West Somerset Council & Exmoor National Park Authority

Strategic Flood Risk Assessment

Level 1

Final Report
March 2009

Prepared for:

WEST SOMERSET COUNCIL

EXMOOR NATIONAL PARK

Revision Schedule

Level 1 Strategic Flood Risk Assessment
March 2009

Rev	Date	Project Number	Details	Prepared by	Reviewed by	Approved by
01	January 2009	D122558	Draft Level 1 SFRA	**Mark Crussell** Assistant Hydrologist **Dr Rob Sweet** Senior Flood Risk Specialist	**Dr Rob Sweet** Senior Flood Risk Specialist	**Jon Robinson** Associate Director
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Abbreviations

Acronym	Definition
AOD	Above Ordnance Datum
DG5	Director General 5
DPD	Development Plan Documents
EA	Environment Agency
ENPA	Exmoor National Park Authority
GIS	Geographical Information Systems
LiDAR	Light Detection and Ranging
LDF	Local Development Framework
NFCDD	National Flood and Coastal Defence Database
PPS25	Planning Policy Statement 25: Development and Flood Risk
SA	Sustainability Appraisal
SFRA	Strategic Flood Risk Assessment
SFRM	Strategic Flood Risk Mapping
SuDS	Sustainable Drainage Systems
WSC	West Somerset Council

Glossary

Term	Definition
1 in 100 year event	Event that on average will occur once every 100 years. Also expressed as an event, which has a 1% probability of occurring in any one year.
1 in 200 year event	Event that on average will occur once every 200 years. Also expressed as an event, which has a 0.5% probability of occurring in any one year.
1 in 100 year design standard	Flood defence that is designed for an event, which has an annual probability of 1%. In events more severe than this the defence would be expected to fail or to allow flooding.
Flood Zone 1	This zone comprises of land assessed as having a less than 1 in 1000 annual probability of river of sea flooding in any year (0.1%).
Flood Zone 2	This zone comprises land assessed as having between a 1 in 100 year and 1 in 1000 year annual probability of river flooding (1% - 0.1%) or between a 1 in 200 year and a 1 in 1000 year annual probability of sea flooding (0.5% - 0.1%) in any year.
Flood Zone 3a	This zone comprises land assessed as having a 1 in 100 or greater annual probability of river flooding (>1%) or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year.
Flood Zone 3b – Functional Floodplain	This zone comprises land where water has to flow or be stored in times of flood. SFRAs should identify this Flood Zone (land which would flood with an annual probability of 1 in 20 (5%) or greater in any year or is designed to flood in an extreme (0.1%) flood, or at another probability to be agreed between the LPA and the Environment Agency, including water conveyance routes).
Flood defence	Infrastructure used to protect an area against floods as floodwalls and embankments; they are designed to a specific standard of protection (design standard).
Floodplain	Area adjacent to river, coast or estuary that is naturally susceptible to flooding.
Flood storage	A temporary area that stores excess runoff or river flow often ponds or reservoirs.
Fluvial flooding	Flooding by a river or a watercourse.
JFLOW	Broad-scale raster based routing model used to determine flood extents by the Environment Agency.
Local Development Framework (LDF)	The LDF is a suite of documents that will guide spatial planning policies and will replace Local Plans. Documents include a Core Strategy which sets out strategic policies; Development Control policies, to guide development and Proposals Maps. Other documents may also be included such as Area Plans, Supplementary Planning Documents and Site Allocations. .
Mitigation measure	An element of development design which may be used to manage flood risk or avoid an increase in flood risk elsewhere.
Overland Flow	Flooding caused when intense rainfall exceeds the capacity of the drainage systems or when, during prolonged periods of wet weather, the soil is so saturated such that it cannot accept any more water.
Risk	The probability or likelihood of an event occurring.
Sustainable drainage system	Methods of management practices and control structures that are designed to drain surface water in a more sustainable manner than some conventional techniques.
Sustainable development	Development that meets the needs of the present without compromising the ability of future generations meeting their own needs.

1 Introduction

Background

1.1 The Planning and Compulsory Purchase Act 2004 (PCPA) (HMSO, 2004) requires Local Planning Authorities (LPAs) to produce Local Development Frameworks (LDFs) that will replace the system of Local, Structure and Unitary Development Plans. LDFs are a portfolio of documents (Local Development Documents (LDDs)) that collectively deliver the spatial planning strategy for the authority area. The PCPA 2004 requires LDDs to undergo a Sustainability Appraisal (SA), which assists LPAs in ensuring that their policies fulfil the principles of sustainability. Strategic Flood Risk Assessments (SFRAs) constitute a component of the SA process and should be used in the review of LDDs or in their production.

1.2 The release of Planning Policy Guidance Note 25: Development and Flood Risk in July 2001 (PPG25) (DTLR, 2001) introduced the responsibility that LPAs have to ensure flood risk is understood and managed effectively using a risk-based approach as an integral part of the planning process.

1.3 PPG25 was superseded by Planning Policy Statement 25: Development and Flood Risk (PPS25) (CLG, 2006) in December 2006. PPS25 re-emphasises the active role LPAs should have in ensuring that flood risk is considered in strategic land use planning, PPS25 states that this should be achieved by the production of a SFRA. In June 2008, a Practice Guide to accompany PPS25 was released following a consultation period. The Practice Guide provides supplementary information, including a suggested approach for the production of SFRAs.

Definition of a SFRA

1.4 A SFRA is a tool which provides an overview of the flood risk, from a variety of sources, within a particular LPA area. In accordance with the Practice Guide, SFRAs are completed in two consecutive stages (where required). The two stages are:

Level 1 SFRA

1.5 The Level 1 SFRA is primarily a desk-based study using information and data collected from a variety of stakeholders, including the Environment Agency, LPAs and water utility companies. The collation, review and preparation of this information allows a broad scale assessment of flood risk, which provides details of historic flooding incidents, areas at risk and areas which may become at risk from flooding in the future. It also identifies details of existing flood defences intended to reduce the aforementioned flood risk. Furthermore, consideration of the impact of new development upon flood risk is of critical importance.

1.6 To assist LPAs in their strategic land use planning, SFRAs should present sufficient information to enable LPAs to apply the Sequential Test to their proposed development sites. The Sequential Test seeks to guide development to areas of low flood risk (i.e. Flood Zone 1) or, when development cannot be located in Flood Zone 1, to where the particular development vulnerability is appropriate to the flooding probability of an area, as defined

within PPS251. To achieve this, the SFRA should have regard to catchment wide flood issues and also involve a:

'Process which allows the LPA to determine the variations in flood risk across and from their area as the basis for preparing appropriate policies for flood risk management for these areas'.

1.7 In addition, where development sites cannot be located in accordance with the Sequential Test as set out in PPS25 (i.e. to steer development towards areas of lowest risk):

'*The scope of the SFRA should be increased to provide the information necessary for the application of the Exception Test*.'

1.8 The aim of the Level 1 SFRA is to present sufficient information to enable the LPA to make informed decisions during application of the Sequential Test and the associated allocation of development sites.

1.9 The Level 1 SFRA should inform the preparation of strategies and development control policy to be included within the LDF. It should also inform development control decisions, seeking a consistent approach, including the requirements of site specific Flood Risk Assessments (FRAs) throughout the LPA area.

1.10 Where allocation of development sites is necessary within areas at high risk of flooding (such as in Flood Zone 2 or 3), the Level 1 SFRA is unlikely to provide sufficient information for an appropriate evaluation of flood risk, a Level 2 SFRA may be required.

Level 2 SFRA

1.11 Where no reasonably available sites can be identified in areas of lower flood risk to meet development targets, a Level 2 SFRA will provide sufficient information to facilitate the application of the Exception Test, where required. The objective of a Level 2 SFRA is to provide more detailed information pertaining to a particular site and reduce uncertainty so that development can be designed appropriately, with consideration of the flood risk. The Level 2 SFRA is based on information collected for the Level 1 SFRA and additional work where necessary.

Aim of SFRA

1.12 A suitable Level 1 SFRA should present sufficient information to enable the West Somerset Council (WSC) and Exmoor National Park Authority (ENPA) to apply the Sequential Test (Chapter 3) to potential development sites. Where the Exception Test is required, the Level 2 SFRA should present sufficient information to demonstrate that development will be safe from the risks of flooding for the lifetime of the development.

[1] Flood risk is one of many constraints in which LPAs will need to evaluate as part of their allocation process of development sites.

SFRA Objectives

1.13 To achieve the aim of the Level 1 SFRA, a staged approach is proposed in keeping with guidance presented in the Practice Guide accompanying PPS25 (DCLG, 2008). The principal objectives of the WSC and ENPA Level 1 SFRA are outlined below:

- To provide an assessment of the impact of all potential sources of flooding in accordance with PPS25, including an assessment of any future impacts associated with climate change and sea level rise;
- To provide the information required to apply the Sequential Test for identification of land suitable for development in line with the principles of PPS25;
- To provide information to determine whether application of the Exception Test is likely to be necessary;
- To provide baseline data to inform the SA of Development Plan Documents (DPDs) with regard to catchment wide flooding issues which affect West Somerset and Exmoor National Park, to help appraise the vulnerability of areas to flooding;
- To allow WSC and ENPA to assess the flood risk for specific potential development sites and setting out the requirements for site specific FRAs and assess the appropriateness of mitigation measures;
- Enable planning policies to be identified to minimise and manage flood risks;
- To provide advice regarding Sustainable Drainage Systems (SuDS) and a review of suitable techniques, in terms of the soils and geology throughout West Somerset and Exmoor National Park;
- To enable WSC and ENPA to use the SFRA as a basis for decision making at the planning application stage;
- To inform emergency planning within WSC and ENPA where required.

Deliverables

1.14 This Level 1 SFRA report includes background information, technical and supplementary information, culminating in the presentation of the mapping deliverables appended to this report. A series of maps and associated Geographical Information System (GIS) data files form the primary deliverable of this Level 1 SFRA.

1.15 The mapping represents the main tool for application of the Sequential Test. The mapping is grouped into themes, which are intended to help identify flood risk and flood risk management considerations within West Somerset and Exmoor National Park.

1.16 The information presented in this Level 1 SFRA should not be considered as an exhaustive list of all available flood related data for West Somerset and Exmoor National Park. This Level 1 SFRA report is a presentation of flood sources and risk, based on the best available data collected following consultation with and input from WSC, ENPA and stakeholders within the available timeframe.

1.17 SFRAs are 'live' documents and should be updated on a regular basis as new information becomes available to WSC and ENPA. This includes the GIS data files, which can easily be

updated as new information becomes available, which will help to ensure that decisions made by WSC and ENPA are based on the most up-to-date information.

2 Study Area

2.1 The study area is located in the South West of England, along the Severn Estuary and is defined by the administrative boundaries of WSC and ENPA. A map of the study area is illustrated in Figure 1 indicating the individual boundaries of WSC and ENPA. The study area has borders with Sedgemoor District Council, Taunton Deane Borough Council, Mid Devon District Council and North Devon Council.

2.2 The study area covers an area of approximately 945 km^2. ENPA is the planning authority for areas of West Somerset (490 km^2) and North Devon (201 km^2) located within Exmoor National Park, an area of approximately 691 km^2.

2.3 WSC is the planning authority for areas of West Somerset located outside of the Exmoor National Park boundary, an area of approximately 254 km^2.

2.4 The main flood sources within the study area are from fluvial (river) and tidal/coastal (sea). Surface water flooding and sewer flooding also occurs within the study area.

Local Watercourses and Catchment Areas

2.5 The headwaters of the majority of watercourses within the study area rise on Exmoor. The watercourses can be divided into two distinct groups, those which generally flow to the south of the study area and those which generally flow to the north of the study area. Watercourses which flow to the south generally form part of larger river catchments, discharging to the sea outside the study area boundary, whilst those that flow to the north discharge to the sea, along the study area coastline. The main watercourses within the study area are identified on Figure 2.

West Somerset Coastal Rivers

2.6 The rivers along the West Somerset coast, which stretch from the Culbone Hills, located within Exmoor National Park, to Hinkley Point located to the east of West Somerset. The headwaters of these rivers rise on the peaks of Exmoor and flow towards the low lying coastal areas in the north of the study area.

2.7 The rivers which discharge to the Exmoor National Park coastline include the Hawkcombe Stream, Horner Water and the River Aller.

2.8 The rivers which discharge to the West Somerset coastline include the Bratton Stream, the River Avill, the Pill River, the Washford River, the Holford Stream and the Doniford Stream, with its major tributary the Monksilver Stream.

2.9 These rivers drain approximately 38% of the study area. This area of the study area is largely rural, however there a number of major settlements located in the low lying coastal zones. The main urban settlements are Minehead, Watchet, Williton, Dunster and Washford located within West Somerset and Porlock located within Exmoor National Park.

North Devon Coastal Rivers

2.10 The rivers along the North Devon coast located within Exmoor National Park include the River Heddon, the West Lyn River, the East Lyn River with its major tributaries Hoaroak Water and Farley Water. These rivers, characterised by very steep gradients, drain approximately 17% of the study area.

2.11 The River Heddon flows through Parracombe, Bodley and Hunter's Inn before discharging to the sea at Heddon's Mouth. The West Lyn is joined by the Barbrook before flowing through Barbrook village. The West Lyn River flows through Lynton before discharging to the sea at Lynmouth. The East Lyn River is joined by a number of tributaries, the largest being Hoaroak Water and Farley Water prior to discharging to the sea at Lynmouth. The main settlements along the East Lyn River are Leeford, Brendon and Rockford.

The River Exe Catchment

2.12 The headwaters of the River Exe and the River Barle rise on Exmoor towards the west of the Exmoor National Park. The River Exe (Upper) and River Barle sub-catchments drain approximately 16% and 14% of the study area respectively. These two rivers flow south east through steep sided narrow wooded valleys. The River Exe is joined by the River Haddeo, prior to its confluence with the River Barle to the south east of Brushford.

2.13 The River Exe flows through a number of small settlements within Exmoor National Park, including Exford and Winsford. The River Barle flows through Simonsbath, Withypool and Dulverton and then flows into West Somerset, before crossing the study area southern boundary. In Dulverton, the River Barle is joined by the Hollham Brook, which flows from the north. The flows within the River Haddeo are regulated by Wimbleball Reservoir prior to flowing through Hartford and Ford Bury. Downstream of the study area the River Exe is joined by a number of major tributaries before flowing into the Exe Estuary south of Exeter.

The River Taw Catchment

2.14 Although the River Taw is located outside of the study area the headwaters of two of its main tributaries, the River Bray and the River Mole, are located towards the south west of the study area within Exmoor National Park. The River Bray and the River Mole sub-catchments are characterised by steep channel slopes and drain approximately 3% and 4% of the study area respectively.

2.15 The River Bray flows through Challacombe and the River Mole flows through Heasley Mill both small settlements located near the study area boundary. Outside of the study area the River Mole joins the River Bray to the south of South Molton, before flowing into the River Taw. The mouth of the River Taw is in Barnstaple.

The River Tone Catchment

2.16 The headwaters of the River Tone rise on the Brendon Hills, located to the south east of Exmoor. The River Tone drains Clatworthy Reservoir before flowing south out of the study area and then east towards Taunton. East of Taunton the River Tone forms part of the Somerset Levels and Moors. The River Tone catchment drains approximately 4% of the

study area. Although the River Tone flows through no settlements within the study area, Clatworthy and Brompton Ralph are located within this rural catchment.

Tidal/Coastal Areas

2.17 The study area has approximately 76km of coastline along its northern boundary with 41 km within ENPA and 35 km within WSC.

2.18 The Exmoor National Park coastline between Combe Martin Bay in the west and Porlock Bay is dominated by steep cliffs. Only the steep sided valleys of the coastal rivers break up the uniform profile of the cliffs along this stretch of coastline. The cliffs recede around Porlock Bay to form a low lying open valley. Managed alignment of the coastline at Porlock is being undertaken. The cliffs then rise up again along the coastline between Porlock Bay and Minehead.

2.19 The West Somerset coastline between Minehead and Blue Anchor is a low lying saltmarsh area protected from tidal flooding by sea walls in front of the built up areas at Minehead and Blue Anchor. To the east of Minehead towards Dunster the salt flats are overlain by sand dunes, with a shingle ridge shoreline between Dunster and Blue Anchor. The coastline between Blue Anchor and Audries Bay consists of low cliffs backed by agricultural land. The cliffs and foreshore along this stretch of coastline are designated as Site of Special Scientific Interest (SSSI).

2.20 The majority of the West Somerset coastline between Audries Bay and Hinkley Point consists of low cliffs with low lying areas around Klive and Lilstock. Eastwards of Lilstock there is a RAMSAR designation along the foreshore crossing into Sedgemoor District Councils administrative area. This designation also extends inland in the area of Wick Moor and North Moor. Artificial sea wall defences protect the Hinkley Point nuclear power station complex. The majority of this stretch of coastline is undeveloped used mainly for agriculture.

Topography and Geology

Exmoor National Park

- Within the administrative area of Exmoor National Park the topography is dominated by high rolling hills with gently sloping ridges and rocky outcrops of Exmoor National Park;
- Elevations within Exmoor National Park range from 250m AOD to 519m AOD at Dunkery Beacon. The rolling hills extend beyond the National Park boundary to the Brendon Hills in the east;
- The geology within Exmoor National Park is dominated by Middle and Upper Devonian sandstones, slates and shales dipping towards the south. Chapter 8 provides a more detailed description of the dominant solid and drift geology across the study area;
- The topography and geology, significantly influences the catchment hydrology and the response to rainfall. Many of the watercourses within Exmoor National Park form incised channels flowing through steep confined valleys. Where channel gradients

are steep, flood flows respond rapidly to rainfall and velocities and depths can be high.

West Somerset

- Within the administrative area of West Somerset for planning purposes, the topography is subdued with lower lying areas forming coastal plains along the north coast;
- The Quantock Hills is an area of raised elevation within West Somerset. Elevations typically range between sea level and approximately 300m AOD;
- Within West Somerset the geology covers a range of periods including Devonian (Lynton, Ilfracombe and Morte Slates), Carboniferous rocks (Pilton Shales), Permian Sandstones, Triassic sediments (Mercia mudstones) and Jurrassic (Blue Lias);
- The topography and geology, significantly influences the catchment hydrology and the response to rainfall. Areas draining from the higher ground of Exmoor into West Somerset typically have steep channel gradients and have a rapid response to rainfall;
- In the lower lying coastal areas, channel gradients are less than those experienced in the upper reaches and typically flow through relatively unconfined floodplains. These channels respond slower to rainfall with lower velocities and depths experienced during times of flooding.

Relevant Policies

2.21 Policies relevant at a national, regional and local level with respect to flood risk have been reviewed. Appendix B identifies key policies that may be used to inform documents as part of the LDF process. Policy considerations are also provided based upon the information collated within this Level 1 SFRA.

3 PPS25 Sequential Test

3.1 The main aim of this Level 1 SFRA is to present sufficient information to enable WSC and ENPA to apply the Sequential Test. The Sequential Test is a simple decision-making tool designed to ensure that sites at little or no risk of flooding are developed in preference to areas at higher risk. It can be applied at all levels and scales of the planning process, both between and within flood zones. All opportunities to locate new developments in reasonably available areas of little or no flood risk should be explored, prior to any decision to locate them in areas of higher risk.

What is the Sequential Test?

3.2 The Sequential Test refers to the application of the sequential approach by Local Planning Authorities. This allows the determination of site allocations based on flood risk and vulnerability (see Table 3-1 and 3-2, provided below). Development should be directed to Flood Zone 1 wherever possible, and then sequentially to Flood Zone 2 and then Flood Zone 3, and to the areas of least flood risk within Flood Zones 2 and 3, as identified within this Level 1 SFRA.

Table 3-1: PPS25 Flood Zone Definitions

Flood Zone	Definition
Flood Zone 1	Low probability - Defined as zone where there is a less than 0.1% (1 in 1000 year) probability of flooding each year.
Flood Zone 2	Medium probability - Defined as having between 0.1% and 1% (between 1 in 1000 and 1 in 100 year) probability of fluvial flooding each year and between 0.1% and 0.5% (between 1 in 1000 and 1 in 200 year) probability of tidal flooding each year .
Flood Zone 3a	High probability - Defined as having a 1% or greater (1 in 100 year or greater) probability of fluvial flooding each year and a 0.5% or greater (1 in 200 year or greater) probability of tidal flooding each year.
Flood Zone 3b	Functional floodplain - Defined as land where water has to flow or be stored in times of flood. Defined as the 5% (1 in 20 year) annual probability floodplain or an area designed to flood in an extreme (0.1%) flood, or another probability agreed between the Local Planning Authority (LPA) and the Environment Agency. (The Environment Agency do not currently produce Flood Zone 3b mapping for England and Wales).

3.3 The application of the Sequential Test aims to manage the risk from flooding by avoidance. This will help avoid the promotion of sites that are inappropriate on flood risk grounds. The application of the Exception Test, where required, through a Level 2 SFRA will ensure that

new developments in flood risk areas will only occur where flood risk is clearly outweighed by other sustainability drivers[2].

Table 3-2: Flood Risk Vulnerability Classification (from PPS25, Table D2)

Essential Infrastructure	• Essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk, and strategic utility infrastructure, including electricity generating power stations and grid and primary substations.
Highly Vulnerable	• Police stations, Ambulance stations and Fire stations and Command Centres and telecommunications installations required to be operational during flooding. • Emergency dispersal points • Basement dwellings. • Caravans, mobile homes and park homes intended for permanent residential use. • Installations requiring hazardous substances
More Vulnerable	• Hospitals • Residential institutions such as 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.
Less Vulnerable	• 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 for agriculture and forestry. • Waste treatment (except landfill and hazardous waste facilities). • Minerals working and processing (except for sand and gravel working). • Water treatment plants. • Sewage treatments plants (if adequate pollution control measures are in place).
Water-compatible Development	• Flood control infrastructure. • Water transmission infrastructure and pumping stations. • Sewage transmission infrastructure and pumping stations. • Sand and gravel workings.

[2] The sustainability drivers for WSC are available by emailing ldf@westsomerset.gov.uk. The sustainability drivers for ENPA at present reflect those contained within the draft RSS, these can currently be found at: http://gosw.limehouse.co.uk/file/304183

	• Docks, marinas and wharves. • 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). • Lifeguard and 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 warning and evacuation plan.

3.4 The LPAs must demonstrate that they have considered a range of possible sites in conjunction with the Flood Zone information from the SFRA and applied the Sequential Test, and where necessary, the Exception Test, in the site allocation process. In cases where development cannot be fully met through the provision of site allocations, it is expected that a realistic allowance be made for windfall development, based on past trends.

3.5 PPS25 acknowledges that some areas will (also) be at risk of flooding from flood sources other than fluvial or tidal systems. Consequently all sources of flooding must be considered when looking to locate development in any of the flood zones described in Chapter 5 Table 5-1. The other sources of flooding requiring consideration when situating new development allocations include:

- Surface water;
- Groundwater;
- Sewers; and,
- Artificial sources.

3.6 These sources (as sources of flooding) are typically less well understood than tidal and fluvial sources. Consequently data often only exists as point source data or through interpretation of local conditions. In addition, there is no guidance on suitable return periods to associate with floods arising from these sources. For example modern storm water drainage systems are constructed to a 1 in 30 year standard as required in Sewers for Adoption (Water UK, 2006). Any storm event in excess of the 30 year return period storm would be expected to cause flooding. Consequently when assessing these sources through the Sequential Test, if a location is recorded as having experienced repeated flooding from the same source this should be investigated further.

Application of the Sequential Test

3.7 The Sequential Test should be undertaken by the LPAs and be accurately documented to ensure decision processes can be transparently communicated and reviewed where necessary. The Sequential Test should be carried out on all development sites, seeking to balance the flood probability and development vulnerability of sites throughout the

administrative area. Only where there are no reasonably available[3] alternative sites should development be considered in Flood Zone 2 and then Flood Zone 3. The Sequential Test also applies to any new planning application including allocated sites that pre-date PPS25 and windfall sites.

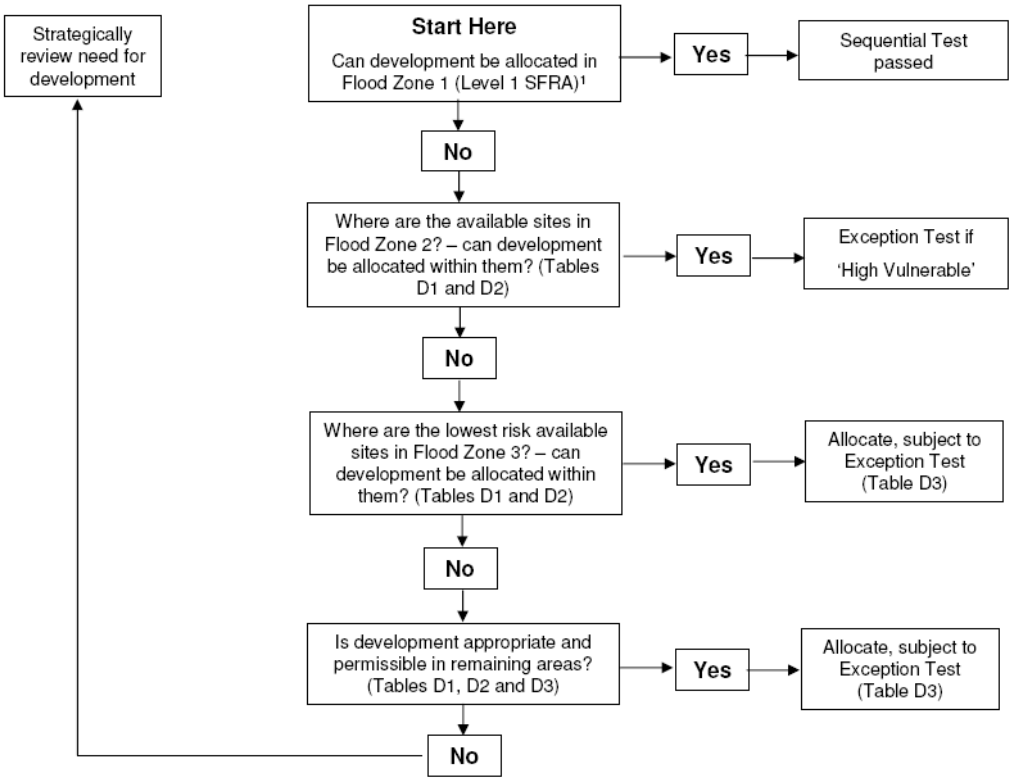
3.8 The PPS25 Practice Guide states:

> *'The Sequential Test should be applied to windfall sites, unless the area in which they occur has been sequentially tested on the basis of a SFRA. Where the Sequential Test has not been applied to the area, proposals will need to be dealt with on an individual basis and the developer will need to provide evidence to the LPA that they have adequately considered other reasonably available sites. This will involve considering windfall sites against other sites allocated as suitable for housing plans'.*

3.9 The Sequential Test can also be applied within an overall Masterplan area. Vulnerable development (or for that matter, all development) can steered into the parts of the site least at risk from flooding. Areas intended for green open space for example, could be positioned within areas with greater risk of flooding. This strategy allows a sustainable approach to development allocation within the floodplain.

3.10 Mapping within this Level 1 SFRA provides the tools for the LPAs to undertake the Sequential Test. The recommended steps required in undertaking the Sequential Test are provided in the flow diagram provided below. This is based on the Flood Zone and Flood Risk Vulnerability and is summarised in Table 3.3 (from PPS 25, Table D.3).

[3] This is defined in terms of deliverable and developable as per guidance in PPS25 and the PPS25 Practice Guide that refers to PPS3: Housing and the associated practice guide – Strategic Housing Land Availability Assessments.



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

Diagram 3-1: Decision flow chart illustrating the application of the Sequential Test (adapted from Figure 4.1 from PPS25 Practice Guide).

Table 3-3: Flood Risk Vulnerability and Flood Zone 'Compatibility' (from PPS25, Table D.3)

Flood Risk Vulnerability Classification		Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone	Zone 1	✓	✓	✓	✓	✓
	Zone 2	✓	✓	Exception Test Required	✓	✓
	Zone 3a	Exception Test Required	✓	×	Exception Test Required	✓
	Zone 3b (Functional Floodplain)	Exception Test Required	✓	×	×	×

✓ - Development is appropriate
× - Development should not be permitted

3.11 Further guidance is provided on the Environment Agency website for the application of the Sequential Test by Local Authorities[4].

Additional Guidance

3.12 The sequence of steps presented below in tandem with flow diagram is designed to guide the LPAs and developers through the Sequential Test. The steps are designed to ensure land allocations are primarily allocated in line with the principles of the Sequential Test or failing this the requirement for application of the Exception Test is clearly identified.

Recommended Stages for the LPAs

1. Assign all potential developments with a vulnerability classification (Table 3-2). Where development is mixed, this should be moved to the higher classification;

2. The location and identification of potential development should be recorded e.g. SS 970461, Minehead #1;

3. The Flood Zone classification of potential development sites should be determined based on a review of the flood zones for fluvial and tidal sources as described in Chapter 5. Where these span more than one Flood Zone, all zones should be noted;

4. The design life of the development should be considered with respect to climate change:

    - 60 years – for commercial / industrial developments; and,
    - 100 years – for residential developments.

5. Identify if there are existing flood defences serving the potential development sites based on the mapping presented in Chapter 7;

6. Highly vulnerable developments to be accommodated within the LPAs area should be located in those sites identified as being within Flood Zone 1. If these cannot be located in Flood Zone 1, because the identified sites are unsuitable or there are insufficient sites in Flood Zone 1, sites in Flood Zone 2 can then be considered. If sites in Flood Zone 2 are inadequate then the LPAs may have to identify additional sites in Flood Zones 1 or 2 to accommodate development elsewhere in their settlements/locations within their administrative area or seek opportunities to locate the development outside their administrative area;

7. Once all highly vulnerable developments have been allocated to a development site, the LPAs can consider those development types defined as more vulnerable. In the first instance more vulnerable development should be located in any unallocated sites in Flood Zone 1. Where these sites are unsuitable or there are insufficient sites remaining, sites in Flood Zone 2 can be considered. If there are insufficient sites in Flood Zone 1 or 2 to accommodate more vulnerable development, sites in Flood Zone 3a can be considered. More vulnerable developments in Flood Zone 3a will require application of the Exception Test;

8. Once all more vulnerable developments have been allocated to a development site, the LPAs can consider those development types defined as less vulnerable. In the first

[4] http://www.environment-agency.gov.uk/research/planning/82584.aspx

instance less vulnerable development should be located in any remaining unallocated sites in Flood Zone 1, continuing sequentially with Flood Zone 2, then Flood Zone 3a. Less vulnerable development types are not appropriate in Flood Zone 3b (functional floodplain);

9. Essential infrastructure should be preferentially located in the lowest flood risk zones, however, this type of development may be located in Flood Zones 3a and 3b, provided the Exception Test is fulfilled;

10. Water compatible development has the least constraints with respect to flood risk and it is considered appropriate to allocate these sites last;

3.13 For the above stages, it will also be necessary to consider the risks posed to the site from other flood sources and where comparable, development sites in the same flood zone may be more suitable due to:

- Flood risk management measures;
- The rate of flooding;
- Flood water depth; or,
- Flood water velocity.

3.14 Where the development type is highly vulnerable, more vulnerable, less vulnerable or essential infrastructure and a site is found to be impacted by a recurrent flood source (other than tidal of fluvial), the site and flood sources should be investigated further regardless of any requirement for the Exception Test. Confirmation of the assessment method should be established with the Environment Agency, this could be through either a Level 2 SFRA, a Strategic Surface Water Management Plan or a site specific FRA.

3.15 The effect of climate change for potential sites located within fluvial and tidal flood risk zones is described in Chapter 5. It is recommended that a Level 2 SFRA or a site specific Flood Risk Assessment should investigate the effects of climate change in greater detail, where required.

3.16 Appendix A provides a table for completion by the LPAs for each potential development site, using the approach and responses to the questions provided. This will aid the determination of the most suitable type of development for each site based on development vulnerability and flood risk. Where sites are identified as requiring the Exception Test, these should be transferred to second table in Appendix A for the LPAs to provide responses for parts ‘a’ and ‘b’ of the Exception Test.

4 Data Collection and Review

Overview

4.1 This chapter provides details of the collection and review of available data relating to flooding within the study area. This information/data is then presented in a format to enable the LPAs to undertake the Sequential Test (see Chapter 3). The review of this available information/data allows gaps to be identified in order to ascertain additional requirements that may be needed to meet the objectives of a Level 2 SFRA, where required.

Programme of Works

4.2 The programme of works undertaken in the preparation of this Level 1 SFRA is shown below:

- Inception meeting with WSC, ENPA and the Environment Agency on 5th November 2008;
- Identification of the local stakeholders;
- Issue of letters to stakeholders requesting data/information;
- Followed-up data requests (where required);
- Collation and review of available data;
- Review of received data against the SFRA objectives;
- Production of a broad-scale assessment of flood risk.

4.3 All tasks were completed between November 2008 and January 2009.

Stakeholder Meetings

4.4 The inception meeting held with WSC, ENPA and the Environment Agency on the 5th November 2008 allowed the identification of key stakeholders, data and information sources and discussed the proposed format of the SFRA reporting.

Stakeholder Consultation

4.5 The following stakeholders were contacted to provide data and information with respect to flood risk, which was used to inform this Level 1 SFRA:

- West Somerset Council;
- Exmoor National Park Authority;
- Environment Agency (Devon and Cornwall area office, North and South Wessex area office);
- Wessex Water Ltd;
- South West Water Ltd;
- Devon County Council;

- Somerset County Council;
- The Devon and Somerset Fire and Rescue Service;
- The National Trust.

4.6 All of the information/data was provided in GIS format, or the raw data was manipulated into this format for use within the study.

Information/Data Review

4.7 The remainder of this chapter summarises the key information/data collected as part of this Level 1 SFRA. This includes a brief description of the data, how it applies to the Level 1 SFRA

Environment Agency Flood Zone Map

4.8 The Environment Agency has provided an extract of their Flood Map for the study area. The Flood Map shows the estimated extent of Flood Zones 2 and 3 (ignoring the presence of flood defences) for all Main Rivers, watercourses with identified critical drainage problems and coastal areas. The Environment Agency do not differentiate between Flood Zone 3a (high probability) and Flood Zone 3b (functional floodplain). These flood zones are discussed further in paragraphs 5.12 to 5.18. The Flood Map gives an indication of the areas at risk of both fluvial and tidal flooding in the study area; however it does not provide details on individual properties.

4.9 The fluvial Flood Map extents have been developed by the Environment Agency using a combination of localised, broad-scale model (JFLOW) and earlier methods which include the use of Synthetic-Aperture Radar (SAR) topography together with data based on historic records and engineering judgement. In some areas of the study area the extent of Flood Zone 2 includes digital outlines of historic flood events used to identify the flood risk associated with fluvial flooding.

4.10 The Environment Agency Flood Map does not provide information on flood depth or velocity of flow. It also does not cover flooding from other sources, such as groundwater, direct runoff from fields, or overflowing sewers. The Environment Agency updates Flood Zone Maps on a quarterly basis, incorporating the results of detailed studies where relevant.

Detailed Hydraulic Modelling

4.11 The Flood Map has been modified in a number of locations through hydraulic modelling. Hydraulic models use detailed topographic data and rigorously derived flow estimates to define flood extents. Where hydraulic models exist, these provide greater accuracy in defining flood extents. In these locations Flood Maps generated using JFLOW and earlier methods have been superseded.

4.12 The Environment Agency undertook hydraulic modelling in March 2008 in order to update the Flood Maps with the latest river flow data. The outcome of the hydraulic modelling was a revised 1 in 100 year fluvial Flood Map and 1 in 200 year tidal Flood Map within the modelled areas. The hydraulic models, provided as part of the data request, are summarised below:

- River Avill – HEC-RAS 1D model;
- Holford Stream – HEC-RAS 1D model;
- Washford River – HEC-RAS 1D model.

Catchment Flood Management Plans

4.13 Catchment Flood Management Plans (CFMPs) are high level strategic documents produced by the Environment Agency that provide an overview of the main sources of flood risk and how these can be managed in a sustainable way over the next 50 to 100 years. The Environment Agency engages stakeholders within the catchment in order to produce policies for sustainable flood management whilst also considering the land use changes and the effects of climate change.

4.14 There are four CFMPs covering the catchments within the study area. These CFMPs provide important information on historic flood events within the study area. The CFMPs are provided below:

- North Devon (Environment Agency, August 2008);
- Parrett (Draft v8) (Environment Agency, October 2008);
- West Somerset (Final Plan) (Environment Agency, September 2008);
- Exe (Environment Agency, August 2008).

Regional Flood Risk Appraisal

4.15 As part of the evidence base for the South West Regional Spatial Strategy, the Regional Flood Risk Appraisal (RFRA, 2007) focuses on nine sub-regional Strategically Significant Cities and Towns (SSCTs) within the South West. The Taunton and Bridgwater SSCTs covers an extensive rural area and includes part of Exmoor National Park and West Somerset. Taunton is identified as being at significant flood risk from the River Tone. Although Taunton is not located within the study area, the headwaters of the River Tone are located within the study area.

Shoreline Management Plan

4.16 The Shoreline Management Plan as described in Appendix B provides information on the policies with respect to the preferred management options for the coastline within the study area. This document is currently being reviewed and updated, therefore changes in existing policy should be incorporated into future updates of the Level 1 SFRA.

Report on Regional Extreme Tide Levels (Posford Haskoning Ltd, 2003)

4.17 Extreme tidal still water levels of return period 1, 5, 10, 25, 50, 100, 200 and 1000 years are provided in the 'Report on Regional Extreme Tide Levels' (Posford Haskoning Ltd, 2003).

4.18 The extreme tidal still water levels in conjunction with guidance on sea level rise associated with climate change contained within PPS25, have been used to produce tidal climate change outlines at vulnerable coastal locations within the study area. Information within the

report has also been used to demonstrate the reduction in return period of indicative defence crest levels due to sea level rise associated with climate change.

Topographic Data - LiDAR

4.19 The Environment Agency has provided Light Detection and Ranging (LiDAR) for the study area. LiDAR is an airborne mapping technique that uses a laser to measure the distance between the aircraft and the ground. It varies in accuracy depending on the nature of the terrain such as in woodlands or complex urban areas. However, LiDAR data is generally recognised to be accurate to within +/- 300mm when compared to actual vertical levels.

Flood Defences

4.20 Traditionally, flood defences are often man-made structures, such as walls or embankments, adjacent to the open coast or aligned along the banks of a river system, which are intended to prevent flooding of land that lies behind. More recently, 'softer' approaches have been adopted, such as the allocation of land to flood, in preference of somewhere more vulnerable. Flood defences do not entirely remove flood risk, a residual risk will remain, if for example an embankment becomes breached or is overtopped.

4.21 The Environment Agency has provided a GIS layer of the National Flood and Coastal Defence Database (NFCDD) showing details of structures and flood defence assets within the study area. This provides details of the asset reference, location and standard of protection that the structure or defence provides. However, the Environment Agency has confirmed that the information contained within the NFCDD should be treated with low confidence for the study area.

Historical Flood Incidents

4.22 Records of historic flood incidents have been provided by the Environment Agency and the Devon and Somerset Fire and Rescue Team. The Environment Agency Devon and Cornwall area office have provided flood incident information from their Flood Reconnaissance Information System (FRIS) database. FRIS allows the identification of flooding attributed to different sources, where known.

4.23 The Environment Agency North and South Wessex area office has provided a Section 105 Historic Flood Event database, which provides additional historic flood incident information. The Environment Agency Devon and Cornwall area office has provided a FRIS property database, which identifies general locations where properties have been affected by flooding.

4.24 This information was supplemented by a database provided by the Devon and Somerset Fire and Rescue Service. This database documents flood incidents responded to by the Fire and Rescue Service.

Groundwater Flooding Information

4.25 Information on groundwater flooding is limited within the study area, in part, due to the underlying substrate. The Environment Agency includes groundwater flood incidents within its FRIS database.

4.26 Inspection of the Environment Agency Groundwater Source Protection Zones (SPZ) within the study area has identified a number of areas located within a SPZ. This indicates that there is a resource used for public water supply that should be safeguarded from potential pollution. The location and approximate National Grid Reference (NGR) for the SPZ are provided below:

West Somerset

- West of Williton (NGR: ST064408).

Exmoor National Park

- Croydon Hill (NGR: SS968409);
- East of Treborough (NGR: ST011364);
- North east of Wootton Courtenay (NGR: SS948440);
- North of Woodcombe (NGR: SS956472);
- West of Allerford (NGR: SS915468);
- West of Porlock (NGR: SS862460);
- South west of Withypool (NGR: SS828344);
- Blagdon Cross (NGR: SS911395);
- Brendon Hill Farm (NGR: SS929380).

It should be noted that although these indicate locations where groundwater resources exist, it does not necessarily infer that groundwater emergence will occur at these locations.

Sewer Flooding Information

4.27 The management of storm water/foul water for the study area is the responsibility of Wessex Water Ltd, South West Water Ltd, Somerset County Council and Devon County Council. In addition, private individuals may be responsible for drainage systems that operate prior to discharge either into a watercourse or into a public sewer.

4.28 Wessex Water Ltd and South West Water Ltd are the statutory water undertakers responsible for the public sewer systems within the study area. Wessex Water Ltd is responsible for the majority of the WSDC administrative area and South West Water Ltd is responsible for the majority the ENPA administrative area.

4.29 Wessex Water Ltd has provided data from their risk register (DG5 Register) which identifies problematic areas affected by sewer flooding. Details from this risk register are displayed in Chapter 6 and Appendix C.

4.30 South West Water Ltd has reported that there are no flooding issues attributable to the public sewer system within their area of the study area. Additional sewer flooding records are provided within the FRIS and Section 105 database provided by the Environment Agency.

Artificial Flood Source Information

4.31 Within the study area there are a number of reservoirs and storage areas that are considered under the Reservoirs Act 1975 (volume greater than 25000 m^3). The Environment Agency Reservoirs Team (Manley House, Exeter) provided the location and details of reservoirs that are within the remit of the Reservoirs Act within the study area.

4.32 There are six operational impounding reservoirs located within the study area that may present a flood risk due to failure or overtopping. The reservoir names and approximate NGR locations are provided below:

West Somerset

- Clatworthy (NGR: ST043314).

Exmoor National Park

- Challacombe (NGR: SS697421);
- Pinkworthy Pond (NGR: SS723422);
- Holywell (NGR: SS763308);
- Nutscale (NGR: SS862434);
- Wimbleball (NGR: SS967293).

Geological and Soil Maps

4.33 British Geological Survey (BGS) maps and the Soil Survey of England and Wales (SSEW) map have been reviewed and used to provide an overview of the geology and soils within the study area (see Chapter 8).

5 SFRA Flood Mapping

5.1 This chapter describes how the data reviewed in the previous chapter has been used in the production of mapping and GIS deliverables for this Level 1 SFRA. It is important that the methodologies, assumptions and limitations discussed below are understood before the mapping is used for planning purposes.

5.2 The Level 1 SFRA flood mapping is the key component to assist in the application of the Sequential Test, by providing flood risk information to guide decisions on location of future development.

Requirements of PPS25

5.3 PPS25 and the accompanying Practice Guide require SFRAs to present sufficient information on all flood sources to enable LPAs to apply the Sequential Test within their administrative areas. In order to apply the Sequential Test, information is required on the probability (High, Medium or Low) associated with flooding from different sources.

5.4 In addition, where possible, the assessment of probability should also account for the effects of climate change on a flood source for the lifetime of any development that would be approved through the emerging LDF.

5.5 Apart from tidal and fluvial sources, the lack of available data makes the definition of robust classifications of probability unreliable. Furthermore, where information is available, it tends to be subjective and of poor quality (i.e. 3 houses were flooded or the worst storm in living memory). Consequently, where only anecdotal evidence of flooding is available, subjective assessments of probability are not appropriate. Quantification of probability should be investigated through a site specific FRA submitted as part of a planning application. Details of the requirements for FRAs are presented in Chapter 9.

5.6 The following sections explain how the available data has been used to develop the mapping for use in undertaking the Sequential Test.

GIS Layers and Mapping

5.7 Geographical data such as flood extents and recorded flood incidents that can be used to inform appropriate planning decisions, have been presented as maps (attached to this report) using the MapInfo GIS platform.

5.8 GIS acts as an effective management tool for the coordinated capture, storage and analysis of data of a geographical nature. GIS handles data in a hierarchical manner by storing spatial features within various layers, which are allied to an underlying database. GIS is a recognised tool for the efficient collation, storage and analysis of information and is also an increasingly valuable resource for LPAs.

5.9 The GIS mapping layers contain additional attribute data, which provides more detailed information regarding the date, location and cause of the flood event.

Fluvial and Tidal Flooding

Flood Zones (Figure 3 A-F)

5.10 PPS25 requires fluvial and tidal flood zones to be identified to allow LPAs to undertake the Sequential Test. The definitions of these flood zones are provided in Chapter 3.

5.11 Flood Zone 1, 2 and 3 constitute the Environment Agency Flood Maps, identified upon Figures 3 A-F. The Environment Agency do not differentiate between Flood Zone 3a (high probability) and Flood Zone 3b (functional floodplain). A methodology was agreed with the Environment Agency for the delineation of Flood Zone 3b and is discussed below. Areas not lying within Flood Zone 2 or 3a/b are classified as Flood Zone 1.

Flood Zone 3b Functional Floodplain (Figure 3 A-F)

5.12 PPS25 aims to steer development away from areas of flood risk, functional floodplain (Flood Zone 3b) has the highest probability of flooding and therefore only water compatible development is appropriate in such locations.

5.13 Therefore it is important to consider the location of Flood Zone 3b in the future spatial planning and emerging LDF documents. Flood Zone 3b relates only to river and coastal flooding, it does not include other sources of flooding (e.g. surface water, sewers).

5.14 The PPS25 Practice Guide states that areas which would naturally flood with an annual exceedence probability of 1 in 20 (5%) or greater, but which are prevented from doing so by existing infrastructure or solid buildings, will not normally be defined as Flood Zone 3b. Defences and other flood risk management infrastructure should be considered when defining Flood Zone 3b.

5.15 The principal settlements (Town and Area/Rural Centres) within the study area are set out below. Within these locations, areas located outside of Flood Zone 3b functional floodplain have been defined, based on the above PPS25 Practice Guide advice. The six locations are:

- Minehead (West Somerset);
- Watchet (West Somerset);
- Williton (West Somerset);
- Dulverton (Exmoor National Park);
- Porlock (Exmoor National Park);
- Lynton and Lynmouth (Exmoor National Park).

5.16 Within these locations, where the standard of protection of flood defences has an annual probability of 5% or greater (as defined in the NFCDD), the adjacent floodplain would not be considered Flood Zone 3b (see Figure 5 A-B). Additionally, developed areas where there is existing infrastructure and solid buildings have not been considered as Flood Zone 3b.

5.17 In areas where development is unlikely to occur, a precautionary approach has been adopted whereby Flood Zone 3b (functional floodplain) has been assumed to equal the

extent of Flood Zone 3a, until an appropriate site specific FRA can demonstrate to the Environment Agency that it can be considered to be located within Flood Zone 3a (High Probability).

5.18 The assumption that the standard of defences, where present, will be maintained (including an allowance for the anticipated effects of climate change) suggests that an area defined as Flood Zone 3a, could revert back to Flood Zone 3b functional floodplain over time. Previously developed land adjacent to watercourses could also be reinstated to Flood Zone 3b in liaison with the Environment Agency and the LPA.

Climate Change

5.19 It is predicted that climate change will bring milder wetter winters that are characterised by periods of long duration rainfall. In contrast, frequent and short duration, high-intensity rainfall linked with longer drier summers is predicted. These scenarios are likely to cause increased flooding from fluvial, surface water and sewer sources. In addition, the effects of climate change on sea level will increase the likelihood of coastal and tidal flooding in low lying areas.

5.20 PPS25 requires that flood zones are also mapped allowing for the predicted effects of climate change. Flood zones should be mapped to account for the effects of climate change over the lifetime of any developments that may be granted planning permission within the lifetime of the emerging LDF. The PPS25 Practice Guide identifies an indicative lifetime for residential developments of 100 years; consequently flood zones should be defined accounting for the effects of at least 100 years of climate change. The indicative lifetime for other forms of development (i.e. commercial, infrastructure) should be agreed.

5.21 In line with PPS25 guidance on climate change, sea levels are predicted to rise by 1.08 m, in the southwest of England by 2115 and as a precautionary sensitivity for peak river flows an allowance of 20% should be accounted for.

Climate Change – Tidal/Coastal Flooding

5.22 Using the methodology described in Appendix D. Tidal climate change outlines (up to 2115) for Flood Zone 2 (medium probability) and Flood Zone 3 (high probability) for five coastal locations were undertaken, these are:

West Somerset

- Minehead to Blue Anchor;
- Hinkley Point;
- Watchet.

Exmoor National Park

- Porlock Bay;
- Lynmouth.

These tidal climate change outlines are not shown on the mapping but are provided as a GIS layer accompanying this report. The potential for wave overtopping as a result of coastline exposure to wave energy has not been considered as part of this Level 1 SFRA.

Climate Change – Fluvial Flooding

5.23 In terms of fluvial flooding, where hydraulic modelling exists and allowances have been made for the predicted effects of climate change, these can be used to provide flood extents for future scenarios. However, it is noted that the existing models available for the Level 1 SFRA do not incorporate an allowance for climate change.

5.24 For the purpose of this study, this Level 1 SFRA has assumed that the present day Flood Zone 2 (medium probability) becomes Flood Zone 3 (high probability) by 2115.

Unmapped Watercourses

5.25 The Environment Agency Flood Zone mapping covers the majority of watercourses within the study area. However, where catchments are less than 3 km^2 in area, the Environment Agency mapping does not typically define Flood Zones 2 and 3. Consequently, there are some locations where flood zones are not defined. These are generally in areas of higher elevation within the headwaters of small catchments or minor tributaries.

5.26 It is recommended that a 20 m buffer either side of the channel bank top be designated as Flood Zone 3b. This recommendation is consistent with the requirement for consultation by the Environment Agency for Main Rivers. Where required, further investigation and refinement of the flood zones should be undertaken as part of a site specific FRA.

Historic Flood Incidents and Potential Flood Sources

Historic Flood Incidents (Figure 4 A-F)

5.27 The historic flood incident information provided by the Environment Agency and the Devon and Somerset Fire and Rescue Service, as described in Chapter 4, represents the main source of data for surface water, sewer and groundwater flood events. These databases also provide additional information on fluvial and tidal flooding within the study area.

5.28 The location of historic flood incidents have been provided on the Level 1 SFRA flood maps (Figure 4 A-F). GIS points identify the general location of the flood incident and each flood source is represented by a different colour. The historic flood incident GIS layer, which accompanies this Level 1 SFRA provides additional information regarding the flood incident.

5.29 Within the study area, the cause of flood incidents can be attributed to a single flood source or a combination of flood sources. For example there are many incidents where the cause of flooding is reported as fluvial/sewer. This may be due to the effect of an intense storm which causes river banks to overtop, while at the same time the capacity of the sewer is exceeded.

Potential Flood Sources (Figure 4 A-F)

5.30 The reservoir information provided by the Environment Agency, as described in Chapter 4, has been included on Figure 2 and Figure 4 A-F. GIS points represent the location of the reservoir within the study area. Further information regarding the reservoirs is provided in Chapter 6 and the reservoir GIS layer, which accompanies this report.

5.31 Wessex Water Ltd has provided additional sewer flood risk mapping which displays information from the DG5 risk register. The mapping indicates the approximate location of properties at risk of sewer flooding but does not identify the number of properties or precise location. Mapping based on the DG5 risk register is provided in Appendix C.

Broad-Scale Review and Focused Assessments

Broad-scale Flood Risk Review (Appendix E)

5.32 The flood mapping described in the above sections has been used to undertake a broad-scale flood risk review and focused assessments within the study area. The broad-scale flood risk review, provided in Appendix E, consists of a flood risk matrix, providing an initial 'at a glance' overview of flood risk within the study areas main settlements. The flood risk matrix indicates if the settlement has land located within Flood Zone 1, 2 or 3 and identifies if flooding from other sources has been experienced.

5.33 The flood risk mapping provided in Figures 3 to 5, together with the information held within the GIS layers can then be used to provide further information of the flood risk within the main settlements.

Focused Assessment (Appendix F)

5.34 Focused assessments, provided in Appendix F, have been undertaken in locations where the majority of development is likely to be targeted over the plan period. The focused assessments consist of individual maps focused on the Area or Rural Centres, as previously identified within the functional floodplain section of this chapter.

5.35 The focused assessment maps combine all the flood risk mapping information for the particular settlement, providing a practical format to assess the flood risk. The focused assessments also include local and regional policy information regarding housing and employment provisions for the area.

6 Assessment of Potential Flood Sources

6.1 This chapter presents an assessment of potential flood sources within the study area based on Environment Agency Flood Maps and the historic flood incident records collated and reviewed as part of this Level 1 SFRA report. In addition, the assessment also includes flood risk information provided within the CFMPs covering the study area. Links to the Level 1 SFRA Flood Mapping, as described in Chapter 5, are provided at the beginning of each sub-section. Details of the flood risk management infrastructure and flood warning systems are covered in Chapter 7.

Study Area Flood Sources

6.2 There have been many recorded flood events within the study area in recent years. Selected flood events within the study area are provided in Table 6-1. The majority of the flood incident information provided in Table 6-1 has been sourced from the CFMPs covering the study area.

Table 6-1: Selected historic flood events within West Somerset and Exmoor National Park

Flood Event	Location	LPA	Details of Event
August 1952	Lynmouth Dulverton	ENPA	Fluvial flooding from the Lyn. 34 lives claimed, 93 houses and 123 vehicles affected in Lynmouth. Flooding from River Barle affected 35 properties in Dulverton.
December 1960	Brendon	ENPA	Fluvial flooding from the River Heddon. 1 life lost.
December 1960	Williton	WSC	Localised fluvial flooding occurred resulting from blocked structures.
December 1981	Porlock	ENPA	Tidal flooding caused localised flooding.
December 1985	Dulverton	ENPA	Flooding from River Barle affected <135 properties in the Dulverton area.
March 1990	Minehead, Blue Anchor and Porlock	WSC/ENPA	Tidal flooding caused localised flooding.
November 1994	Carhampton	WSC	Blocked river structures flooded 5 houses and gardens.
January 1996	Minehead	WSC	Internal property flooding resulted from tidal flooding.
October 2000	Williton	WSC	Blocked river structures flooded properties
Dec-2000	Williton, Doniford and Minehead	WSC	Internal flooding to residential and commercial

Flood Event	Location	LPA	Details of Event
			properties in Williton was caused by fluvial flooding and surface water run-off affecting approximately 50 different sites. 20 houses were also flooded in Doniford and localised flooding occurred in Minehead.
November 2002	Washford	WSC	2 houses were flooded from surface water flooding and fluvial flooding as a result of blocked structures.

Fluvial Flooding (Figure 3 & 4 Maps)

6.3 Fluvial flooding is most commonly caused by intense rainfall causing flash flooding, or following prolonged rainfall upon saturated ground, resulting in floodplain inundation. Various situations can exacerbate fluvial flood risk, such as blockages at culvert and bridges or infrastructure failure.

6.4 Within the upper reaches of each catchment, the majority of floodplains are confined within steep sided valleys. In the north of the study area many of the lower reaches of each catchment, consist of low lying coastal areas which have open unconfined floodplains.

6.5 Urban areas most affected by fluvial flooding within West Somerset include Minehead, Dunster Marsh and Williton. Urban areas most affected by fluvial flooding within Exmoor National Park include Dulverton, Porlock, Lynmouth and Dunster. Debris can cause watercourses and structures to become blocked exacerbating flooding. The West Somerset CFMP has identified this as a problem within Minehead.

6.6 Transport links within West Somerset, such as the A39 in the vicinity of Williton, Ellicombe and Dunster Marsh, and transport routes within Exmoor National Park around Dulverton are affected by fluvial flooding. The Police Station and Fire Station are also at risk from fluvial flooding in Dulverton.

6.7 Using the methodology described in Chapter 5, the effects of climate change can be identified by comparing the extent of present day Flood Zone 2 with present day Flood Zone 3.

6.8 The lower catchments of the coastal rivers within the study area show the most significant increase in the extent of Flood Zone 3 due to climate change. These areas have more open floodplains when compared to the deep incised channels of the upper catchments.

6.9 The areas below are likely to experience a dramatic increase in fluvial flood risk due to the impacts of climate change:

West Somerset

- Bratton Stream (north west Minehead);
- River Avill (east of Dunster);

- Monksilver Stream (Williton).

Exmoor National Park

- Hawkcombe Stream (Porlock).

Tidal/Coastal Flooding (Figure 3 & 4 Maps)

6.10 Tidal flooding occurs when sea level rises above the normal tidal range, which can affect the open coast and estuarine areas. In addition to high tides, tidal flooding can become exacerbated by storm or tidal surges and from wave action. High sea levels can cause tide locking, which may reduce the drainage of water from rivers and sewers causing an additional source of risk.

6.11 Steep cliffs dominate the majority of the study areas coastline. Therefore areas exposed to tidal/coastal flooding are confined to the flatter coastal plains where the cliffs recede away. The tidal influence on the watercourses within the study area extends into the flatter coastal plains where structures allow. The steep topography moving further inland to the south restricts the upstream extent of the tidal influence. The larger urban areas most affected by tidal/coastal flooding include:

- Minehead (West Somerset);
- Watchet (West Somerset);
- Porlock (Exmoor National Park).

6.12 Tide locking can occur in many of the watercourses within the study area, these include the Bratton Stream, Pill River and Washford River, within West Somerset. The Bratton Stream, located within Minehead, discharges into the sea via a flapped outfall. During a combined river and tidal event, the potential flood risk posed by the Bratton Stream is likely to increase.

6.13 A comparison of the present day tidal Flood Zones 2 and 3 with the tidal climate change outlines, identified using the methodology described in Appendix D, indicate that although there may be a slight increase in the flood extent the increase in flood depth will be more significant.

Surface Water Flooding (Figure 4 Maps)

6.14 Surface water flooding is typically generated by short duration, intense rainfall events where precipitation is unable to infiltrate the ground or enter drainage systems. Subsequently, water may become transferred overland causing localised flooding.

6.15 There are a number of historic surface water flood incidents shown on the SFRA Level 1 Flood Mapping. Surface water flooding is likely to occur at the base of hills, escarpments and low points in terrain. Overland flow is exacerbated by urban development and the permeability of underlying soils and geology.

6.16 A number of steep escarpments exist within the study area. The majority are located within the steep river valleys and the foothills around the periphery of Exmoor National Park.

Groundwater Flooding (Figure 4 Maps)

6.17 Groundwater flooding occurs when water levels in the ground rise above surface elevations and cause spring resurgence. This type of flooding is dependant on the underlying geological strata and the antecedent conditions.

6.18 The nature of the underlying geology within the study area means that groundwater flooding is not significant. The Environment Agency FRIS database indicates that a single historic flood incident is classified as being from groundwater sources. The groundwater flood incident was reported to occur in Brendon, affecting one property within the village.

Sewers Flooding (Figure 4 Maps & Appendix C)

6.19 Sewer systems are typical to all the urban locations within the study area. Modern sewer systems are typically designed to accommodate storm events with a 30 year return period in accordance with Sewers for Adoption (Water UK, 2006) and are normally separated into foul and surface water sewers. Older sewer systems were often constructed without consideration of a design standard and may in some areas have an effective design standard of less than 30 years. In addition, these systems were often designed to convey foul and surface water flows in combination. Consequently, storm events with a return period exceeding 30 years would be expected to result in flooding of some parts of the sewer system.

6.20 In the past, as towns and villages expanded to accommodate growth, original sewer networks were not upgraded to sufficient capacity therefore reducing the effective design standard. The effects of climate change will compound these problems with predictions of milder wetter winters and increased rainfall intensity in summer months. This combination is likely to result in more frequent sewer flooding.

6.21 A flood risk map provided by Wessex Water identifies the general location where sewer flooding may be problematic. The flood risk mapping provided by Wessex Water is presented in Appendix C and is summarised in Table 6-2.

Table 6-2: Settlement locations of properties at risk from foul sewer flooding

Location	DG5A	DG5B	DG5C
Washford	Yes	-	-

6.22 The three categories on the DG5 Register are:

- DG5A – property flooding with frequency of 2 in 10 years;
- DG5B – property flooding with frequency of 1 in 10 years; and,
- DG5C – property flooding with frequency of 1 in 20 years.

6.23 The location of additional historic sewer flooding incidents, identified within the Environment Agency FRIS database are shown on the Figure 4 mapping.

Artificial Flood Sources (Figure 4 Maps)

6.24 Artificial flood sources include raised channels such as canals or storage features such as ponds and reservoirs, where water is retained above natural ground level. Infrastructure failure may occur as a result of being overwhelmed and/or as a result of dam or bank failure. However, the likelihood of failure is low due to regular inspection and maintenance, however, should a breach occur, the consequences are likely to be significant.

6.25 Artificial sources of flooding are present within the study area, although no records of flooding associated with artificial sources have been identified from the stakeholders contacted. For the purposes of this Level 1 SFRA the main sources of artificial flooding are associated with reservoirs.

6.26 The open reservoirs within the study area are mainly used for water supply and recreation. Information regarding the reservoirs capacity and status have been provided by the Environment Agency and is summarised below in Table 6-3.

Table 6-3: Summary of impounding reservoirs located within the study area

Reservoir	Location	Water Undertaker	Capacity (m^3)
Challacombe (Bray)	ENPA	South West Water Services Ltd	52,300
Pinkworthy Pond (Pinkery)	ENPA	Exmoor National Park Authority	37,000
Holywell	ENPA	South West Water Services Ltd	44,750
Nutscale	ENPA	Wessex Water Services Ltd	178,000
Wimbleball	ENPA	South West Water Services Ltd	21,541,000
Clatworthy	WSC	Wessex Water Services Ltd	5,364,000

6.27 In addition to the Figure 4 maps, reservoir locations and the predominant flood risk direction in the event of dam or bank failure are shown on Figure 2.

6.28 The Water Act 2003 amended the Reservoirs Act 1975 and introduced a requirement for reservoir undertakers to prepare reservoir flood plans.

A reservoir flood plan will include:

- An inundation analysis to identify the extent and severity of flooding which could result from an uncontrolled release of water;
- An on-site plan setting out what the undertaker would do in an emergency to try to contain and limit the effects of the incident;
- A communications plan with external organisations, mainly the emergency services.

6.29 They are expected to become a legal requirement in spring 2009 and the Pitt Review (2008) reinforced this requirement. Flood plans will be required for reservoirs where failure could have a major impact on risk to property and lives.

7 Flood Risk Management

Introduction

7.1 The Level 1 SFRA Flood Maps, introduced in Chapter 5, do not necessarily account for any flood risk management measures which are in place, although these exist throughout the study area. This chapter is intended to raise awareness of current and future potential flood risk management measures, which should be considered during allocation of development sites.

Flood Defences

7.2 Flooding may occur across areas of the study area with minimal effect to people, buildings, infrastructure or the economy, however, in some areas there may be a significant effect. Where required, flood defences are usually focused in and around the urban areas where for social, economic and sustainability reasons these are required to minimise disruption to individuals, businesses and the wider community.

7.3 Environment Agency Flood Maps do not account for the presence of flood defences when delineating the Flood Zone extent and therefore areas of land situated behind these defences are still attributed with a flood risk. The presence of flood defences does not remove the risk for the areas protected as failure through overtopping or breaching may occur, therefore, a residual flood risk remains. Where required, areas benefiting from defences should be investigated in a Level 2 SFRA.

Indicative Standard of Protection (Figure 5 Maps)

7.4 The NFCDD (as previously described in Chapter 4) is compiled by the Environment Agency and contains information on natural and man-made defences, including the Standard of Protection (SoP). Figure 5 A-B illustrates the indicative SoP provided by flood defences throughout the study area. The indicative SoP does not take into account the following:

- Defence Type;
- Defence age, condition, ownership or maintenance regime;
- The potential for wave over topping of the defences.

7.5 Considering the above, and guidance from the Environment Agency stating that the information contained within the NFCDD should be treated with low confidence, Figure 5 A-B should be used as a preliminary assessment of the SoP provided by flood defences, instead of a reliable dataset. Where necessary, a more detailed assessment of the defences should be undertaken as part of a Level 2 SFRA.

7.6 The defences within Figure 5 A-B have been categorised based on the standard of protection afforded by them. These figures illustrate that the presence of formal raised man-made flood defences are limited throughout the study area, except for coastal defences within West Somerset, in the vicinity of Minehead, Blue Anchor, Watchet and Hinkley Point, which primarily consist of sea wall. The defences at Porlock, located within Exmoor National

Park, are subject to managed realignment of the coastline where the replenishment of the man-made shingle ridge has been stopped.

7.7 Fluvial man-made flood defences within the study area consist of a small number of relatively short reaches of masonry and concrete wall, raised banks, gabion baskets and timber piling. In addition, the River Avill was realigned within a concrete channel in the 1960's.

Climate Change Indicative Standard of Protection

7.8 As discussed in Chapter 5, in line with PPS25 guidance on climate change, sea levels are expected to rise by approximately 1.08 m, in the southwest of England by 2115. Based on extreme tidal still water levels for Minehead (Posford Haskoning Ltd, 2003) an indication for the reduction in return period of the indicative SoP in 2115 after 100 years of sea level rise is provided in Diagram 7.1.

7.9 This diagram provides the LPAs with an example of how the effects of climate change will reduce the indicative SoP provided by existing defences within coastal areas of the study area.

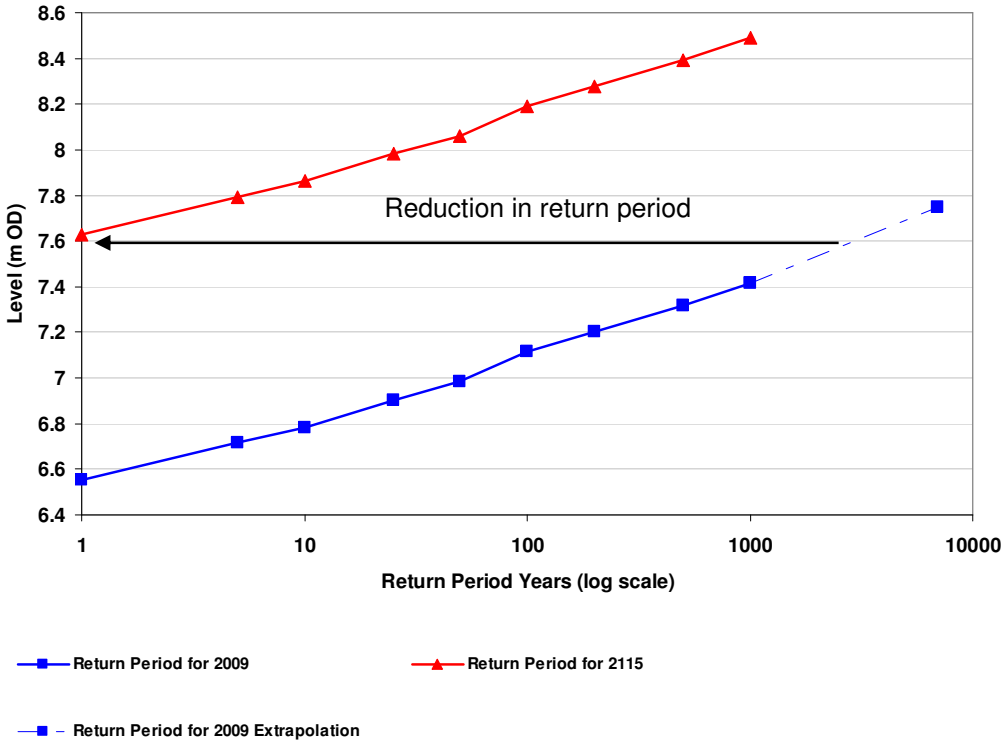


Diagram 7.1 Reduced return period of the indicative SoP due to 100 years of sea level rise. Based on extreme tidal still water levels for Minehead (Posford Haskoning Ltd, 2003) and PPS25 guidance on sea level rise due to climate change.

Flood Defence Structures (Figure 6 Maps)

7.10 Figure 6 A-B identifies the location of various structures within the study area. The GIS attributes illustrate the dominant asset type is flood defence structures, and includes features such as road bridges, steel trash screens and breakwaters.

7.11 Maintenance of Main Rivers is primarily the responsibility of the riparian owner(s) although the Environment Agency have permissive powers to undertake work where required. Maintenance of ordinary watercourses is the responsibility of WSC, ENPA or individual riparian owners. Figure 6 A-B (and Figure 2) also illustrates the location of Main Rivers within the study area.

Residual Risk

7.12 Whilst flood defences do offer significant benefit, residual risk must be considered during evaluation of suitable sites for development allocation. Furthermore, it is suggested that an assessment of the likely flood routes associated with overtopping or infrastructure failure should form part of a site specific FRA where required (see Chapter 9). An appreciation of the actual or residual risk can therefore be identified through this process.

Emergency Planning

7.13 When extreme flood events occur it is essential to have an emergency plan in place to provide clear procedural instructions. The mobilisation and organisation of the emergency services and supporting agencies is required to rescue, treat and transport potentially large numbers of people. During and after a flood event the role of the Local Authority includes providing transport for the evacuees and safe rest centres to house people in the event of homes being flooded. Further health and welfare issues are inevitable as a result of serious flood event.

7.14 Somerset County Council have a Somerset Major Incident Co-ordination Group (SMICG) Flood Warning and Response Plan which can be found in local libraries or can be obtained from the Somerset County Council. Devon County Council has a Devon Flood Warning and Response Plan (DFWRP) which can be obtained form Devon County Council or accessed via the internet (www.devon.gov.uk/flood_warning_response_plan_nov_06-2.pdf).

7.15 Both the Somerset and Devon Flood Warning Response Plans are based on the concept of Integrated Emergency Management and therefore build on existing procedures that bring together the Emergency Services, Local Authorities and other partners to provide a co-ordinated response to a specific flood warning to assist the affected community. The Flood Warning Response Plans provide the framework for responding to all forms of major flooding events across the study area.

7.16 At a strategic level this Level 1 SFRA will provide a useful information base which can be used to consider viable safe access and escape route during flood events. However, at a site specific level, a more detailed assessment of proposed evacuation routes will need to be investigated to ensure that safe access and escape routes are achievable for the lifetime of the development. If required this can be undertaken either within a site specific FRA, or at the Level 2 SFRA stage.

7.17 This Level 1 SFRA can also be used to contribute to the development of emergency planning policy for existing developments at risk from flooding within their local authority. Figures 3 A-F can be used to determine the suitability of key access routes within their administrative boundary.

Flood Warning Areas

7.18 Although LAs are responsible for the development of Flood Warning and Response Plans, the Environment Agency undertakes a considerable amount of work in terms of flood warning. This key element of flood warning should be in integrated into the development of the LAs Flood Warning and Response Plans. ENPA flood warning and response plans are covered by WDC and North Devon Council.

7.19 The Environment Agency operates a flood warning service in all areas at risk of flooding, which is available on their website (www.environment-agency.gov.uk). There are four flood warning codes that indicate the level of severity of flooding expected to the area (Table 7.1).

Table 7-1: Environment Agency Flood Warning Codes

Flood Warning Code	Description
Flood Watch	Flooding of low-lying land and roads is expected. Make the necessary actions to prepare for a flood event.
Flood Warning	Flooding of homes and businesses is expected. Take immediate action.
Severe Flood Warning	Severe flooding is expected. Extreme danger to life and property is expected. Take immediate action.
All Clear	Flood watches or warnings are no longer in force for this area

7.20 Within the study area there are a number of Flood Watch areas. Flood Watch areas are hydrologically similar (or groups of catchments). Within each Flood Watch area are focussed areas, known as Flood Warning areas, where flooding is known to occur during larger flood events. The Flood Watch and Flood Warning areas within the study area are displayed in Figures 7 A & B, which identifies the settlements that benefit from the system.

7.21 The flood warnings are disseminated through a variety of mediums that include TV, radio, and Flood Warnings Direct, which is a service direct to a phone/fax/pager/internet. Loudhailers are also used in certain circumstances. There is also an emergency Floodline number (0845 988 1188) and a quick dial number for individual rivers.

7.22 The Environment Agency aim to give a minimum of two hours warning prior to the onset of a flood event. However the rapid onset of some flood events, after a breach in flood defences or following a period of high intensity rainfall, means that sufficient warning cannot always be raised.

8 Drainage of Development Sites

Principles

8.1 Traditionally, built developments have utilised piped drainage systems to manage storm water and convey surface water run-off away from developed areas as quickly as possible. Typically these systems connect to the public sewer system for disposal to local watercourses and/or treatment. Whilst this approach rapidly transfers storm water from developed areas, the alteration of natural drainage processes can potentially impact on downstream areas by increasing flood risk and reducing water quality. Receiving watercourses are therefore much more sensitive to rainfall intensity, volume and catchment land uses after a catchment or areas of a catchment have been developed.

8.2 Due to the difficulties associated with up grading sewer systems it is uncommon for sewer and drainage systems to keep pace with the rate of development/re-development and there are increasingly stringent controls placed on discharges to watercourses. As development progresses and/or urban areas expand these systems become inadequate for the volumes and rates of storm water they receive, resulting in increased flood risk and/or pollution of watercourses. Allied to this are the implications of climate change on rainfall intensities, leading to flashier catchment/site responses and surcharging of piped systems.

8.3 In addition, as flood risk has increased in importance within planning policy, a disparity has emerged between the design standard of conventional sewer systems (1 in 30 year) and the typical design standard flood (1 in 100 year). This results in drainage inadequacies for the flood return period developments need to consider, often resulting in potential flood risk from surface water/combined sewer systems.

8.4 A sustainable solution to these issues is to reduce the volume and/or rate of water entering the sewer system and watercourses.

What are SuDS?

8.5 Sustainable Drainage Systems (SuDS) are the Government's preferred method for managing the surface water run-off generated by developed sites and PPS25 notes that regional planning bodies and Local Authorities should promote their use for the management of runoff. SuDS seek to manage surface water as close to its source as possible, mimicking surface water flows arising from the site, prior to the proposed development. Typically this approach involves a move away from piped systems to softer engineering solutions inspired by natural drainage processes.

8.6 SuDS should be designed to take into account the surface run-off quantity, rates and also water quality ensuring their effective operation up to and including the 1 in 100 year design standard flood including an increase in peak rainfall of 30% to account from climate change.

8.7 Wherever possible, SuDS techniques should seek to contribute to each of the three goals identified below with the favoured system contributing significantly to each objective. Where possible SuDS techniques for a site should seek to:

- Reduce flood risk (to the site and neighbouring areas);

- Reduce pollution; and,
- Provide landscape and wildlife benefits.

8.8 These goals can be achieved by the SuDS management train, as outlined in The SuDS Manual 2007, where each component adds to the performance of the whole system:

- Prevention good site design and upkeep to prevent runoff and pollution (e.g. limited paved areas, regular pavement sweeping);
- Source control runoff control at/near to source (e.g. rainwater harvesting, green roofs, pervious pavements);
- Site control water management from a multitude of catchments (e.g. route water from roofs, impermeable paved areas to one infiltration/holding site); and,
- Regional control integrate runoff manage from a number of sites (e.g. into a detention pond).

8.9 In keeping with the guidance of PPS25, local authorities should encourage the application of SuDS techniques. This chapter presents a summary of the SuDS techniques currently available and a review of the soils and geology of the study area, enabling the local authorities to identify where SuDS techniques could be employed in development schemes.

8.10 The application of SuDS techniques is not limited to one technique per site. Often a successful SuDS solution will utilise a number of techniques in combination, providing flood risk, pollution and landscape/wildlife benefits. In addition, SuDS can be employed on a strategic scale, for example with a number of sites contributing to large scale jointly funded and managed SuDS, however, each development site must offset its own increase in runoff and attenuation cannot be “traded” between developments.

8.11 Detailed design guidance can be found in the SuDS Manual C697, and associated Site Handbook for the Construction of SuDS, C698[5]. These publications provide best practice guidance on the planning, design, construction, operation and maintenance of SuDS, to ensure effective implementation within developments.

SuDS Policies

8.12 There are a number of policies and planning documents that promote the implementation of SuDS in new developments.

Planning Policy Statement 25 (PPS25)

8.13 In terms of identifying a requirement to consider SuDS on a development project the following general principle (set out in PPS25) should be followed:

8.14 ’The surface water drainage arrangements for any development site should be such that the volumes and peak flow rates of surface water leaving a developed site are no greater than rates prior to the proposed development, unless specific off-site arrangements are made and result in the same net effect.’

[5] These are available from CIRIA – see http://www.ciria.org/suds/publications.htm for details.

8.15 This is to alleviate the pressure on sewer systems that are often antiquated, serving a catchment area greater than their original design and/or designed to a standard less than that required to mitigate development from a 1% annual probability flood event.

8.16 If a proposed development is likely to increase rates of surface water runoff due to an increase in impermeable area, SuDS should be incorporated into the design to manage these issues. This will ensure that peak flow rates and volumes are no greater than rates prior to the proposed development.

Code for Sustainable Homes

8.17 The Code for Sustainable Homes identifies reduction of surface water runoff and flood risk as a component towards achieving a rating of between Level 1 to Level 6 (with Level 6 being the most sustainable). The surface water element is worth up to two credits within the scoring system. Through incorporating suitably designed systems into a development, SuDS can also contribute to other assessment criteria under Code for Sustainable Homes including ecology and potable water consumption.

SuDS Design

8.18 SuDS techniques can be used to reduce the rate and volume of surface water runoff and improve the water quality of surface water discharges from sites to the receiving environment (i.e. natural watercourse or public sewer etc).

8.19 The design of SuDS measures should be undertaken as part of the drainage strategy and design for a development site. A ground investigation will be required to assess the suitability of using infiltration measures, with this information being used to assess the required volume of on-site storage. Hydrological analysis should be undertaken using industry-approved procedures, to ensure a robust design storage volume is obtained.

8.20 During the design process, liaison should take place with the Local Planning Authority and the Environment Agency in order to establish that the design methodology is satisfactory and to also agree on a permitted rate of discharge from the site.

8.21 A key consideration of SuDS design is the maintenance regime to ensure they operate effectively, which should be sufficiently detailed and agreed at the design stage. The maintenance regime should set out a framework with a clear identification of responsibility for the lifetime of the proposed development. Table 8-1 provides a summary of the different SuDS techniques.

Table 8-1: Summary of SuDS techniques and their suitability to meet the three aims for sustainability (see Section 9.2)

Management Train	Component	Description	Water Quantity	Water Quality	Amenity Biodiversity
Source – Prevention	Green roofs	Layer of vegetation or gravel on roof areas providing absorption and storage.	●	●	●
Source – Prevention	Rainwater harvesting	Capturing and reusing rainwater for domestic or irrigation uses.	●	○	○
Source – Prevention	Permeable pavements	Infiltration through the surface into underlying layer.	●	●	○
Source	Filter drains	Drain filled with permeable material with a perforated pipe along the base.	●	●	×
Source	Infiltration trenches	Similar to filter drains but allows infiltration through sides and base.	●	●	×
Source	Soakaways	Underground structure used for store and infiltration.	●	●	×
Source	Bio-retention areas	Vegetated areas used for treating runoff prior to discharge into receiving water or infiltration	●	●	●
Source	Swales	Grassed depressions, provides temporary storage, conveyance, treatment and possibly infiltration.	●	●	○
Source	Sand filters	Provides treatment by filtering runoff through a filter media consisting of sand.	●	●	×
Site	Basins	Dry depressions outside of storm periods, provides temporary attenuation, treatment and possibly infiltration.	●	●	○
Site	Ponds	Designed to accommodate water at all times, provides attenuation, treatment and enhances site amenity value.	●	●	●
Site	Wetland	Similar to ponds, but are designed to provide continuous flow through vegetation.	●	●	●
Regional					

Key: ● – highly suitable, ○ - suitable depending on design, × - not suitable

Where can SuDS be utilised?

8.22 The underlying ground conditions of a development site will often determine the type of SuDS approach to be used at development sites. This will need to be determined through ground investigations carried out on-site; however an initial assessment of a site's suitability to the use of SuDS can be obtained from a review of the available soils/geological survey of the area.

8.23 Based on a review of the BGS geological maps covering the study area potentially suitable SuDS techniques that would be compatible with the underlying geology have been recommended. A summary of these recommendations are provided in Table 8-2 and Table 8-3. This information should be used as a guide only and should not be used to accept or refuse SuDS techniques. In the design of any drainage system and SuDS approach, consideration should be given to site-specific characteristics and where possible be based on primary data from site investigations.

Table 8-2: Suitable SuDS techniques dependent on bedrock geology

SuDS Technique	Permeability	Geology	Description
Infiltration or Combined Infiltration and Attenuation	Low/Moderate	Blue Lias	Thinly interbedded limestone (laminated, nodular, or massive and persistent) and calcareous mudstone or siltstone (locally laminated). Individual limestones are typically 0.10-0.30m thick. In some areas, intervening mudstone units with relatively few limestone beds. Found in Exmoor National Park and West Somerset.
	Low/Moderate	Mercia Mudstone Group	Predominantly red, less commonly green-grey, mudstones and subordinate siltstones with thick halite-bearing units in some basinal areas. Thin beds of gypsum/anhydrite widespread; sandstones are also present. Found in the Minehead and Williton area (West Somerset).
	Low/Medium	Penarth Group	Dark grey/black mudstones with lenticular limestones, sandstones and bone beds. Permeability will be variable depending on depth and extent of weathering. Found in Exmoor National Park and West Somerset.

SuDS Technique	Permeability	Geology	Description
	Low/Medium	Pilton Beds	Grey mudstones and siltstones with thin- to thick-bedded, locally calcareous sandstones and beds and lenses of limestone. Sandstones are thickest and predominate in the lower half of the formation, whereas mudstones predominate in the upper half. Found towards the south of West Somerset.
	Low/Medium	Pickwell Down Beds	Purple, brown and grey fine- to medium-grained sandstones, siltstones and slates. Found in Dulverton (Exmoor National Park) area.
	Low/Medium	Lynton Formation	Finely-laminated sandstones and mudstones, slates, siltstones. Trace fossil Chondrites abundant. Thin shell beds. Found in the Lynton and Lynmouth (Exmoor National Park) area.
	Low/Medium	Hangman Sandstone	Mainly sandstone, purple, grey and green, commonly thick-bedded and parallel laminated, locally convolute-bedded or cross-bedded, fine- to medium-grained. Interbeds of cleaved shale, siltstone and silty very fine-grained sandstone, and some thicker units of cleaved purple mudstone interlaminated with very fine-grained sandstone. Found in Exmoor National Park and West Somerset.
Attenuation	Low	Alluvium/Marine Alluvium	Permeability is typically low but depends on the content of sand, silt and clay. Increased content of silt and clay will reduce effective permeability. Superficial deposits located within the tidal and fluvial floodplains including Minehead (West Somerset) and Porlock (Exmoor National Park) areas.

Table 8-3: Suitable SuDS Techniques Dependant on Soil Type

SuDS Technique	Permeability	Soil Association	Geology	Description
Infiltration or Combined Infiltration and Attenuation	Low/ Moderate	Denbigh 1	Palaeozoic slaty mudstone and siltstone	Well drained fine loamy and fine silty soils over rock. Some similar soils with slowly permeable subsoils and slight seasonal waterlogging. Shallow soils and some bare rock locally. Found in Dulverton, Winsford, Exton, Brompton Regis and Combe Martin localities (Exmoor National Park).
	Low/ Moderate	Hafren	Palaeozoic slaty mudstone and siltstone	Loamy permeable upland soils over rock with a wet peaty surface horizon and bleached subsurface horizon, often with thin ironpan. Some peat on higher ground. Rock and scree locally. Found in Wootton Courtney locality (Exmoor National Park).
	Moderate	Larkbarrow	Devonian reddish sandstone	Reddish very acid permeable loamy upland soils over sandstone. Associated loamy soils, some with a seasonal wet thin peaty surface horizon and some with thin ironpan but otherwise permeable subsoils. Found in Wootton Courtney locality (Exmoor National Park).
	Low/ Moderate	Lydcott	Devonian reddish sandstone	Loamy permeable reddish upland soils over sandstone with a wet peaty surface horizon and bleached subsurface horizon. Some soils have a thin ironpan. Rock and scree locally. Found in Wootton Courtney locality (Exmoor National Park).

SuDS Technique	Permeability	Soil Association	Geology	Description
	Moderate	Manod	Palaeozoic slate, mudstone and siltstone	Well drained fine loamy or fine silty soils over rock, shallow soils in places. Bare rock locally. Steep slopes common. Found in the Lynton, Lynmouth and Withypool localities (Exmoor National Park).
	Low/ Moderate	Rivington 2	Palaeozoic sandstone and shale	Well drained coarse loamy soils over rock. Some fine loamy soils with slowly permeable subsoils and slight seasonal waterlogging. Steep slopes locally. Found in Dunster and Minehead localities (West Somerset and Exmoor National Park).
Attenuation	Low	Crowdy 2	Blanket and basin peat	Thick very acid amorphous raw peat soils. Perennially wet. Hagged and eroded in places. Limited areas on higher ground, development unlikely in these locations.
	Low	Evesham 2	Jurassic and Cretaceous clay	Slowly permeable calcareous clayey soils. Some slowly permeable seasonally waterlogged non-calcareous clayey and fine loamy or fine silty over clayey soils. Landslips and associated irregular terrain locally. Found in the Watchet locality (West Somerset).
	Low	Hallsworth 1	Drift from Palaeozoic shale	Slowly permeable seasonally waterlogged clayey soils. Predominantly found on higher ground of Exmoor

SuDS Technique	Permeability	Soil Association	Geology	Description
	Low	Wallsea	Marine alluvium	Deep stoneless non-calcareous and calcareous clayey soils. Souls locally have humose or peaty surface horizons. Groundwater controlled by ditches and pumps. Flat land, risk of flooding. Found in lower lying areas adjacent to cost at Minehead and Porlock (West Somerset and Exmoor National Park).
	Low	Whimple 3	Drift over Permo-Triassic and Carboniferous reddish mudstone	Reddish fine loamy or fine silty over clayey soils with slowly permeable subsoils and slightly seasonal waterlogging. Some similar clayey soils on brows. Slowly permeable seasonal waterlogging fine loamy and fine silty over clayey soils on lower slopes. Found in Williton and Bicknoller locality (West Somerset).
	Low	Winter Hill	Blanket Peat	Thick very acid raw peat soils. Perennially wet. Hagged and eroded in places. Limited areas on higher ground, development unlikely in these locations.
	Low	Worcester	Permo-Triassic Reddish Mudstone	Slowly permeable non-calcareous and calcareous reddish clayey soils over mudstone, shallow on steeper slopes. Associated with similar non-calcareous fine loamy over clayey soils. Found in Wootton Courtney, Washford and Old Cleave localities (West Somerset and Exmoor National Park).

SuDS Constraints

8.24 There are several constraints that may limit the application of SuDS. These will vary between locations and may include:

- Ground Contamination;
- Ground Conditions;
- Ground Use / Vulnerability;
- Capacity of the receiving watercourse.

Ground Contamination

8.25 Ground contamination has the potential to contaminate groundwater and/or surface water resources if incorrectly managed. In some cases the nature of the ground contamination may be such that certain types of SuDS are not appropriate. Ground contamination should be determined by site investigation on a site by site basis.

Groundwater Use / Vulnerability

8.26 Groundwater resources can be vulnerable to contamination from both direct sources (e.g. into groundwater) or indirect sources (e.g. infiltration of discharges onto land). Groundwater vulnerability within the study area has been determined by the National Rivers Authority (now the Environment Agency), based on a review of aquifer characteristics, local geology and the leaching potential of overlying soils. To identify the groundwater vulnerability on and surrounding a potential development site the map reference below covers the study area:

- National Rivers Authority Groundwater Vulnerability Map, Sheets 41, 42 and 50.

8.27 The vulnerability of the groundwater is important when determining the suitability of SuDS. The Environment Agency are the responsible drainage authority for any discharges to groundwater and should be consulted on proposals to discharge to ground.

Groundwater Source Protection Zones

8.28 The Environment Agency also defines groundwater Source Protection Zones (SPZ). SPZs are defined to protect areas of groundwater that are used for potable (drinking) supply, including public/private potable supply, (including mineral and bottled water) or for use in the production of commercial food and drinks.

8.29 Depending on the nature of the proposed development and the location of the development site with regards to the SPZs, restrictions may be placed on the types of SuDS appropriate to certain areas. Consideration should be given to the SPZs when determining the suitability of SuDS for development sites. The groundwater section in Chapter 4 identifies the location, and provides an approximate NGR for the SPZs within the study area. Further information is available on the Environment Agency website: www.environment-agency.gov.uk.

8.30 SPZs are defined based on the time it takes for pollutants to reach an abstraction point. This transmission time enables the Environment Agency to define three zones around a groundwater abstraction point. The four zones are:

- **Zone 1 (Inner Protection Zone)** – This is defined as 'any pollution that can travel to the borehole within 50 days from any point within the zone is classified as being inside zone 1'. Developments proposed within this area are likely to have the tightest constraints on SuDS.
- **Zone 2 (Outer Protection Zone)** – This is defined as the area that 'covers pollution that takes up to 400 days to travel to the borehole, or 25% of the total catchment area – whichever area is the biggest'.
- **Zone 3 (Total Catchment)** - The total catchment is the total area needed to support removal of water from the borehole, and to support any discharge from the borehole.
- **Zone 4 (Zone of special interest)** – In the study area a fourth zone has been defined. 'This is usually where local conditions mean that industrial sites and other polluters could affect the groundwater source even though they are outside the normal catchment area'. These areas are likely to have the least constraints on SuDS.

Planning Considerations for SuDS

8.31 The application of SuDS may require space on development sites to be set-aside. Early consideration of SuDS will assist in determining the space required and identify methods to spread the management of storm water throughout a site using the Management Train principle presented in the CIRIA report C697.

8.32 The design of SuDS measures should be undertaken as part of a drainage strategy proposed during the master planning of development sites. A ground investigation will be required to access the suitability of using infiltration SuDS, with this information also being used to assess the required volume of on-site storage. Hydrological analysis should be undertaken using industry-approved procedures; to ensure a robust design storage volume is obtained. The consideration of utilising SuDS as part of a development will depend on many factors such as:

- The underlying geology and drift layers;
- The depth of the groundwater table;
- Site slopes;
- Run-off quality;
- Site restrictions;
- Maintenance requirements;
- Economical viability; and,
- Groundwater protection and ecological considerations.

8.33 The final drainage scheme and SuDS for a site should consider each of these elements in its design.

8.34 All relevant organisations should meet at an early stage of the drainage design process to agree on the most appropriate drainage system for the particular development. These organisations may include the Local Authority, the sewerage undertaker, Highway Agency, and the Environment Agency. Liaison with these organisations should focus on establishing a suitable design methodology, any restrictions and provision for the long-term maintenance of the feature.

8.35 The most convenient vehicle for agreeing long-term management responsibilities is through Section 106 of the Town and Country Planning Act. Under this, agreement for SuDS maintenance can be a requirement of the planning application, forcing the issue to be addressed.

9 Site Specific FRA Guidance

9.1 A Level 1 SFRA should present sufficient information to assist LPAs to apply the Sequential Test and identify where the Exception Test may be required. These documents are predominately based on existing data. The broad scale of assessment undertaken for a Level 1 SFRA provides sufficient detail to identify flood zones relevant to potential and existing allocations but is not of sufficient resolution to provide a detailed assessment within them.

9.2 A site specific Flood Risk Assessment (FRA) aims to refine the available information and minimise these risks through site design, layout and where required, mitigation. This chapter presents the recommendations for site specific FRAs prepared for submission with planning applications in the WSC and ENPA administrative area.

When is a FRA Required?

9.3 When informing developers of the requirements of a FRA for a development site, consideration should be given to the position of the development relative to flood sources, the vulnerability of the proposed development and its scale. The Environment Agency Website provides standing advice on the requirement of FRAs for developers and LPAs[6].

9.4 In the following situations a FRA should always be provided with a planning application:

- The development site is located in Flood Zone 2 or 3;
- The site area of proposed development is greater than 1 ha and located in Flood Zone 1;
- The development site is located in an area known to have critical flooding problems from any flood source;
- The development is located within 20 m of any watercourse regardless of Flood Zone classification; and
- Liaison with the LPA identifies the requirement for a FRA.

FRA Requirements

9.5 Annex E of PPS25 presents the minimum requirements for FRA. These include:

- Consideration of the risk of flooding arising from the development in addition to the risk of flooding to the development;
- Identify and quantify the vulnerability of the development to flooding from different sources and identify potential flood risk reduction measures;

[6] http://www.environment-agency.gov.uk/research/planning/82584.aspx

- Assessment of the remaining 'residual' risk after risk reduction measures have been taken into account and demonstrate that this is acceptable for the particular development;
- The vulnerability of those that could occupy and use the development, taking account of the Sequential and Exception Tests and the vulnerability classification, including arrangements for safe access;
- Consideration of the ability of water to soak into the ground may change with development, along with how the proposed layout of development may affect drainage systems; and,
- Fully account for current climate change scenarios and their effect on flood zoning and risk.

9.6 The Practice Guide to PPS25 advocates a staged approach to site specific FRA. The findings from each stage inform the next stage iteratively throughout the development process. The following paragraphs describe the three levels of site specific FRAs.

Level 1 - Screening Study

9.7 A Level 1 Screening Study is intended to identify if a development site has any flood risk issues that warrant further investigation. This should be based on existing information such as that presented in the Level 1 SFRA. Therefore this type of study could be undertaken by a Land Drainage Engineer/Development Control Officer in response to the developer query or by a developer where the Level 1 SFRA is available. Using the information presented in the Level 1 SFRA and associated GIS layers a Land Drainage Engineer/Development Control Officer could advise a developer of any flooding issues affecting the site. This information can then be used by the developer as the basis to further their understanding of how the flood risks could potentially affect their development.

Level 2 - Scoping Study

9.8 A Level 2 Scoping Study is predominately a qualitative assessment designed to further understanding of how the flood sources affect the site and the options available for mitigation. The Level 2 FRA should be based on existing available information where this is available and use this information to further a developers understanding of the flood risk and how it affects their development. This type of assessment should also be used to inform master plans of the site raising a developer's awareness of the additional elements the proposed development may need to consider.

Level 3 – Detailed Study

9.9 Where the quality and/or quantity of information for any of the flood sources affecting a site is insufficient to enable a robust assessment of the flood risks, further investigation will be required. For example, it is generally considered inappropriate to base a FRA for a residential care home at risk of flooding from fluvial sources on Flood Zone maps alone. In such cases the results of hydraulic modelling are preferable to ensure details of flood flow velocity, onset of flooding and depth of floodwater is fully understood and that the proposed development incorporated appropriate mitigation measures.

10 Recommendations

The Next Stage

Planning Policy

10.1 Based on the information presented in this Level 1 SFRA and the accompanying GIS layers, WSC and ENPA have sufficient information to apply the PPS25 Sequential Test to their development sites, seeking to guide development to areas of lowest flood risk wherever possible.

10.2 Where there are insufficient sites in Flood Zone 1 to accommodate the required growth, consideration should be given to the vulnerability classification of the development to ensure that it is located in an area of acceptable risk as defined in PPS25 (DCLG, 2006). In some cases this may require application of the Exception Test.

10.3 Where application of the Exception Test is required it will be necessary to undertake a Level 2 SFRA. The scope of the Level 2 SFRA consists of a more detailed assessment of the flood hazard to the development, which includes considering the following:

- Flood probability;
- Flood depth;
- Flood velocity; and,
- Rate of onset of flooding.

10.4 This will allow informed decisions to be made regarding the safety of the development.

10.5 Where the Exception Test is required for a development, hydraulic modelling is normally required to define the above flood characteristics. Therefore in the absence of existing detailed hydraulic modelling additional modelling may be needed.

Further Work

10.6 Until the LPAs have undertaken the Sequential Test it is not possible to determine the requirements and scope of the Level 2 SFRA.

10.7 However, based on the information presented within this Level 1 SFRA together with the Environment Agency CFMPs and growth targets set out in the Draft RSS, further work is unlikely to be required at the Level 2 SFRA stage within the ENPA administrative boundary.

10.8 WSC are likely to require further work at the Level 2 SFRA stage to investigate flood hazard, due to the anticipated effects of climate change, within the settlements of Minehead and Williton. Surface Water Management Plans (SWMPs) are also likely to be required within Minehead, Williton and Washford to reduce the risk of surface water flooding.

10.9 Appendix B provides considerations for area specific strategies, which LPAs should seek to incorporate into their emerging LDF.

Development Control

10.10 Development Control Officers within the LPAs should familiarise themselves with the Level 1 SFRA and ensure that site specific FRAs are provided where necessary and prepared against the recommendations presented in Appendix G.

10.11 In addition, Development Control Officers should also familiarise themselves with the geology and soils within the study area together with local drainage issues when considering the use of SuDS as detailed in Chapter 7.

Level 1 SFRA Updates

10.12 Through the preparation of this Level 1 SFRA the data collected is deemed sufficient to apply the sequential test, however, in certain locations where data is questionable, further investigation may required within a site specific FRA.

10.13 To continually improve future updates of this Level 1 SFRA more robust recording of flood events will be of considerable benefit and enable calibration of modelled data, reducing uncertainty.

10.14 The LPAs may develop a database to record flood events that occur within their administrative area, this should be recorded on a GIS system and include (as a minimum) information on:

- The date of the flood event;
- The location of the flood event;
- Properties affected by the flood;
- The extent of the flood event (mapped);
- The cause (source) of the flooding.

10.15 SFRAs should be considered as ‘live’ documents where regular review and monitoring should be undertaken. The associated GIS layers can be readily updated and should be considered as the live part of the Level 1 SFRA. The GIS layer should be updated as part annual monitoring process.

Emergency Planning

10.16 LAs should use the findings of this Level 1 SFRA to refine and inform emergency plans developed for the area. This should include liaison with local emergency services to share and discuss the available data and its implications for emergency planning.

11 References

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12 Figures

13 Appendices

Appendix A: Sequential & Exception Test

Appendix B: Policy Review and Considerations

Appendix C: Wessex Water Sewer Flooding Data

Appendix D: Technical Methodology

Appendix E: Broad-scale Flood Risk Review

Appendix F: Focused Assessments