitigation measures have been assessed as part of the Level 2 SFRA and recommendations for measures to be investigated further have been made for eight strategic zones. These zones were defined based on areas with similar flooding mechanisms, existing and proposed development characteristics and to fit with

the previously defined defence sections. The zones were defined solely for the purpose of the SFRA and have no other status. Given the scale of flooding anticipated in the future, a strategic approach to flood risk mitigation is recommended over site specific mitigation (although a combined approach may still be needed in some locations). The strategic zones are shown in Figure 9.3 and recommended options for more detailed assessment are shown in Table 9.2. It is emphasised that the reader should refer to Section 8 of the Technical Report for the full assessment of these measures.

Table 9.2 Summary of outcomes of multi criteria assessment

((colours indicate relative suitability: Green = recommended for detailed consideration & likely to provide suitable mitigation, Orange = recommended for further consideration however may prove to be unsuitable or difficult to implement))

Flood Risk Management Measure	SZ1	SZ2	SZ3	SZ4	SZ5	SZ6	SZ7	SZ8
Improvements to defences to increase SoP and keep pace with climate change	✓	✓	✓	✓	✓	✓	✓	✓
Change of use*		✓				✓		✓
Strategic land raising			✓	✓	✓		✓	
Recommendation of local scale land raising	✓	✓	✓	✓	✓	✓	✓	✓
New / improved access routes	✓	✓	✓	✓	✓	✓	✓	✓
Property resilience / resistance measures^	✓	✓	✓	✓**	✓**	✓		
Flood warning / flood event management	✓	✓	✓	✓	✓	✓	✓	✓
Improvements to the Rhine network (local & strategic)			✓***	✓***	✓	✓	✓***	✓

*Policy measures to discourage highly vulnerable development and essential infrastructure

** Includes local flood defence schemes

***Including strategic rhine improvements and storage to reduce fluvial flooding

^ Thorough assessment of the feasibility of these options will be needed on a site-specific level taking into account local flood depths & velocities & the vulnerability of the proposed land use

9.52. Improvements to defences are considered essential for the Avonmouth / Severnside area to remain viable in the future given the scale of future flooding expected due to climate change.

9.53. Flood incident management and emergency preparedness will be key to reducing risk to life and property in a defence breach situation, it is therefore imperative that flood incident management plans are developed on an individual development and a zone wide basis and that occupants of properties within the Avonmouth / Severnside area are well prepared and know how to respond in a defence breach situation.

9.54. Further investigation into the effectiveness and feasibility of residual flood risk mitigation options and their impacts on flooding elsewhere is required, in particular further investigation is required into:

- The flood risk associated with wave overtopping taking account of joint probability;
- The impact of land raising and raised access routes on flooding to existing development and property (in particular the cumulative impacts of land raising – refer to chapter 8 of the technical report for the outcomes of a preliminary assessment);
- Improvements to the Rhine network and provision of flood storage areas to reduce fluvial flood risk.
- Funding sources, including the scope for and means of ensuring appropriate developer contributions towards strategic mitigation measures.

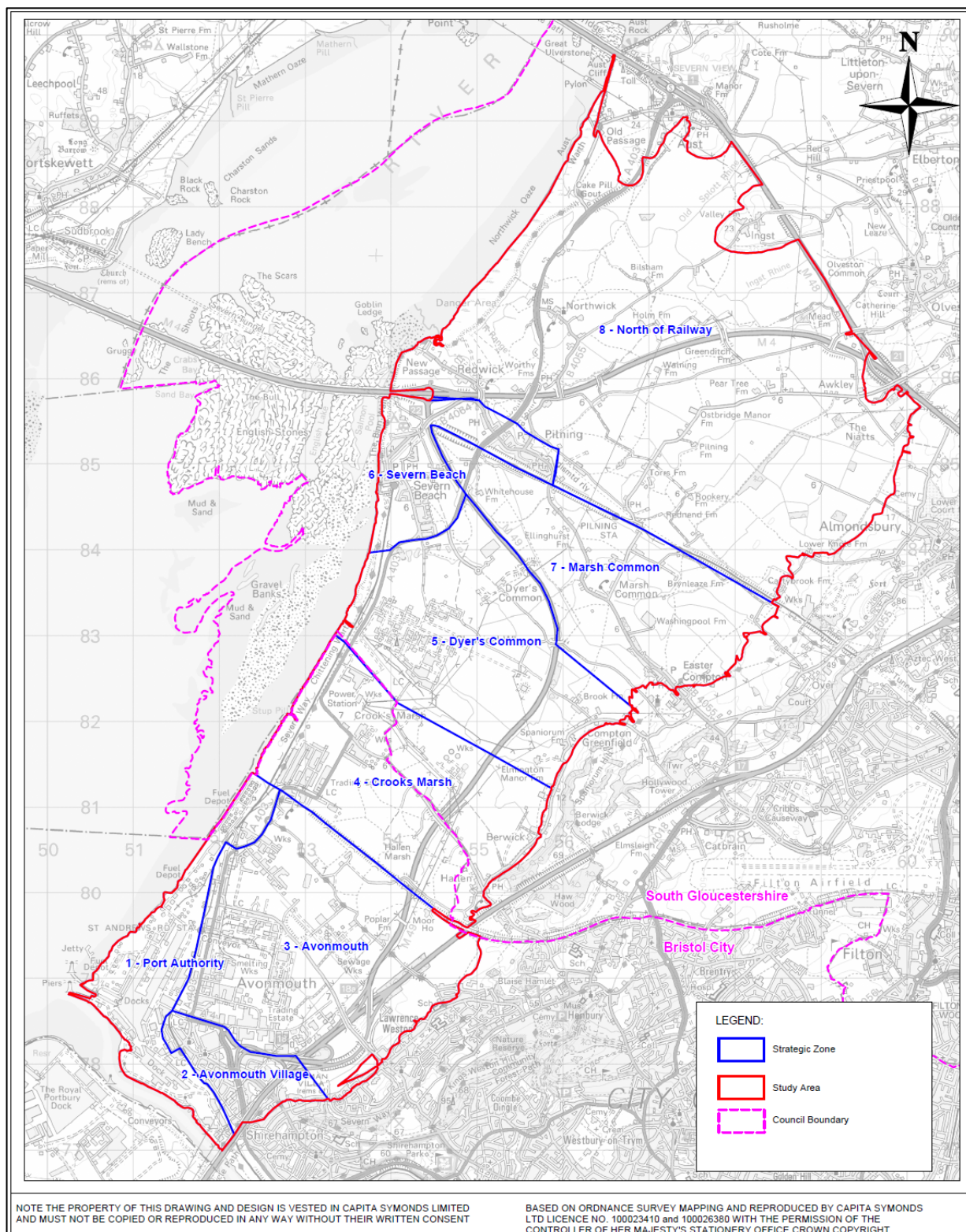


Figure 9.3 Avonmouth / Severnside Strategic Zones

Setting policies for sites which will need to satisfy part C of the Exception Test

- 9.55. Proposals which are required to satisfy parts a) and b) of the Exception Test have, by definition, a proposed location in an area which is not generally considered to be appropriate for that type of development. Part c) of the Exception Test requires that these developments are safe, do not increase flood risk elsewhere and, where possible, reduce flood risk overall. Given the scale of flooding issues in Avonmouth / Severnside strategic approaches to flood risk reduction are recommended to make development safe in accordance with PPS25. Developer contributions towards strategic solutions may be required.
- 9.56. A Flood Risk Assessment (FRA) will be required to demonstrate that Part c) of the Exception Test has been passed. The specific requirements will depend on the development and location in question, however general items to consider are outlined below.
- 9.57. 'Safe' development requires that development is designed such that the likelihood of flooding at the development, and the consequences of flooding that could occur are not unacceptably severe and in particular are unlikely to lead to loss of life and disruption to normal living. The flood hazard (related to flood depths and flood velocities) is one of the most important considerations for safe development with respect to access and egress during a flood for the public or attendance of emergencies by the Fire Rescue Service. What is considered 'safe' for one development may not be for another and this must be assessed at each site, taking into account the specific hazard and the specific land use.
- 9.58. Guidance and advice on acceptable flood hazard for different circumstances is regularly updated and therefore it is advisable that BCC and SGC set policies that refer to using up to date guidance rather than setting fixed policies within the LDF. BCC and SGC may wish to consider policies for the following items:
- Development layout – the development layout should be designed so that more vulnerable (e.g. residential) land uses are located at the lower risk areas of the site.
 - Development and floor levels may need to be raised for safety. Development levels set above the estimated flood level (to remain dry during an event) are the safest however developments that flood can still be considered safe, considering the

vulnerability of the development in question. FRAs should refer to the latest guidance when assessing acceptable flood depths, velocities and freeboard allowances. The impacts of raised ground and floor levels on flood storage and flow routes will need to be assessed.

- Safe access is a requirement stated in PPS25. Dry vehicular access is preferable, although pedestrian and flooded access may also be acceptable provided it can be demonstrated to be safe. FRAs should refer to the latest guidance when assessing acceptable flood depths, velocities and freeboard allowances, considering the vulnerability of the development in question. The SFRA findings indicate that maintaining safe access and egress to development may be difficult to achieve in Avonmouth / Severnside, hence there may need to be a greater emphasis on effective flood warning & management plans and provision of safe refuge areas within development sites;
- Consideration should be given to the capacity of the emergency services to operate effectively in the light of anticipated level of flood hazard (most influential being flood depth and flood velocity). Flood evacuation plans are unlikely to assist in a defence breach situation, where provision of safe refuge may be more important.
- The requirement to ensure that all proposed critical civil infrastructure is implemented so that it remains operational during flood events.
- The potential impact of residual risk events (defence overtopping or breach) should be analysed and proposed development should be designed to reduce residual risk as far as possible.

9.59. Developments can increase flood risk elsewhere through three main flood mechanisms:

- Increase in surface water runoff
- Loss of flood plain storage
- Impacts on flood flow routes

9.60. FRAs should demonstrate that the development will not adversely impact on flood plain storage or flood flow routes, and that where necessary competent mitigation measures are provided. The preliminary assessment completed for the SFRA indicates that unless properly designed and mitigated, large scale land raising or provision of raised access routes could significantly increase the impact of flooding to existing

development, especially in the event of a defence breach. It may be necessary to consider alternative solutions, such as raised buildings incorporating voids or stilts; roads on viaducts, and limiting the area of land raising. Such structures would need to be designed to withstand the predicted flood depths and velocities. The cumulative impact of land raising will need to be considered.

- 9.61. Surface water runoff on sites should be managed appropriately, in accordance with the relevant LSDB strategy or SWMP recommendations. Where appropriate, SuDS systems should be employed to manage surface water runoff, according to the system priority as set out previously.
- 9.62. FRAs should provide evidence that the possibility of reducing flood risk through the development has been considered. This could be by providing additional flood plain storage to enhance the existing capacity, reducing surface water runoff below existing levels and replacing more vulnerable land uses with less vulnerable land uses. The FRA should provide justification why it is not possible to reduce flood risk if this is the case.
- 9.63. Flooding from sewers (and the 'backing up' of the sewer network when Rhines are in flood) should be managed by the development control process. Further collation of all relevant data, such as sewer capacity, past events and consultation with water companies and operating authorities should be undertaken when preparing site specific flood risk assessments, particularly for extensive development.

Guidance on the preparation of Flood Risk Assessments

- 9.64. The FRA will be required to demonstrate that flood risk to the development and from the development can be managed now and in the future. Planning applications for development proposals of 1 hectare or greater in Flood Zone 1 and all proposals for new development located in Flood Zones 2 and 3 require a FRA.
- 9.65. The FRA is required whether the site is a windfall site or an allocated site (i.e. in LDDs). Furthermore, a FRA is still required if a site has been subject to a Sequential Test and, if necessary, an Exception Test.

- 9.66. FRAs should consider all sources of flooding and, where appropriate, mitigation measures and should evaluate conditions for the proposed lifetime of the development so that climate change effects are considered. Where risk of flooding from sources other than the sea or rivers has been identified such as groundwater or surface water flooding the FRA needs to consider the risk of flooding at the site. FRAs should also consider the impact of the development on flood risk elsewhere. Residual risks should be assessed.
- 9.67. Paragraphs 22 and 23 of PPS25 clarify the responsibilities of developers to consider flood risk issues at a site as early as possible. Key points include the responsibility of landowners for safeguarding land and other property against hazards. It is the responsibility of property owners and users to manage the drainage of their land, as far as possible to prevent adverse impacts on neighbouring land.
- 9.68. Developers are advised to make independent checks regarding flood risk before purchasing a site. Where a site is allocated within the LDF that has been sequentially tested for the type of development proposed and is supported by a SFRA, the Sequential Test does not have to be applied. However the developer should apply a sequential approach to determine the appropriate land uses across the site with respect to any flood risk within the site.
- 9.69. The scope of any FRA should be agreed with the Local Planning Authority, and if necessary the Environment Agency, and it should be agreed who the developer needs to consult. For example the developer may need to consult Sewerage undertakers, Highways Authorities, LSDB, Emergency Services etc. The developer is responsible for demonstrating the development is consistent with the policies in PPS25 and those on flood risk in the LDFs.
- 9.70. SFRAs should be used as the starting point as FRAs may be relatively minor in nature. For example the development may be small, on a low risk site and have minimal secondary effects on flood risk. FRAs should be proportional to the size and type of development and risk of flooding.
- 9.71. LDDs may provide specific guidance on, or criteria for, allocated development sites. Where sites have been allocated by the LPA in accordance with the Exception Test, the SFRA may provide more detailed background information. A key requirement for

FRAs is that they consider all sources of flooding and demonstrate how flood risk will be managed taking into account climate change.

9.72. Flood Risk Assessments may be standalone documents submitted by the developer to accompany a planning application, or where an environmental statement is required, the developer should ensure that the FRA is incorporated into the study. The objectives of the FRA include;

- Establishing whether a proposed development is likely to be affected by current or future flooding from all sources;
- Whether the development will increase flood risk elsewhere;
- Whether the measures proposed to manage flood risk are appropriate; and
- Whether the site will be safe to enable part C of the Exception Test to be passed if required.

9.73. The Practice Guide Companion to PPS25 provides guidance on the level of Flood Risk Assessment required and sources of information to aid in completing each stage. The principles and key requirements of a FRA are provided in PPS25 Appendix E. The scope of a FRA includes;

- a description of the development and the planning context
- definition of flood hazard
- probability of flooding and the impact of climate change on flood risk
- surface water drainage
- detailed description of development proposals
- flood risk management measures including the application of SuDs
- impacts of the development off site
- an assessment of residual risk.

9.74. Guidance on flood risk management measures, both for the development and to reduce the impact of the development on flood risk elsewhere is provided in the SFRA Level 2 technical report.

9.75. The scope of the FRA should always be commensurate with the scope and scale of flood risk, the scope should be determined in consultation with the Environment Agency and BCC / SGC at the earliest opportunity. The scope must always include a statement of the existing flood risk, details of the proposed development, a statement on the flood

risk management measures and their effects upon the baseline risk and finally a statement of residual risk. Consideration must always be given to both the development in question and potential off site impacts.

9.76. PPS25 advocates a three tiered approach to undertaking a FRA that is presented in CIRIA publication C624 Development and Flood Risk – guidance for the construction industry. The three tiers are;

- Screening study
- Scoping study
- Detailed study

More details of the scope of each study can be found in the PPS25 Practice Guide.

Screening study in Avonmouth / Severnside

9.77. The screening study for Avonmouth / Severnside is captured in the content of the Level 2 SFRA. This document defines the Flood Zones, and in doing so the areas where there are further flooding issues that warrant further consideration. The majority of the Avonmouth / Severnside area requires further consideration.

9.78. All sites greater than 1.0ha in size, even if located in an area with a low probability of flooding, are required to prepare a FRA that considers the implications of increased runoff rates from the site.

Scoping studies in Avonmouth / Severnside

9.79. According to Table 3.5 in the PPS25 Practice guide, the Scoping study is to be undertaken if the Level 1 FRA indicates that the site may lie within an area that is at risk of flooding or that the site may increase flood risk due to increased run-off.

9.80. The scoping study should explore and assess whether there is sufficient existing quantitative information to undertake an appropriate FRA. The assessment should be based on the existing information presented in the full Level 2 SFRA for Avonmouth / Severnside, and other documents listed in Table 3.6 of the PPS25 Practice Guide.

9.81. Preparing a FRA at this stage assumes that no new data is required. FRAs prepared for Avonmouth / Severnside, should pay particular attention to;

- variation of flood depth, velocity and climate change information;
- vulnerability levels appropriate to the location within the flood zone;
- the availability of a safe and dry access route, and alternative measures where necessary;
- whether the site may be at risk from failure of flood management infrastructure;
- effectiveness of flood warning and flood management plans and the ability of the emergency services to respond;
- the impact of flooding on wider infrastructure in Avonmouth / Severnside;
- the impact of the development and mitigation measures on flood risk, particularly through the cumulative impacts of land raising; and
- consideration of appropriate surface water management measures.

9.82. In any case, statements on the proposed development type and vulnerability of the intended residents and any flood risk mitigation / management measures will be required.

Detailed studies in Avonmouth / Severnside

9.83. According to Table 3.5 in the PP25 practice guide, a detailed study is to be undertaken if the Level 2 FRA concludes that further quantitative analysis is required to assess flood risk issues related to the development site. Usually this quantitative analysis will be based on extending or improving an existing flood risk model or by producing a new flood risk model where the development:

- is located in an area where the source and certainty of information is considered low;
- is located within 50m of an area already identified with a higher probability of flooding (following an assessment of the local topography);
- lies within the area at risk of flooding from failure of existing flood defences and infrastructure;
- is located within 100m upstream or downstream of a sluice gate; and
- is located in an area identified as a critical drainage area, and in particular if it falls under a surface water management plan (SWMP).

9.84. A detailed study would usually be required if any form of flood risk mitigation / management were required. Once more detailed flood risk information is available, it will enable more informed consideration of the items listed previously.

9.85. Detailed studies in Avonmouth / Severnside should consider the following:

- Assessment of flood risk in the future in line with planned defence improvements;
- Assessment of wave overtopping effects, considering variation in tide levels along the Avonmouth / Severnside frontage and joint probability of extreme tides and waves;
- Assessment of the impact of failure of flood defences and infrastructure (e.g. rhine culvert structures and tidal outfalls);
- The impact of proposed land raising, for development or access, (possibly considering cumulative as well as specific impact) and how the effects may be mitigated;

10. Summary of recommendations

10.1. The following provides a summary of recommendations from the Avonmouth / Severnside Level 2 SFRA:

10.2. The defences protecting Avonmouth / Severnside are of varying design and few details are available on construction materials, maintenance regime, quality and standard of protection. It is recommended that BCC / SGC, with the Environment Agency, consider formalising the responsibilities and maintenance regime for the defences that provide protection to Avonmouth / Severnside. This should provide improved certainty in the level of protection provided now and in the future.

10.3. Given the scale of flooding anticipated in the future, a strategic approach to flood risk mitigation is recommended over site specific mitigation (although a combined approach may still be needed in some locations). It is recommended that a detailed flood risk management strategy is developed for the Avonmouth / Severnside area, led by BCC / SGC with input from the EA and LSDB, which should consider the following key points:

- Improvements to the tidal defences is a key component of the management of flood risk on the Avonmouth / Severnside area;
- Flood incident management and emergency preparedness will be key to reducing risk to life and property in a defence breach situation; and
- The effectiveness and feasibility of residual flood risk mitigation options and their impacts on flooding elsewhere needs more detailed investigation, particularly the flood risk associated with wave overtopping taking account of joint probability and the impact of land raising and raised access routes on flooding to existing development and property.

10.4. An extended flood zone 3a policy is recommended for the breach hazard bandwidth. In addition to the standard flood zone 3a requirements the extended policy should require an Exception Test for all types of development within the breach hazard bandwidth and should also limit development to water compatible and less vulnerable development types only.

11. Maintenance of the SFRA

- 11.1. Land use and development control decisions in the Avonmouth / Severnside area will refer to the information contained in the Level 2 SFRA and this will be monitored and reviewed when necessary to accommodate future change. To be robust and able to withstand challenge in the planning process there is a need to ensure that the Level 2 SFRA reflects conditions at the time of evaluation. Failure to maintain the Level 2 SFRA will result in delays in plan making, the potential neglect of flood risk considerations and failure to capture strategic solutions.
- 11.2. A Management Group will be established with responsibility for monitoring, managing and maintaining the Level 2 SFRA.
- 11.3. By following this process of information dissemination and review, the Level 2 SFRA Management Group can ensure a consistent and up to date supply of strategic flood risk information to all levels of planning process, as shown diagrammatically in Figure 10.1.

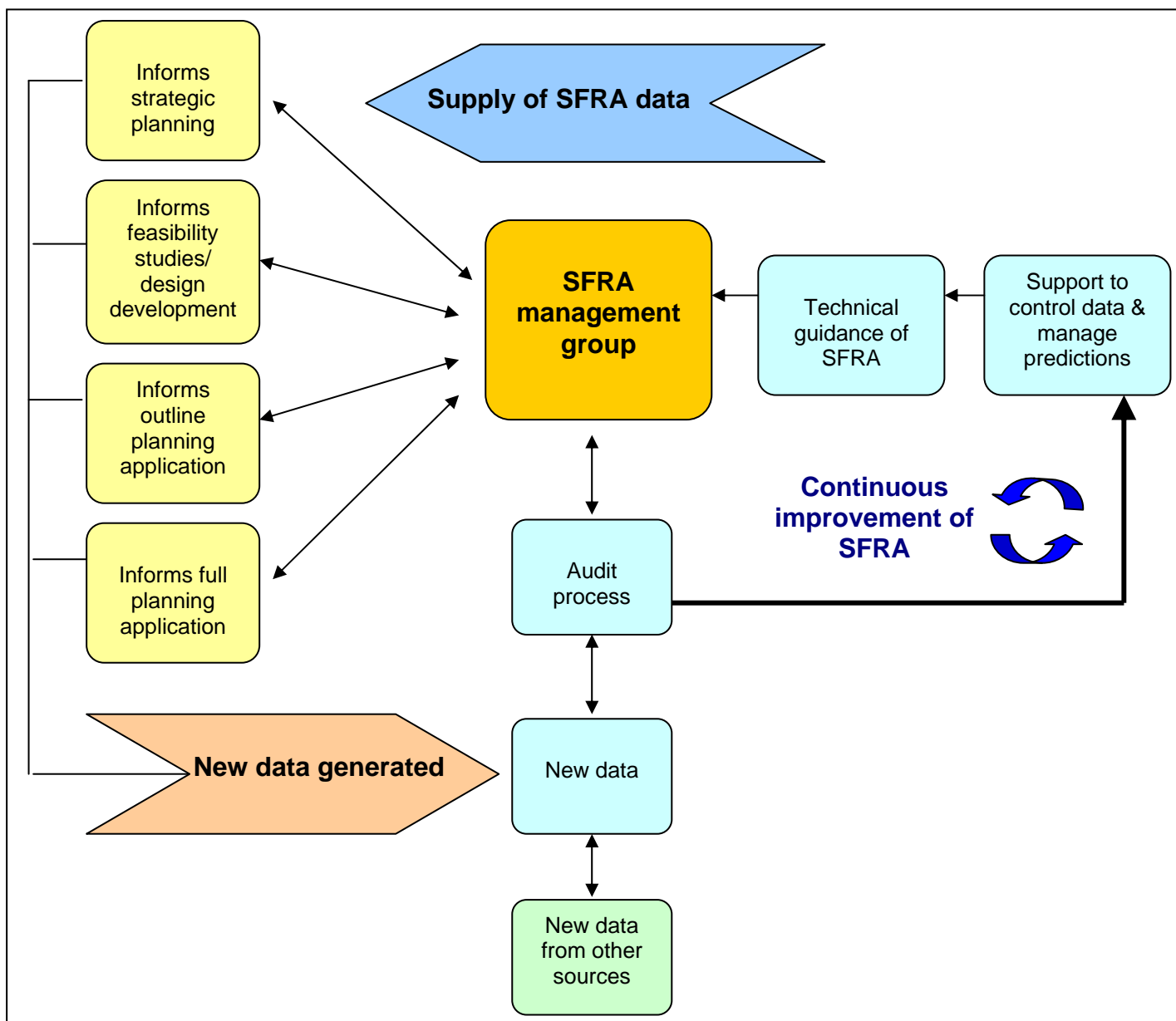


Figure 10.1 Level 2 SFRA Management Group Protocol

12. References

- Defra (March 2006) 'Flood Risks to People'
- Defra (October 2006) 'Supplementary Note to Operating Authorities – Climate Change Impacts'
- Department of Communities and Local Government (March 2010) 'Planning Policy Statement 25' (PPS25)
- Department of Communities and Local Government (December 2009) 'Planning Policy Statement 25: Practice Guide
- Environment Agency (2003) 'Strategy for Flood Risk Management (2003/4 to 2007/8) version 1.2'
- Flood & Water Management Act 2010
- C522 – Sustainable Urban Drainage Systems – design manual for England and Wales;
- C523 – Sustainable Urban Drainage Systems – best practise for England, Scotland, Wales and Northern Ireland
- C609 – Sustainable Drainage Systems – Hydraulic, structural and water quality advise
- CIRIA 697 - The SuDS manual.
- CIRIA C635 - Designing for exceedance in urban drainage – good practice
- Environment Agency (2009), Bristol Avon CFMP (Summary Report)
- Environment Agency (2009), Severn Tidal Tributaries CFMP (Summary Report)