west sussex county council

# Strategic Flood Risk Assessment of West Sussex

## VOLUME I
## DECISION SUPPORT DOCUMENT

January 2010

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# Issue box

The West Sussex Strategic Flood Risk Assessment (SFRA) is a 'live' document. The current version is developed using the best information and concepts available at the time.

As new information and concepts become available the document will be updated and so it is the responsibility of the reader to be satisfied that they are using the most up-to-date information and that the SFRA accounts for this information.

All revisions to this document are listed in the table below.

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# Foreword

West Sussex County Council (WSCC) is required to prepare a Strategic Flood Risk Assessment (SFRA) to support the development of their Minerals and Waste Development Framework (MWDF). In doing so, they will be able to demonstrate that they have applied a risk-based sequential approach in preparing the framework, as required by Planning Policy Statement 25: Development and Flood Risk (PPS25).

The main objective of the SFRA is to provide flood information:

- so that an evidence based and risk based sequential approach can be adopted when making planning decisions, in line with PPS25;
- that is strategic in that it covers a wide spatial area and looks at flood risk today and in the future;
- that supports sustainability appraisals of the local development frameworks; and
- that identifies what further investigations may be required in flood risk assessments for specific development proposals.

A Level 1 SFRA has been undertaken over the whole of the county. Additional information, that would normally be included in a Level 2 SFRA, has been supplied at key locations.

The approach for undertaking the SFRA is consistent with relevant planning guidance and has been discussed with the Environment Agency and WSCC throughout development. The SFRA is primarily based on existing information, however some new modelling and analyses have been undertaken where existing information was not available. These additional analyses were presented to the Environment Agency for discussion and agreement during the scoping stage. As it is not practical to undertake a highly detailed assessment across the whole of the county, a balance has been made between accuracy of results and cost effectiveness.

The SFRA is presented in a number of documents:

- VOLUME I – decision support document
- VOLUME II – technical report and maps
- VOLUME III – management guide
- VOLUME IV – sites of search (Part A - Minerals sites, Part B - Waste sites)

The SFRA is a live document which is intended to be updated as new information and guidance become available. The outcomes and conclusions of the SFRA may not be valid in the event of future changes. It is the responsibility of the user to ensure they are using the best available information.

# 1. Introduction

*It is accepted that the technical content of the West Sussex SFRA will need to be reviewed and amended as new information becomes available.*

*Although there is no statutory consultation requirement at this stage the nature of the intended end use for the information makes it appropriate to obtain feedback relating to the report in order to contribute to the overall robustness and credibility of this work. This information will also be an aid when formulating the necessary next steps in engaging those parties who will be involved in the future.*

*It is the responsibility of the reader to be satisfied that they are using the most up to date information and that this has been included within the West Sussex SFRA.*

***This version of Volume I of the SFRA has been prepared in advance of the application of the Sequential and Exception Tests and the preparation of policy on flood risk and land allocations. It is recommended that the contents of this document are thoroughly reviewed following the preparation of policy and the application of the Sequential and Exception Tests in order that the contents of Volume I of the SFRA are compatible with the final plan outcomes.***

The information in this Strategic Flood Risk Assessment (SFRA) is used to inform the West Sussex County Council (WSCC) sustainability appraisal, land allocations, and policies regarding catchment wide flooding issues. The SFRA provides information required to apply the Sequential Approach and Sequential Test on the Minerals and Waste Development scale as defined by PPS25. The decisions made using the SFRA should also draw on the outcome of the South East Plan (SEP) and the Regional Flood Risk Appraisal (RFRA). The SFRA will inform Flood Risk Assessments prepared in support of particular applications for development in accordance with the Minerals and Waste Development Framework (MWDF).

The SFRA contains information that demonstrates that flood risk has informed the preparation of the MWDF as it provides data that enables a risk based sequential test to be applied. PPS 25 advocates that the risk based Sequential Test is applied at all stages of planning. The applicable stages are identified as being:

- Regional Level (South East Plan) - RFRA
- County Level (MWDF) - SFRA
- Site Level (individual planning applications) - FRA

At the Site Level it would be necessary for the applicant to refer to the 'Sequential and Exception Tests' performed at the Regional and County Level. It is not the responsibility of the applicant to perform the 'testing' but they can be required to submit information to WSCC to enable them to do so.

A Sequential Approach should be applied throughout all stages so that the vulnerability of the intended use is matched to the risk (i.e. higher vulnerability land uses are sited in locations of lower probability of flooding). The Exception Test should only be applied after the application of the Sequential Test.

The underlying objective of the SFRA is to provide a platform for the consistent consideration of flood risk and accommodation of current practice and best available data for the duration of the framework. Inevitably this will require that consideration is given to the lifetime of development for the land uses within the framework so climate change effects described in PPS 25 should be incorporated.

This decision support document provides advice on how to interpret the SFRA results to inform land use planning, flood warning and emergency planning and development management. The document also provides guidance for site-specific Flood Risk Assessment (FRA). The document requires the user to refer to technical information and flood maps contained in Volumes II (and Volume IV) of this SFRA.

The level of detail included in the SFRA depends on its intended use. In this case, a Level 1 has been undertaken over the whole of the county. It is important to remember that this is a strategic (higher level) assessment and so the level of certainty is not equal to that of a more detailed assessment. Care should be applied when using the data for other purposes.

This guidance does not supersede that provided in planning policy or by the Environment Agency or WSCC.

# 2. Flooding in the county of West Sussex

## 2.1. Context

A Level 1 SFRA has been undertaken for West Sussex County, following the guidance set out in PPS25, the Practice Guide and specific Environment Agency advice. West Sussex is affected by all six sources of flooding, although the sources which affect the largest area are rivers (fluvial), the sea (tidal) and groundwater.

Whilst flooding in West Sussex is not as significant as some other counties, the type of land use investigated in this SFRA can be located in areas that are more prone to flooding. In addition, the number of 'reasonably available sites' can be limited. For this reason, some additional flooding information (such as flooding with the presence of flood defences and flood depth) is presented.

The impact of flood defences has been assessed by providing Flood Zone extents (ignoring the presence of defences) and Actual and Residual Risk extents (with defences). The assessment has aimed to characterise flood risk today and also into the future. Two time horizons have been analysed (2059 and 2109) to predict the likely impacts of climate change.

The Environment Agency and other key stakeholders have been contacted throughout the SFRA process in an attempt to gather as much information as possible. Several meetings with the Environment Agency have provided an insight into their expectations of the SFRA.

The methodology proposed for the SFRA was based on the best use of available information and involved minimal new analyses and hydraulic modelling. Each dataset was reviewed with regard to its accuracy and the most appropriate datasets were used to define flood risk across West Sussex under varying conditions.

In general, the results of the more detailed Environment Agency hydraulic models (TUFLOW) were used in preference to the results from their national generalised broad scale models (JFLOW), in defining Flood Zones. The extents of hydraulic models that were used in the SFRA are shown in **Map M3**. It is important that the source of flood data is considered whenever using the data in informing a land use planning decision.

This chapter provides a summary of the flooding information generated during the SFRA. More information, including the sources of information and methodologies used in the assessment are included in the Technical Report (Volume II of the SFRA). The user should refer to this information to make sure that the results of the analyses are suitable for the intended use.

## 2.2. The County

The county of West Sussex covers an area of approximately 2000 $km^2$ in southern England, as shown on **Map O**. It extends from Crawley in the north, to the southern coastline, and from Southwick in the east, to West Wittering in the west. The main urban areas include Midhurst, Petworth, Shoreham-by-Sea, and Littlehampton.

The county covers a number of large river catchments, including the River Adur, River Arun and a number of smaller watercourses that make up the West Sussex Rifes. The Environment Agency has now signed off Catchment Flood Management Plans for England which provide policies for flood risk management in the future. The Catchment Flood Management Plan areas and selected policies for the county of West Sussex are shown in **Maps M1 and M2**.

The main flood defences in West Sussex are along the coastline and tidal reaches of the River Adur and River Arun. The Environment Agency is currently reviewing its flood defences in developing System Asset Management Plans (SAMPs). The SAMP units, and location and standard of protection of flood defences in West Sussex are shown on **Map D**. In addition to the hard defences, the Environment Agency operates a flood warning service. Flood warning areas are shown on **Map W**.

Potential mineral and waste 'sites of search' within West Sussex are shown on **Map O**.

## 2.3. Summary of flooding

### Flooding from rivers (fluvial)

**Map F1-F** shows the flooding from rivers ignoring the presence of flood defences, and **Map A1-F** shows the flooding from rivers with flood defences in place. The largest area affected by flooding from rivers is along the largest rivers, the River Adur and River Arun. The floodplain from these rivers is also expected to feature the deepest floodwaters during large flood events. **Map A2-F** shows the estimated flood depths during a 1% annual exceedance probability (AEP) river flood event.

The latest government guidance suggests that climate change will increase river flows by 20 per cent by 2109. In addition, mean sea levels are expected to rise, which can exacerbate river flooding in tidally influenced systems. **Maps C2-F** and **C1-F** show the estimated extents of flooding from rivers in a 2059 and 2109 time frame, with and without flood defences being in place.

**River Adur**

The River Adur is one of the larger rivers in the county. The river rises on the relatively impermeable sandstone of the High Weald with its steep slopes, dense drainage network, and well-incised channels. As a result, the upper catchment tends to have a flashy nature with a quick runoff response to rainfall. The onset of flooding is rapid in these areas.

The middle to upper reaches of the river cross the broad low-lying valleys of the Low Weald. As the Low Weald is underlain by a band of impermeable Weald Clay, drainage is poor and the overlying soils are prone to prolonged waterlogging during winter months.

The middle to lower reaches of the river run through the highly permeable chalk escarpment of the South Downs. The chalk and lime dominated soils are characteristically very shallow and sustain little

vegetation. Rain can easily infiltrate these permeable soils and is released slowly through springs, which help to maintain baseflow. The streams respond to seasonal groundwater variations and groundwater flooding occurs in the broad chalk valleys following prolonged wet weather.

Downstream of the South Downs the river crosses the lowland coastal plain before discharging into the English Channel. Large areas of low-lying land in the coastal plain tend to be more prone to flooding. This flooding is exacerbated by dense urban development, flat low lying ground, and tide-locking preventing natural drainage both at the coast, and along the tidal River Adur. The lower reaches of the River Adur itself are heavily influenced by tides.

The main flood defences on the River Adur are walls and embankments along the tidal extent of the river from Shoreham-by-Sea to Henfield. The standard of protection these offer varies from a flood with a 30% AEP to a flood with a 1% AEP.

**River Arun and Western Rother**

The River Arun is similar to the River Adur. It rises on the Weald, flows through the South Downs and across the coastal plan before discharging to the English Channel. The river has a tidal influence up to its confluence with the Western Rother at Pulborough.

The main flood defences on the River Arun are walls and embankments along the tidal extent of the river from Littlehampton to Pulborough. The standard of protection these offer varies from a flood with a 3.33% AEP to a flood with a 1% AEP.

**West Sussex Rifes**

The West Sussex Rifes are a group of smaller watercourses that rise in or just south of the South Downs in the western extent of the county. They include the River Lavant, River Ems, the Bosham Stream, the Aldingbourne Rife and other coastal streams draining the Manhood Peninsula. The chalk geology of the South Downs has a significant influence on the behaviour of the watercourses, and in particular, flow in the River Lavant is heavily influenced by groundwater levels within the Downs.

The River Lavant runs through Chichester and has been modified over time and now includes a flood relief channel and flood storage pond east of the urban area. Whilst these modifications were undertaken for flood defence purposes, the modifications are now considered by the Environment Agency to be part of the river system, rather than a stand-alone flood defence. Chichester is not expected to flood during a 1% AEP fluvial flood event, however may be affected by this magnitude event in the future (due to climate change).

Downstream of the Downs, the topography flattens and geology is less permeable. This, combined with their discharge outlets being blocked during high tides, means that the area is relatively poorly drained. In some areas, water levels are managed through small earth embankments and pumping. These activities have limited impact during large flood events. Relatively shallow depths of flooding can affect large areas and can last for a significant amount of time.

## Flooding from the sea (tidal)

The length of the West Sussex open coastline is approximately 54km, extending from Southwick in the east to the River Ems in the west. The shoreline includes Chichester and Pagham Harbours, as well as a number of tidal inlets such as the estuaries of the River Arun and River Adur.

The low-lying parts of the West Sussex coastline are at risk of flooding from high tides and storm surges on the English Channel. Historical development has taken place on areas which were once

part of the coastal environment, for example large flat marshy areas were previously associated with the tidal inlets of the Ferring Rife, Teville Stream and Aldingbourne Rife were regularly inundated.

Land drainage and the development of defences enabled occupation and then intensification of development within these areas. The sea defences consist of shingle beaches stabilised by rock and timber groynes. In some areas seawalls at the rear of shingle beaches enhance flood protection.

In most instances, sea defences are constructed to offer protection from the 0.5% AEP storm surge. However there exists a residual risk of flooding behind these defences exists from the chance that extreme high tides and tidal surges, coupled with wave action, could produce water levels exceeding the design height of the frontage and therefore cause them to be overtopped.

In addition to the open coastline, the River Adur and River Arun are both tidally influenced and thus flooding from sea affects land a significant distance away from the immediate coastline. With sea level rise, this distance will become even greater.

**Map F1-T** shows the flooding from rivers ignoring the presence of flood defences, and **Map A1-T** shows the flooding from rivers with flood defences in place. **Map A2-T** shows the estimated flood depths during a 0.5% AEP river flood event.

The latest government guidance suggests that climate change will increase mean sea levels by approximately 1m by 2109. The area at risk of flooding from sea is therefore expected to significantly increase in the future. **Maps C2-T** and **C1-T** show the estimated extents of flooding from rivers in a 2059 and 2109 time frame, with and without flood defences being in place.

There exists a risk of flooding due to flood defences overtopping or breaching. Whilst this level of assessment was considered too detailed for the Level 1, a number of locations have been identified which are considered to be more prone to a breach, as shown in **Map B**.

## Flooding from groundwater

Due to the large chalk bands across the middle of West Sussex, the county has a significant proportion of land which is more likely to be affected by groundwater flooding. **Map G** shows the groundwater emergence zones, results of a spatial analysis of GIS datasets and historic incidents of groundwater flooding.

Most at risk will be deep foundations, basements and underground infrastructure. The location of the emergence points cannot be accurately located. Groundwater can often emerge over a large or diffuse area, but can also emerge at single points. It has therefore only been possible to identify a broad area over which emergence may occur.

## Flooding from land (surface water) and sewers

The potential for surface water flooding is highly variable across the county, reflecting the changing geology, soil types and rainfall patterns. A broad scale spatial analysis has been undertaken to assess areas which may be more prone to surface water flooding. The results of this analysis and the historic incidents of surface water flooding are shown in **Map L**. Due to the dependence on the local sewer infrastructure; it is not beneficial to undertake a spatial analysis to identify areas more prone to sewer flooding. In this case, historic incidents of sewer flooding have been used to define this source of flooding, as shown on **Map S**.

A site specific assessment is required to refine the flood risk from sewers and surface water. It is expected that this will be undertaken during the detailed flood risk assessment of proposed development sites.

The Environment Agency has recently released a map showing areas susceptible to surface water flooding. The intended use and guidance for using this map is not yet available. Any more detailed studies should consider the map when assessing surface water flood risk. It is recommended the information be considered when the update Maps L and S in future SFRA updates.

## Flooding from artificial sources

**Map R** shows the location of canals and reservoirs within West Sussex that may be a potential source of flooding. An assessment of the risk of flooding from these artificial sources was considered too detailed for the Level 1 assessment. However the potential for this source of flooding should be considered during the plan planning process and the hazards associated with the source of flooding be studied in detail as part of site-specific flood risk assessments.

The Environment Agency are currently undertaking a reservoir inundation mapping exercise. This information was not available at the time of the SFRA update. Any more detailed studies should consider the findings of this project when assessing flood risk for artificial sources. It is recommended the information be considered when the update Maps R in future SFRA updates.

# 3. How to use the SFRA in land use planning

## 3.1. Introduction

Guidance on development and flood risk is given in PPS25. This statement requires that flood risk be considered through the application of a Sequential Test. The process of how to obtain the information needed to perform the Sequential Test is described in this chapter.

PPS25 advocates a sequential risk-based approach when preparing an assessment. The policies in PPS25 require that all stages of the development planning process should take account of both the nature and spatial distribution of flood risk and the degree of vulnerability of different types of development. Thus this should be achieved in the SEP, the MWDF and in individual planning applications.

It is not the intention for guidance provided in this document to supersede that contained in PPS25 or other plans or policies. The information and procedures are included as an interpretation of national policy for the use in the SFRA.

The Environment Agency's 'Strategy for Flood Risk Management 2003 - 2008' (Environment Agency 2003), describes flood risk as a combination of two components, the:

- *"**chance (or probability)** of a particular flood event; and,*
- ***impact (or consequence)** that the event would cause if it occurred."*

PPS 25 captures this intent by requesting that flood risk is avoided, reduced and managed *by taking full account in decisions on plans and application of:*

- present and future flood risk, involving both the statistical probability of a flood occurring and the scale of its potential consequences, whether inland or on the coast; and
- the wider implications of flood risk of development located outside of flood risk areas.

The concept of flood risk is described in further detail in Annex A.

The evidence in the SFRA is intended to inform the formulation of the vision, policies and broad search areas during the production of the Core Strategy to an appropriate level of detail so that the Core Strategy is robust with respect to flood risk.

The SFRA provides WSCC with the information to assess their allocations of new development sites and apply a risk-based Sequential Test. The SFRA also provides the necessary information for planners to make strategic decisions that identify the amount and type of development that may be appropriate, requirements for the management of run off, and in some cases, the identification of strategic responses (options) to manage flood risk.

The results of the SFRA can be used to:

- prepare appropriate policies for the management of flood risk within West Sussex; and
- inform the sustainability appraisal so that flood risk is taken into account when considering options and the preparation of strategic land use policies.

## 3.2. Sequential Test

It is recognised that flood risk information must be considered alongside other spatial planning issues. Allocations are thus 'Tested' on the basis of their flood risk attributes and the outcome used to inform decisions that include other spatial planning issues.

The Sequential Test is applied at all stages of planning. The SFRA provides the flood risk data to enable the application of the risk based Sequential Test in the process of identifying land that is suitable for development in the Minerals and Waste Development Framework. It also provides information to inform Flood Risk Assessments at particular sites and contributes further data to inform future revisions to the South East Plan (Regional Flood Risk Appraisal). Specifically the SFRA contains information on flood risk that enables WSCC to demonstrate that they have tested the reasonably available alternative sites using a risk based search sequence.

To perform the Sequential Test WSCC first need to be aware of what sites are reasonably available alternatives within the county. It is necessary to clearly define 'reasonably available' and be able to provide evidence that there are no locations outside of those considered with a lower probability of flooding that could be considered to be 'reasonably available'.

When applying the Sequential Test it will be important for WSCC to demonstrate that:

- a transparent process has been formulated and followed;
- this process has sought to steer new development to areas with the lowest probability of flooding (according to table D.1 of PPS 25); and
- full consideration has been given to reasonably available alternatives on land with a lower probability of flooding.

As an example Figure 3.1 provides a flow chart for applying the Sequential Test in determining an appropriate location for an intended land use. This flow chart is provided in the *PPS25 Development and Flood Risk Practice Guide* (June 2008). It is a tool to help the decision-maker locate a proposed development in lower flood risk categories.

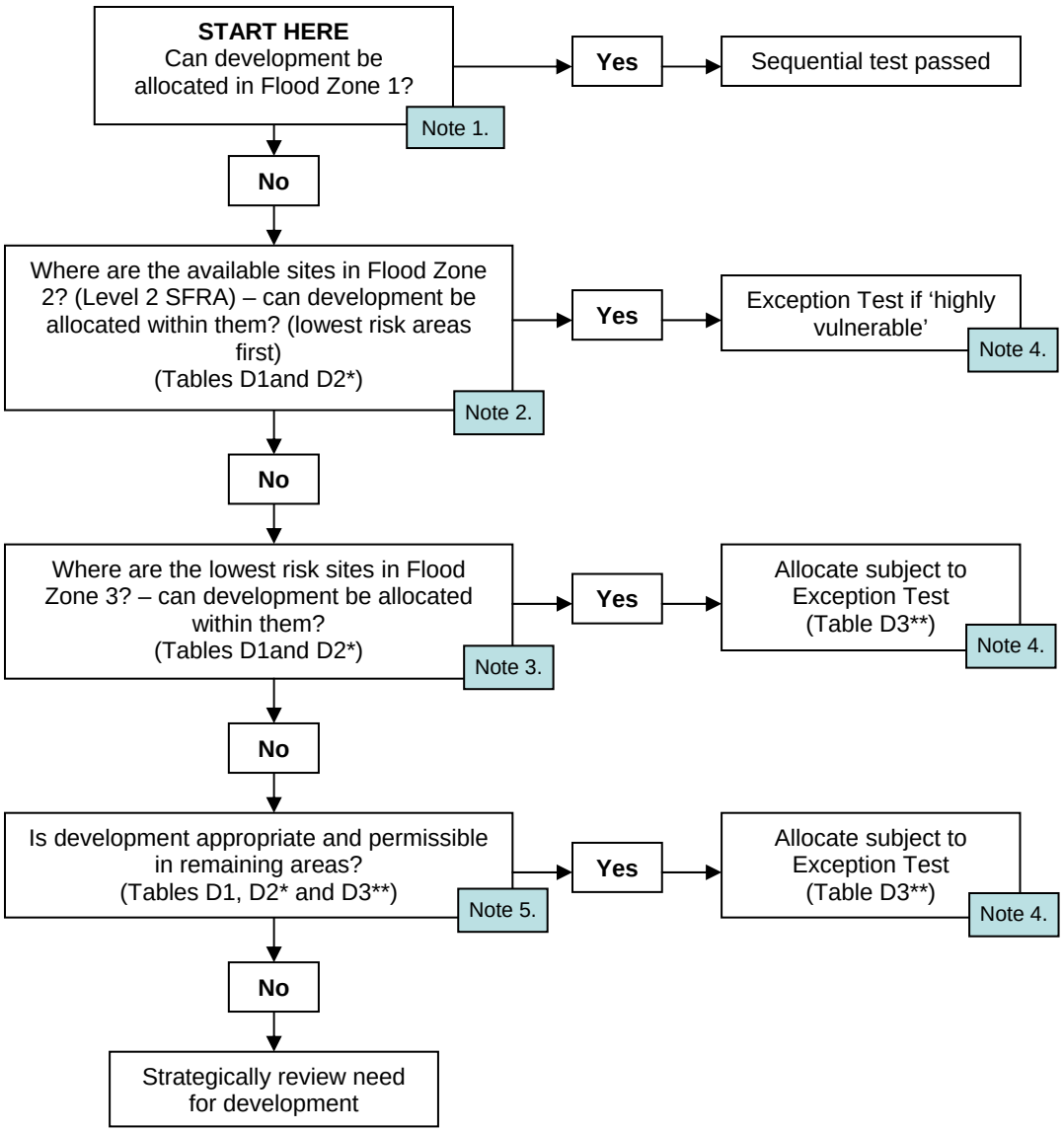
The notes provided in the *PPS25 Development and Flood Risk Practice Guide* to accompany the chart combine Flood Zones with flooding from other sources to provide an overall flood risk summary for the site. This may not be beneficial in some instances, as it means that the potential consequence of each source of flooding would be lost. For example, a site with a high probability of tidal flooding would be placed in the same category as a site with a high probability of surface water flooding. The hazard of each source of flooding is significantly different and so it may be beneficial for the Sequential Test to be undertaken with knowledge of the different sources in mind.

It is recommended that WSCC revises Figure 3.1 to formulate a bespoke flow chart that:

- adopts the same conceptual logic as the figure (provided in the *PPS25 Development and Flood Risk Practice Guide)*;
- clearly sets out the information used to inform the 'Yes/No' decisions;
- identifies the process used to select 'reasonably available alternatives'; and
- records how information on other material planning issues has been considered in the decision making process.

Table 3.1 provides some notes for undertaking the Sequential Test with SFRA maps. Both the county-wide maps in Volume II of the SFRA and site maps in Volume IV are referred to. This ensures that all sources of flooding are considered as well as the potential impacts of climate change.

The protocols adopted for the Sequential Test should ideally be agreed with the Environment Agency. It is important that the decision maker engages key stakeholders early in the decision making process. It is also important to consider uncertainty of information when making land use planning decisions.




** refer to Table D.1: Flood Zones and Table D.2: Flood Risk Vulnerability Classification in PPS25 to determine the vulnerability of the proposed development*

*** refer to Table D.3: Flood Risk Vulnerability and Flood Zone Compatibility in PPS25 to determine the compatibility of the proposed development*

***Figure 3.1 Application of the Sequential Test at the Local Level for LDD preparation (see Table 3.1 for chart notes)***

(based on the flow chart in the *PPS25 Development and Flood Risk Practice Guide*, June 2008)

***Table 3.1 Notes for use in the Application of the Sequential Test Flow Chart (Figure 3.1)***

| Note | Description | Flood Zone* | Map Ref. | Use |
|---|---|---|---|---|
| **1** | An area with a low probability of flooding from all sources, i.e. all of the area outside of Flood Zone 2 and 3 and not affected by other sources of flooding. | 1 | F1-F | Fluvial (river) Flood Zones |
| | | | F1-T | Tidal (sea) Flood Zones |
| | | | L, G, S, R (& H**) | Other sources of flooding |
| **2** | An area with a medium probability of flooding (from one or more sources). | 2 | F1-F | Fluvial (river) Flood Zones |
| | | | F1-T | Tidal (sea) Flood Zones |
| | | | L, G, S, R (& H**) | Other sources of flooding |
| **3** | An area with a high probability of flooding (from one or more sources). | 3a | F1-F | Fluvial (river) Flood Zones |
| | | | F1-T | Tidal (sea) Flood Zones |
| | | | L, G, S, R (& H**) | Other sources of flooding |
| | An area with a high probability of flooding within the functional floodplain, where water has to flow or be stored in times of flood. | 3b | F1-F | Fluvial (river) Flood Zones |
| | | | F1-T | Tidal (sea) Flood Zones |
| | | | L, G, S, R (& H**) | Other sources of flooding |
| **4** | Exception Test | N/A | See Section 3.3 | |
| **5** | Is the development safe and not expected to increase flooding elsewhere?<br><br>Is the site safe during the lifetime of the development?<br><br>Required to pass part c) of the Exception Test, where applicable<br><br>(see Tables D2 and D3 of PPS25 to determine whether the Exception Test is applicable). | N/A | If the site is affected by fluvial flooding:<br>A1-F, A2-F, C1-F | Use Map A1-F to determine whether site is affected by fluvial flooding when flood defences are in place.<br>If the site is still affected, use Map A2-F to see the depth of the flooding.<br>Use Map C1-F to determine whether the site is likely to be affected in the future, if current flood defences are maintained. |
| | | | If the site is affected by tidal flooding:<br>A1-T, A2-T, C1-T, B | Use Map A1-T to determine whether site is affected by tidal flooding when flood defences are in place.<br>If the site is still affected, use Map A2-T to see the depth of the flooding.<br>Use Map C1-T to determine whether the site is likely to be affected in the future, if current flood defences are maintained.<br>Use Map B to identify areas where flood defences may be more susceptible to a breach. |

* *used for the probability of fluvial and tidal flooding only*

** *historic incidents of other sources of flooding are shown Map H for the sites of search in Volume II of the SFRA*

## 3.3. Exception Test

If, following the application of the Sequential Test, it is not possible for the development to be located in zones of lower probability of flooding, the Exception Test may be required. The Exception Test has three elements, of which all must be passed:

- It must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk.
- The development should be on developable previously-developed land or, if it is not on previously developed land, that there are no reasonable alternative sites on developable previously-developed land.
- A FRA must demonstrate that the development will be safe, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.

Table D3 of PPS25 provides a matrix for when the Exception Test is required. The matrix compares the vulnerability of the proposed land use against the probability of the site flooding.

The land uses considered in the MWDF mostly fall into the lowest three vulnerability classifications (more vulnerable, less vulnerable and water compatible). However there may be times when some land uses are considered highly vulnerable (such as installations requiring hazardous substances consent). Consideration should be given to those mixed use permanent waste facilities that accept hazardous waste materials.

Once the vulnerability of the site is established, Table D3 of PPS25 can be used to determine whether the Exception Test is required. Following the application of the Sequential Test, common scenarios for West Sussex may include:

- Allocating land in Flood Zone 2, for an installation requiring hazardous substances consent;
- Allocating land in Flood Zone 3a for landfill and waste management facilities for hazardous waste (and/or educational facilities);
- Allocating land for essential infrastructure in Flood Zones 3a or 3b.

Table 3.2 provides guidance on applying the Exception Test for Essential Infrastructure, Highly Vulnerable and More Vulnerable land-uses in Flood Zones 2 and 3a. This expands upon Table D3 of PPS25 by providing additional guidance on the likely criteria for development in each combination of land use and flood hazard. A detailed FRA is required to undertake the Exception Test for Essential Infrastructure in Flood Zone 3b.

It is important that WSCC retain a record of all their assumptions and decisions with regard to both the Sequential and Exception Tests, in order to demonstrate that they have gone through the process.

Information in the SFRA can be use to assess the safety of particular locations since it gives greater detail on the actual risks, residual risks and the associated magnitude of the flood hazard. Consideration should be given to the safe access and egress arrangements that can be implemented so that during flood events the appropriate level of safety can be maintained.

Flood events, more than many other emergencies, can affect a wide area and the time to recover from a flood emergency can be prolonged. Accordingly it should be remembered that the level of 'safety' will vary depending on the vulnerability of the community affected. More vulnerable land uses will potentially be more severely affected by the consequences of flooding and levels of safety should be commensurate with the risk.

***Table 3.2 EXAMPLE decision support guidance for applying the Exception Test (to be refined by WSCC)***

| Vulnerability classification | | Essential infrastructure | Highly vulnerable | More vulnerable |
|---|---|---|---|---|
| **Examples** | | Essential transport infrastructure (including mass evacuation routes) and strategic utility infrastructure | Installations requiring hazardous substances consent, fire stations, command centres etc | Landfill and sites used for waste management facilities for hazardous waste, educational establishments |
| **ACTUAL RISK of flooding from rivers and the sea** | | | | |
| **1) Extent of flooding** (during 1% AEP river event and/or 0.5% AEP sea event, with flood defences in place) (**Maps A1-F and A1-T**) | Not shown to flood | Go to **4) Residual Risk (breach)** | Highly vulnerable development is not appropriate in Flood Zone 3 (1% AEP river flood or 0.5% AEP sea flood), whether or not the site is defended, Exception Test not appropriate. | Go to **4) Residual Risk (breach)** |
| | Shown to flood | Go to **2) Depth of flooding** | | Go to **2) Depth of flooding** |
| **2) Depth of flooding*** (during 1% AEP river event and/or 0.5% AEP sea event, with flood defences in place) (**Maps A2-F and A2-T**) | Depth is less than 0.5m* | **May be appropriate**<br>FRA to demonstrate that the development is safe for its lifetime, including an assessment of flood velocities, residual risk (overtopping and breach), taking into account the impacts of climate change.<br>Consider strategic options for managing flood risk. | | **May be appropriate**<br>FRA to demonstrate that the development is safe for its lifetime, including an assessment of flood velocities, residual risk (overtopping and breach), taking into account the impacts of climate change.<br>Consider strategic options for managing flood risk. |
| | Depth is between 0.5 and 1m* | **May be appropriate**<br>FRA to demonstrate that the development is safe for its lifetime, including an assessment of flood velocities, residual risk (overtopping and breach), taking into account the impacts of climate change.<br>Consider strategic options for managing flood risk. | | **May be appropriate**<br>FRA to demonstrate that the development is safe for its lifetime, including an assessment of flood velocities, residual risk (overtopping and breach), taking into account the impacts of climate change.<br>Consider strategic options for managing flood risk. |
| | Depth is greater than 1m* | **Generally not appropriate**<br>FRA to demonstrate that the development is safe for its lifetime, including an assessment of flood velocities, residual risk (overtopping and breach), taking into account the impacts of climate change.<br>Consider strategic options for managing flood risk. | | **Generally not appropriate**<br>FRA to demonstrate that the development is safe for its lifetime, including an assessment of flood velocities, residual risk (overtopping and breach), taking into account the impacts of climate change.<br>Consider strategic options for managing flood risk. |
| **RESIDUAL RISK of flooding from rivers and the sea** | | | | |
| **3) Residual Risk (overtopping)** (during 0.1% AEP river or sea event, with flood defences in place) (**Maps A1-F and A1-T**) | Not shown to flood | Exception Test not required for sites within Flood Zone 2. | Go to **4) Residual Risk (breach)** | Exception Test not required for sites within Flood Zone 2. |
| | Shown to flood | | **May be appropriate**<br>FRA to demonstrate that the development is safe for its lifetime, including an assessment of flood velocities, residual risk (breach), taking into account the impacts of climate change.<br>Consider strategic options for managing flood risk. | |
| **4) Residual Risk (breach)** (areas where existing river or sea defences are expected to be more susceptible to a breach) (**Map B**) | Not close to an area likely to breach | Go to **5) Climate Change** | Go to **5) Climate Change** | Go to **5) Climate Change** |
| | Close to an area likely to breach | **May be appropriate**<br>FRA to demonstrate that the development is safe for its lifetime, including a breach assessment, taking into account the impacts of climate change. | **May be appropriate**<br>FRA to demonstrate that the development is safe for its lifetime, including a breach assessment, taking into account the impacts of climate change.<br>Consider strategic options for managing flood risk. | **May be appropriate**<br>FRA to demonstrate that the development is safe for its lifetime, including a breach assessment, taking into account the impacts of climate change. |
| **CLIMATE CHANGE impacts on flooding from rivers and the sea** | | | | |
| **5) Climate Change** (during a future 1% AEP river event and/or future 0.5% AEP sea event, with flood defences in place) (**Maps C1-F and C1-T**) | Not shown to flood within design life of development | **Generally appropriate**<br>FRA to demonstrate that flood defences can be maintained and residual risk can be managed, for the lifetime of the development. | **Generally appropriate**<br>FRA to demonstrate that flood defences can be maintained and residual risk can be managed, for the lifetime of the development. | **Generally appropriate**<br>FRA to demonstrate that flood defences can be maintained and residual risk can be managed, for the lifetime of the development. |
| | Shown to flood within design life of development | **May be appropriate**<br>FRA to demonstrate that the development is safe for its lifetime, including an assessment of flood depths and velocities, taking into account the impacts of climate change.<br>Consider strategic options for managing flood risk. | **May be appropriate**<br>FRA to demonstrate that the development is safe for its lifetime, including an assessment of flood depths and velocities, taking into account the impacts of climate change.<br>Consider strategic options for managing flood risk. | **May be appropriate**<br>FRA to demonstrate that the development is safe for its lifetime, including an assessment of flood depths and velocities, taking into account the impacts of climate change.<br>Consider strategic options for managing flood risk. |

** Note: depth of flooding only provides a guide to flood hazard, and are based on Figure 2.1 of Defra Technical Report FD2321/TR2. To fully assess flood hazard, other factors must be examined, including velocity, debris and rate of rise.*

## 3.4. Potential development within West Sussex

WSCC have provided a number of sites that potentially could be used for minerals and waste land uses. A summary of flooding at each site has been provided in Volume IV of the SFRA, as well as a series of site-specific maps.

The guidance outlined in Sections 3.2 and 3.3 for applying the Sequential and Exception Tests can be used to 'Test' these sites. It will be important to revise Volume IV of the SFRA in the event that new reasonable available sites are identified.

# 4. How to use the SFRA in flood warning and emergency planning

PPS25 recognises that flooding is a natural process that plays an important role in shaping the natural environment. However, flooding also threatens life and causes substantial damage to property. Although flooding cannot be wholly prevented, its impacts can be avoided and reduced through good planning and management. While physical defences may provide a level of protection, they may be breached or overtopped. A necessary component of flood defence is flood warning, backed up by civil protection measures. In this context, the Environment Agency is the authority responsible for issuing forewarning of possible events to the public, local authorities and emergency services.

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

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

The SFRA provides information on the spatial distribution of flood hazard, which can inform the production of emergency flood management plans. The GIS datasets provided with this SFRA contain flood depth information across much of the County, which can be used to improve existing flood emergency plans and flood warning systems. In particular, consideration should be given to:

- maintaining an up-to-date vulnerable persons, sites and essential infrastructure database;
- identifying suitable locations for rest, reception and media centres;
- completing pre-multi-agency planning, such as identification of transport routes;
- review of council properties at risk and the vulnerability of the community affected;
- understanding the spatial variability of the hazards posed by breach failure or overtopping events (residual flood risk events); and
- providing updated information on the council website.

The Civil Contingencies Act 2004 also places a legal duty on category one responders (which includes Local Authorities) to produce a community risk register. Community Risk registers are a compilation of risk assessments for hazards, including flood risk.

The outputs of the SFRA will support WSCC in the maintenance of the Community Risk Register and provide data of a higher resolution than shown on Environment Agency mapping so that the magnitude of risks can be evaluated with greater precision in West Sussex. This will help to facilitate joined-up local planning, based on consistent planning assumptions and provide data that can be used to prepare strategic responses to reduce the consequences of flood emergencies and hence reduce the risks to all.

As stated the SFRA provides information on the spatial distribution of flood hazard. This information should be used to feed upwards to strategic land use planning (SEP and RFRA), and down to individual site development management. Inappropriate development in flood risk areas can pose a significant risk to life, especially to the young, elderly and infirm. Flood risk maps are provided in Volume II of this SFRA. It is essential that those new developments which occur within flood risk areas are safe, and that new developments are designed and constructed such that the health, safety and welfare of people is appropriately managed. This is of particular reference to developments which proceed following the application of the Exception Test.

Consideration of health and safety issues should also be a fundamental issue during the design and construction of new developments. The outputs of this SFRA will support WSCC in understanding the level of flood risk management requirements at each proposed development. As noted the safety levels considered should be proportionate to the vulnerability of the community affected by the flood risk.

The spatial distribution of flood hazard should also inform the production of emergency flood management plans. Emergency flood management plans should minimise risks to life and property, through, for example, ensuring that evacuation procedures are adequate to the kinds of risks that a major flooding event may create. Developers and consultants preparing site specific emergency plans for new developments should consult with the WSCC Emergency Planning team during the preparation of such plans.

The findings of the SFRA should also be used to inform the production of a Flood Plan, which should include updating the existing guidance on flooding. LPAs have a legal duty to prepare and update emergency plans for major and local civil emergencies, including flooding. As part of the requirements the LPA has a duty to:

- assist other relevant services and agencies, including the emergency services and the Environment Agency, with regards to alerting or warning the public if local flooding is either imminent or likely.
- assist the emergency services with the evacuation of residents from areas that are likely to be, or have already been flooded.
- identify and staff public reception centres for evacuees to offer information, refreshments and if necessary shelter over-night.
- assist the Fire Brigade in dealing with floodwater and mitigating damage, by providing flood control measures such as filled sandbags.
- assist the emergency services to control access to the scene by undertaking road closures or erecting road barriers etc.

The findings of the SFRA can be used to support these legal requirements, for example the mapping provided in Volume II will support WSCC in identifying evacuation area and reception centre locations in areas of low flood risk. The SFRA can also help to identify implications for the future resourcing of emergency planning, for example the implications of climate change and flood risk.

In the past the many LPAs have provided emergency assistance on an ad hoc basis dependent upon local knowledge and experience of the situation. Council contractors keep a stock of filled sandbags, which can be collected by residents. The mapping outputs of the SFRA can help LPAs determine appropriate storage locations for these sandbags, through identifying those areas at greatest flood risk, and therefore with the likely greatest need of sand bags.

The Draft Flood and Water Management Bill will potentially change the roles and responsibilities of County Councils in relation to Flood Risk Management, flood warning and emergency planning. Local Authorities and County Councils in two tier areas will have an executive role as category one responders under the Civil Contingencies Act, responsibilities will include delivery of flood warnings.

WSCC do not currently provide a flood warning service. Should this be required in the future, the SFRA findings can be used to support the development of this service. For example, through highlighting those areas within the County at greatest flood risk and therefore who would receive greatest benefit from an 'inform and warn' network. At the present time, the council will assist with the dissemination of Environment Agency flood warnings where appropriate

The SFRA (Volume II) also provides details of the Environment Agency's current Flood Warning Service.

The information in the SFRA if made available to those attending flood emergencies would potentially reduce the magnitude of the risks that personnel might be exposed to. Importantly it enables those attending flood emergencies to prepare in advance and reduce the chance of unforeseen exposure to high hazard magnitudes during a flood emergency.

# 5. How to use the SFRA in development management

## 5.1. Introduction

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

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

The SFRA should be used to provide high level flood risk information for decisions on land use planning. This can be done on an 'as required' basis, matching the needs of phased submission of applications.

It is the responsibility of developers to carefully consider the flood risks at a site as early as possible. Developers should be referred to the SFRA at the start of any pre-application consultation with WSCC.

A developer is not required to apply the Sequential Test if a proposed development is located on a site which has been allocated for that type of development in a MWDF that has been sequentially tested and supported by a SFRA. However, the developer should still apply the sequential approach to any flood risk within the site itself and demonstrate compliance with PPS25 when determining the location of appropriate land uses. The aim of the sequential approach is to minimise the flood risk by considering the probability of flooding in conjunction with the vulnerability of receptors.

Where developers promote development outside of the allocated areas identified in the MWDF and within flood risk areas defined by the SFRA they are responsible for:

- demonstrating compliance with PPS25 notably obtaining confirmation from WSCC that the proposed application site satisfies the outcome of the Sequential Test. This might require the developer to collect and submit information to WSCC as evidence to be used in performing the Sequential Test and if appropriate the Exception Test;
- providing an assessment of the impact of flooding on the development and of the development on flood risk elsewhere; and
- satisfying the LPA that flood risk to the development and the impact of the development on flood risk elsewhere will be appropriately managed.

In areas where flood risk has been identified as an issue, developers should liaise with WSCC to agree on who should be consulted. The scope of any site specific FRA should be agreed with WSCC, and will be informed by the outputs from this SFRA and consultation with the Environment Agency.

The level of information in FRAs should be proportionate to the degree of flood risk and the scale, nature and location of the proposed development. The SFRA provides information already available which should be considered in the production of site-specific FRAs. In these instances the SFRA allows WSCC to identify the level of detail required.

The information within the SFRA should also be used to inform the development of planning constraints within development areas designated in the MWDF and where relevant, in the case of windfall planning applications.

The Development Management team should then refer to the more detailed maps in Volume II as appropriate. In cases where the flood risk is predominantly from other sources, the Development Management team should consult the Environment Agency to obtain the latest historic information and if necessary, request site specific investigations.

## 5.2. Consultation Matrix

Although this SFRA has been undertaken for West Sussex, it does not negate the need for site specific FRA to be undertaken at the planning application stage. Instead, this SFRA provides advice on the scope of the additional information required within FRA.

PPS25 is relatively clear that a FRA is required for all new development, greater than 1ha in area in Flood Zone 1, and all new developments of any area in Flood Zones 2 and 3. The guidance is not so clear for changing the use of an existing development (to a higher vulnerability classification) and for extensions to existing development.

To help Development Management Officers decide when a flood risk assessment is required, the Environment Agency has developed a consultation matrix (Table 5.1), which identifies when the Environment Agency should be consulted, and what level of information needs to accompany the FRA if one is required.

The different colour boxes provide an indication of the level for consultation and FRA required. No consultation or FRA is required in the grey boxes. Information that should be included in FRAs is expanded upon in Section 5.3.

The Environment Agency Consultation Matrix is part of the Environment Agency's Flood Risk Standing Advice version 2 (FRSA) released in February 2009, which is provided to LPAs for more straightforward planning applications. The FRSA also allows LPAs to identify those higher risk development situations where consultation with the Environment Agency is essential. This information is available on the Environment Agency website at www.environment-agency.gov.uk/research/planning/33098.aspx and should be checked regularly for updates.

***Table 5.1 Environment Agency consultation matrix***

| A | B | C | D | E | F |
|---|---|---|---|---|---|
| **Development category** | **Development (including boundary walls etc.) within 20 metres of the top of a bank of a Main River** | **Includes culverting or control of flow of any river or stream** | **Within Flood Zone 3** | **Within Flood Zone 2** | **Within Flood Zone 1** |
| **Minor extensions** | | | | | |
| Non-residential extensions with a footprint of less than 250m$^2$ ; Householder development and alterations | Consult EA on flood defence consent requirements. | Consult EA with FRA showing design details of any culvert or flow control structure proposed. | No consultation - see EA standard comment. | No consultation - see EA standard comment. | No EA consultation required. |
| **Material change of land use** | | | | | |
| Change of use from 'water compatible' to 'less vulnerable' development | Only consult EA if site also falls with Flood Zone 3. FRA required. | No EA consultation required. | Consult EA with FRA. | No EA consultation required. | No EA consultation required.. |
| Change of use resulting in 'highly vulnerable' or 'more vulnerable' development | Only consult EA if site also falls with Flood Zone 3 or 2. FRA required. | No EA consultation required. | Consult EA with FRA. | Statutory standing advice May apply. | No EA consultation required. |
| **Development involving building, mining or engineering works.** | | | | | |
| Operational development less than 1 hectare | Consult EA on flood defence consent requirements. | Consult EA with FRA showing design details of any culvert or flow control structure proposed. | If highly vulnerable EA likely to object but consult EA with FRA. Other vulnerabilities consult EA with FRA and Sequential Test evidence and where required confirm Exception Test has been applied. | Statutory standing advice May apply. | No consultation required - see surface water management good practice advice – see EA standard comment. |
| Operational development of 1 hectare or greater | Consult EA on flood defence consent requirements. | Consult EA with FRA showing design details of any culvert or flow control structure proposed. | If highly vulnerable EA likely to object but consult EA with FRA. Other vulnerabilities consult EA with FRA and Sequential Test evidence and where required confirm Exception Test has been applied. | Highly vulnerable - consult EA with FRA and sequential test evidence and confirm Exception Test has been applied. Other vulnerabilities - consult EA with FRA and Sequential Test evidence. | Consult EA with FRA. |

Consult EA with information as detailed  Do not consult the EA  Standing advice/ standing comments

*Note: This table, and further supporting information, is available at* www.environment-agency.gov.uk/research/planning/82584.aspx

## 5.3. Sequential Test

The Environment Agency FRSA sets out the evidence required from Local Planning Authorities as a demonstration that the Sequential Test has been properly applied for individual planning applications.

Figure 5.1 contains a summary of the information extracted from the FRSA advice to demonstrate the flood risk Sequential Test for planning applications which is available on the Environment Agency website www.environment-agency.gov.uk/research/planning/82587.aspx. The website contains a number of useful notes and links and should be checked regularly for updates.

***Table 5.2 Demonstrating the flood risk Sequential Test for planning applications (summary)***

**Stage 1- Strategic application and development vulnerability**

The Sequential Test can be considered adequately demonstrated if both of the following criteria are met:

- The Sequential Test has already been carried out for the site (for the same development type) at the strategic level (development plan) in line with paragraphs D5 and D6 of PPS25 (supply reference to the Development Document Plan in question); and
- The development vulnerability is appropriate to the Flood Zone (see table D1 and D3 PPS25).

**Stage 2- Defining the evidence base**

2.1 Identify the geographical area of search over which the test is to be applied (this will usually be over the whole of the LPA area but may be reduced where justified by the functional requirements of the development).

2.2 If greater or less than the district boundary justify why the geographical area for applying the test has been chosen.

2.3 Identify the source of reasonably available sites:

- Drawn from the evidence base/ background documents produced to inform the LDF (state which);
- Other sites known to the LPA that meet the functional requirements of the application;
- Windfall sites, previously developed sites that have unexpectedly become available.

2.4 State the method used for comparing flood risk between sites, either:

- Environment Agency Flood Map;
- Up to date SFRA held by the LPA;
- Site specific FRA where suitable for purpose; or
- Other map or sources of flooding information not listed (state which).

**Stage 3- Applying the Sequential Test**

Compare the reasonably available sites identified under stage 2 with the application site.
3.1 State the name and location of the reasonably available site options being compared to the application site.

3.2 Indicate whether flood risk on the reasonably available options is higher or lower than the application site (state the Flood Zone or SFRA classification for each site).

3.3 State whether the reasonably available options being considered are allocated within the Development Plan (confirm the status of the plan).

3.4 State the approximate capacity of each reasonably available site being considered based on:

- The density policy within a LDD; and
- Past performance in this respect.

3.5 Detail any constraints to the delivery of the identified reasonably available options; for example, availability within a given time period or lack of appropriate infrastructure. Include recommendations on how these restraints could be overcome.

**Sequential Test conclusion**

Are there any reasonably available sites in areas with a lower probability of flooding that would be appropriate to the type of development or land use proposed?

Where necessary, the Exception Test should be applied in the circumstances set out by table D1 and D3 of PPS25.

Applying the sequential approach at site level - PPS25 sets out the requirement for developers to apply the sequential approach (see paragraph 14 and D8) to locating development within the site.

*Note: Further supporting information, is available at* www.environment-agency.gov.uk/research/planning/82587.aspx

## 5.4. Content of Flood Risk Assessments

The FRA will be required to demonstrate that flood risk to the development can be managed now and in the future, that the development will not increase the risk of flooding elsewhere and that the proposals are compliant with the SFRA.

The principles and key requirements of a FRA are provided in Appendix E of PPS25. The guidance in PPS25 recommends that the level of detail in the FRA should be proportionate to the risk and appropriate to the scale, nature and location of the development.

The Environment Agency's Flood Risk Standing Advice (FRSA) Version 2 provides guidance on the suggested content of FRAs in various circumstances. This can be accessed through their website at www.environment-agency.gov.uk/research/planning/93498.aspx and should be checked regularly for updates.

The advice suggests the following should be included in the FRA:

- **Household and other minor extensions (FRA Guidance Note 2)** - evidence that the extension will be flood proof or flood resilient. A more detailed FRA may be required in cases where the cumulative effect of extensions is known to exacerbate flooding.

- **Development greater than 1ha in Flood Zone 1 (FRA Guidance Note 1)** -location plan with existing surface water infrastructure, an assessment of the proposed development on existing surface water runoff rates (including an allowance for climate change), how any increase in runoff rates will be managed and if any other sources of flooding are likely to affect the site. The FRA is required to consider the proposal relevant to the SFRA.

- **Minor Extensions where the cumulative impact of development needs to be addressed (FRA Guidance Note 2)** - evidence that the extension will be flood proof or flood resilient, an assessment of the actual and residual risk of flooding and an indication of the effect of the proposed development on flood storage, flood flow routes and surface water runoff rates. In some cases this may be a short-written statement based on information contained within the SFRA.

- **Development in Flood Zones 3 and 2 (Excluding Minor Extensions) (FRA Guidance Note 3)** - a detailed FRA is required as described below. It is recommended that applicants seek advice from the LPA before undertaking the FRA to make sure that the site passes the Sequential and is likely to pass the Exception Test.

The following information to be included in a detailed FRA:

- a description of the development and the planning context;
- definition of flood hazard;
- probability of flooding;
- impacts of climate change on flood risk;
- detailed description of development proposals;
- flood risk management measures including the application of Sustainable Drainage Systems (SuDS);
- impacts of the development off site; and
- an assessment of residual risk.

The *PPS25 Development and Flood Risk Practice Guide* provides a proforma for developers to complete when undertaking a detailed FRA (see Annex B). The LPA should encourage all FRAs to include this proforma as an appendix.

The SFRA contains a number of maps that may be helpful in preparing a FRA (see Table 5.2. In some cases, the information in the maps will be sufficient for producing the FRA. In other cases, more detailed hydrological and hydraulic modelling studies will be required. It is the responsibility of the user to make sure that the data used in the FRA is proportionate to the risk and appropriate to the scale, nature and location of the development.

***Table 5.3 SFRA maps most relevant to FRAs***

| Source of flooding | Overview Map (Volume II) | Site Map (Volume IV) | Description |
|---|---|---|---|
| Rivers (fluvial) | Map F1-F | Map F1-F | Fluvial Flood Zones 2, 3a and 3b as defined in PPS25<br>(Note: Flood Zone 2 and 3a ignore the presence of flood defences) |
| | Map C2-F | Map C2-F | Climate change Fluvial Flood Zones 3a and 3b, for 2059 and 2109 time horizons<br>(Note: Flood Zone 3a ignores the presence of flood defences and Flood Zone 3b assumes that existing flood defences are maintained in accordance with current CFMP policy |
| | Map A1-F | Map A1-F | Extent of flooding during a 1% AEP (actual risk) and 0.1% AEP (residual risk) flood event with defences |
| | Map A2-F | Map A2-F | Depth of flooding during a 1% AEP flood with defences (actual risk) |
| | Map C1-F | Map C1-F | Climate change extent of flooding during a future 1% AEP flood event with defences, for 2059 and 2109 time horizons<br>(Note: Flood Zone 3b assumes that existing flood defences are maintained in accordance with current CFMP policy |
| Sea (tidal/ coastal) | Map F1-T | Map F1-T | Tidal Flood Zones 2, 3a and 3b as defined in PPS25<br>(Note: Flood Zone 2 and 3a ignore the presence of flood defences) |
| | Map C2-T | Map C2-T | Climate Change Tidal Flood Zones 3a and 3b, for 2059 and 2109 time horizons<br>(Note: Flood Zone 3a ignores the presence of flood defences and Flood Zone 3b assumes that existing flood defences are maintained in accordance with current CFMP policy |
| | Map A1-T | Map A1-T | Extent of flooding during a 0.5% AEP (actual risk) and 0.1% AEP (residual risk) flood event with defences |
| | Map A2-T | Map A2-T | Depth of flooding during a 0.5% AEP flood with defences (actual risk) |
| | Map B | N/A | Locations where breach modelling may be required (based on SMP/CFMP data suggesting that a breach is more likely) |
| | Map C1-T | Map C1-T | Climate change extent of flooding during a future 0.5% AEP flood event with defences, for 2059 and 2109 time horizons<br>(Note: Flood Zone 3b assumes that existing flood defences are maintained in accordance with current CFMP policy) |
| Groundwater | Map G | Map H | Areas more likely to be affected by groundwater flooding (based on a spatial analysis), and historic incidents of groundwater flooding |
| Land | Map L | Map H | Areas more likely to be affected by surface water flooding (based on a spatial analysis), and historic incidents of surface water flooding |
| Sewer | Map S | Map H | Historic incidents of sewer flooding |
| Artificial sources | Map R | Map H | Potential sources of artificial flooding |

## 5.5. Sustainable Drainage Systems

As recognised within PPS25 and the accompanying guidance, that SuDS are a useful tool in the management of flood risk and water quality. As a result, the use of SuDS in individual planning applications should be promoted by WSCC.

The advantages and disadvantages of different SuDS techniques should be considered for each proposed development site. When doing this, the Development Management team should consider the particular setting, (including consideration of the site area, the proposed development type, its environmental soundness, and its location in or out of the flood plain) and especially the ground conditions.

With the diverse range of geology, soils and topography across West Sussex, many of the SuDS techniques may be applicable. It is recommended that developers should consult WSCC, the Environment Agency, and relevant service authorities and utility companies at the earliest stage of the development process to establish the best solution for a particular site.

SuDS aim to control surface water runoff as close to its origin as possible, before it is discharged to a watercourse or sewer. This involves moving away from traditional piped drainage systems towards softer engineering solutions which seek to mimic natural drainage regimes. SuDS have many benefits such as reducing flood risk, improving water quality, encouraging groundwater recharge and providing amenity and wildlife benefits. For a drainage system to be termed 'sustainable' it must meet three criteria, as depicted in Figure 5.2.

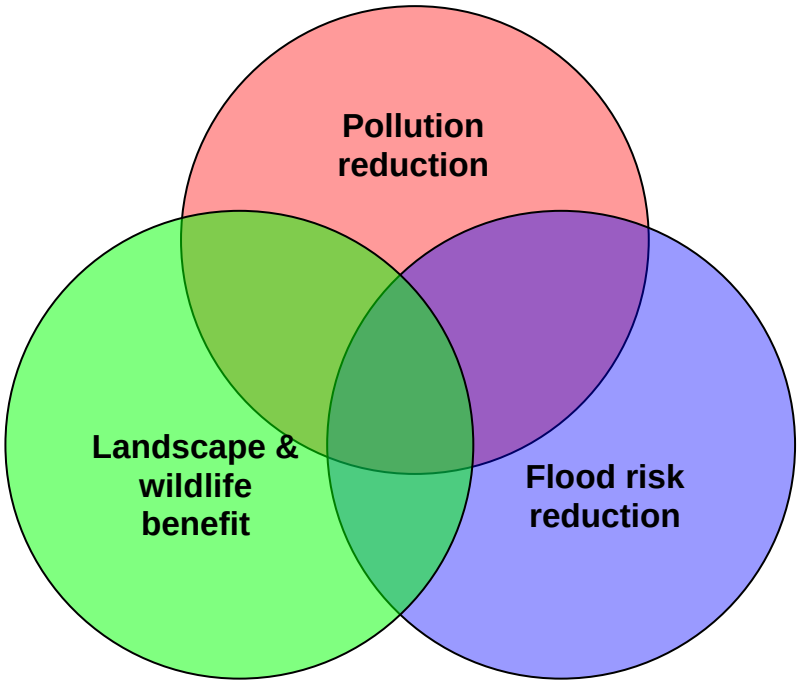


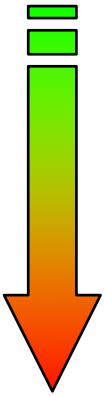

***Figure 5.2 Broad criteria of Sustainable Drainage Systems***

All three criteria should be considered when designing a drainage scheme. Table 5.3 depicts a hierarchical approach to the selection of SuDS techniques with the most sustainable techniques located at the top of the table. The most sustainable techniques meet all three SuDS criteria.

All probable SuDS options should be explored as part of a site investigation. Before the site layout is decided, it is important that land is first allocated to accommodate these SuDS requirements. A drainage design can be made up of a range of SuDS techniques. SuDS systems need to be carefully

designed to ensure that they provide habitat for flora and fauna as well as reducing flood risk and improving water quality.

***Table 5.4 The SuDS hierarchy***

| | SuDS technique | Flood reduction | Pollution reduction | Landscape & wildlife benefit |
|---|---|---|---|---|
| Most Sustainable  | **Basins and ponds**<br>- Constructed wetlands<br>- Balancing ponds<br>- Detention basins<br>- Retention ponds | ✔ | ✔ | ✔ |
| | **Filter strips and swales** | ✔ | ✔ | ✔ |
| | **Infiltration devices**<br>- soakaways<br>- infiltration trenches and basins | ✔ | ✔ | ✔ |
| | **Permeable surfaces and filter drains**<br>- gravelled areas<br>- solid paving blocks<br>- porous paviors | ✔ | ✔ | |
| Least Sustainable | **Tanked systems**<br>- over-sized pipes/tanks<br>- storms cells | ✔ | | |

Whereas conventional piped networks can be accurately sized using scientific and empirical calculations, SuDS are not so accurate due to the many 'natural' variables that exist, such as soil permeability, the effect of vegetation, irregular channel shapes, etc.

There is no definitive design codes or standards for SuDS although design guidance is available. CIRIA offers the following design documents:

- C522 – Sustainable Urban Drainage Systems – design manual for England and Wales
- C523 – Sustainable Urban Drainage Systems – best practise for England, Scotland, Wales and Northern Ireland
- C609 – Sustainable Drainage Systems – Hydraulic, structural and water quality advise

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Fleming, G (2001) 'Learning to Live with Rivers – Final Report to the Insitution of Civil Engineers.'

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# 7. Glossary and notation

| | |
|---|---|
| **Actual risk** | The risk that has been estimated based on a qualitative assessment of the performance capability of the existing flood defences |
| **AEP** | Annual Exceedance Probability. The annual chance of experiencing a flood with the corresponding flood magnitude, i.e. a 1% AEP flood is a flood with a flow magnitude that has a 1% chance of occurring in each and every year |
| **Breach or failure hazard** | Hazards attributed to flooding caused by a breach or failure of flood defences or other infrastructure which is acting as a flood defence. |
| **CDS** | Coastal Defence Strategy |
| **CFMP** | Catchment Flood Management Plan |
| **CLG** | Communities and Local Government. Government Department responsible for issuing Planning Policy Statement 25: Development and Flood Risk |
| **Flood defence** | Natural or man-made infrastructure used to prevent flooding |
| **Flood risk** | *Flood risk is a combination of two components: the chance (or probability) of a particular flood event and the impact (or consequence) that the event would cause if it occurred* (EA 2003). |
| **Flood risk management** | *Flood risk management can reduce the probability of occurrence through the management of land, river systems and flood defences, and reduce the impact through influencing development in flood risk areas, flood warning and emergency response* (EA 2003). |
| **Flood Zones** | This refers to the Flood Zones in accordance with Table D1 of PPS25. For the purpose of the SFRA, the definition of flood zones varies slightly from PPS25 in that it shows the extent of flooding ignoring the presence of flooding defences, "except where the 'actual risk' extent is greater" |
| **Fluvial** | Relating to a watercourse (rivers or streams) |
| **FRA** | Flood Risk Assessment |
| **FRSA** | Flood Risk Standard Advice - provided by the Environment Agency via their website: www.environment-agency.gov.uk/planning |
| **Groundwater** | Groundwater is the term used to describe the water stored underground in areas of permeable rocks, known as aquifers. Consistently high levels of groundwater can lead to groundwater flooding. |
| **JFLOW** | Two-dimensional cellular inundation model |

| | |
|---|---|
| **LDD** | Local Development Documents |
| **LDF** | Local Development Framework |
| **LPA** | Local Planning Authority |
| **MWDF** | Minerals and Waste Development Framework |
| **PPS25** | Planning Policy Statement Note 25: Development and Flood Risk (December 2006). |
| **Residual risk** | Flood risks resulting from an event more severe than for which particular flood defences have been designed to provide protection. |
| **RFRA** | Regional Flood Risk Appraisal |
| **RSS** | Regional Spatial Strategy |
| **SAMP** | System Asset Management Plans - Environment Agency plan to assist in the long term management of their assets |
| **SEP** | South East Plan |
| **SFRA** | Strategic Flood Risk Assessment |
| **SMP** | Shoreline Management Plan |
| **SUDs** | Sustainable Urban Drainage Systems |
| **Surface water** | Any body of water that is not groundwater (for example rivers, estuaries, ponds etc) as well as temporary waters resulting from flooding, run-off etc. |
| **TUFLOW** | Two-dimensional fully hydrodynamic modelling software, used to define floodplain flows, depth, velocities and extents |
| **Windfall Sites** | Sites which become available for development unexpectedly and are therefore not included as allocated land in a planning authority's development plan |
| **WSCC** | West Sussex County Council |

# Annex A: How flood risk has been assessed

**Introduction**

This appendix defines flood risk and its sources. It then goes on to consider the four stage approach to the assessment of flood risk that has been undertaken in line with PPS25. It then considers the impact of climate change on flood risk, before going on to consider uncertainty. It concludes with a brief discussion of currency of information.

**Defining flood risk**

The Environment Agency's 'Strategy for Flood Risk Management 2003 - 2008' (Environment Agency 2003), describes flood risk as a combination of two components, the:

- *"**chance (or probability)** of a particular flood event; and,*
- ***impact (or consequence)** that the event would cause if it occurred."*

By considering both the definition of risk and the "source-pathway-receptor" model, it is beneficial to assess risk in terms of the components shown in Figure A.1.

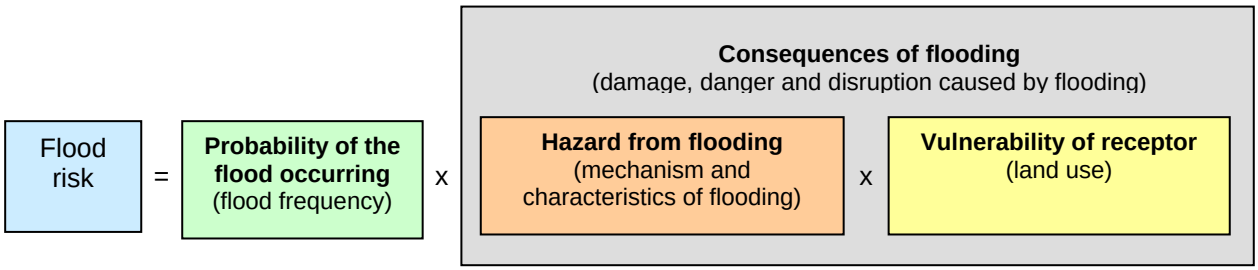


***Figure A.1 Risk equation***

The probability of flooding can be defined using data and statistical analysis. The hazard from flooding can be evaluated by considering the depth of floodwater, the velocity of flow, the speed of onset of flooding and the rate of rise of floodwater. The vulnerability of flooding can be assessed through analysis of the land use, property or people that would be affected by flooding.

It can be seen from the risk equation Figure A.1 that by reducing the hazard or vulnerability of flooding, it is possible to reduce the risk. It follows that, development proposals within West Sussex should be developed and assessed using a risk-based search sequence avoiding risk where possible and managing it elsewhere.

There is inherent uncertainty in estimation of flood probability due to the need to simplify variability in rainfall, storm types, soil types, land cover and antecedent conditions into one design event. By separating flood risk into its three components, it is possible to gauge risk even if the exact probability of an event is uncertain. In this way a precautionary principle can be applied, as flood risk will be higher for floods with significant hazards and consequences, even when the probability of occurrence is uncertain.

This information can then be used to inform the Sequential Test. By including consideration of climate change the procedure is precautionary, in accordance with PPS25.

The SFRA provides high level information for decisions on land use planning within West Sussex. The strategic approach defined in this document will require that information supporting all planning applications in the study area make reference to the SFRA and clearly demonstrate adoption of a risk-based sequential approach.

**Sources of flood risk**

Flooding can come from rivers, the sea, directly from rainfall, groundwater, highway and sewer drainage systems, and from artificial sources such as canals. The impact of flooding will depend upon its source and the land-use. Further information on flooding from the six sources is contained within Annex C PPS25 and the PPS25 Development and Flood Risk Practice Guide.

The Autumn 2000 Flood Report produced by the Environment Agency reported that 42 per cent of flooding reported nationally arose from sources other than river flooding (Environment Agency 2000).

The Flood Zones based on the Environment Agency Flood Map account only for river flooding and flooding from the sea.

In accordance with PPS25 the SFRA has refined the information on the Environment Agency Flood Map to account for other forms of flooding as well. Information on groundwater, surface water, sewers and artificial sources has been collated. This information should be used when preparing appropriate policies for flood risk management and land use allocation.

**Types of flood risk**

The SFRA provides a range of information so that the hazard of flooding, not just the probability of flooding, can be examined. In keeping with PPS25, there are four types of flood risk to be considered.

*1. Flood Zones*

As defined in Table D1 of PPS25, Flood Zones show areas at risk of river and sea flooding, ignoring the presence of flood defences. It is important to recognise that because the Flood Zones ignore the presence of flood defences, they do not describe an actual level of flood risk. Thus, large areas of development behind flood defences can be shown as at risk.

PPS25 also defines the functional floodplain as the area where water has to flow or be stored at times of flood, and that SFRAs should identify this by the land liable to flood during a flood with a 5% AEP. The PPS25 Development and Flood Risk Practice Guide clarifies that this should be with flood defences in place.

PPS25 requires that all sources of flooding be examined. Flood Zones are a good starting point for this assessment as they show areas at risk of flooding from rivers and the sea, which cause the most damage across England and Wales. However other sources and types of flooding must be examined, even if a proposed development lies within a low probability Flood Zone. Thus the actual and residual risks must be examined as well.

*2. Actual risk*

Actual risk provides information on flooding, when the impact of existing flood defences is considered (assuming that they operate as they are supposed to). The actual risk of river flooding is usually assessed using the 1% AEP flood event. As the hazards associated with tidal flooding are typically greater than for river flooding, the actual risk of tidal flooding is usually assessed using the less probable 0.5% AEP flood event.

Actual risk of flooding from other sources (land, groundwater, sewers and artificial sources) can be assessed using a range of analyses. However, for the level of assessment required in an SFRA, these sources are usually assessed via a review of historic flood incidents records and a qualitative analysis of catchment characteristics.

*3. Residual risk (overtopping or exceedance)*

In recognition that engineered flood reduction measures cannot completely eliminate flood risk, there is a need to be aware of the residual risk generated by an event more severe than that for which the defences have been designed to provide protection. Accordingly, this risk assessment usually considers the flooding associated with an extreme event (such as a 0.1 per cent AEP) or flooding that may result from climate change.

*4. Residual risk (breach and/or failure)*

This involves the assessment of breach or failure of flood defences or other features, which may act as a defence. Such scenarios may include collapse of a flood defence wall, blockage of a culvert or structural failure of a canal or reservoir embankment. Whilst the probability of a breach or failure is generally low, the consequences of an event are often very high. Following the precautionary principle, such high hazards should be considered when making land use planning decisions.

Breach and failure hazards are site specific and should be assessed in individual flood risk assessments. The SFRA provides locations where breach assessments may be required for FRAs.

**Climate change**

Projections of future climate change indicate that more frequent short-duration, high intensity rainfall and more frequent periods of long duration rainfall could be expected. Winters are expected to become wetter with summers and autumn becoming drier than at present. Global sea level rise is also expected to continue. These kinds of changes will have implications for all forms of flooding.

Changes in the extent of inundation as a result of climate change are likely to be negligible in well-defined floodplains but may be dramatic in low-lying and flat areas. It is expected that climate change will lead to a reduction in the standard of protection provided by defences constructed in the past. Changes in the depth of flooding may reduce the return period of a given flood and as a result the flood zone classification within which certain areas fall.

The Environment Agency Flood Map and Flood Zones do not take account of climate change. PPS25 requires that the spatial planning process should consider the implication of changes in our climate.

The WSCC SFRA contains information on flood probability areas in the future based on two time horizons 50 years (2059) and 100 years (2109) into the future. Two scenarios are presented, the effect of climate change on Flood Zones (no defences) and the effect of climate change if existing flood management practices were continued into the future.

In the UK the implications of climate change are assessed by the UK Climate Impacts Programme and latest government guidance on allowance for the impacts of climate change on flooding is provided in Defra guidance issued in October 2006 and reproduced in PPS 25 Annex B. Further research and updates are expected in the future.

It is imperative that allowances for climate change are based on the latest predictions and up to date guidance. PPS25 states:

“The most up-to-date guidance on climate change and flooding from the Environment Agency, Defra, Communities and Local Government and the UKCIP should be considered in the preparation of…Strategic Flood Risk Assessments…”

The user must ensure that the most recent climate change guidance is considered over an appropriate time horizon when using the SFRA to inform decision making.

**Uncertainty**

Flood risk can be assessed using a number of techniques and also to various degrees of detail. It is important to be confident that the methods used for estimation of flood risk produce results that are sufficiently certain for land use planning decisions to be based upon.

Uncertainty in flood estimation arises from the:

- Complexity of the flooding;
- Quality of the input data; and
- The uncertainty of climate change.

When using the SFRA to inform land use planning the following questions must be answered:

- Is the assessment suitable for the type of flooding and the scenarios being considered (fit for purpose)?
- Is the study appropriate for the level of detail required for the proposed land use (vulnerability)?
- Are the limitations of the method clearly understood and reported?
- Are the studies appropriately verified?
- Are the key assumptions identified and stated?
- Is the key input data justified and appropriate for the level of assessment (fit for purpose)?
- Have sensitivity analyses been carried out?
- Have all relevant uncertainties (such as climate change) been identified and appropriately addressed?

Where there is high certainty in flood estimation there may be no need for further analyses. Conversely low certainty requires more detailed assessment.

The potential impacts of climate change are an important aspect of uncertainty relevant to flood risk estimation. Government guidance suggests that the impacts of climate change can be managed by either monitoring change in risk and adapting in the future as the need arises (Managed Adaptive Approach) or acting now to manage the eventuality (Precautionary Approach).

Adopting a "Managed Adaptive Approach" to land use planning is not advised. Future adaptation to the impacts of climate change may not be technically feasible in the long-term or practical in intervening periods and the requirement to review and take action can be managed more effectively through individual planning applications rather than by WSCC within the LDF process.

Climate change information within the SFRA has been based therefore on a precautionary approach to ensure that planning led decisions are “no-regret”.

**Currency of information**

It is imperative to ensure that the latest information is used when assessing flood risk. The source and currency of the flood risk information should be checked before using any information. Management protocols are included in Volume III.

# Annex B: FRA Proforma

| |
|---|
| **1 Development description and location** |
| *1a. What type of development is proposed and where will it be located?* |
| *1b. What is its vulnerability classification?* |
| *1c. Is the proposed development consistent with the Local Development Documents?* |
| *1d. Please provide evidence that the Sequential Test or Exception Test has been applied in the selection of this site for this development type?* |
| **2. Definition of the flood hazard** |
| *2a. What sources of flooding could affect the site? (see Annex C, PPS25)* |
| *2b. For each identified source, describe how flooding would occur, with reference to any historic records wherever these are available* |
| *2c. What are the existing surface water drainage arrangements for the site?* |
| **3. Probability** |
| *3a Which flood zone is the site within?* |
| *3b If there is a Strategic Flood Risk Assessment covering this site, what does it show?* |
| *3c What is the probability of the site flooding taking account of the contents of the SFRA and of any further site-specific assessment?* |
| *3d What are the existing rates and volumes of run-off generated by the site?* |
| **4. Climate change** |
| *4a How is flood risk at the site likely to be affected by climate change?* |
| **5. Detailed development proposals** |
| *5a Please provide details of the development layout, referring to the relevant drawings* |
| *5b Where appropriate, demonstrate how land-uses most sensitive to flood damage have been placed in areas within the site that are at least risk of flooding* |
| **6. Flood risk management measures** |
| *6a. How will the site be protected from flooding, including the potential impacts of climate change, over the development's lifetime?* |
| **7. Off site impacts** |
| *7a How will you ensure that your proposed development and the measures to protect your site from flooding will not increase flood risk elsewhere?* |
| *7b How will you prevent run-off from the completed development causing an impact elsewhere?* |
| **8. Residual risks** |
| *8a What flood-related risks will remain after you have implemented the measures to protect the site from flooding?* |
| *8b How, and by whom, will these risks be managed over the lifetime of the development?* |