Defra / Environment Agency
Flood and Coastal Defence R&D Programme

# Flood Risk Assessment Guidance for New Development

## Phase 2

## Framework and Guidance for Assessing and Managing Flood Risk for New Development – Full Documentation and Tools

R&D Technical Report FD2320/TR2

Environment Agency

defra
Department for Environment Food and Rural Affairs

**Defra / Environment Agency**
**Flood and Coastal Defence R&D Programme**

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Framework and Guidance for Assessing and Managing Flood Risk for New Development – Full Documentation and Tools

R&D Technical Report FD2320/TR2

October 2005


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**Statement of use**
This report describes the framework for assessing and managing flood risk for new development and provides all of the guidance produced by this project to support this framework. Digital tools are provided on the CD-ROM that accompanies this report.

**Dissemination Status**
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| John Blanksby | Pennine Water Group – Sheffield University |

# EXECUTIVE SUMMARY

This research and development (R&D) project was carried out as part of the Joint Defra/Environment Agency (EA) R&D Programme for Flood and Coastal Defence, under the theme of Risk Evaluation and Understanding Uncertainty.

Defra and the EA identified a need for a framework that would be based on a robust risk-based approach, to assist practitioners in undertaking appropriate assessments of flood risk for new development and also enable improved decision-making, by improving transparency and accountability.

Project FD2320 has developed such a framework by simplifying existing processes, guidance and tools and integrating these with the latest findings from research projects.

In summary, the framework provides the following:

- Links between the different decision-making scales (i.e. national, regional, sub-regional, local or site-specific) and different assessment types, such as National Flood Risk Assessments (NaFRA), Catchment Flood Management Plans (CFMPs), Shoreline Management Plans (SMPs) and strategic or site-specific Flood Risk Assessments (SFRAs and FRAs respectively).
- Links to the related activities of flood risk management planning and Sustainability Appraisals.
- Directs users to the latest R&D and new or existing guidance and tools, identifying gaps in understanding of flood risk and development that will be filled by ongoing R&D projects.

At the core of the framework is a generic approach that can be applied at all decision scales. This has been based on the *Guidelines for Environmental Risk Assessment and Management* (DETR *et al.*, 2000), which is generally recognised within the UK as the best practice approach to assessing and managing environmental risk. This approach has already been adopted in the Flood and Coastal Defence Project Appraisal Guidance (FCDPAG) and refined by the Risk Assessment for Strategic Planning (RASP) methodology. Therefore, the basis of the framework is wholly consistent with current Defra and Environment Agency practices.

The guidance that accompanies the framework has been provided in two parts:

a) A set of **support guidance** to enable effective use of the framework, including:

- How to use/navigate the framework,
- How to manage the assessment processes (i.e. reporting, information management, auditing and control, stakeholder engagement and linkage to statutory requirements), and
- Key issues identified during the consultation exercises as worthy of separate guidance (i.e. climate change, risks to people behind defences, safe access and exit, brownfield development and mitigation measures).

b) A set of **decision guidance** to enable users to determine:

- What information is needed for a particular development planning scale,
- Which flood risk indicators can be used as part of the decision-making process, and
- Which types of assessment of flood risk can be used to provide the required information.

A lot of the guidance produced by this project should only be considered as interim, based on the science currently available, and should be updated or added to in the future. The framework and guidance have been designed with this in mind by being in a modular format for easy access and amendment.

At the present time, the project outputs should only be considered as R&D recommendations; they do not represent the policies of Defra, the Office of the Deputy Prime Minister or the EA. However, some of the guidance and tools are useful to support practitioners in the short-term and this is being encouraged.

The project outputs need to be tested and parallel policies and practices need developing by the relevant stakeholder groups. This was outside of the scope of the project. However, the project has provided recommendations regarding how the project outputs should be taken forward over the short and medium to long terms. These can be found in the Project Record.

This project has resulted in the following:

- An improved means of communicating risk-based approaches outside the R&D community, with particular emphasis on consistency of terminology and the use of plain English as much as possible.
- An improved understanding of the practical application of risk-based approaches within development planning.
- An improved understanding of the relationships between development planning (at all decision scales) compared to flood risk management planning (undertaken by Defra, the EA and other flood defence authorities).
- A recognition that the majority of current guidance is still applicable, if not taking full advantage of latest R&D. Where current guidance is still recommended, the outputs from this project can be used to add value by improving transparency, confidence and accountability in the decision-making processes.

This report describes the framework and provides all of the guidance and tools produced by this project. However, this report is not a conventional R&D Technical Report. To maximise usability, to enable more effective implementation and to provide a means to update and control the framework and guidance once implemented, the guidance notes and tools have been designed to be viewed digitally as separate, but linked, modules. Therefore, **a "digital version" of all guidance notes and tools is also available and it is recommended that the digital version is used on a day to day basis rather than referring to this large single volume report.** The modular versions of the guidance notes and the digital tools have been provided as part of the project deliverables on CD-ROM and are also provided on the Defra/EA R&D website. As part of a project extension, this digital version is being converted to a website.

# CONTENTS

**Appendices**

# 1. ABOUT THIS REPORT

## 1.1 Background

This research and development (R&D) project was carried out as part of the Joint Defra/Environment Agency R&D Programme for Flood and Coastal Defence, under the theme of Risk Evaluation and Understanding Uncertainty.

There are a number of R&D studies or initiatives that have been recently completed or are still in progress that cover various aspects of flood risk assessment and flood risk management. The most pertinent of these in relation to this project are described in Appendix C of this report. As these come on-line, it is becoming apparent that there is a need to bring all of the current policies, processes and science together to produce a framework for assessing flood risk for new development, covering national, regional, local and site-specific scales that can work effectively within the planning process.

## 1.2 Project Aim

The aim of this project was to provide guidance on the assessment of flood risk (and the mitigation of that risk) to assist with the regulation and planning of new developments in England and Wales.

## 1.3 Project Objectives

The immediate objectives of this project were the following:

1. To define what is an appropriate assessment of flood risk for use at all scales of development planning (from national scale planning down to individual planning applications for development sites) and all types of development;

2. To provide guidance on how to carry out SFRAs and FRAs, including selection and use of data and tools;

3. To provide guidance on how to audit FRAs and how to interpret the results from a FRA to assist with planning decisions;

4. To provide simple tools (if required) based on robust science to support the development of SFRAs and FRAs;

5. To provide guidance regarding analysis of flood risk management methods within SFRAs and FRAs;

6. To provide a plan for communicating guidance and tools effectively to users; and

7. To provide a plan for monitoring and reviewing the successful uptake of the guidance and the impact that it has on reducing inappropriate development.

The longer-term objectives and intended benefits of this work are:

- A contribution to the Government's policy of flood risk reduction:

- A consistent risk assessment approach used by the EA and planning authorities for setting planning policies and development control;

- An ability to quantify the change in risk due to new development, including climate change, and to quantify risk of both existing and proposed development (people and properties);

- A clear risk based understanding for Defra and the EA regarding what is considered to be "appropriate and inappropriate" development in flood risk areas;

- An appreciation of the tiered approach to the assessment of flood risk and implications of development plans at various scales (although to a certain extent this can only be considered as general guidance due individual circumstances);

- An understanding of integrated flood risk management requirements such as drainage planning by the development industry and regulators;

- The development of appropriate integrated approaches for flood risk limitation; and

- Input into ongoing R&D initiatives (such as RASP, PAMS, CFMPs, SMPs).

This project does not define where development should or should not take place, as flood risk is only one of the issues that have to be taken into account in planning policies and decisions and this is the responsibility of planning authorities. However, this project provides guidance to assist planning authorities and the Environment Agency in deciding what might be considered appropriate or inappropriate development from the perspective of flood risk and also provide guidance regarding the management of that risk.

### 1.4 Project Structure

The project was split into two Phases:

- Phase 1 was a scoping study and consisted of a review of current policies, processes and science; consultation with practitioners and other stakeholders (via two workshops held in March 2004); and production of a detailed scope for Phase 2. The first phase was completed in July 2004.

- Phase 2 consisted of providing the framework, guidance and tools, based on the assessed needs in Phase 1. This was completed in March 2005.

### 1.5 Project Deliverables

This report is one of five project deliverables, as listed below.

- Phase 1 Interim Report (FD2320/IR)

- Phase 2 Technical Report 1 (FD2320/TR1) – Framework and guidance for assessing and managing flood risk for new development – An overview[1]

[1] The draft TR1 was produced December 2004 and consisted of a description of the framework and flood risk indicators. This format has been superseded due to the recognition of a more appropriate format.

- Phase 2 Technical Report 2 (FD2320/TR2) – Framework and guidance for assessing and managing flood risk for new development – Full documentation and tools
- Project Record (FD2320/PR1)
- Technical Summary (FD2320/TS)

This report is not a conventional R&D Technical Report. To maximise usability, to enable more effective implementation and to provide a means to update and control the framework and guidance once implemented. The guidance notes and tools have been designed to be viewed digitally as separate, but linked, modules. This report has provided all of these in a single document, but the formatting, referencing, etc. are unchanged from the modular versions.

### 1.6 Structure of this Report

This report has four parts:

- This section "About this Report"
- **Part A – Support Guidance**
  A set of guidance to enable effective use of the framework, including:
  - How to use/navigate the framework,
  - How to manage the assessment processes (i.e. reporting, information management, auditing and control, stakeholder engagement and linkage to statutory requirements), and
  - Key issues identified during the consultation exercises as worthy of separate guidance (i.e. climate change, risks to people behind defences, safe access and exit, brownfield development and mitigation measures).
- **Part B – Decision Guidance**
  A set of guidance to enable users to determine:
  - What information is needed for a particular development planning scale,
  - Which flood risk indicators can be used as part of the decision-making process, and
  - Which types of assessment of flood risk can be used to provide the required information.
- **Appendices**
  The tools produced as part of this project and that accompany the guidance:
  - Activity Chart (printout of overview only)
  - Information Chart (printout of Excel worksheets)
  - Flood Risk Indicator Tables
  - Flood Risk to People Calculator
  - Assessment Check-List

# PART A – SUPPORT GUIDANCE

## 2. S1.1 INTRODUCTION TO THE FRAMEWORK FOR ASSESSING AND MANAGING FLOOD RISK FOR NEW DEVELOPMENT

### 2.1 Contents



### 2.2 Purpose of the Framework

The purpose of the framework is to link the three main aspects of flood risk assessment and management for new developments, as illustrated in Figure 2.1.

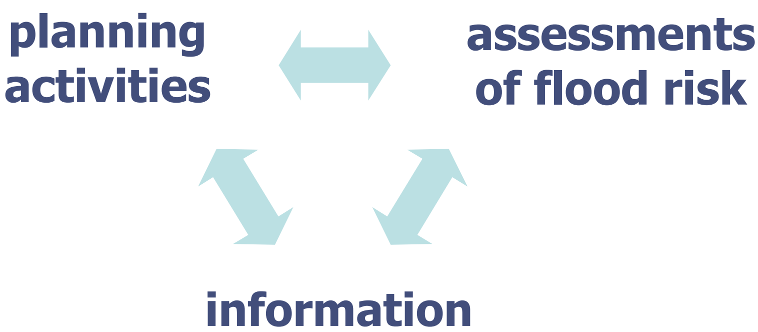


**Figure 2.1 Aspects of the framework**

The framework provides the context for and the links between the following:

- Decision scales for new development, these being:
  - National,
  - Regional,
  - Sub-regional,
  - Local, and
  - Site-specific

- Types of assessment of flood risk, these being:
  - National Flood Risk Assessments (NaFRA),
  - Catchment Flood Management Plans (CFMPs),
  - Shoreline Management Plans (SMPs),
  - Strategic Flood Risk Assessments (SFRAs), and
  - Site-specific Flood Risk Assessments (FRAs).

- Related activities of flood management planning and Sustainability Appraisals.

The framework directs users to the following:

- The latest research and development,
- New or existing guidance, and
- New or existing tools.

The framework also identifies gaps that will be filled by ongoing R&D projects.

## 2.3 Basis of the Framework

The information management method that has been adopted to develop the framework is known as the Business Elements Method, developed at the London School of Economics, in conjuncture with HR Wallingford. This method is able to encompass all aspects of the work, including supply chains, roles and responsibilities, monitoring and control procedures, as well as data handling and assessment methods. The method incorporates sound tools and techniques that have been successfully applied in many settings. [2]

At the core of the framework is a Generic Approach that can be applied at all decision scales. This has been based on the DETR report *Guidelines for Environmental Risk Assessment and Management*[3], which is generally recognised within the UK as the best practice approach to assessing and managing environmental risk. This approach has already been adopted in the Flood and Coastal Defence Project Appraisal Guidance (FCDPAG)[4] and refined by the Risk Assessment for Strategic Planning (RASP) methodology.[5] Therefore, the basis of the framework is wholly consistent with current Defra and Environment Agency practices.

The Generic Approach is also consistent with the HM Treasury Principles of Managing Risks to the Public.[6]

## 2.4 Structure of the Framework

The framework has five parts:

- The Generic Approach
- Activity Chart
- Guidance Documents (Decision Guidance and Support Guidance)
- Information Chart
- Tools

The relationships between these parts are illustrated in the Figure 2.2. A full list of the framework elements can be found in the Information Chart.

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[2] Millard, K, and Sayers, P (2000) *Maximising the use and exchange of coastal data - a guide to best practice*, CIRIA, London.
[3] DETR (2000) *Guidelines for Environmental Risk Assessment and Management, 2nd edition*, The Stationary Office, London, Institute of Environmental Health.
http://www.defra.gov.uk/environment/risk/eramguide/index.htm
[4] See Figure 1.1 in MAFF (2000) *Flood and Coastal Defence Project Appraisal Guidance, Approaches to Risk (FCDPAG4),* MAFF. http://www.defra.gov.uk/environ/fcd/pubs/pagn/fcdpag4.pdf
[5] Sayers, P, Gouldby, B, Simm J, Meadowcroft, I, Hall, J (2002) *Risk, Performance and Uncertainty in Flood and Coastal Defence – A Review,* Defra/EA R&D Technical Report FD2302/TR1.
[6] http://www.hm-treasury.gov.uk/media/C87/A1/risk_principles_180903.pdf

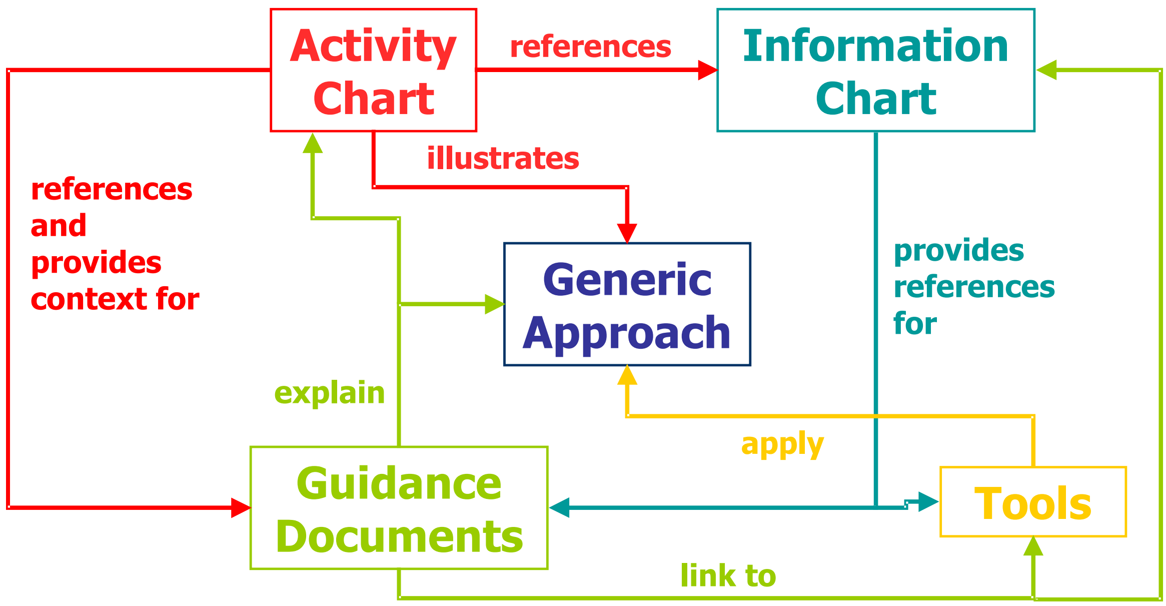



**Figure 2.2 Relationships between framework parts**

## 2.5 Generic Approach

The Generic Approach can be applied at all decision-making and assessment scales either by those undertaking the decision-making or those undertaking the assessments.

A single approach is required, because the decision-making and assessment processes are iterative. It is important for assessments to be designed to suit the decision-making needs.

The Generic Approach enables:

- Those undertaking assessments to determine how to carry out an appropriate assessment,
- Those reviewing assessments to determine whether the assessment has been carried out appropriately,
- Those undertaking the decision-making to use the results of the assessment appropriately, and
- Those reviewing the decision-making to determine whether the decision-makers have used the results of the assessment appropriately.

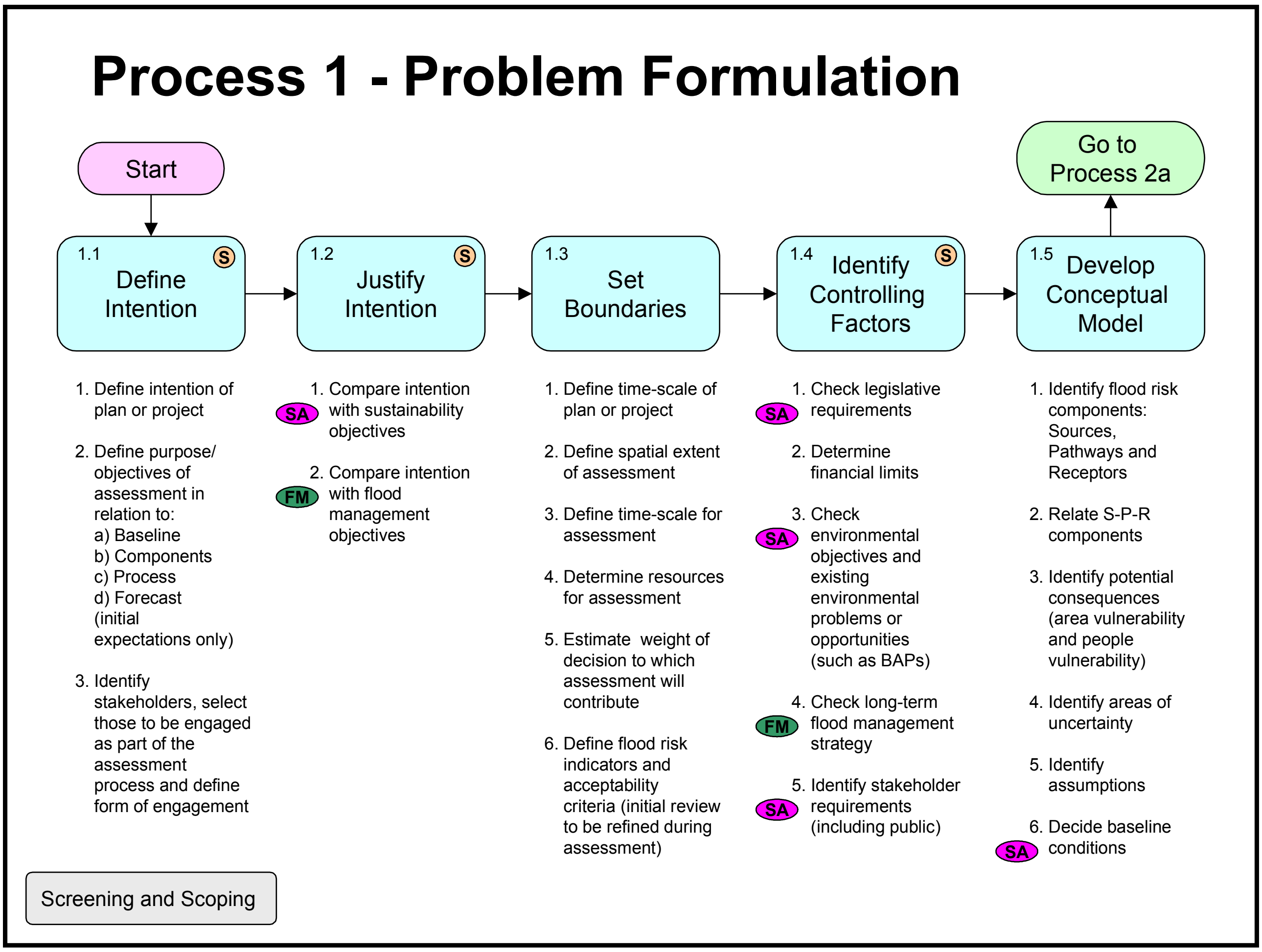
This approach has been developed into a series of simple, user-friendly processes, which can be applied to any type of assessment of flood risk. There are 5 processes, as listed below.

- Process 1 – Problem Formulation
- Process 2a – Tiered Risk Assessment
- Process 2b – Stages of Risk Assessment
- Process 3 – Options Appraisal
- Process 4 – Monitoring and Review

These processes have been drawn up into a series of flow-charts, which are included in this guidance note.

It should be noted that not all elements of the Generic Approach need to be undertaken in detail depending on the type of assessment being undertaken (i.e. NaFRA, CFMP, SMP, SFRA or FRA) and the level of detail (i.e. coarse, intermediate or detailed). The Decision Guidance provides further details of how to interpret the Generic Approach in different circumstances.

### 2.5.1 Process 1 – Problem Formulation




Whether undertaking a decision-making exercise based on the results of an assessment of flood risk or undertaking the assessment itself, it is necessary to understand what you are trying to achieve and the boundaries that you must work within.

As stated in the DETR report *Guidelines for Environmental Risk Assessment and Management*,[7] "it is often tempting to omit any formal documented definition of the problem, particularly where there is pressure to complete the risk assessment quickly. However, failure to define the problem clearly is to lose the focus of the assessment itself, and may even result in an inappropriate output."

Benefits of undertaking this process include:

- Identification of flood risk management objectives and sustainability objectives, which enables more holistic decision-making to be undertaken and, in turn, should result in better 'value for money' solutions.
- Early buy-in from stakeholders, which reduces the likelihood of delays at later stages.
- Recognition that assessments are undertaken with limited time and budget, but by careful planning and an appropriately focused assessment, robust decisions can still be undertaken.

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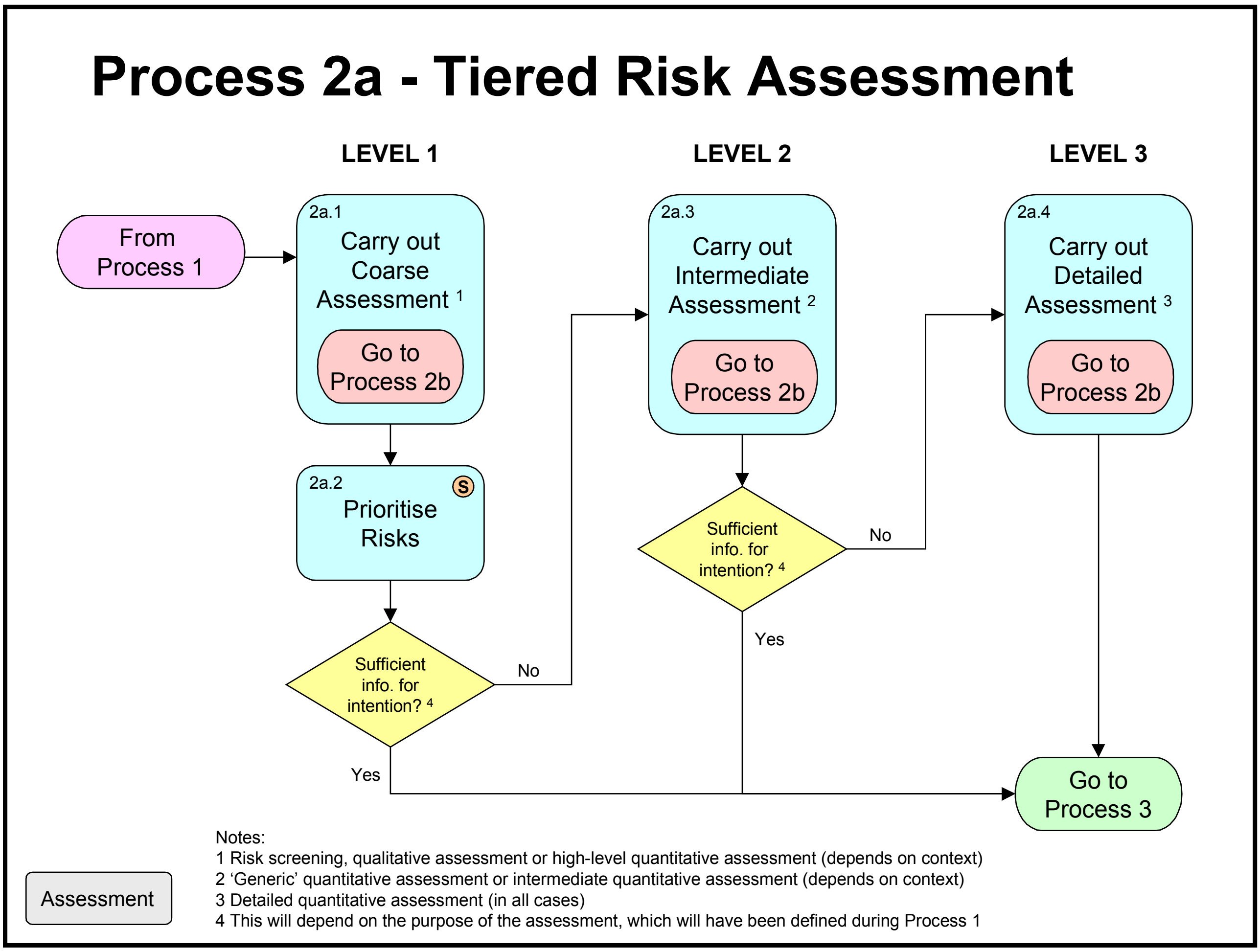
[7] DETR (2000) *Guidelines for Environmental Risk Assessment and Management*, 2nd edition, The Stationary Office, London, Institute of Environmental Health.

### 2.5.2 Process 2a – Tiered Risk Assessment




The purpose of undertaking a tiered approach is to allow proportionate effort to be applied, based on a number of factors including the following:

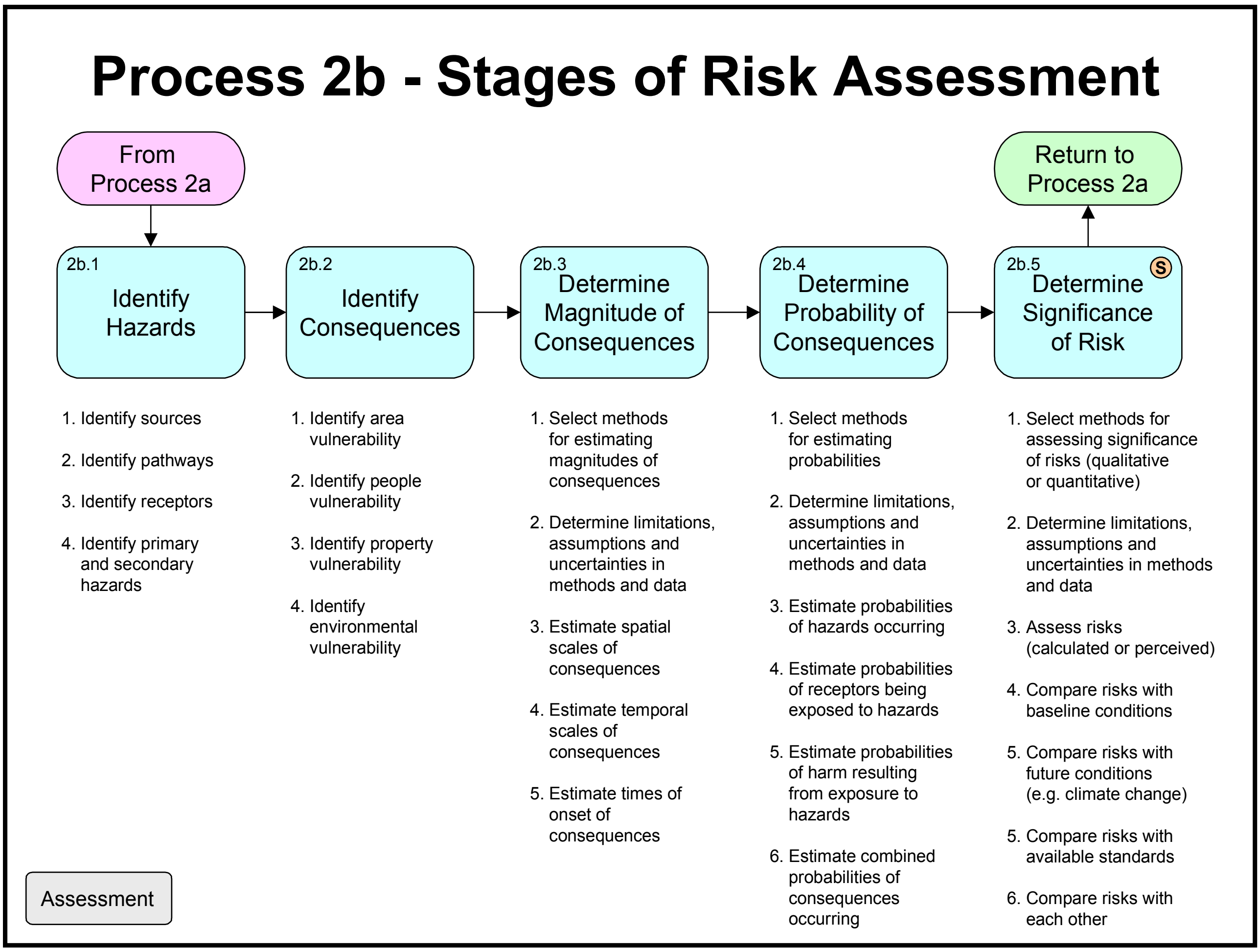
- Decision-making requirements,
- Scale of the risk,
- Degree of uncertainty,
- Scale of the development, and
- Unique characteristics of the site.

All assessments undertake a coarse assessment (Level 1). The baseline conditions used to decide whether to proceed to the next level of detail are determined during Process 1 – Problem Formulation, although these may need refining as understanding of the risks associated with a development improves.

This process is fully compatible with the new CIRIA guidance C624 *Development and flood risk – guidance for the construction industry*.[8]

[8] Lancaster, J, Preene, M and Marshall, C (2004) C624 *Development and Flood Risk – Guidance for the Construction Industry,* CIRIA, London.

### 2.5.3 Process 2b – Stages of Risk Assessment



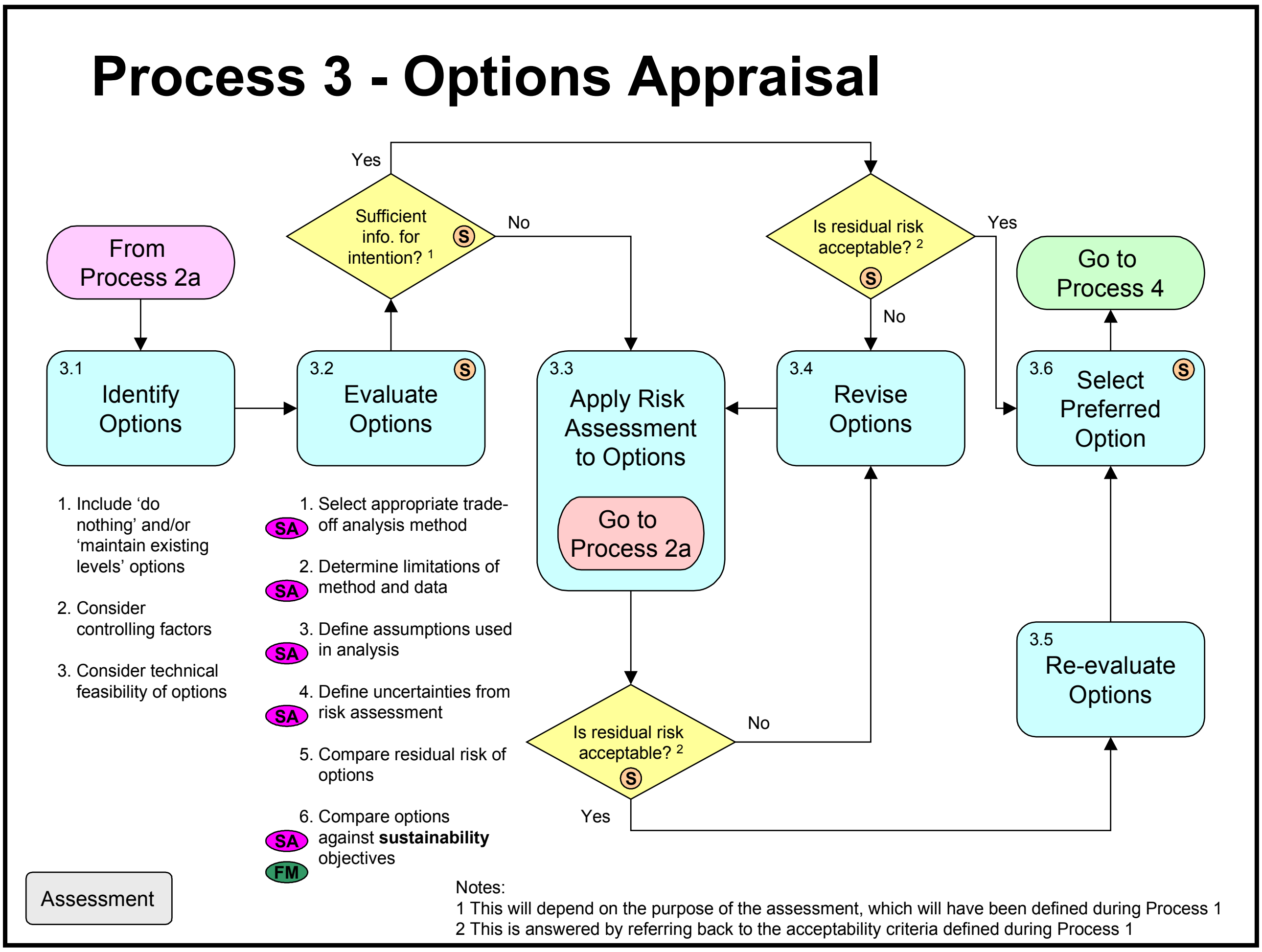

These stages are undertaken for each level of the tiered risk assessment. However, the complexity of approach increases for Levels 2 and 3, in order to reduce the degree of uncertainty.

For a coarse assessment (Level 1) the analysis will tend to be based on existing information and a qualitative assessment of some of the risk components. However, depending on circumstances, a quantitative analysis can sometimes be undertaken, but the degree of uncertainty in either the input data or results is usually high.

For an intermediate assessment (Level 2) the analysis usually becomes more quantitative, but still with a moderate degree of uncertainty in either the input data or results. The prioritisation process (see the flow diagram for Process 2a – Tiered Risk Assessment) may result in only some of the flood risks being considered with this or the next level of detail.

A detailed assessment nearly always involves detailed quantitative analysis, with the intention of reducing the degree of uncertainty as much as possible.

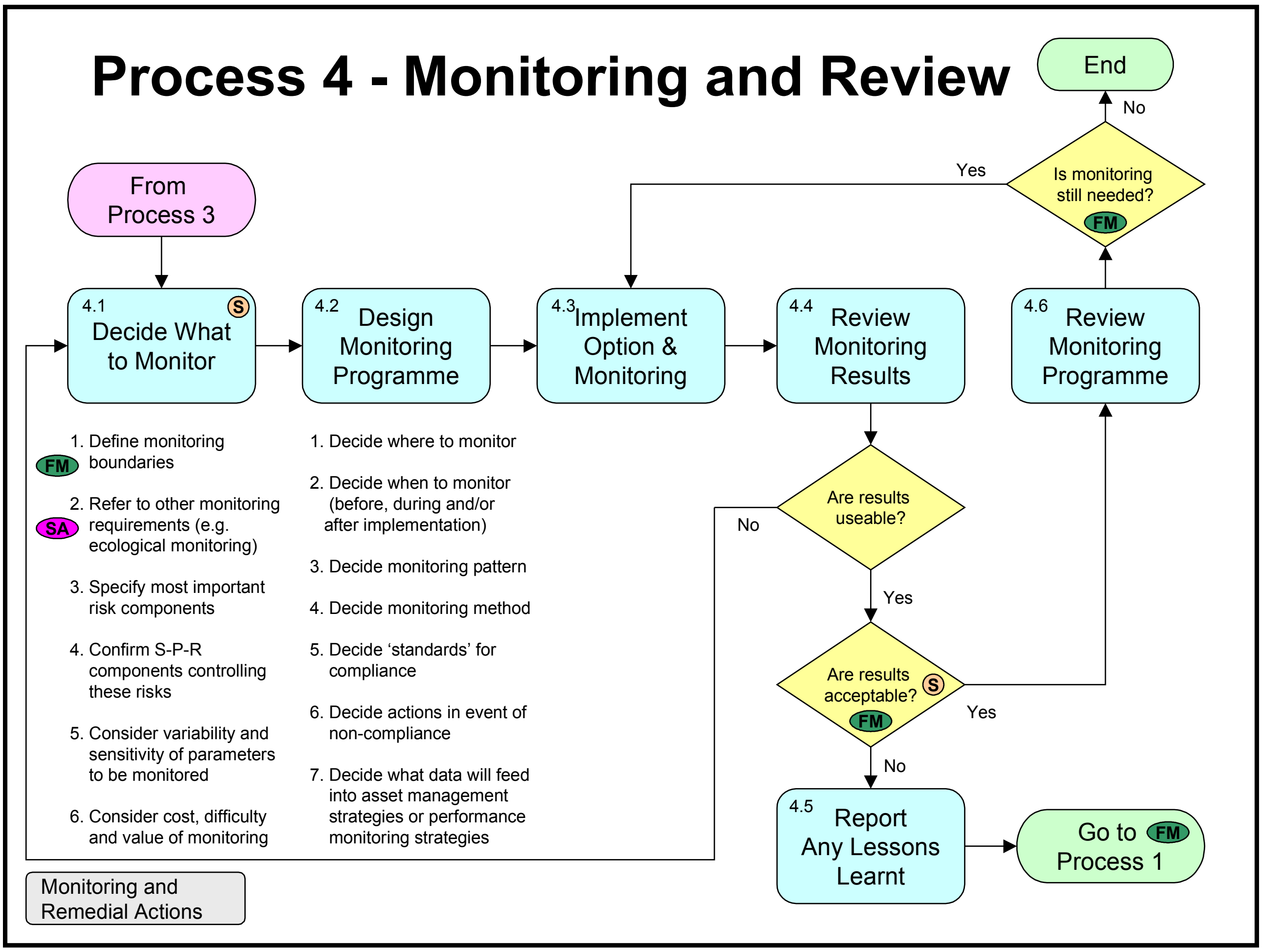
### 2.5.4 Process 3 – Options Appraisal




Whichever level of assessment of flood risk is required, all development planning activities will require an Options Appraisal stage. This is an appraisal of development options, taking all planning issues into account (not just those associated with flood risk) including sustainability objectives. All spatial planning should promote sustainable development and the evaluation of options should be accompanied by a Sustainability Appraisal.

A review of residual risk is required as part of this process and appropriate mitigation measures need to be considered. It is sometimes necessary to undertake an iterative approach to reviewing the residual risk to understand the trade-off between these means of mitigation versus alternative spatial planning decisions.

#### 2.5.5 Process 4 – Monitoring and Review




The monitoring and review process is an integral part of flood risk management and key for determining and ensuring sustainable development. This process is vital to ensure successful transfer of responsibilities between different functions within organisations, for example, from planning authority to operating authority.

At the present time, perhaps this process is more aspirational than current practice, but should be encouraged as part of a best-practice approach. Based on Defra's consultation exercise[9], it is clear that there is a need for greater integration between flood risk management of new developments and existing development and this process provides a link between the two. (This is currently being considered as part of several ongoing R&D projects, including WaND, AUDACIOUS and the Flood Risk Management Research Consortium, details of which are provided in the Information Chart.)

[9] Defra (2004) *Making Space for Water - Developing a new Government strategy for flood and coastal erosion risk management in England*, Defra. http://www.defra.gov.uk/corporate/consult/waterspace/index.htm

## 2.6 Activity Chart

The Activity Chart encapsulates on a single sheet the principles of the framework and the guidance that supports it. If used in conjunction with the Information Chart, it enables the user to access all parts of the framework quickly and easily. (If you have access to the website produced as part of the project extension, then this can be used instead of the Activity Chart.)

The Activity Chart is split into 4 parts:

- The **Generic Approach** (as described above) in the form of a series of flow diagrams;

- Illustrations of **how assessments of flood risk are used**, in the form of models of the development planning process, flood management process and sustainability assessment process (within development planning) showing where assessments of flood risk should be used;

- A set of **Decision Guidance** documents to enable stakeholders to determine:
  - What information is needed for a particular development planning scale (i.e. what is an appropriate assessment of flood risk),
  - Which flood risk indicators can be used as part of the decision-making process, and
  - Which types of assessment of flood risk can be used to provide the required information (either existing or new).

- A set of **Support Guidance** documents to enable effective use of the framework.

The Activity Chart is self-explanatory, if symbols are checked against the keys. Further guidance is provided in Guidance Note S1.2 How to use the Activity Chart.

## 2.7 Using Assessments

It should be noted that the purpose of this project is to look at the development planning process. However, it is important to identify the links between this process and other processes, to provide clarification regarding the existing and potential application of assessments across stakeholders in development planning and flood risk management. These links have been identified on an initial basis, but could be explored further as part of a follow-on project.

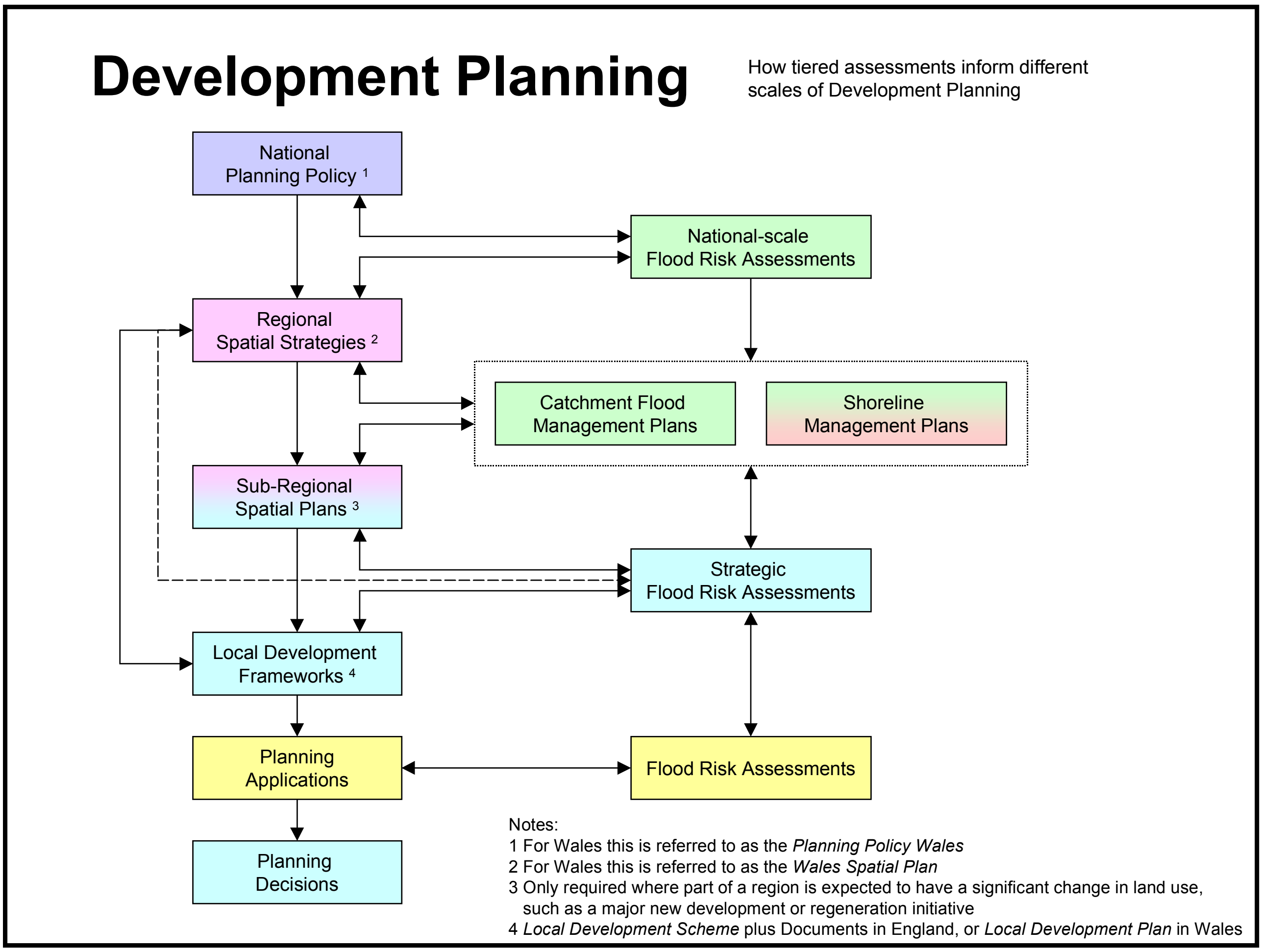
Three different diagrams are provided on the Activity Chart:

- Development Planning
- Flood Management Planning
- Sustainability Appraisals

A key of "lead responsibilities" has been provided on the Activity Chart, which gives a colour for each of the main organisations responsible for the activities shown on the diagrams. However, it should be remembered that other stakeholders are involved in these activities.

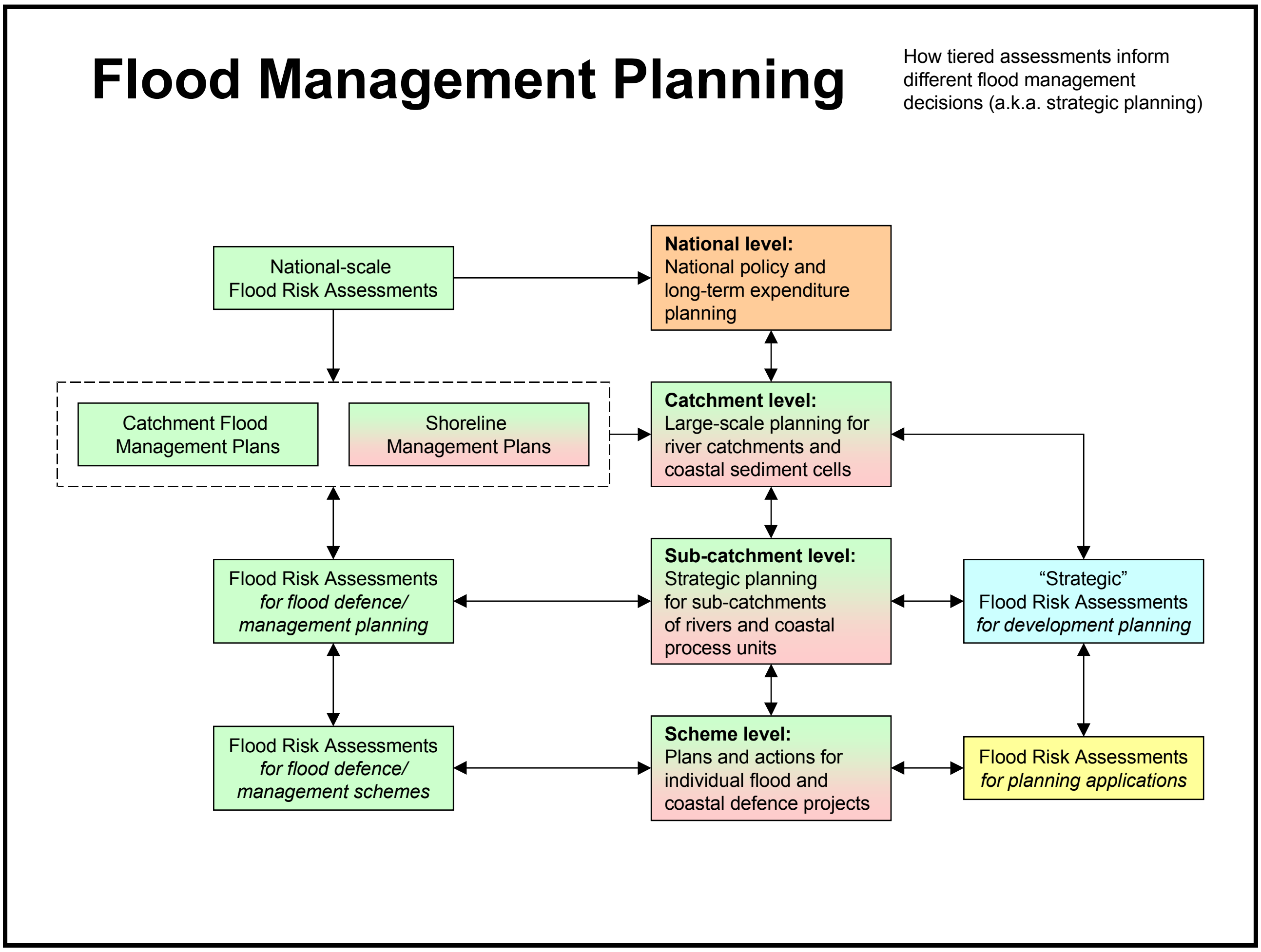
### 2.7.1 Development Planning

The primary purpose of SFRAs and FRAs is to inform the development planning process. Hence, these are the responsibility of the LPAs and Developers respectively. NaFRAs, CFMPs and SMPs can also inform the development planning process, but are undertaken by the EA and flood defence authorities and are primarily intended to inform the flood management planning process.



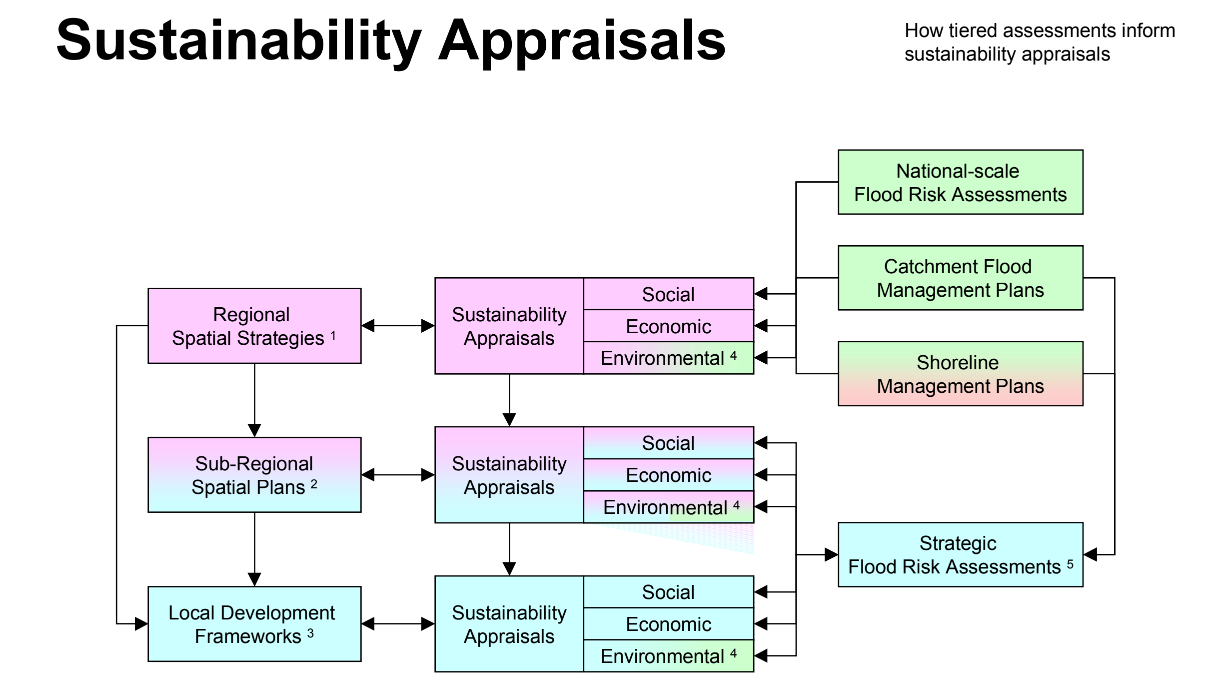
### 2.7.2 Flood Management Planning

This diagram shows the primary purpose of the EA's assessments of flood risk: this being to inform their own strategic planning for flood risk management. However, links between this process and the development planning process should be encouraged to ensure holistic decision-making.



### 2.7.3 Sustainability Appraisals

There is a mandatory requirement for Regional Spatial Strategies and Local Development Frameworks to include a Sustainability Appraisal.[10] Again, assessments of flood risk can inform this process and, as with development planning and flood management planning, it has to be an iterative process should the outcome not be considered acceptable.




Notes:
1 For Wales this takes the form of the *Wales Spatial Plan*
2 Not always required, depends on circumstances
3 *Local Development Scheme* plus Documents in England, or *Local Development Plan* in Wales
4 The EA contributes to and reviews the environmental aspects, and checks that they are assessed in sufficient detail to meet with the SEA Directive
5 At the SFRA level the process is iterative, whilst at the higher levels it tends to be one-way

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[10] ODPM (2003) *The Strategic Environmental Assessment Directive: Guidance for Planning Authorities*, HMSO, London. http://www.odpm.gov.uk/index.asp?id=1143289

## 2.8 Decision Guidance

There are 3 parts to the decision guidance. These are:

- **What's needed for development planning? -** which contains 4 guidance notes regarding what is an appropriate assessment of flood risk to enable development planning to be carried out effectively (at all scales of decision-making). Guidance is given from the context of the planning needs and expands on the information already provided in PPG25[11] and TAN15.[12]

- **Which indicators can be used? -** which directs the user to a guidance note and associated tools that enable the selection of suitable flood risk indicators for the planning needs.

- **Which type of assessment can be used?** – which contains 5 guidance notes for the 5 main types of assessment. These notes describe the specific approach for each assessment type, based on the Generic Approach.

References to ongoing R&D are provided via the Information Chart and cross-references to support guidance for the framework are also provided.

Each guidance note has been given a unique reference, so that, if accessing these digitally, these can be found easily either via the Activity Chart or directly.

The intention is for these guidance notes to be updated individually as the need arises (either due to legislative changes, organisational changes or new science). They are not long or complex, but provide context, key information and relevant cross-references to larger documents for further details, should the reader wish to refer to them.

On the Activity Chart a key is provided of "lead responsibilities", which gives a colour for each of the main organisations responsible for the activities described in the guidance notes provided. However, other stakeholders should still refer to these guidance notes. Further details of stakeholders are provided within the guidance notes under Roles and Responsibilities.

## 2.9 Support Guidance

These guidance notes cover the main support activities required to implement the framework effectively.

There are 3 parts to the support guidance. These are:

- **How to navigate the framework**, which is helpful if using the framework for the first time and contains 4 guidance notes.

- **How to manage the assessment processes**, which provides 5 guidance notes covering the main support activities required to implement the framework effectively.

- **Key issues**, which provides additional guidance of the five most pressing technical issues as identified by the consultation process undertaken at the start of this project.

References to ongoing R&D are provided via the Information Chart and cross-references to decision guidance for the framework are also provided.

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[11] DTLR (2001) *Planning Policy Guidance Note 25: Development and Flood Risk*, HMSO, London. http://www.odpm.gov.uk/index.asp?id=1144113

[12] National Assembly for Wales (2004) *Technical Advice Note 15: Development and Flood Risk*, National Assembly for Wales, Cardiff. http://www.wales.gov.uk/subiplanning/content/tans/tan15/

Again, the intention is for these guidance notes to be updated individually as the need arises (either due to legislative changes, organisational changes or new science). They are not long or complex, but provide context, key information and relevant cross-references to larger documents for further details, should the reader wish to refer to them.

Each guidance note has been given a unique reference, so that, if accessing these digitally, these can be found easily either via the Activity Chart or directly.

## 2.10 Tools

Three tools have been produced by the project to assist users of the guidance. These are in addition to the Activity Chart and Information Chart that are also "tools" of the framework. These are:

- Flood Risk Indicator Tables
- Flood Risks to People Calculator
- Assessment Check-List

These are referred to and cross-referenced in relevant guidance notes and can also be accessed directly via the Activity Chart.

## 2.11 Information Chart

An Information Chart has been developed in parallel to the Activity Chart. The purposes of the Information Chart are:

- To provide links to all of the guidance documents and tools provided with the framework, and
- To provide links to the information referred to in the guidance documents and tools.

If used in conjunction with the Activity Chart, it enables the user to access all parts of the framework quickly and easily.

The chart has been developed in such a way that it could be converted into a web-based tool (in conjunction with the Activity Chart) that will enable the full guidance documents and information to be accessible directly. This has been undertaken as part of a project extension.

The Information Chart is in the form of an Excel spreadsheet with 5 worksheets:

- Framework Contents
- References
- Research & Initiatives
- Statutes & Regulations
- EA Guidance

The content of each is described in the following sections.

### 2.11.1 Framework Contents

This worksheet contains a list of the contents of the framework, which can be opened via hyperlinks.

### 2.11.2 References

This worksheet contains published or soon to be published documents referred to in the guidance notes. If the document is available on the internet, the hyperlink to the appropriate web-site or the document itself is also provided.

### 2.11.3 Research & Initiatives

This worksheet contains a list of research projects or initiatives relevant to assessment and management of flood risk for new development. This list is not exhaustive and should not be considered as such, but it is intended to cover the most prominent work that is currently underway or has been completed recently. Hyperlinks to websites for further information are provided where available. In some cases, the final documents may have been produced and might be included under References as well.

Each project or initiative has been reviewed and referenced with respect to Technical Themes and Sources-Pathways-Receptors-Consequences. Therefore, it is possible at a quick glance to determine which projects/initiatives might be of relevance to a particular user. Project descriptions are available in the Project Record for project FD2320, FD2320/PR1.

### 2.11.4 Statutes & Regulations

This worksheet contains a list in reverse chronological order of all Directives, Acts, Regulations, Orders and Bylaws referred to either directly in the guidance and tools of this framework or in the references provided.

This should not be treated as a definitive list of all statutory requirements that need to be taken into consideration when assessing and managing flood risk for new development. The responsibility for determining the relevant statutory requirements remains with the bodies carrying out the assessments and managing the flood risk.

Hyperlinks to websites are provided where available. Additional comments are provided in a few cases.

### 2.11.5 EA Guidance

A substantial number of guidance documents either in use or in development at the Environment Agency have been provided for reference in this framework.

The information contained in each guidance document has been summarised into the 5 principles of information management, namely:

- Information and Data
- Roles and Responsibilities
- Processes and Procedures
- Tools and Technology
- Audit and Control

A brief description of what is provided under each heading is given, along with additional comments.

Each guidance document has been reviewed to determine whether any science/engineering specifications are provided, whether these figures need reviewing and whether any other statements should be reviewed.

Each guidance document has been reviewed with respect to Sources-Pathways-Receptors-Consequences. Therefore, it is possible at a quick glance to determine which guidance might be of relevance to a particular aspect of risk.

# 3. S1.2 HOW TO USE THE ACTIVITY CHART

## 3.1 Purpose

The purpose of the Activity Chart is to encapsulate on a single sheet the principles of the framework and the guidance and tools that support it. If used in conjunction with the Information Chart, it enables the user to access all parts of the framework and additional reference material quickly and easily.

If you have access to the website produced as part of the project extension, then this can be used instead of the Activity Chart.

## 3.2 Quick Start

The Activity Chart is best viewed as a digital PowerPoint Slide Show. This enables the user to utilise the hyperlinks between pages of the PowerPoint file and to the guidance notes and tools of the framework.

When navigating around the PowerPoint Slide Show, it is possible to use the “Home” or “Chart” buttons to return to the Home Page or the main Activity Chart, respectively.

If a hyperlink has opened a Word or Excel file, by activating the “Web” toolbar and using the Back button (usually a blue arrow pointing left or a green circle with a white arrow pointing left), it is possible to navigate throughout the framework, guidance and tools.

It takes a bit of practice, if you are not familiar with these actions. This tool is only intended as a means to demonstrate the potential for the framework, guidance and tools to be transformed into a web-based tool. This is beyond the scope of the R&D project, but one of the recommendations from the project.

If you experience problems, there is an alternative way to link to the guidance notes and tools, which is by opening the Information Chart and using the Framework Contents. If all else fails, each file can be opened as a normal Word or Excel file.

Both the Activity Chart and Information Chart hyperlinks only work if you have all of the guidance notes and tools saved in the appropriate sub-directories accompanying the charts.

The Activity Chart is intended to be self-explanatory, if symbols are checked against the keys. Therefore, it is not essential to read the following sections. However, if you are not familiar with the assessment process, it is advisable to read on.

## 3.3 The Overall Format

When first opening the Activity Chart, you will find a “Home Page”. This is intended to introduce first-time users to both the Activity Chart and the Information Chart, as these are most useful when used together.

The Activity Chart itself can be found on the second page or by using the hyperlink on the Home Page.

The Activity Chart is split into 4 parts as shown in Figure 3.1. All parts inter-relate and where you might wish to start will depend on your needs. However, the Generic Approach is the core of the framework and all of the guidance and tools refer to this.

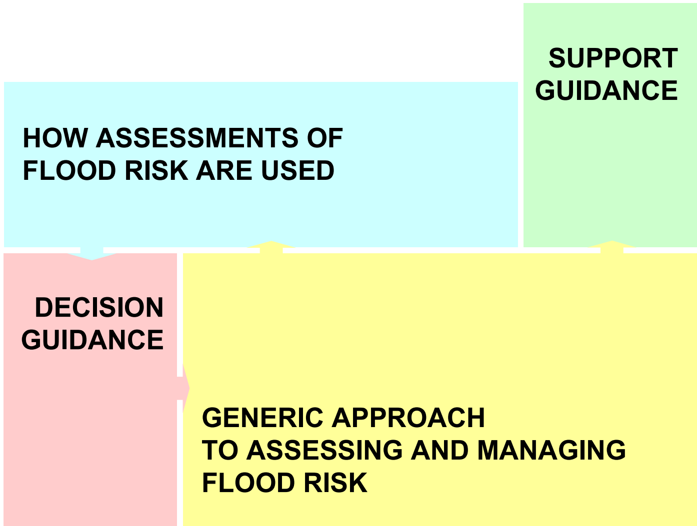


**Figure 3.1 Layout of Activity Chart**

## 3.4 How Assessments of Flood Risk are Used

Three different diagrams are provided:

- Development Planning
- Flood Management Planning
- Sustainability Appraisals

This framework is primarily interested in Development Planning, but as we are also looking at the application of different types of assessment of flood risk, it is useful to understand the relevance of these assessments in other contexts.[13]

If the boxes on these diagrams are selected on the digital version of the Activity Chart, a hyperlink will take the user to the appropriate guidance note.

A key of lead responsibilities has also been provided, which gives a colour for each of the main organisation responsible for the activities shown on the diagrams.

## 3.5 Generic Approach

The generic approach is based on the DETR report *Guidelines for Environmental Risk Assessment and Management*[14] (also known as Green Leaves 2), translated into a flowchart. The different elements of the process boxes are shown in Figures 3.2 and 3.3 of this guidance note.

There are 5 processes, each with its own box on the Activity Chart:

- Process 1 – Problem Formulation
- Process 2a – Tiered Risk Assessment

[13] Further details can be found in Guidance Note S1.1 Introduction to the Framework
[14] DETR (2000) *Guidelines for Environmental Risk Assessment and Management, 2nd edition*, The Stationary Office, London, Institute of Environmental Health.

- Process 2b – Stages of Risk Assessment
- Process 3 – Options Appraisal
- Process 4 – Monitoring and Review

Each process has been subdivided into **process parts**, these being the key activities that make up the process. Sometimes (but not always) a breakdown is provided of the tasks or issues that should be considered during a process part. These have been called **process tasks**.

Each process part has been given a unique reference, e.g. 1.1, which enables cross-referencing to an Assessment Check-list that has also been provided.[15]

An additional grey box in the left-hand corner of each process box indicates to which part of the Strategic Environmental Assessment (SEA) process these activities would usefully contribute.[16]

A letter S in an orange circle has also been used to indicate where it is recommended to have stakeholder involvement.[17]

Green and magenta symbols have also been given to some of the process tasks to identify links or parallel processes within Flood Management Planning or Sustainability Appraisals[18] respectively.

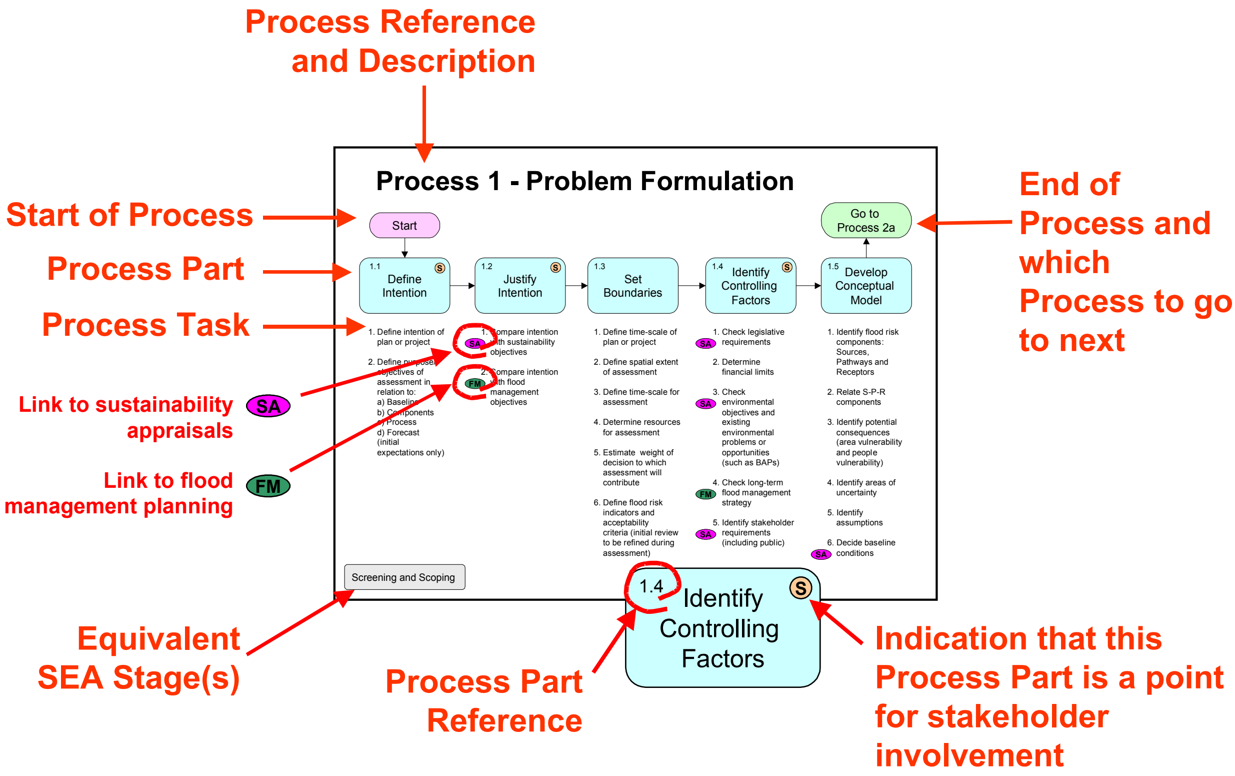


**Figure 3.2 – Example 1 of process box**

[15] see Guidance Note S2.3 Auditing and Control
[16] See Guidance Note S2.5 Linkage to Statutory Requirements for further information about the SEA process
[17] See Guidance Note S2.4 Stakeholder Engagement for further information
[18] See Guidance Note S2.5 Linkage to Statutory Requirements for further information about Sustainability Appraisals

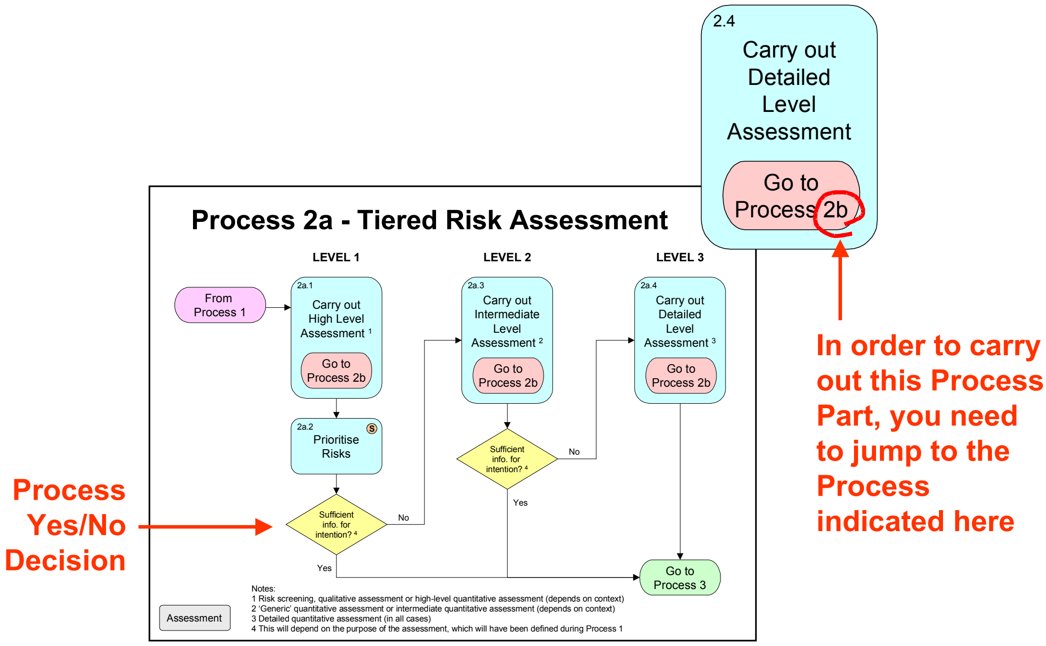


**Figure 3.3 – Example 2 of process box**

## 3.6 Decision Guidance

There are 4 boxes provided under decision guidance.  These are:

- **Key of lead responsibilities**, which gives a colour for each of the main organisation responsible for the activities described in the guidance notes provided.

- **What's needed for Development Planning?** which shows that there are 4 guidance notes summarising the needs within the planning process for the assessment and management of flood risk. If the coloured boxes are selected on the digital version of the Activity Chart, a hyperlink will take the user to the appropriate guidance note.

- **Which indicators can be used?** which directs the user to a guidance note and tools that enable the selection of suitable flood risk indicators for the planning needs.  If the coloured box is selected on the digital version of the Activity Chart, a hyperlink will take the user to the guidance note.  If the tables are selected, the user will go directly to the Excel tables of flood risk indicators.  If the calculator user note is selected, the user will go to a second guidance note.  If the calculator is selected, the user will go directly to the excel spreadsheet.

- **Which type of assessment can be used?** which shows that there are 5 guidance notes summarising the 5 main types of assessment used for determining flood risk and flood management requirements. If the coloured boxes are selected on the digital version of the Activity Chart, a hyperlink will take the user to the appropriate guidance note.

A brief summary of the contents of each guidance note is provided on the Activity Chart, which can be reviewed before deciding whether or not to access and read the full note.

Each guidance note has been given a unique reference, so that these can be found and accessed easily either via the Activity Chart or directly from within the directory structure.

### 3.7 Support Guidance

There are 3 boxes within Support Information. These are:

- **How to navigate the framework**, which should be referred to if using the framework for the first time and contains 4 guidance notes (including this one).

- **How to manage the assessment processes**, which shows that there are 5 guidance notes covering the main support activities required to implement the framework effectively.

- **Key issues**, which provides additional guidance of the five most pressing technical issues as identified by the consultation process

Again, each guidance note has been given a unique reference, so that these can be found and accessed easily via the Activity Chart or directly from within the directory structure.

If the coloured boxes are selected on the digital version of the Activity Chart, a hyperlink will take the user to the appropriate guidance note.

# 4. S1.3 HOW TO USE THE INFORMATION CHART

## 4.1 Purpose

The purposes of the Information Chart are:

- To provide links to all of the guidance documents and tools provided with the framework
- To provide links to the information referred to in the guidance documents and tools

If used in conjunction with the Activity Chart, it enables the user to access all parts of the framework quickly and easily.

If you have access to the website produced as part of the project extension, then this can be used instead of the Information Chart.

## 4.2 Summary of Format

The information is in the following Excel worksheets:

- Framework Contents
- References
- Research & Initiatives
- Statutes & Regulations
- EA Guidance

## 4.3 Framework Contents

This worksheet contains a list of the contents of the framework, which can be opened via hyperlinks.

## 4.4 References

This worksheet contains published or soon to be published documents referred to in the guidance notes. If the document is available on the internet, the hyperlink to the site or the document itself is also provided.

## 4.5 Research & Initiatives

This worksheet contains a list of research projects or initiatives the have a relevance to FD2320. This list is not exhaustive and should not be considered as such, but it is intended to cover the most prominent work that is currently underway or has been completed relatively recently. Hyperlinks to websites for further information are provided where available. In some cases, the final documents may have been produced and might be included under References as well.

Each project or initiative has been reviewed with respect to Technical Themes and Sources-Pathways-Receptors-Consequences. Therefore, it is possible at a quick glance to determine which projects/initiatives might be of relevance to a particular user. Project descriptions are provided in the Project Record for FD2320, report FD2320/PR1.

## 4.6 Statutes & Regulations

This worksheet contains a list in reverse chronological order of all Directives, Acts, Regulations, Orders and Bylaws referred to either directly in the guidance and tools of this framework or in the references provided.

This should not be treated as a definitive list of all statutory requirements that need to be taken into consideration when assessing and managing flood risk for new development. The responsibility for determining the relevant statutory requirements remains with the bodies carrying out the assessments and managing the flood risk.

Hyperlinks to websites are provided where available. Additional comments are provided in a few cases.

## 4.7 EA Guidance

A substantial number of guidance documents either in use or in development at the Environment Agency have been provided for reference in this project.

The information contained in each guidance document has been summarised into the 5 principles of information management, namely:

- Information and Data
- Roles and Responsibilities
- Processes and Procedures
- Tools and Technology
- Audit and Control

A brief description of what is provided under each heading is given, along with additional comments.

Each guidance document has been reviewed to determine whether any science/engineering specifications are provided and whether these figures need reviewing and whether any other statements should be reviewed.

Each guidance document has also been reviewed with respect to Sources-Pathways-Receptors-Consequences. Therefore, it is possible at a quick glance to determine which guidance might be of relevance to a particular user dealing with a particular aspect of risk.

Cross-references to the other worksheets are provided in brackets, based on a colour coding system. The colours are as follows:

- References are blue,
- Research projects and initiatives are red,
- Statutes and regulations are yellow, and
- Other EA guidance is green.

# 5. S1.4 GLOSSARY AND ABBREVIATIONS

## 5.1 Glossary of Terms

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|---|---|
| **Adoption of Sewers** | The transfer of responsibility for the maintenance of sewers to a sewerage undertaker. |
| **Afflux** | Increase in upstream flood level caused by an obstruction to flow in a watercourse or on a floodplain. |
| **Aims** | The objective of groups/individuals/organisations involved with a proposal. The aims are taken to include ethical and aesthetic considerations. |
| **Annual probability** | The estimated probability of a flood of given magnitude occurring or being exceeded in any year. Expressed as, for example, 1 in 100 chance or 1%. |
| **Annual average frequency** | Expected number of occurrences per year (1/return period). This measure is often used in economic analysis of flood defence schemes, where the expected average annual damage is used as a performance measure. |
| **Antecedent conditions** | The condition of a catchment area at the start of a rainfall event. |
| **Appraisal** | The process of defining objectives, examining options and weighing up the costs, benefits, risks and uncertainties before a decision is made. |
| **Appraisal life** | The period of time over which a return on investment (time and/or money) is expected. |
| **Aquifer** | A source of groundwater comprising water-bearing rock, sand or gravel capable of yielding significant quantities of water. |
| **Artificial drainage system** | A constructed drainage system such as a drain, sewer or ditch. |
| **Astronomical tide level** | The tide level resulting from the gravitational effects of (mainly) the sun and the moon. |
| **Baseline** | A measurement that serves as a basis to which all following measurements are compared. |
| **Bias** | The disposition to distort the significance of the various pieces of information that have to be used. |
| **Boundary condition** | A specified variable, typically water level or flow, which is defined at the edge of the spatial extent of a model to allow the model to solve its governing equations. |
| **Brownfield site** | Any land or site that has been previously developed |

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| **Catastrophic failure** | Failure of the defence to such an extent that, once a threshold is exceeded, only limited residual resistance is afforded. The consequences associated with catastrophic failure are often dramatic. |
| **Catchment** | The area contributing flow or runoff to a particular point on a watercourse. |
| **Catchment Flood Management Plan** | A high-level planning strategy through which the EA works with other key decision-makers within a river catchment to identify and agree policies to secure the long-term sustainable management of flood risk. |
| **Characterisation** | The process of expressing the observed/predicted behaviour system for optional use in decision-making. |
| **Climate change** | Long term variations in global temperature and weather patterns both natural and as a result of human activity, primarily greenhouse gas emissions. |
| **Coastal cell** | See **Sediment cell**. |
| **Coastal defence** | A term used to encompass both coastal protection against erosion and sea defence against flooding. |
| **Coastal encroachment** | The gradual movement landwards by the sea. See **Coastal erosion**. |
| **Coastal erosion** | The gradual wearing away of the coastline through a combination of wave attack and, in the case of coastal cliffs, slope processes (e.g. high groundwater levels). This may include cliff instability, where coastal processes result in the periodic reactivation of landslide systems or promote rock falls. |
| **Coastal flooding** | Flooding from the sea. |
| **Coastal floodplain** | Low-lying area adjacent to the sea or estuaries that suffers from occasional inundation of salt water. |
| **Coastal squeeze** | The process by which coastal habitats and natural features are progressively lost or drowned, caught between coastal defences and rising sea levels. |
| **Coastal zone** | Includes a shoreline, inshore waters and land influenced by coastal processes. |
| **Coastal Zone Management Plan** | A non-statutory plan aimed at achieving a balance between the various uses of the coast, notably agriculture, development, recreation, conservation, navigation and fisheries interests. |
| **Coast protection** | Protection of the coast from erosion or encroachment by the sea. |
| **Confidence interval** | A measure of the degree of (un)certainty of an estimate, usually presented as a percentage. |

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| **Conceptual model** | A method for presenting the hypothesised relationships between sources, pathways and receptors. It can be in either visual or written form. |
| **Consequence** | An impact such as economic, social or environmental damage/improvement. May be expressed quantitatively, by category or descriptively. |
| **Correlation** | Between two random variables, the correlation is a measure of the extent to which a change in one tends to correspond to a change in the other. |
| **Cost-benefit analysis** | Comparison of present value scheme benefits and costs as part of an economic appraisal. The cost-benefit ratio is the total present value benefits divided by the total present value costs. |
| **Critical element** | Component of a system (or sub-system), the failure of which will lead to the failure of the entire system (or sub-system). |
| **Culvert** | Covered channel or pipe that forms a watercourse below ground level. |
| **Defence system** | Two or more defences acting to achieve common goals (e.g. maintaining flood protection to a single flood cell/community) |
| **Demountable defence** | A defence that is built to achieve the appropriate level of flood protection once removable elements have been reinstated. |
| **Design event** | A historic or notional flood event of a given annual flood probability, against which the suitability of a proposed development is assessed and mitigation measures, if any, are designed. |
| **Design flood level** | The maximum estimated water level during the design event. |
| **Design objective** | The objective put forward by a stakeholder, for the eventual performance of a scheme or system, once implemented. |
| **Design standard** | A performance indicator that is specific to the engineering of a particular defence to meet a particular objective under a given loading condition. |
| **Dependence** | The extent to which one variable depends on another variable. Dependence affects the likelihood of two or more thresholds being exceeded simultaneously. When it is not known whether dependence exists between two variables or parameters, guidance on the importance of any assumption can be provided by assessing the fully dependent and independent cases. |
| **Deterministic process/method** | A method or process that adopts precise single-values for all variables and input values, giving a single value output. |
| **Development** | The carrying out of building, engineering, mining or other |

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| | operations in, on, over or under land or the making of any material change in the use of any buildings or other land. |
| **Development control** | Planning responsibilities relating to individual development proposals (planning applications). |
| **Development plans** | Previously, structure plans and local plans, these now include the Regional Spatial Strategy and the development plan documents, contained within the Local Development Framework. |
| **Discharge** | Rate of flow of water. |
| **Economic appraisal** | An appraisal that takes into account a wide range of costs and benefits, generally those that can be valued in money terms. |
| **Element life** | The period of time over which a certain element will provide sufficient strength to the structure with or without maintenance. |
| **Environmental Impact Assessment** | A technique used for identifying the environmental effects of development projects. As a result of European Union Directive 85/337/EEC (as amended 1997), this is a legislative procedure to be applied to the assessment of the environmental effects of certain public and private which are likely to have significant effects on the environment. |
| **Estuarial flooding** | Flooding from an estuary, where water level will be influenced by river flows and tidal conditions. |
| **Event (in context)** | An independent realisation of one variable such as a particular wave height threshold or flood extent. |
| **Expectation** | Expectation, or 'expected value' of a variable, refers to the mean value the variable takes. |
| **Failure** | Inability to achieve of a defined performance threshold (response given loading). "Catastrophic" failure describes the situation where the consequences are immediate and severe, whereas "prognostic" failure describes the situation where the consequences only grow to a significant level when additional loading has been applied and/or time has elapsed. |
| **Failure mode** | Description of one of any number of ways in which a defence may fail to meet a particular performance indicator. |
| **Failure probability** | The estimated probability of a failure occurring in an specified time period. |
| **Field drainage** | System of drains to control the water table in agricultural land. |
| **Flap valve** | A simple form of non-return valve, employing a hinged flap to prevent reverse flow. |
| **Flood defence** | Flood defence infrastructure, such as flood walls and |

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| | embankments, intended to protect an area against flooding, to a specified standard of protection. |
| **Flood Defence Agency** | A generic term used to refer to the Environment Agency in England and Wales, the Scottish Environment Protection Agency in Scotland, and the Rivers Agency in Northern Ireland, together with Internal Drainage Boards and Local Authorities, acting in their role as technical advisors to Local Planning Authorities on flood risk issues. |
| **Flood defence level** | The level to which flood defences are constructed, that is the level of the top of flood walls and embankments, expressed relative to Ordnance Datum. |
| **Flood event** | A flooding incident characterised by its peak level or flow, or by its level or flow hydrograph. |
| **Flooding** | Inundation by water whether this is caused by breaches, overtopping or banks or defences, inadequate or slow drainage of rainfall, underlying groundwater levels or blocked drains and sewers. |
| **Floodplain** | Area of land adjacent to a watercourse, an estuary or the sea, over which water flows in time of flood, or would flow but for the presence of flood defections where they exist. |
| **Floodplain compensation** | The provision of new floodplain storage capacity to replace lost natural floodplain due to development. |
| **Flood probability** | The estimated probability of a flood of given magnitude occurring or being exceeded in any specified time period. |
| **Flood risk** | An expression of the combination of the flood probability and the magnitude of the potential consequences of the flood event. |
| **Flood Risk Assessment** | A study to assess the risk of a site or area flooding, and to assess the impact that any changes or development in the site or area will have on flood risk. Usually used in the context of a site-specific Flood Risk Assessment (FRA). See **Project Flood Risk Assessment**. |
| **Flood Risk Management** | Combines the functions of mitigating (see **Mitigation measure**) and monitoring flood risks and may include pre-flood, flood-event or post-flood activities. |
| **Flood storage** | The temporary storage of excess runoff or river flow in ponds, basins, reservoirs or on the flood plain. |
| **Fluvial** | Relating to a river or rivers |
| **Fluvial flooding** | Flooding from a river or other watercourse. |
| **Forward planning** | Often used in place of 'development planning' to describe the activities carried out in order to produce a spatial plan, usually in the form of a Local Development Framework (previously either a Structure Plan or Local Plan). |

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| **Fragility** | The propensity of a particular defence or system to fail under a given load condition. Typically expressed as a fragility function curve relating load to probability of failure. Combined with descriptors of decay/deterioration, fragility functions enable future performance to be described. |
| **Freeboard** | The difference between the design flood level and the lowest point on the flood defence. |
| **Functional design** | The design of an intervention with a clear understanding of the performance required of the intervention. |
| **Functional floodplain** | Unobstructed areas of the floodplain where water regularly flows in time of flood. (The EA interprets 'regularly' as 10% annual probability (a 1 in 10 year) flood event.) |
| **Future risk** | The estimated risk given likely effects of sea level rise and changing weather patterns in the future. (In relation to developments, the anticipated life of the development should be taken into consideration when determining how many years into the future the risk should be estimated.) |
| **Greenfield runoff rate** | The rate of runoff that would occur from the site in its undeveloped (and therefore undisturbed) state. |
| **Groundwater** | Water in the ground, usually referring to water in the saturated zone below the water table. |
| **Groundwater flooding** | Flooding caused by groundwater escaping from the ground when the water table rises to or above ground level. |
| **Harm** | Disadvantageous consequences |
| **Hazard** | A situation with the potential to result in harm. A hazard does not necessarily lead to harm. |
| **Hierarchy** | A process where information cascades from a greater spatial or temporal scale to lesser scale and vice versa. |
| **Hydrograph** | A graph that shows the variation with time of the level or discharge in a watercourse. |
| **Indicative Floodplain Map** | A map that delineates the areas estimated to be at risk of flooding during an event of specified flood probability. "Indicative" acknowledges that such maps give an indication of the areas at risk; they cannot be relied upon to give precise information in relation to individual sites. |
| **Infiltration Capacity** | A soil characteristic determining or describing the maximum rate at which water can enter the soil. |
| **Information management** | The skilful handling of knowledge in order to produce the desired results. |
| **Infrastructure failure** | Structural, hydraulic, geotechnical, mechanical or operational failure of infrastructure which normally retains, transmits or controls the flow of water. |

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| **Internal Drainage Board** | Body with powers and duties relating to ordinary watercourses within an Internal Drainage District. |
| **Internal Drainage District** | An area of land designated as such by Defra, or a predecessor Ministry, on the grounds that it derives benefit or avoids danger as a result of drainage operations. |
| **Integrated risk management** | An approach to risk management that embraces all sources, pathways and receptors of risk and considers combinations of structural and non-structural solutions. |
| **Intervention** | A planned activity designed to effect an improvement in an existing natural or engineered system (including social, organisation and defence systems). |
| **Joint probability** | The probability of specific values of one or more variables occurring simultaneously. For example, extreme water levels in estuaries may occur at times of high river flow, times of high sea level or times when both river flow and sea level are above average levels. When assessing the likelihood of occurrence of high estuarine water levels it is therefore necessary to consider the joint probability of high river flows and high sea levels. |
| **Judgement** | Conclusions/decisions arising from the critical assessment of the relevant knowledge. |
| **Knowledge** | Spectrum of known relevant information. |
| **Knowledge uncertainty** | Uncertainty due to lack of knowledge of all the causes and effects in a physical or social system. |
| **Land drain** | Drain used in agriculture to control the water table and reduce the frequency with which land becomes waterlogged. |
| **Likelihood** | A general concept relating to the chance of an event occurring. Likelihood is generally expressed as a probability or a frequency. |
| **Limit state** | The boundary between safety and failure. |
| **Load** | Refers to environmental factors such as high river flows, water levels and wave heights, to which the flooding and erosion system is subjected. |
| **Local Planning Authority** | Body responsible for planning and controlling development, through the planning system. |
| **Main river** | A watercourse designated on a statutory map of main rivers maintained by Defra. |
| **Managed realignment** | Setting back the line of actively maintained defences to a new line inland of the original. |
| **Managed retreat** | See **Managed realignment**. |

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| **Material consideration** | Matters that need to be taken into account by a planning authority when determining an application for planning permission. |
| **Mitigation measure** | A generic term referring to an element of development design which may be used to manage flood risk to the development, or to avoid an increase in flood risk elsewhere. |
| **Multi-criteria analysis** | A method for measuring different scenarios against a number of different criteria, in order to compare the performance of the scenarios. |
| **Natural variability** | Uncertainties that stem from the assumed inherent randomness and basic unpredictability in our natural world and are characterised by the variability in known or observable populations. |
| **Nature of risk** | The magnitude (degree of harm, cost etc) and frequency of an outcome. |
| **Ordinary watercourse** | A watercourse that is not a private drain and is not a designated main river. |
| **Overland flow flooding** | Flooding caused by surface water runoff when rainfall intensity exceeds the infiltration capacity of the ground, or when soil is so saturated that it cannot accept anymore water. |
| **Passive floodplain** | Areas that are within the "natural" floodplain but are not now subject to frequent flooding, because of the presence of flood defences. |
| **Pathway** | Provides the connection between a particular source (e.g. high river or tide level) and the receptor that may be harmed (e.g. property). In flood risk management pathways are often 'blocked' by barriers, such as flood defence structures to manage the risk. |
| **Penstock** | A sluice or gate used to control the flow of water. |
| **Performance** | The degree to which a process or activity succeeds when evaluated against some stated aim or objective. |
| **Performance based engineering** | See **Functional design**. |
| **Performance evaluation** | Performance evaluation is a general concept that refers to the process of assessing past or future performance of a defence, policy or project against defined performance indicators. |
| **Performance indicator** | The well articulated and measurable objectives of a particular project or policy. These may be detailed engineering performance indicators, such as acceptable overtopping rates or rock stability, or more generic indicators such as public satisfaction or other key performance indicators. |
| **Performance management** | The process that predicts future risks and informs management decisions. |

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| **Performance review** | The process that investigates past performance and includes the processes of learning (how performance could have been improved taking account of advances in knowledge) and feedback into best practice. |
| **Peri-urban** | Area surrounding the urban area. |
| **Permanent defence** | A defence built to the appropriate level for flood protection with no further operation required. |
| **Pluvial** | Relating to rain. |
| **Post project evaluation** | A process to determine whether an investment has represented value for money and how the associated asset performed and provide insight into how that asset, and other similar assets, should be managed in the future. |
| **Potency** | Potency comments on the likely severity of the harm that may be caused from different sources. |
| **Precautionary principle** | The approach, to be used in the assessment of flood risk, which requires that the lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to avoid or manage flood risk. |
| **Probabilistic method** | Method in which the variability of input values and the sensitivity of the results are taken into account to give results in the form of a range of probabilities for different outcomes. |
| **Probabilistic reliability methods** | These methods attempt to define the safety of a structure through assessment of a response function. |
| **Probability** | A measure of the chance that an event occurs. The probability of an event is typically defined as the relative frequency of occurrence of that event, out of all possible events. |
| **Probability density function** | Function which describes the probability of different values across the whole range of a variable (for example flood damage, extreme loads, particular storm conditions). |
| **Process model uncertainty** | See **Knowledge uncertainty** |
| **Progressive failure** | Failure where once a threshold is exceeded significant residual resistance remains enabling the defence to maintain restricted performance. The immediate consequences of failure are not necessarily dramatic but further, progressive, failures may result. |
| **Project** | An activity undertaken to meet stated objectives. |
| **Project Flood Risk Assessment** | A site-specific Flood Risk Assessment. |
| **Proportionate methods** | Provide a level of assessment and analysis appropriate to the decision being made. |
| **Protected floodplain** | Natural floodplain prevented from flooding by defences. |

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| **Receptor** | Receptor refers to the entity that may be harmed. |
| **Record** | Not distinguished from event (see **Event**). |
| **Reliability index** | A probabilistic measure of the structural reliability with regard to any limit state. |
| **Residual life** | The residual life of a defence is the time to when the defence is no longer able to achieve minimum acceptable values of defined performance indicators in terms of its serviceability function or structural strength. |
| **Residual risk** | The risk that remains after risk management and mitigation. It may include, for example, risk due to very severe storms (above design standard) or risks from unforeseen hazards. Not to be confused with **Future risk**. |
| **Resilience** | The ability of a system to recover from the damaging effect of extreme loads. |
| **Response** | The reaction of a defence or system to environmental loading or changed policy. |
| **Response function** | Equation linking the reaction of a defence or system to the environmental loading conditions. |
| **Return period** | A term used to express the frequency of extreme events. It refers to the estimated average time interval between events of a given magnitude. Return period is often used to describe the Source term such as extreme rainfall, river or tide levels. This may or may not be similar to the probability of flooding at a particular location, depending on the presence and performance of defences, flood inundation, etc. |
| **Risk** | Risk is a combination of the chance of a particular event, with the impact that the event would cause if it occurred. Risk therefore has two components – the chance (or **probability**) of an event occurring and the impact (or **consequence**) associated with that event. The consequence of an event may be either desirable or undesirable. Generally, however, the flood and coastal defence community is concerned with protecting society and hence a risk is typically concerned with the likelihood of an undesirable consequence and our ability to manage or prevent it. |
| **Risk assessment** | The process of identifying hazards and consequences, estimating the magnitude and probability of consequences and assessing the significance of the risk(s). |
| **Risk management** | According to context, either action taken to mitigate risk, or the complete process of risk assessment, options appraisal and risk mitigation. |
| **Risk mitigation** | See **Risk reduction**. |
| **Risk profile** | The change in performance, and significance of the resulting |

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| | consequences, under a range of loading conditions. In particular the sensitivity to extreme loads and degree of uncertainty about future performance. |
| **Risk reduction** | The reduction of the likelihood of harm, the consequence of harm, or some combination of the two. |
| **Risk register** | An auditable record of the project risks, their consequences and significance, and proposed mitigation and management measures. |
| **River flooding** | See **Fluvial flooding**. |
| **Robustness** | The ability of a system to remain operational under load and despite the failure of an individual component or sub-systems. |
| **Runoff** | The flow of water from an area on the catchment surface, caused by rainfall. |
| **Sea defences** | The provision of defences to protect low-lying coastal areas from flooding by sea or tidal water. See **Coastal defence**. |
| **Sediment cell** | A length of coastline and its associated near shore area within which the movement of coarse sediment (sand and shingle) is largely self-contained. Interruptions to the movement of sand and shingle within one cell should not affect beaches in an adjacent sediment cell. |
| **Sediment sub-cell** | A sub-set of a sediment cell within which the movement of coarse sediment (sand and shingle) is relatively self-contained. The sediment sub-cell is, in many cases, likely to provide the appropriate basis for the development of Shoreline Management Plans. |
| **Sensitivity** | Refers to either: the resilience of a particular receptor to a given hazard or the change in a result or conclusion arising from a specific perturbation in input values or assumptions. |
| **Sequential Test** | A risk based approach to assessing flood risk, which gives priority to sites in ascending order of flood risk, i.e. lowest risk first. Referred to in PPG25. |
| **Serviceability** | The performance of a system required on a regular basis. |
| **Serviceability functions** | The individual performance characteristics requested on a regular basis. |
| **Serviceability limit state** | Limiting condition beyond which a structure or element no longer meets a particular serviceability criterion. |
| **Service life** | The period of time over which the owner expects the structure to perform, guidance on which is often given in Codes of Practice. |

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| **Sewer flooding** | Flooding caused by the blockage or overflowing of sewers or urban drainage systems. |
| **Shoreline Management Plan** | A document that sets out a strategy for coastal defence for a specified length of coast up to and including a whole sediment cell. |
| **Site-Specific Flood Risk Assessment** | See Project Flood Risk Assessment |
| **Source** | Source refers to a source of hazard (e.g. strong winds, heavy rainfall) |
| **Stakeholder** | A person or organisation with an interest in, or affected by, decisions made. |
| **Standard of protection** | The flood return period event (or annual probability) above which channel capacity or defence level is exceeded. |
| **Standard of service** | The measurable performance of an option related to a defined performance indicator. |
| **Statistical inference uncertainty** | See **Knowledge uncertainty**. |
| **Statistical model uncertainty** | See **Knowledge uncertainty**. |
| **Storm surge** | Water that is pushed toward the shore by the force of the winds swirling around the storm, causing a rise in water level. This may be enhanced by low atmospheric pressure at the centre of the storm causing additional water level rise through the inverted barometer effect. |
| **Strategic Flood Risk Assessment** | An assessment of flood risk carried out for forward planning purposes. |
| **Supply Chain** | The sequence of organisations (or groups within organisations) and associated activities that must be performed by these organisations to achieve the desired outcomes from source. |
| **Strategic planning** | Review of choices to be made in order to target resources most favourably. Often used by the EA in the context of flood management planning. |
| **Surge** | See **Storm surge** |
| **Sustainable drainage system** | A sequence of management practices and control structures, often referred to as SUDS, designed to drain surface water in a more sustainable manner than some conventional techniques. Typically, these techniques are used to attenuate rates of runoff from development sites. |
| **Sustainable development** | Development which meets the needs of the present without compromising the ability of future generations to meet their own needs. |

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| **System** | In the broadest terms, a system may be described as the social and physical domain within which risks arise and are managed. An understanding of the way a system behaves and, in particular, the mechanisms by which it may fail, is an essential aspect of understanding risk. This is true for an organisational system like flood warning, as well as for a more physical system, such as a series of flood defences protecting a flood plain. |
| **System state** | The condition of a system at a point in time characterised in relation to its ability to repeat performance objectives at that time. |
| **Temporary defence** | A protection measure that has no permanent elements, which is deployed as an emergency measure. |
| **Tidal surge** | See **Storm surge** |
| **Tide locking** | The situation where a watercourse that drains to the sea, estuary or other watercourse cannot discharge at times of high water levels in the sea, estuary or other watercourse. |
| **Tolerability** | Tolerability does not mean acceptability. It refers to willingness to live with a risk to secure certain benefits and in the confidence that it is being properly controlled. To tolerate a risk means that we do not regard it as negligible, or something we might ignore, but rather as something we need to keep under review, and reduce still further if we can. |
| **Ultimate limit state** | Limiting condition beyond which a structure or element is assumed to become structurally unfit for its purpose. |
| **Uncertainty** | A general concept that reflects our lack of sureness about something, ranging from just short of complete sureness to an almost complete lack of conviction about an outcome. |
| **Urban creep** | The process whereby the impermeability of the urban area increases over time, due to modifications to individual properties. |
| **Value management** | The process by which the performance of a project is optimised in terms of the value it provides. |
| **Voluntariness** | The degree to which an individual is willing to accept the risk to which they are exposed. |
| **Vulnerability** | Refers to the resilience of a particular group, people, property and the environment, and their ability to respond to a hazardous condition. For example, elderly people may be less able to evacuate in the event of a rapid flood than young people. |
| **Wader scrape** | A shallow depression in the ground providing habitat for wading birds. |
| **Washlands** | The area of floodplain where water is stored in time of flood. |

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| **Water table** | The level of groundwater in soil and rock, below which the ground is saturated. |
| **Wetlands** | An area where saturation or repeated inundation of water is the determining factor in the nature of the plants and animals living there. |

## 5.2 List of Abbreviations and Acronyms

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| **ABI** | Association of British Insurers |
| **ADA** | Association of Drainage Authorities |
| **ADAS** | Agricultural Drainage Advisory Service |
| **ALARP** | As Low As Reasonably Practicable |
| **AMP4** | Asset Management Plan 4 |
| **AUDACIOUS** | Adaptable Urban Drainage - Addressing Change in Intensity, Occurrence and Uncertainty of Stormwater |
| **CEH** | Centre for Ecology and Hydrology |
| **CFMP** | Catchment Flood Management Plan |
| **CHMP** | Coastal Habitat Management Plan |
| **CMAM** | Condition Monitoring and Asset Management |
| **CoMAH** | Control of Major Accident Hazard |
| **CRoW** | Countryside and Rites of Way |
| **CZMP** | Coastal Zone Management Plan |
| **DARDNI** | Department of Agriculture and Rural Development (Northern Ireland) |
| **Defra** | Department of the Environment, Food and Rural Affairs |
| **EA** | Environment Agency |
| **EFO** | Extreme Flood Outline |
| **EPSRC** | Engineering and Physical Sciences Research Council |
| **FCM** | Flood and Coastal Management |
| **FDA** | Flood Defence Agency |
| **FDMM** | Flood Defence Management Manual |
| **FDMS** | Flood Defence Management System |
| **FEH** | Flood Estimation Handbook |
| **FLOWS** | Floodplain Land-use Optimising Workable Sustainability |

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| **FRA** | Flood Risk Assessment |
| **FRM** | Flood Risk Management |
| **FRMRC** | Flood Risk Management Research Consortium |
| **FRMS** | Flood Risk Management Strategy |
| **GIS** | Geographical Information System |
| **GPS** | Global Positioning System |
| **HBF** | House Builders Federation |
| **HRW** | HR Wallingford Ltd |
| **IDB** | Internal Drainage Board |
| **IDD** | Internal Drainage District |
| **IFM** | Indicative Floodplain Map |
| **IRMF** | Integrated Risk Management Framework |
| **LDD** | Local Development Document |
| **LDF** | Local Development Framework |
| **LEAP** | Local Environment Agency Plan |
| **LFDC** | Local Flood Defence Committee |
| **LGA** | Local Government Association |
| **LPA** | Local Planning Authority |
| **MDSF** | Modelling and Decision Support Framework |
| **NaFRA** | National Flood Risk Assessment |
| **NFCDD** | National Flood and Coastal Defence Database |
| **NFDDDMS** | National Flood Defence Data and Data Management Strategy |
| **NFFS** | National Flood Forecasting System |
| **NHBC** | National House Builders Council |
| **ODPM** | Office of the Deputy Prime Minister |
| **OFWAT** | Office of Water services |

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| **OS** | Ordnance Survey |
| **OSBM** | Ordnance Survey Bench Mark |
| **OST** | Office of Science and Technology |
| **PAG4** | Project Appraisal Guidance Note 4 |
| **PAMS** | Performance based Asset Management System |
| **PCPA2004** | Planning and Compulsory Purchase Act 2004 |
| **PPS** | Planning Policy Statement |
| **PPG23** | Planning Policy Guidance Note 23: Planning and Pollution Control |
| **PPG25** | Planning Policy Guidance Note 25: Development and Flood Risk |
| **PPW** | Planning Policy Wales |
| **PVI** | People Vulnerability Index |
| **R&D** | Research and Development |
| **RASP** | Risk Assessment for flood and coastal defence for Strategic Planning |
| **RBMP** | River Basin Management Plan |
| **RFDC** | Regional Flood Defence Committee |
| **RPG** | Regional Planning Guidance |
| **RSS** | Regional Spatial Strategy |
| **SA** | Sustainability Appraisal |
| **SEA** | Strategic Environmental Assessment |
| **SEPA** | Scottish Environmental Protection Agency |
| **SFRA** | Strategic Flood Risk Assessment |
| **SFVI** | Social Flood Vulnerability Index |
| **SMP** | Shoreline Management Plan |
| **SMURF** | Sustainable Management of Urban Rivers and Floodplains |
| **SoP** | Standard of Protection |
| **SPP7** | Scottish Planning Policy No. 7: Planning and Flooding |

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| **SPRC** | Source Pathway Receptor Consequence |
| **SSSI** | Site of Special Scientific Interest |
| **SuDS** | Sustainable Drainage Systems |
| **TAN15** | Technical Advice Note (Wales) 15: Development and Flood Risk |
| **UA** | Unitary Authority |
| **UDP** | Unitary Development Plan |
| **UKCIP** | UK Climate Impacts Programme |
| **WaND** | Water cycle management for New Developments |
| **WFD** | Water Framework Directive |

# 6. S2.1 REPORTING

**This guidance note:**
- Provides generic guidance regarding reporting of assessments of flood risk and the management of that risk for new developments

**This guidance note does NOT:**
- Supersede guidance provided for specific assessment types

## 6.1 Contents



## 6.2 Introduction

The requirements of all reports are the following:

- **Complete** – the assessment processes and required outcomes are described in full, so that they are auditable.[19]

- **Accurate** – the information provided is correct and unambiguous.

- **Compliant** – the content of the report should be agreed with those that will use it for decision-making (preferably prior to the commencement of the assessment). This includes the need for it to be understandable for its intended users.

- **Authorised –** the report should be reviewed and signed off, as appropriate, prior to use for decision-making purposes.

## 6.3 Data and Information

The report produced for an assessment of flood risk is the most useful source of data and information relating to the flood risk of the area in question. It is also the means by which the assessment can be audited and subsequent decision-making processes are held accountable. Therefore, it is essential that the report contains full details of the following:

### 6.3.1 Incoming Data and Information

- Sources of data used, including details of accuracy and validity.

- Previous assessments, plans, strategies, etc. and how these have been used or taken into consideration.

[19] See Guidance Note S2.3 Auditing and Control

- Associated statutory requirements and planning policy guidance, or supplementary guidance, produced by the relevant planning authorities.

- Any other information provided by stakeholders (whether verbal or written), including the Environment Agency.

### 6.3.2 Outgoing Information

- The existing plan area/site and existing flood risk, including an indication of uncertainty.

- The planned/proposed development and future flood risk, including consideration of climate change and level of uncertainty.

- If required, proposed mitigation measures and residual risk, including consideration of operational, maintenance and monitoring needs and management of uncertainty.

- How the information contained in the report should or should not be used for the relevant decision-making processes and how it might inform other related processes (e.g. sustainability appraisals, flood management strategies, asset management strategies, performance monitoring strategies, etc.).

### 6.3.3 Approach

- Type of assessment method applied, including details of limitations of the method, assumptions used, levels of uncertainty and sensitivity testing.

### 6.3.4 Science

- Source of science applied, and where appropriate, reference to the authentication of the science.

### 6.3.5 Decision-making

- Involvement of stakeholders in determining perceived as well as actual risk.
- Involvement of stakeholders in determining acceptability of risk.

## 6.4 Roles and Responsibilities

All reports produced for assessments of flood risk should be:

- **Written** by those who carried out the assessment, to ensure **completeness**.

- **Reviewed** by an independent body with appropriate technical expertise, to verify **completeness** and **accuracy**.

- **Reviewed** by the decision-making authority, to verify that the report is **compliant** with their expectations and decision-making needs (and is fully understandable).

- **Authorised** by the decision-making authority, once the reviews have been completed and any remedial actions have been carried out.

## 6.5 Processes and Procedures

### 6.5.1 Specific Reporting Requirements for Different Types of Assessment

*National-scale Flood Risk Assessments (NaFRAs)*
No guidance is currently available on the required content of a NaFRA report.

*Catchment Flood Management Plans (CFMPs)*
There are 4 reports produced for a CFMP (Inception Report, Scoping Report, Draft CFMP, Final CFMP). The required content of these are summarised in the CFMP Policy Guidance[20] and described in more detail in the CFMP Processes and Procedures[21]. These documents also provide details of when these reports should be produced.

*Shoreline Management Plans (SMPs)*
Guidance regarding reporting of SMPs can be found in the Procedural Guidance for the Production of SMPs[22], in particular Chapter 7 *Presentation of the plan* includes details of format, content and minimum mapping requirements to support the report. This is supported by Appendix K – *SMP contents*.

*Strategic Flood Risk Assessments (SFRAs)*
No national guidance is currently available on the content of a SFRA report. However, guidelines for the North West Region of England on carrying out Sequential Flood Risk Tests[23] include a section on documentation (Section 4) and a suggested table of contents (Appendix A).

*Site-specific Flood Risk Assessments (FRAs)*

- Although not specifically written from the context of reporting, PPG25[24] and TAN15[25] can be used as initial guidance for the contents of a FRA report. In particular, several plans are specified in both documents.
- More detailed guidance regarding the content of FRA reports can be found in the CIRIA guidance C624[26], particularly in Box 5.6 *Recommended contents of a FRA report*.
- Guidance regarding when the FRA report should be submitted can be found in the CIRIA guidance C624, particularly in Figure 5.1 *FRA Process for Development Proposals* and Chapter 6 *Flood Risk Assessment Toolkit*.
- The EA is currently developing a simple leaflet called "*Guidance on Producing a Flood Risk Assessment*", which provides examples of simple FRA statements required to accompany planning applications for small developments.

### 6.5.2 Generic Reporting Requirements

Fundamentally, it is the content of the report that is important and not the format, as long as the report is understandable for the intended users and auditable. However, in the absence of specific reporting requirements, a suggested table of contents is provided at the end of this guidance note. This table of contents could be adapted/modified by the decision-making authority at the outset of the assessment in order to define a compliant report.

The size of the report and level of detail should be proportionate to the level of assessment undertaken. The suggested table of contents is most appropriate for a relatively detailed assessment.

[20] Environment Agency, Defra and The Welsh Assembly (2004) *Catchment Flood Management Plans, Volume 1 – Policy Guidance*, Environment Agency, Bristol.
[21] Environment Agency, Defra and The Welsh Assembly (2004) *Catchment Flood Management Plans, Guidelines Volume I1 – Processes and Procedures*, Environment Agency, Bristol.
[22] Defra (2003) Procedural Guidance of the Production of Shoreline Management Plans, Interim Guidance, May 2003 (Consultation Version) http://www.defra.gov.uk/corporate/consult/smpguidance/index.htm
[23] Environment Agency (NW Region) and NW Regional Assembly (2004) *Meeting the Sequential Flood Risk Test: Guidelines for the North West Region*. http://rpg.nwra.gov.uk/documents/index.php?group_id=73&expand=102
[24] DTLR (2001) *Planning Policy Guidance Note 25: Development and Flood Risk*. HMSO, London.
[25] National Assembly for Wales (2004) *Technical Advice Note 15: Development and Flood Risk*, National Assembly for Wales, Cardiff.
[26] Lancaster, J, Preene, M and Marshall, C (2004) *C624 Development and Flood Risk – Guidance for the Construction Industry*, CIRIA, London.

## 6.6 Tools and Technologies

The appropriate use of GIS mapping, supplementing the report text, should be encouraged where ever possible, to maximise usability for planners in combination with other planning activities.

Provision of the report and mapping on CD-ROM, in addition to paper format, should also be encouraged to assist with dissemination and usability (potentially via a website).

## 6.7 Audit and Control

All reports should be reviewed and authorised before use, as described under Roles and Responsibilities.

The Assessment Check-List provided with this project includes consideration of the appropriate documentation (reporting) of assessments.

## 6.8 Implementation of this Guidance

The approach presented in this guidance note is robust and accepted as best practice through publications from the British Standards Institution (BSi).[27] It has been successfully applied to both the private and government sectors by the London School of Economics.

However, the suggested table of contents should be piloted alongside the framework and guidance, prior to implementation.

[27] BSI standards publications: BSI-DISC PD 0008:1999, *Code of Practice for Legal Admissibility of Information Stored on Electronic Document Management Systems* (Second Edition – subsequently updated in 2004), BSI-DISC PD 0009:1999, *Compliance Workbook* (Second Edition), BSI-DISC PD 0010:1997, *Principles of Good Practice for Information Management*.

### 6.9 Table of Contents

Suggested table of contents for a report of the assessment and management of flood risk for new development:

Quality Control, Authorisation Sheet or similar

Executive Summary (non-technical)

- Overall Approach
- Objectives of Assessment
- Main Options
- Conclusions

Technical Summary

Contents

Glossary and Abbreviations

1. Introduction
2. Requirements of Assessment
3. Assessment Approach
    - Uncertainties
    - Sensitivity Testing
4. Existing Risk
5. Proposed Options
6. Future Risk (without mitigation)
7. Mitigation Measures
8. Residual Risk
9. Monitoring and Review Plan
10. Conclusions of Assessment
11. Recommended Usage of Assessment

References

Appendices

- Plans/mapping
- Details of Data Collection (including a list of used data sources)
- Any completed checklists, etc.

# 7. S2.2 INFORMATION MANAGEMENT

**This guidance note:**

- Provides an introduction to the principles of effective information management across the whole process of assessment and management of flood risk for new development
- Provides generic guidance regarding data management and control associated with assessments of flood risk and the management of that risk for new developments

**This guidance note does NOT:**

- Supersede guidance provided for specific assessment types

## 7.1 Contents



## 7.2 Introduction

Information management is the skilful handling of knowledge in order to produce the desired results.[28] In other words, it is about providing the right information at the right time to enable organisations to carry out their operations to the best of their abilities.

**Examples of information include:**

- Numerical data
- Records
- Maps
- Reports
- Policy Statements
- Acts, Directives or Regulations
- Communications
- Site visits
- Computer models
- Physical models
- Metadata (data about data)

**It can have the following formats:**

- Paper
- Electronic
- Verbal
- Visual

**During its life-time, it might be:**

- Created
- Recorded
- Reviewed
- Updated
- Stored
- Received
- Issued
- Deleted

The five principles, as defined in the R&D project FD2314 *Position Review of Data and Information Issues within Flood and Coastal Defence*[29], can serve as guidelines for those involved in assessing

[28] http://lorien.ncl.ac.uk/ming/cleantech/glossary.htm

[29] McCue J, Millard K, von Lany P, Clark M (2004) *Position Review of data and information issues within Flood and Coastal defence*, R&D Technical Report FD2314/TR1, Environment Agency. http://www2.defra.gov.uk/research/project_data/More.asp?I=FD2314&SCOPE=0&M=CFO&V=WSAST

flood risk, irrespective of the methods employed. The principles bring together everything from high-level policy issues to detailed analysis. They are intended to provide a framework within which all those involved can develop comprehensive procedures.

The five principles take the form of a set of statements of objectives for information management. These are:

- **Data and Information** - Recognise and understand all types of data and information.

- **Roles and Responsibilities** - Understand the legal issues (such as statutory requirements) and execute "duty of care" responsibilities.

- **Processes and Procedures** - Identify and specify all processes and procedures (whether research science, development of application, business process or policy based).

- **Tools and Technologies** - Identify tools and enabling technologies to support processes and procedures.

- **Audit and Control** - Monitor and audit processes and procedures and set in place remedial actions should they be required.

Guidance notes provided as part of the FD2320 framework are broken down into these five principles, to enable users to identify these common principles across all topics.

## 7.3 Data and Information

Data and information should be:

- **Complete** – the data/information required/used/stored/issued as part of the assessment and management processes should be available and auditable.[30]

- **Accurate** – the data/information is up to date, correct (within the bounds of recognised uncertainty) and unambiguous.

- **Compliant** – the incoming data/information should be agreed as being appropriate for use as part of the assessment process and/or as part of the flood risk management process.

- **Authorised –** all data or information should be checked for suitability for transfer from and to appropriate stakeholders to ensure legality, issues of confidentiality, public interest, etc. are managed effectively.[31]

Information regarding the above (known as metadata) is also required to manage the data/information effectively. Metadata might include the following:

- Description of data/information,
- Source,
- Date received,
- Status (e.g. draft, final, consultation, superseded),
- Format (e.g. paper, electronic),
- Date last updated,
- Ownership,
- Confidentiality,
- Expiry date,

[30] See Guidance Note S2.3 Auditing and Control

[31] BSI Code of Practice - BSI DISC PD 5000:1999 *Electronic Documents and e-Commerce Transactions as Legally Admissible Evidence*

- Where it is stored,
- Who has reviewed it,
- What it has been used for,
- Confidence/Benchmarking score (related to e.g. level of accuracy, confidence in source).

## 7.4 Roles and Responsibilities

Information management is the responsibility of each and every stakeholder involved in the assessment and management of flood risk for new development.[32] The extent and complexity of the management requirements for each stakeholder depends on the types, quantity and quality of information involved, relevant roles and responsibilities, processes and procedures undertaken, tools and technologies used and audit and control requirements, i.e. the five principles. The basic approach, however, as described in this guidance note, can be applied generically.

There are 4 main roles for information management that should be performed during the assessment process. These roles are summarised below.

- **User** – should ensure that an information management system is in place and being used appropriately as part of the assessment and management process

- **Reviewer –** should review incoming and outgoing information for the assessment, to verify completeness, accuracy and technical compliance

- **Decision-maker –** should review outgoing information from the assessment, to verify compliance with their requirements for decision-making

- **Authoriser -** should review all outgoing information, to ensure appropriate issue to other stakeholders

Each stakeholder/organisation will need to determine which of these roles are relevant to them. This can be achieved by analysing the relevant supply chains.

## 7.5 Processes and Procedures

### 7.5.1 Data Flows between Assessment Types

The Activity Chart[33] provided as part of this project includes a section called *How assessments of flood risk are used*. This shows the potential data flows between different types of assessment in the three main contexts for their use. These being:

- Development planning
- Flood management planning
- Sustainability appraisals

Increased use of these data flows, by taking advantage of existing studies, will reduce duplication of work and improve continuity of approach and, hence, continuity of decision-making.

Further research and development would be required to set up a formal system to facilitate this.

### 7.5.2 Generic Data Management Requirements

Defra and the EA commissioned a study in 2003 to identify how Flood and Coastal Erosion Risk Management was limited by data and information issues[34]. The project made a series of recommendations that are subsequently being taken forward in the ongoing Defra/EA R&D project

[32] See Guidance Note S2.4 Stakeholder Engagement
[33] Go to Activity Chart Overview (Appendix A)

FD2323 *Improving Data and Knowledge for Effective Integrated Flood and Coastal Erosion Risk Management*.

However, the development of the National Flood and Coastal Defence Database (NFCDD) is an important step in the process of developing an integrated and comprehensive approach across England and Wales. Further details are provided in Tools and Technology.

### 7.5.3 Specific Data Management Requirements for Different Types of Assessment

Guidance documents available for different types of assessment provide varying quantities of information regarding data management. In general these are similar, as the objectives are the same, and good ideas from one guidance document can often be applied to another type of assessment. Specific issues/ideas within different guidance documents are given in the sections below.

*Catchment Flood Management Plans (CFMPs)*
The CFMP approach[35] includes guidance on collecting and managing data. This includes reference to the following:

- recruitment of a Data Manager
- data sources and ensuring the most up to date data is obtained
- receipt, assessment and audit
- identification of key knowledge holders
- lists of significant national datasets
- lists of other potential data
- dealing with survey data
- standard formats
- facilitating reuse for subsequent studies

*Shoreline Management Plans (SMPs)*
Guidance regarding data management for SMPs is provided in Defra's *Procedural Guidance for Production of Shoreline Management Plans*[36]. This includes reference to the following:

- making best use of existing SMP datasets
- provision of a 'Standard Data Package'
- standardisation of formats
- creation/use of metadata

*Strategic Flood Risk Assessments (SFRAs)*
No national guidance is currently available on data management for SFRAs. However, guidelines for the North West Region of England on carrying out Sequential Flood Risk Tests[37] include a section on potential data sources (Section 5).

[34] FD2314 - Position Review on Data and Information Issues in Flood and Coastal Management (see earlier for reference for Technical Report)
[35] Chapter 6 Guidance on Data Collection of: Environment Agency (2004) *Catchment Flood Management Plans: Guidelines Volume II – Processes and Procedures* (Fourth Draft - April 2004), Environment Agency, Bristol.
[36] Chapter 3 and Appendix C of: Defra (2003) *Procedural Guidance for Production of Shoreline Management Plans: Interim Guidance*, Consultation Version, May 2003. The consultation report was subsequently published August 2004. The revised version of the guidance is not yet available. The consultation version of the guidance (including appendices) and the consultation report are both available at this website: http://www.defra.gov.uk/corporate/consult/smpguidance/index.htm
[37] Environment Agency (NW Region) and NW Regional Assembly (2004) *Meeting the Sequential Flood Risk Test: Guidelines for the North West Region*.

*Site-specific Flood Risk Assessments (FRAs)*
In the CIRIA guidance C624[38] the following issues are fundamental to the recommended assessment approach and comprehensive details are provided:

- Sources and types of data,
- Implications of data availability on assessment approach,
- Requirements to review specific types of data,
- Accuracy and uncertainty.

Further information regarding the suitability of information and data for FRA purposes is described in the FLOWS WP1biii project *Modelling and Mapping of Flood Risk*.[39]

## 7.6 Tools and Technologies

### 7.6.1 Modelling and Decision Support Framework (MDSF)

The MDSF[40], which has been developed to enable those undertaking CFMPs and SMPs to produce effective and consistent plans, is a valuable tool for assessing and inspecting data. It is GIS based and uses a number of generic datasets.

At present MDSF is only being applied to CFMPs and SMPs, but it could be applied to SFRAs. The value that such an approach would provide to a SFRA would depend on the scale and complexity of the SFRA required, with larger scale plans (such as Sub-Regional Planning Strategies) with high levels of flood risk having the greatest benefit.

### 7.6.2 National Flood and Coastal Defence Database (NFCDD)

The aim of the NFCDD project is to provide a single, easily accessible and definitive store for all data on flood and coastal defences that is made available to all operating authorities to allow them to make better-informed decisions on the implementation of flood and coastal erosion management.[41]

Its development is an important component in enabling all operating authorities to comply with the requirements of the High Level Targets[42], allowing the reporting of progress, and providing evidence that policy is being delivered on the ground.[43]

The NFCDD is intended to improve access to data, using the Internet as the primary medium for doing this. This data will be provided by and be accessible to all flood and coastal defence operating authorities, with limited access also being provided for other organisations.

The Environment Agency is taking the lead on the development and implementation of the NFCDD, but all operating authorities are involved.

Key issues that have to be dealt with include:

- Provision of tools to enable manipulation, analysis and reporting of the data,
- Relating data to specified administrative areas and map based outputs to facilitate planning,
- Making data input as easy as possible, including on site or by consultants working on behalf of the operating authorities,

[38] Lancaster, J, Preene, M and Marshall, C (2004) *C624 Development and Flood Risk – Guidance for the Construction Industry*, CIRIA, London.
[39] Currently being undertaken by Atkins on behalf of the Environment Agency and due to be completed 2005.
[40] www.mdsf.co.uk
[41] Further details on the aims of the NFCDD, what it will deliver and progress to date can be found at http://www.defra.gov.uk/environ/fcd/hltarget/nfcdd.htm
[42] http://www.defra.gov.uk/environ/fcd/hltarget/default.htm
[43] See FD2320 recommended monitoring and review plan provided in the Project Record, FD2320/PR1.

- Data quality, including standard formats, benchmarking and consistent scoring systems,
- Appropriate use of approximate or aggregate data until detailed data can be provided,
- Phased development, including testing and training.

## 7.7 Audit and Control

Two aspects of information management have been included in this guidance note:

- The role of information management across the whole of the "assessment and management of flood risk for new development process" (i.e. the five principles).

- Specific requirements for managing data and information used or produced from the assessment/management process (i.e. completeness, accuracy, compliance and authorisation).

Therefore, two check-lists have been provided at the end of this guidance note. These are:

- Data Control Check-List, which can be used for each data/information item required for an assessment of flood risk.

- Information Management Health-Check, which can be used by organisations involved in assessing and managing flood risk for new development to see if they are following best practice in information management.

Remedial actions, should data control or the information management practices of an organisation not be appropriate, have not been explicitly considered in this guidance note.

It should also be noted that reference to assumptions and uncertainty associated with data is also contained in the Assessment Check-List.

## 7.8 Implementation of this Guidance

The approach presented in this guidance note is robust and is being applied in both private and government sectors as best practice through publications from the British Standards Institution (BSi).[44]

Adoption of this approach should include reference to the following documents, which provide best practice guidelines for data management within the context of coastal and estuary data management:

- CIRIA (2000) *Maximising the Use and Exchange of Coastal Data: A guide to best practice*, CIRIA publication C541.

- Defra/Environment Agency (2002) *Scientific Data Management by Project Consortia: Best Practice Guidelines*, R&D Technical Report FD2110, Defra, London.

The suggested check-lists should be piloted alongside the framework and guidance, prior to implementation.

[44] BSI standards publications: BSI-DISC PD 0008:1999, *Code of Practice for Legal Admissibility of Information Stored on Electronic Document Management Systems* (Second Edition – subsequently updated in 2004), BSI-DISC PD 0009:1999, *Compliance Workbook* (Second Edition), BSI-DISC PD 0010:1997, *Principles of Good Practice for Information Management*.

## 7.9 Information Management Check-Lists

### 7.9.1 Data Control Check-List

The following check-list can be used for each data/information item required for an assessment of flood risk:

1. Is the data/information available?
2. Is the data/information in a usable format?
3. Is the source of the data/information traceable for audit?
4. Is the data/information complete?
5. Is the data/information up to date?
6. Is the data/information correct (within the recognised bounds of uncertainty)?
7. Is the data/information unambiguous?
8. Has it been agreed that the data/information is appropriate for use in the assessment?
9. Is the data/information suitable for transfer outside of your Organisation?
10. Does the data/information need to be retained/stored for audit?
11. Where has the data/information been stored?
12. Has appropriate metadata (i.e. data about the data/information) been produced and stored?

### 7.9.2 Information Management Health-Check

The following Health-Check is for Organisations involved in assessing and managing flood risk for new development

*Organisation responsibilities*

1. Is your Organisation aware of legal and regulatory compliance needs for information management?
2. Does your Organisation recognise and reflect the role of information management?
3. Does your Organisation have comprehensive information management policies?
4. Does your Organisation know the value of its information assets?
5. Does your Organisation have a system to protect the integrity and availability of its information assets?

*Staff responsibilities*

6. Are staff recruited and trained in information management skills?
7. Are staff aware of legal and regulatory compliance needs for information management?
8. Are staff aware of your Organisation's policy regarding information management?
9. Do staff follow your Organisation's policy regarding information management
10. Is information management performance reported and reviewed?
11. Is there clear responsibility for remedial actions?

These questions are based on the approach developed by the Image and Document Management Association, London School of Economics.[45]

[45] Mayon-White Bill (1997) *Information's Real Value*, The Economist, April 1997.

# 8. S2.3 AUDITING AND CONTROL

**This guidance note:**

- Provides a recommended approach to auditing and control of the assessment and management of flood risk for new development,
- Provides references to existing tools available to assist with auditing and control, and
- Provides details of new tools to support the framework and guidance provided as part of project FD2320.

**This guidance note does NOT:**

- Diminish the responsibility of those undertaking or reviewing assessments and management of flood risk to ensure that these activities are carried out appropriately.

## 8.1 Contents



## 8.2 Introduction

All decisions regarding new development and, hence, assessments of flood risk that support the decision-making process should be:

- Robust
- Transparent, and
- Auditable.[46]

Within the context of the framework for assessing and managing flood risk for new development, auditing and control are defined as the following:

**Auditing** is comparing the 'required processes' with those that have actually been carried out. Therefore, auditability is the degree to which the assessment and decision-making processes can be traced back to the source data and information (transparency) and can be supported by proven science (robustness).

**Control** is determining whether any remedial actions need to be carried out (based on the results of the audit) and ensuring that these happen.

These activities are summarised in Figure 8.1.

[46] Defra (2003) *Procedural Guidance for the Production of Shoreline Management Plans*, Interim Guidance, Consultation Version, May 2003.

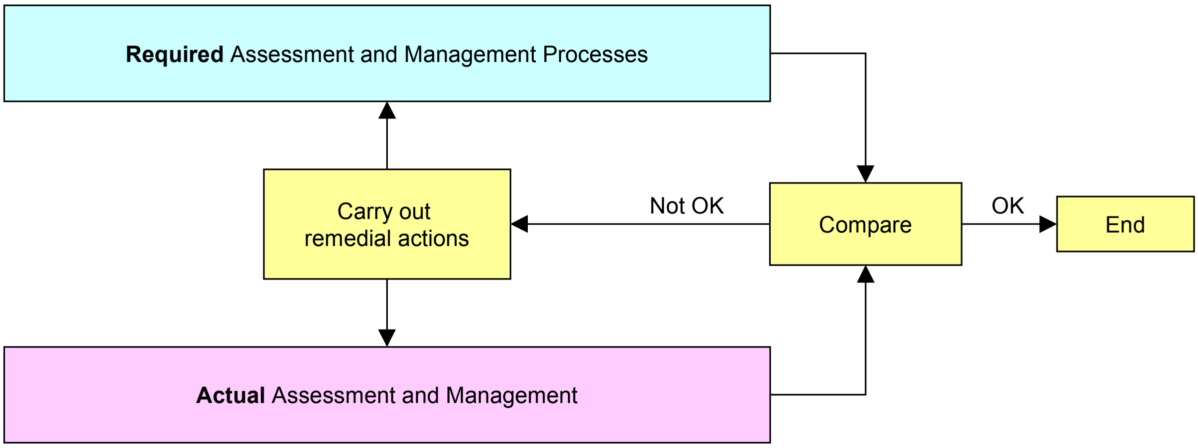


**Figure 8.1 Simplified representation of the audit and control model**

## 8.3 Data and Information

Data or information required for auditing and control can be summarised in the form of performance indicators. The assessment and management of flood risk for new development can be broken down into the following key performance indicators:

1. **Approach** - whether the approach is ***complete*** and ***authentic*** (i.e. an approved approach).
2. **Science** – whether the answers are ***accurate*** (within the bounds of managed uncertainty) and ***authentic*** (i.e. proven science).
3. **Decision-making** – whether the subsequent decisions made are ***compliant*** with policy and ***authentic*** (i.e. agreed with relevant stakeholders).

These key performance indicators can be supplemented by further indicators to produce a full monitoring and review mechanism for the framework, guidance and tools, as well as the assessment and management processes themselves. Further details can be found in the Monitoring and Review Plan produced as part of FD2320.[47]

## 8.4 Roles and Responsibilities

This simple auditing and control model can be used by:

- Those undertaking the assessment to check that they have carried out all necessary processes and used appropriate science in the assessment (reducing the likelihood of objections to the proposed plan or refusal of the planning application due to an inappropriate assessment),
- Those making decisions regarding new development based on the assessment to check that appropriate decisions are made (reducing the likelihood of objections to decisions),
- Those checking the appropriateness of the assessment on behalf of the decision-makers,
- Those checking the appropriateness of decisions based on the assessment,
- Those checking the appropriateness of the framework, guidance and tools, including the generic approach for assessing and managing flood risk (to enable continuous improvements).

Who does what depends on the type of assessment and the decision-making requirements.

[47] This can be found in the Project Record, FD2320/PR1.

## 8.5 Processes and Procedures

There are two types of auditing and control processes that should be used as part of the overall approach for assessment and management of flood risk. These are:

- An audit and control process at each milestone within the Generic Approach to assessing and managing flood risk, and
- A monitoring and review process after completion of all of the required assessment and management processes.

## 8.6 Tools and Technologies

There are both generic tools and tools specific to different assessment types available, either as part of this project FD2320 or provided in other guidance produced/being produced separately.

### 8.6.1 Generic Tools

- **Quick Reference Card**[48] – provides a simplified list of key audit questions for the Generic Approach. This list has been reproduced at the end of this guidance note, called Quick Check List.

- **Assessment Check-List**[49] – provides a full set of audit questions for each milestone point in the Generic Approach.

- **Process Health-Check** – is yet to be devised, but recommendations for how a health-check might be developed are provided in the Monitoring and Review Plan for FD2320.[50]

- **Information Management Check-Lists**[51] - two check-lists have been provided:
    - Data Control Check-List, which can be used for each data/information item required for an assessment of flood risk.
    - Information Management Health-Check, which can be used by organisations involved in assessing and managing flood risk for new development to see if they are following best practice in information management.

- **Stakeholder Engagement Check-List**[52], which is in two parts:
    - Stakeholder Selection, which can be used to check that all relevant stakeholders are identified and an appropriate approach to the engagement is determined
    - Stakeholder Review, which can be used to check the effectiveness of the stakeholder engagement from the perspective of the stakeholders (the effectiveness of the stakeholder engagement from the perspective of the assessment itself is covered by the Assessment Check-List – see above).

Table 8.1 provides a summary of which of these tools can be applied to check

- The approach to assessing and managing flood risk,
- The science behind the assessment, or
- The decisions that result from the assessment.

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[48] See Quick Reference Card in Appendix G
[49] See Assessment Check-List in Appendix F
[50] This can be found in the Project Record, FD2320/PR1.
[51] See Guidance Note S2.2 Information Management
[52] See Guidance Note S2.4 Stakeholder Engagement

**Table 8.1 – Summary of generic auditing tools**

| Generic Tool | Approach | Science | Decisions |
|---|---|---|---|
| Quick Reference Card | ● | | |
| Assessment Check-List | ● | ● | |
| Process Health-Check | ● | ● | ● |
| Information Management Check-Lists | ● | ● | |
| Stakeholder Engagement Check-List | ● | | ● |

### 8.6.2 FRA Specific Tools

There are a number of different auditing tools available covering different aspects of audit for site-specific FRAs:

- **Approach** – Guidance Note D3.5 Flood Risk Assessments provides **minimum requirements** at each milestone point (with cross-references to PPG25 and TAN15).
- **Approach** – The EA's Standing Advice[53] in the form of the Flood Risk Matrix can be used as a check for whether a FRA is required and **minimum requirements** regarding mitigation measures.
- **Science** – Guidance on **uncertainty** associated with data and information sources and modelling and mapping techniques used for FRAs is currently being produced for the FLOWS WP1biii project *Modelling and Mapping of Flood Risk*. This will include a simple method for checking the appropriateness of data sources, mapping and modelling requirements depending on the characteristics of the proposed development.
- **Decision-making** – Checklist A in the CIRIA guidance C624[54] provides a list of likely **sustainability requirements** for a planning application to be considered acceptable.
- **Decision-making** – The EA's Standing Advice can be used as a check for decision-making by the LPA for relatively small and low-risk planning applications to ensure **compliance with EA policy**.

### 8.6.3 Tools for other types of assessment

No tools specifically designed for use with NaFRAs, CFMPs, SMPs or SFRAs have been identified as currently available, although current guidance for SMPs encourages the recording of the assessment and decision-making processes in a transparent and auditable manner. The generic tools presented above, however, can be applied at to any type of assessment.

## 8.7 Audit and Control

The auditing and control system described in this guidance note should be checked and improved as part of the ongoing Process Health-Check, as recommended in the Monitoring and Review Plan.[55]

[53] Environment Agency (2003) *National Standing Advice to Local Planning Authorities for Planning Applications - Development and Flood Risk*, Environment Agency. http://www.pipernetworking.com/floodrisk/index.html
[54] Lancaster, J, Preene, M and Marshall, C (2004) *C624 Development and Flood Risk – Guidance for the Construction Industry*, CIRIA, London.
[55] This can be found in the Project Record, FD2320/PR1.

## 8.8 Implementation of this Guidance

The approach presented in this guidance note is robust and accepted as best practice through publications from the British Standards Institution (BSi).[56] It has been successfully applied to both the private and government sectors by the London School of Economics.

However, the new tools provided as part of FD2320 should be piloted alongside the framework and guidance, prior to implementation.

## 8.9 Quick Check List

**Process 1 - Problem Formulation**

1.1 Has the purpose of the plan or project and associated assessment been defined?
1.2 Can the plan or project be justified with respect to sustainability and flood management objectives?
1.3 Have the spatial and temporal boundaries of the assessment been defined?
1.4 Have the controlling factors (e.g. legislative, financial, environmental, flood management, stakeholder requirements) been identified?
1.5 Has a conceptual model been developed and baseline conditions identified?

**Process 2a - Tiered Risk Assessment**

2a.1 Have risks been screened?
2a.2 Have risks been prioritised?
2a.3 Has an intermediate assessment been carried out (if required)?
2a.4 Has a detailed assessment been carried out (if required)?

**Process 2b - Stages of Risk Assessment**

2b.1 Have the hazards been identified?
2b.2 Have the consequences been identified?
2b.3 Have the magnitudes of consequences been determined?
2b.4 Have the probabilities of the consequences been determined?
2b.5 Has the significance of the risk been determined?

**Process 3 - Options Appraisal**

3.1 Have options been identified (including 'do nothing' and 'maintain existing levels')?
3.2 Have the options been evaluated (considering social, environmental and economic objectives and technical feasibility)?
3.3 Has an assessment of flood risk been carried out for the options (if required)?
3.4 Have options been revised (if required)?
3.5 Have options been re-evaluated (if required)?
3.6 Has the preferred option been selected?

**Process 4 - Monitoring and Review**

4.1 Has it been decided whether monitoring is needed and what needs to be monitored?
4.2 Has a monitoring programme been designed (if required)?
4.3 Has monitoring been carried out (if required)?
4.4 Have monitoring results been reviewed (if required)?
4.5 Have any lessons learnt been reported?
4.6 Has the monitoring programme been reviewed (if required)?

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[56] BSI standards publications: BSI-DISC PD 0008:1999, *Code of Practice for Legal Admissibility of Information Stored on Electronic Document Management Systems* (Second Edition – subsequently updated in 2004), BSI-DISC PD 0009:1999, *Compliance Workbook* (Second Edition), BSI-DISC PD 0010:1997, *Principles of Good Practice for Information Management*.

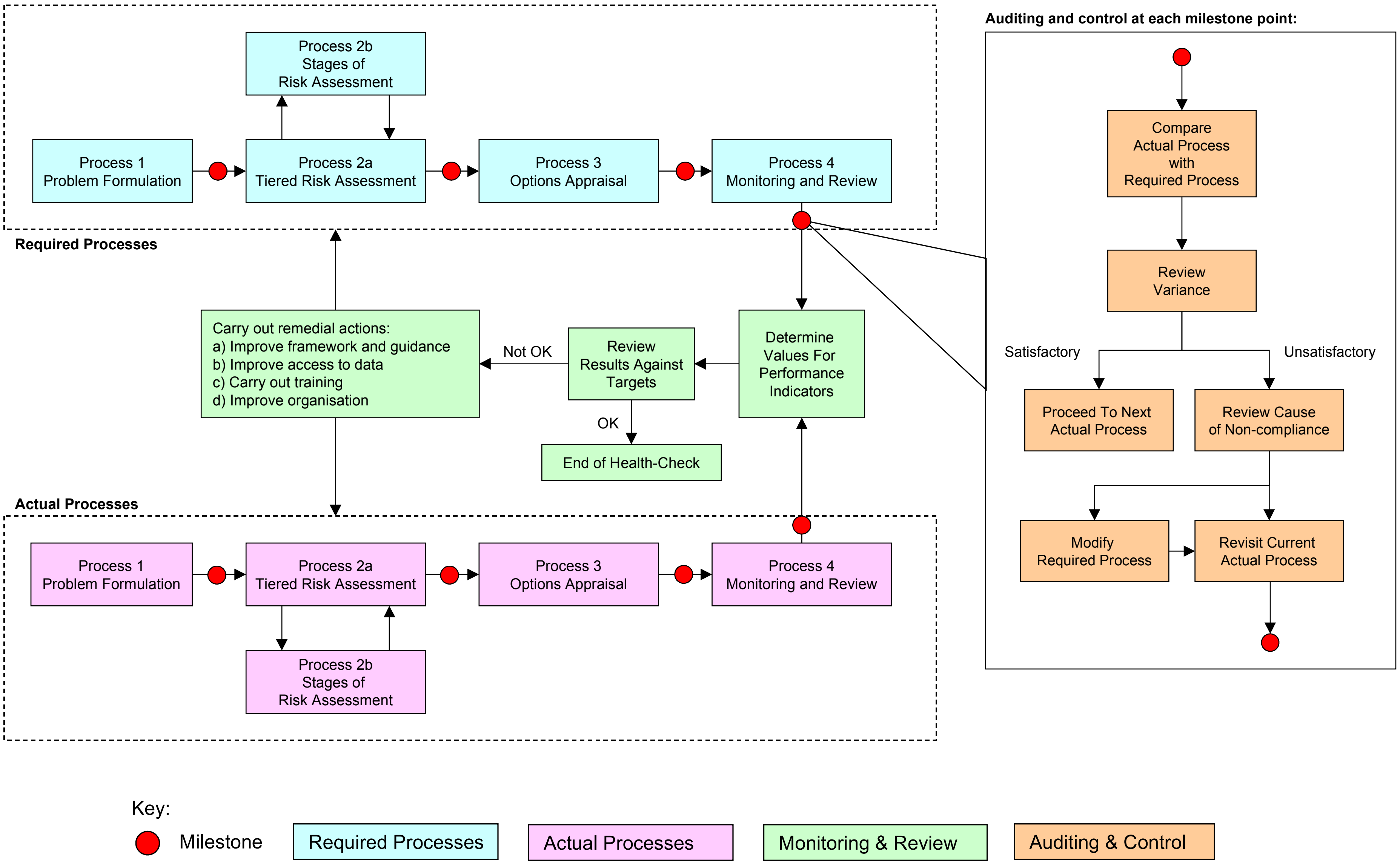


**Figure 8.2 Compliance Model for Assessing and Managing Flood Risk for New Development**

# 9. S2.4 STAKEHOLDER ENGAGEMENT

**This guidance note:**
- Provides generic guidance regarding stakeholder engagement in assessments and management of flood risk for new developments
- Takes into consideration the Defra's consultation exercise *Making Space for Water (Developing a new Government strategy for flood and coastal erosion risk management in England)*[57]
- Builds on *The Principles of Stakeholder Engagement and Consultation in Flood and Coastal Erosion Risk Management*[58], which is one of a series of background papers accompanying Defra's consultation exercise
- Builds on DETR (2000) *Guidelines for Environmental Risk Assessment and Management, 2nd edition*, The Stationary Office, London, Institute of Environmental Health.

**This guidance note does NOT:**
- Provide guidance on mandatory requirements for specific assessment types
- Supersede guidance currently provided for specific assessment types

## 9.1 Contents



## 9.2 Introduction

### 9.2.1 What is stakeholder engagement?

Stakeholder engagement enables those with an interest in the outcomes of the assessment and management of flood risk for new development to be informed about the decisions being made and to influence those decisions.

The way in which stakeholders are engaged should be proportionate to the likely impact of the policy, plan or project and the degree of debate or concern about it.

[57] http://www.defra.gov.uk/environ/fcd/policy/strategy.htm
[58] Hosking A. (2004) *The Principles of Stakeholder Engagement and Consultation in Flood and Coastal Erosion Risk Management,* Defra, http://www.defra.gov.uk/environ/fcd/policy/strategy/stakeng.htm

### 9.2.2 Why have stakeholder engagement?

Stakeholder engagement (including with the public[59]) is an essential part of a sustainable development strategy and a requirement of Sustainability Appraisals.[60]

The benefits of appropriate stakeholder engagement are numerous and can include the following:

- Decisions are soundly based on shared knowledge, experiences and scientific evidence;
- Decisions are influenced by the views of those who are likely to be affected;
- Innovative and creative options are considered;
- Outcomes are workable and acceptable to stakeholders; and
- Less delays in process at late stages.

Recent experience as part of Shoreline Management Plans has shown that stakeholder engagement, in particular early involvement of Elected Members, increases the likelihood of acceptance and understanding of recommended policies.[61] This experience also highlighted that stakeholder engagement can be time-consuming and, therefore, costly. The benefits of the process being realised more through the consultation and adoption stages rather than during the preparation.[62]

## 9.3 Data and Information

Stakeholder engagement within the assessment and management of flood risk for new development is fundamentally about:

- information transfer between individuals and organisations
- use of this information to deliver the best possible outcomes
- use of this information to promote the acceptance of these outcomes

Appropriate information transfer has to be:

- **Complete** – understanding who are the stakeholders (i.e. who is being informed or doing the informing) is achieved by determining the supply chains for the following processes:
  - Assessment process,
  - Decision-making process (including planning),
  - Implementation process (including design, construction, purchase, occupation, insurance, operation and maintenance),
  - Monitoring and review process.
- **Accurate** – correct and complete information is being transferred within the supply chains, as appropriate.
- **Timely** – the information is transferred to and from stakeholders at the appropriate time during the processes listed above (emphasis being on early contact to ensure those carrying out the assessment or decision-making have the appropriate information available to them).
- **Compliant** – the information is being transferred to and from the appropriate stakeholders and in a form that is understandable.

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[59] See ODPM (2004) *Community Involvement in Planning: The Government's Objectives*, ODPM. http://www.odpm.gov.uk/index.asp?id=1144466
[60] See Guidance Note S2.5 Linkage to Statutory Requirements
[61] Jay, H, Hosking, A, Atkinson, A and Burgess, K (2004) *The Reality of Shoreline Management Plans*, Proceedings of the 39th Defra Flood and Coastal Management Conference 2004.
[62] See Guidance Note D3.3 Shoreline Management Plans

- **Authorised –** the information is considered suitable for transfer to and from appropriate stakeholders (legality issues of confidentiality, public interest, etc. are managed effectively).[63]

## 9.4 Roles and Responsibilities

### 9.4.1 Who are the stakeholders?

Stakeholders in the assessment and management of flood risk for new development can be defined as individuals and groups with three main roles:

- Those **affected** by the flood risk or the implementation of the policy, plan or project
- Those able to **inform** the assessment of flood risk or decision-making process
- Those able to **influence** the flood risk or the policy, plan or project.

Understanding who the stakeholders are is achieved by determining the supply chains (i.e. who does what) for the following processes[64]:

- Process 1 – Problem Formulation
- Process 2 – Assessment Process
- Process 3 – Options Appraisal
- Process 4 – Monitoring and Review

The stakeholders for a particular policy, plan or project will depend on the specific nature of the policy, plan or project. A list of potential stakeholders is provided at the end of this guidance note.

It is important that the relevant stakeholders are identified as early as possible in the assessment process[65] and a decision is made regarding which stakeholders should be involved and what form that involvement should take (see Processes and Procedures).

As stated earlier, it is important that stakeholder engagement should be proportionate to the likely impact of the policy, plan or project and the degree of debate or concern about it.

To aid this process the questions in the Stakeholder Selection List (see Tools and Techniques) can be used as part of the selection process.

### 9.4.2 Who is responsible for involving the stakeholders?

Those responsible for the assessment and management of the flood risk (including the decision-makers) are collectively responsible for involving the stakeholders and deciding on the appropriate approach to engagement.

There are cases where engagement of specified stakeholders is mandatory i.e. certain parties must be involved in certain decisions; likewise certain parties are required to provide information. These requirements are currently in transition with the ongoing implementation of the Planning and Compulsory Purchase Act[66], the current review by Defra of its strategy for flood and coastal erosion

[63] Reference can be made to the following British Standards Institution document: Shipman A. (2004) *Code of Practice for Legal Admissibility and evidential weight of information stored electronically*, Third Edition, BSi, London. The principles in this document can be applied to any type of information transfer, not only electronic. These principles being based on the BSi standards publication BSI-DISC PD 0010:1997, *Principles of Good Practice for Information Management*.
[64] See Activity Chart Overview in Appendix A.
[65] See Activity Chart Process 1 – Problem Formulation, Process Part 1.1 Define Intention
[66] Planning and Compulsory Purchase Act 2004, HMSO, May 2004. http://www.legislation.hmso.gov.uk/acts/acts2004/20040005.htm

risk management in England[67] and the proposed revision of PPG25.[68] However, the current system is adequately covered by other documents/guidance produced outside of this project.

## 9.5 Processes and Procedures

Recommended points for stakeholder engagement are indicated in the generic approach to assessing and managing flood risk, with an S in an orange circle.[69] The distinction between those that are mandatory and those that are voluntary has not been made, as this depends on the type of assessment or decision-making process that is being undertaken and cannot be considered generic.

Many different methods exist for involving stakeholders and the public in decision-making. The following information can be found in *The Principles of Stakeholder Engagement and Consultation in Flood and Coastal Erosion Risk Management*:[70]

- How the stakeholder engagement process can operate effectively,
- How to develop a stakeholder engagement strategy,
- Stakeholder engagement techniques.

The key decision is whether a participatory or consultative approach is appropriate.

- A **participatory approach** would involve stakeholders in the decision-making process.
  - A **consultative approach** would involve obtaining information, view, comments, etc. from third parties for consideration. The decision-making process would remain with those responsible for the assessment.

Stakeholder engagement is now being implemented through the latest guidance for Catchment Flood Management Plans (CFMPs) and Shoreline Management Plans (SMPs), incorporating the requirements of the Water Framework Directive (WFD) and the Strategic Environmental Assessment (SEA) Directive which include stakeholder engagement.[71]

### 9.5.1 Catchment Flood Management Plans (CFMPs)

The CFMP approach[72] includes reference to establishing stakeholder engagement (Stage 2). This includes setting up a Steering Group and producing a 'Communication Plan'. Specific guidance on the consultation process is currently being drafted.

### 9.5.2 Shoreline management Plans (SMPs)

Substantial guidance regarding stakeholder engagement for SMPs is provided in Defra's *Procedural Guidance for Production of Shoreline Management Plans*[73], in particular a framework is presented in Appendix A for the 'Stakeholder Engagement Strategy'.

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[67] Defra (2004) *Making Space for Water - Developing a new Government strategy for flood and coastal erosion risk management in England*, Defra.
[68] DTLR (2001) *Planning Policy Guidance Note 25: Development and Flood Risk*. HMSO, London.
[69] See Activity Chart Key for processes
[70] See reference at beginning of this guidance note.
[71] See Guidance Note S2.5 Linkage to Statutory Requirements
[72] Environment Agency (2004) *Catchment Flood Management Plans: Guidelines Volume II – Processes and Procedures* (Fourth Draft - April 2004), Environment Agency, Bristol.
[73] Defra (2003) *Procedural Guidance for Production of Shoreline Management Plans: Interim Guidance*, Consultation Version, May 2003. The consultation report was subsequently published August 2004. The revised version of the guidance is not yet available. The consultation version of the guidance (including appendices) and the consultation report are both available at this website: http://www.defra.gov.uk/corporate/consult/smpguidance/index.htm

#### 9.5.3 Strategic Flood Risk Assessments (SFRAs)

Unlike CFMPs and SMPs, as SFRAs are separate from the plans that they inform, care needs to be taken to prevent duplication of effort in stakeholder involvement. The distinction between the SFRA and the subsequent Sub-regional Spatial Plans or Local Development Frameworks (LDFs) is not of particular relevance to many of the stakeholders.

An example of where care should be taken is public consultation.[74] Should it be decided that public consultation is a requirement of the decision-making process[75] and, hence, will influence the assessment, this should be integrated into the Sustainability Appraisals (SEA Directive) and not be carried out separately for the SFRA. It should also be integrated into the Statement of Community Involvement (SCI) required as part of a LDF. The SCI should set out the LPA's policy for involving the community in the preparation and revision of local development documents and planning applications. PPS12[76] sets out the consultation bodies that LPAs must include in the statement together with a wider list of bodies that LPAs should consider consulting. These bodies include the Environment Agency, English Heritage and the Countryside Agency.

#### 9.5.4 Site-specific Flood Risk Assessments (FRAs)

Guidance regarding stakeholder engagement for FRAs is provided in the CIRIA guidance C624[77], in particular Box 5.4 *Consultation in the FRA process* and in Sections 4.3-4.6 *Parties to flood risk and planning,* etc.

Guidance regarding the involvement of the key stakeholders (Developers, Local Planning Authority and the Environment Agency) is also provided in Guidance Note D3.5 Flood Risk Assessments.

### 9.6 Tools and Technologies

A Stakeholder Engagement Check-List is provided at the end of this guidance note. This provides two lists of questions:

- Stakeholder Selection, which can be used to check that all relevant stakeholders are identified and an appropriate approach to the engagement is determined
- Stakeholder Review, which can be used to check the effectiveness of the stakeholder engagement from the perspective of the stakeholders (the effectiveness of the stakeholder engagement from the perspective of the assessment itself is covered by the Assessment Check-List[78]).

Defra/EA R&D Project FD2010[79] produced a series of **Stakeholder Sheets** to provide specific advice to particular stakeholders. These covered the following stakeholder groups:

- Those who live and/or work on floodplains,
- Farmers and other landowners who own land in flood risk areas,
- Land use planners,
- River and coast managers (Environment Agency, Local Authority engineers, IDBs),
- Emergency services,
- Those involved with conservation and environmental enhancement,
- Those who have assets on floodplains (transport, utilities),

[74] See HM Treasury (2004) *Managing risks to the public: appraisal guidance*, Draft for consultation, HMSO, London. http://www.hm-treasury.gov.uk/media/97B/53/97B5344C-BCDC-D4B3-1F12E3FFEB34F0A0.pdf
[75] See Activity Chart Process 1 – Problem Formulation, Process Part 1.4 Identify Controlling Factors.
[76] ODPM (2004) *Planning Policy Statement 12: Local Development Frameworks,* HMSO, London.
[77] Lancaster, J, Preene, M and Marshall, C (2004) *C624 Development and Flood Risk – Guidance for the Construction Industry*, CIRIA, London.
[78] See Guidance Note S2.3 Auditing and Control
[79] Defra/EA R&D Project FD2010/TR *Guide to the Management of Floodplains to Reduce Flood Risks, Stage 1: Development Draft*, February 2003.

- Business interests (developers, insurance),
- General information for the general public who use floodplains, the media, politicians, etc.

These provide a very useful summary of the issues relating to flood risk, flood management and land use planning from the context of stakeholder groups.

## 9.7 Audit and Control

*The Principles of Stakeholder Engagement and Consultation in Flood and Coastal Erosion Risk Management*[80] recognises the need for those undertaking stakeholder engagement to know whether they are 'getting it right'. The Generic Approach in this framework provides a mechanism to do this and a Stakeholder Review has been provided at the end of this guidance note.

Remedial actions, should it be recognised that the stakeholder engagement has not been adequate, have not been explicitly considered in this guidance note.

## 9.8 Implementation of this Guidance

It is recommended that the finding of the Defra Consultation *Making Space for Water* with respect to stakeholder engagement be taken into consideration prior to implementation of any new guidance regarding stakeholder engagement (whether it is in the form of this guidance note or others). Specific questions in *Making Space for Water* are the following:

Question 4.11: Do you agree that the involvement of stakeholders in assessing risks and management options should be in the context of an agreed national framework?

Question 4.12: Do you have comments on the suggested mechanisms for involving stakeholders at each level of risk assessment?

There is already substantial guidance available in the public domain regarding carrying out stakeholder engagement for a variety of different purposes. At the present time there is a particular need regarding the auditing and control of that process. The starting point for such a process should be based on BSI-DISC PD 0010:1997, *Principles of Good Practice for Information Management*. However, there are also several ongoing R&D projects and initiatives that include identification of stakeholder needs, involving stakeholders to a greater degree in the decision-making process and monitoring participation.[81] Most of these projects are in their infancy, therefore, it is unclear exactly what will be provided as output, but potentially these projects will provide the currently missing links in the overall stakeholder engagement process.

The Stakeholder Sheets drafted as part of the Defra/EA R&D Project FD2010 could be updated and provide a useful dissemination tool at the start of the stakeholder engagement process.

[80] See reference at beginning of this guidance note.
[81] In particular the Flood Risk Management Research Consortium theme *Stakeholder and Policy*

## 9.9 Stakeholder Engagement Check-List

### 9.9.1 Stakeholder Selection

1. Who will potentially be affected by
   a) The risk and the consequences of the flooding?
   b) The implementation of the policy, plan or project?

2. Which parties or individuals have knowledge and expertise that may be useful to inform
   a) Process 1 – Problem Formulation?
   b) Process 2 – Assessment Process?
   c) Process 3 – Options Appraisal?
   d) Process 4 – Monitoring and Review?

3. Which parties or individuals have expressed an interest in this particular, or a similar type of, assessment?

4. Which stakeholders will be prepared to listen, respect diverse viewpoints and be prepared to negotiate?

5. Which stakeholders should be engaged on a
   a) Consultation basis?
   b) Participation basis?

These questions are based on those given in Chapter 3 - The social aspects of risk of *Guidelines for Environmental Risk Assessment and Management*[82].

### 9.9.2 Stakeholder Review

1. How many of the relevant stakeholders were involved in each of the following processes:
   a) Process 1 – Problem Formulation?
   b) Process 2 – Assessment Process?
   c) Process 3 – Options Appraisal?
   d) Process 4 – Monitoring and Review?

2. How many of the involved stakeholders understood:
   a) Their role in the process?
   b) The roles of others in the process?

3. How many of the involved stakeholders thought:
   a) Their involvement was worthwhile?
   b) Their involvement made a difference to the outcome?
   c) Their views were heard and acted upon adequately and appropriately?
   d) The views of others were heard and acted upon adequately and appropriately?

4. How many of the involved stakeholders volunteered to:
   a) Give feedback on the stakeholder engagement process?
   b) Be involved in follow-on assessment processes/stages?
   c) Implement outcomes?
   d) Be involved in similar initiatives in the future?

These questions are based on the example indicators given in *The Principles of Stakeholder Engagement and Consultation in Flood and Coastal Erosion Risk Management*.

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[82] DETR (2000) *Guidelines for Environmental Risk Assessment and Management, 2nd edition*, The Stationary Office, London, Institute of Environmental Health

## 9.10Stakeholders and their Roles

It should be noted that responsibilities can vary between areas. The following is a summary of the most common responsibilities, but should not be treated as exhaustive.

| *Stakeholder* | *General responsibilities* | *Responsibilities in flood risk management and/or development planning* |
|---|---|---|
| **Those who live and/or work on floodplains** | | |
| **Householders/ business owners, farmers, other landowners**<br>Note:<br>Whilst this list primarily refers to those who live and work on floodplains, others outside the floodplains are affected by loss of services, business disruption, etc. | • Property ownership.<br>• Land management.<br>• Drainage of land and management of flows from adjoining land. | • Carry out self help<br>• Prevent adverse drainage impacts<br>• Private flood defences<br>• Riparian owners with land adjacent to Ordinary Watercourses are responsible for maintenance including banks, paths and prevention of erosion<br>• Be aware, be prepared and respond to flood emergencies<br>• Act as Flood Wardens<br>• Residents and businesses need to be engaged in preparing emergency plans |
| **Local residents associations and community groups** | • Raising awareness<br>• Community co-ordination | • Have a neighbour support system<br>• Distribute information<br>• Recruit Flood Wardens |
| **Those with land use planning functions** | | |
| **Regional Assemblies** | • Set strategic priorities and decisions that affect their region | • Prepare draft Regional Spatial Strategies (RSSs) (superseding the Regional Planning Guidance (RPGs)), the main purpose being to provide a regional framework for the preparation of local development plans<br>• Consult public and any interested parties on draft RSSs before submission to Secretary of State<br>• Discourage LDFs and planning applications that are not in conformity with the RSS |
| **County Councils and Unitary Authorities** | • Strategic Planning | • Produce mineral and waste plans for LDFs<br>• Identify strategic planning requirements regarding transport, education, etc.<br>• Regulate mineral and waste developments<br>• Act as consultee on development proposals referred to them from the District Councils |

| *Stakeholder* | *General responsibilities* | *Responsibilities in flood risk management and/or development planning* |
|---|---|---|
| **District Councils and Unitary Authorities** | • Land Use Planning.<br>• Administration of Building Regulations. | • Obtain information from the EA regarding flood risk areas<br>• Obtain advice from the EA regarding flood risk (strategic level)<br>• Prepare Strategic Flood Risk Assessments<br>• Prepare Local Development Frameworks (LDFs) (superseding the Local Plans) including application of the sequential test as specified in PPG25<br>• Provide advice to Developers prior to submission of planning applications, regarding flood risk and any planning requirements to satisfy both the planning authority and the EA on the issues of flood risk and runoff implications of the development and whether an Environmental Statement is required<br>• Obtain advice from the EA regarding the flood risk to a proposed development and its likely risk to other developments when reviewing planning applications<br>• Obtain advice from other bodies with an interest in runoff issues including sewerage undertakers, British Waterways, Internal Drainage Boards<br>• 'Determine' planning applications (both outline and full) submitted by Developers and apply conditions if deemed necessary<br>• Negotiate planning obligations with Developers (including appropriate mitigation measures off-site).<br>• Administer Building Regulations<br>• Record and report to Defra (jointly with the EA) instances where the LPA has decided not to follow EA advice (due to other material considerations)<br>• Report to Secretary of State any instances where the LPA has decided to grant permission that is a departure from the policies laid down in the LDF<br>• Enforce planning conditions applied to developments<br>• Attend planning appeals/public inquiries |
| **River, drainage and coastal managers ('Operating Authorities')** | | |
| **Regional Flood Defence Committees** | • Flood defence responsibilities. | • Decide priorities for flood defence works in the Region<br>• Decide how much money is to be raised for flood defence work in the Region |

| *Stakeholder* | *General responsibilities* | *Responsibilities in flood risk management and/or development planning* |
|---|---|---|
| **Local Flood Defence Committees** | • Flood defence responsibilities. | • Fulfil similar role to the RFDCs but covering smaller areas (It is currently proposed to create a single tiered flood defence committee system, which would result in the abolition of the LFDCs.) |
| **Environment Agency** | • Implementing Government policy.<br>• General supervision over all matters relating to flood defence.<br>• Main Rivers and coasts.<br>• Maintenance of Main Rivers including debris removal. | • Provide floodplain mapping.<br>• Maintain and carry out improvement works on rivers and coasts.<br>• Provide and maintain flood defences on Main Rivers and coasts.<br>• Continuously monitor rainfall and hydrometric data<br>• Issue levies to local authorities regarding operating costs of defences and new defences<br>• Provide representatives for the RFDCs<br>• Carry out River Basin Management Plans (future requirement of the Water Framework Directive)<br>• Carry out Catchment Flood Management Plans – studies to look at flood risk on a catchment wide basis<br>• Enforce flood defence legislation<br>• Act as a planning consultee<br>• Provide advice on all flooding matters<br>• Regulate development within a prescribed distance of a main watercourse or associated defence (consent is required before construction)<br>• Record and report to Defra (jointly with the planning authority) instances where the LPA has decided to not follow EA advice (due to other material considerations)<br>• Provide support to the planning authority at planning appeals by supplying evidence and attending hearings |
| **Local Authorities (District Councils, Unitary Authorities, London Boroughs).** | • General duties of care.<br>• Ordinary Watercourses.<br>• Coast protection.<br>• Amenity and recreation. | • Operate and maintain sea defences (maritime authorities)<br>• Provide new sea defences (maritime authorities)<br>• Carry out works to prevent erosion of the coastline (maritime authorities)<br>• Operate and maintain flood defences on ordinary watercourses (if outside an Internal Drainage District (IDD))<br>• Provide new flood defences on ordinary watercourses (if outside an IDD)<br>• Provide local information on flood risk |

| *Stakeholder* | *General responsibilities* | *Responsibilities in flood risk management and/or development planning* |
|---|---|---|
| **Internal Drainage Boards (IDBs)** | • Drainage of land in Drainage Districts. | • Maintain and improve ordinary watercourses<br>• Operate and maintain flood defences on ordinary watercourses<br>• Provide new flood defences on ordinary watercourses<br>• Provide advice regarding local information on flood risk<br>• Regulate development within a prescribed distance of an ordinary watercourse or associated defence (consent is required before construction) |
| **Water companies** | • Stormwater drainage.<br>• Combined systems.<br>• Sewer flooding including foul flooding. | • Maintain and carry out works on adopted drainage systems (including SUDS) |
| **Those who are responsible for emergency planning, response and flood recovery** | | |
| **Environment Agency** | • Flood warning.<br>• Emergency response. | • Carry out flood forecasting<br>• Issue flood warnings<br>• Provide assistance in flood emergencies<br>• Monitor and repair flood defences<br>• Clear blockages<br>• Collect data on flood events |
| **Met Office** | • Weather forecasting. | • Forecast extreme weather and tidal surges. |
| **Police** | • Law and order. | • Flood emergency planning.<br>• Co-ordinate emergency response.<br>• Interpretation of EA flood warnings<br>• Public safety.<br>• Evacuation. |
| **Local Authorities (County Councils, District Councils and Unitary Authorities)** | • Emergency planning<br>• Emergency response | • Carry out flood emergency planning<br>• Interpretation of EA flood warnings<br>• Provide a flood emergency response including road diversions, rest centres and clearing watercourses.<br>• Provide welfare assistance for flood victims<br>• Co-ordinate voluntary organisations.<br>• Clear up and recovery. |
| **Fire Service** | • Emergency response particularly fires, road accidents, etc. | • Carry out flood emergency planning<br>• Provide emergency response including rescue<br>• Provide pumping out<br>• Deal with pollution clean up |
| **Health Service** | • Public health. | • Provide health support to those affected by floods.<br>• Carry out R&D into health impacts of flooding |

| *Stakeholder* | *General responsibilities* | *Responsibilities in flood risk management and/or development planning* |
|---|---|---|
| **Media** | • News reporting and communication. | • Transmit flood warnings<br>• Carry out awareness raising<br>• Provide information<br>• Provide public reassurance |
| **Voluntary sector** | | • Provide assistance in flood emergencies and recovery |
| **Those involved with nature conservation and environmental enhancement** | | |
| **Nature Conservation bodies** | • Conservation and environmental enhancement. | • Manage conservation areas<br>• Provide advice on conservation matters in flood risk areas |
| **Environment Agency** | • Conservation and environmental enhancement. | • Provide schemes for environmental enhancement<br>• Provide advice on conservation matters<br>• Provide advice on whether an Environmental Statement is required |
| **Policy makers and other supervisory organisations** | | |
| **Office of the Deputy Prime Minister (ODPM)** | • Town and Country Planning.<br>• National planning policy for England (PPGs) | • Provide guidance on development and flood risk (including PPG25).<br>• 'Call-in' planning applications and appeals to Secretary of State (which may be transferred to the Planning Inspectorate)<br>• Directions on, approval of and issue of Regional Spatial Strategies (RSSs) (superseding the Regional Planning Guidance (RPGs)) for each region (drafted by the Regional Assemblies)<br>• Directions and approvals of LDDs, if there are issues of national or regional importance or extend beyond the LPA's area<br>• Prepare regulations regarding the SEA |
| **National Assembly of Wales** | • National planning policy for Wales (Planning Policy Wales) | • Provide guidance on development and flood risk (including TAN15).<br>• Similar responsibilities as ODPM described above. |
| **Department of the Environment, Food and Rural Affairs (Defra)** | • Policy.<br>• Strategic guidance.<br>• Provision of funding. | • Provide national policies for England and Wales regarding flood and coastal defence, reservoir safety, groundwater and water quality<br>• Act as the central government sponsor for the EA<br>• Act as the central government sponsor for English Nature<br>• Provide funding for flood defence work in England<br>• Provide funding for R&D<br>• Appoint members to the RFDCs |

| *Stakeholder* | *General responsibilities* | *Responsibilities in flood risk management and/or development planning* |
|---|---|---|
| **Welsh Assembly Government** | • Delegated powers from the National Assembly of Wales | • Provide funding for flood defence work in Wales<br>• Sponsor the EA in Wales |
| **Planning Inspectorate** | • Executive Agency within the ODPM | • Hold inquiries for appeals and 'called-in' planning applications (to be attended by the applicant, LPA, EA and other third parties that have a specific involvement in the application or objection, such as English Heritage, English Nature, etc.)<br>• Hold examinations in public of RSSs and Local Development Frameworks. |
| **Regional Government Offices** | • Represent government departments in the regions (including Defra, DfT and DTi)<br>• Report to the ODPM | • Publish results of public examination of RSSs |
| **Regional Development Agencies** | • Reports to the DTi<br>• Reports to the relevant Regional Assembly<br>• Prepare Regional Economic Strategies | |
| **Local Government Association (LGA)** | • Local authority co-ordination. | • Co-ordinate on flooding matters. |
| **Office of Water services (OFWAT)** | • Economic regulation for the water and sewerage industry in England and Wales | • Sets price limits for the water and sewerage service providers, which in turn influences capital investment and operational and maintenance programmes<br>• Ensures companies are able to carry out their responsibilities under the Water Industry Act 1991<br>• Protects the standard of service |
| **Association of Drainage Authorities (ADA)** | • IDB co-ordination. | • Co-ordinate on flooding matters. |
| **Building Regulations Advisory Committee** | • Building Regulations. | • Provide regulations for flood proofing of buildings |
| **Those who have assets on floodplains (transport, utilities)** | | |
| **Highway Authorities (County and District)** | • Roads. | • Provide highway drainage<br>• Maintain floodplain structures<br>• Act as a consultee for Local Development Frameworks<br>• Use 'powers of direction' on planning applications |

| *Stakeholder* | *General responsibilities* | *Responsibilities in flood risk management and/or development planning* |
|---|---|---|
| **Highways Agency** | • Trunk roads and motorways. | • Provide highway drainage<br>• Maintain floodplain structures<br>• Act as a consultee for Local Development Frameworks<br>• Use 'powers of direction' on planning applications |
| **Railtrack** | • Railways. | • Provide railway drainage<br>• Maintain floodplain structures. |
| **British Waterways** | • Canals<br>• Navigable waterways | • Protect structures<br>• Manage floodwater within BW systems |
| **Sewerage Undertakers** | • Surface water drainage (via storm or combined sewerage)<br>• Development drainage where this is via adopted sewers (either foul, storm or combined) | • Provide waste water disposal (via foul or combined sewerage) and treatment<br>• Discharge treated effluent to surface water bodies (under consent from the EA)<br>• Assess planning proposals in the light of the impact on the receiving sewerage system (The undertaker may object to the proposal; the local authority will usually take note of the objection and agree suitable changes with the developer.) |
| **Utilities (other)** | • Services (electricity, gas, water supply, communications, etc.). | • Provide utilities<br>• Maintain services<br>• Ensure safety of services<br>• Provide information on service disruption<br>• Supply alternative services during disruption<br>• Carry out clean up/repair |

| *Stakeholder* | *General responsibilities* | *Responsibilities in flood risk management and/or development planning* |
|---|---|---|
| **Private sector organisations** | | |
| **Developers** | • New developments | • Check national and regional planning policy guidance<br>• Check local planning policy guidance and carry out pre-application discussions with the planning authority<br>• Consult with the EA regarding known flooding problems, records of river levels and flows, scope of FRA required, etc.<br>• Consult with other bodies responsible for flood defence (such as Local Authorities and IDBs)<br>• Prepare planning applications (both outline and/or full) for the planning authority, with due consideration for any development policies defined in the planning authority's development plan and any national/regional planning policies<br>• Provide an assessment of whether a proposed development is likely to be at risk from flooding and whether it will affect flood risk elsewhere with any application for planning permission (outline or full)<br>• Demonstrate to the planning authority that any flood risk to a proposed development or additional risk elsewhere will be successfully managed with minimal environmental effect, to ensure that the site can be developed and occupied safely (at outline planning stage, if carried out in 2 stages)<br>• Apply for consent from the EA or IDB regarding development within prescribed distances of watercourses and flood defences<br>• Carry out an Environmental Impact Assessment, if an Environmental Statement is required<br>• Provide an Environmental Statement along with the planning application, if required<br>• Appeal/negotiate with planning authority over applications that have been refused<br>• Appeal (as a last resort) to Secretary of State/Planning Inspectorate against planning applications that have been refused or specific conditions in the approval.<br>• Negotiation of planning obligations with the planning authority.<br>• Provide and maintain flood defence/mitigation measures (including flood warning) or contribute to works undertaken by flood defence authorities<br>• Provide flood information for householders<br>• Carry out self certification of Building Regulations |

| *Stakeholder* | *General responsibilities* | *Responsibilities in flood risk management and/or development planning* |
|---|---|---|
| **Insurance companies** | • Insurance of properties and other assets.<br>• Encourage action by Clients to reduce risk. | • Provide insurance<br>• Set conditions for provision of insurance<br>• Provide financial rewards for reduced risk |
| **ABI** | • Representative body for insurance companies. | • Co-ordinate insurance industry flooding matters.<br>• Ensure fairness of insurance cover |
| **Professional bodies** | • Professional standards.<br>• Technical advances. | • Promote good practice |
| **Public sector organisations** | | |
| **Defra/EA R&D Programme** | • Technical advances. | • Develop new science, tools and techniques<br>• Consult industry to establish R&D needs |

## 9.11Floodplain Management Responsibility Matrix

| Stakeholders | Activity | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Land use planning | Flood management policy | Flood defence: Coasts | Flood defence: Main River | Flood defence: Drainage Districts | Flood defence: Ordinary watercourses | Flood plain structures | Flood forecasting | Flood warning dissemination | Flood awareness | Flood preparedness | Emergency response | Post-flood clean-up and recovery | Improved knowledge |
| Flood-prone community | X | | | | | | | | | X | X | | X | |
| Land owners in floodplains | X | | X | | | X | X | | | X | X | | X | |
| Environment Agency | X | X | X | X | | | X | X | X | X | X | X | X | X |
| Flood Defence Committees | | X | X | X | | | | | | | | | | |
| Local Authorities | X | X | X | | | X | X | | X | X | X | X | X | |
| Internal Drainage Boards | X | | | | X | | X | | | X | X | X | X | |
| Police | | | | | | | | | X | | X | X | | |
| Fire Service | | | | | | | | | | | X | X | X | |
| Health Service | | | | | | | | | | | X | X | | |
| Voluntary organisations | | | | | | | | | | X | X | X | X | |
| Media | | | | | | | | | X | X | | | | |
| Conservation bodies | X | | X | X | X | X | X | | | | X | | X | |
| Defra | | X | X | X | X | X | | X | | X | | | | X |
| ODPM | X | | | | | | | | | X | | | | |
| LGA / ADA/ ABI | | | | | | | | | | | | | | X |
| Railtrack / highway authorities | | | | | | | X | | | | X | | X | |
| Utilities | | | | | | | X | | | | X | | X | |
| Developers | X | | | | | | X | | X | X | X | | | |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Insurance companies | | | | | | | | | | X | X | | X | X |
| Professional bodies | | | | | | | | | | X | | | | X |

# 10.S2.5 LINKAGE TO STATUTORY REQUIREMENTS

**This guidance note:**

- Provides a link to Directives, Acts, Regulations, Orders and Bylaws that relate to Development Planning and assessments of flood risk
- Provides summary information regarding four key areas of legislation that influence the approach to the assessment and management of flood risk for new development and should be integrated into development planning to a greater degree. (This guidance note recognises this as an additional research and development requirement.)

**This guidance note does NOT:**

- Provide a definitive list of all statutory requirements that need to be taken into consideration when assessing and managing flood risk for new development. The responsibility for determining the relevant statutory requirements remains with the bodies carrying out the assessments and managing the flood risk.

## 10.1Contents



## 10.2Introduction

The Information Chart provided as part of the framework contains a worksheet called Statutes & Regulations. In this worksheet can be found a list of 44 Directives, Acts, Regulations, Orders and Bylaws that relate to Development Planning and assessments of flood risk, including those referred to in this guidance note. Where available, a hyperlink to the website containing the relevant documents is provided.

The CIRIA guidance C624[83] (in particular Appendix A1) lists relevant planning regulations (as they existed in March 2004) including the Land drainage Act 1991, the Water Resources Act 1991, Internal Drainage District byelaws and other byelaws with which the Environment Agency (EA) must comply. PPG25[84] (in particular Appendix B) also provides a list of relevant legislation.

During the consultation process of project FD2320, the following statutory requirements were identified as requiring further integration into the framework for development planning:

- Environmental Impact Assessments (EIAs),
- Strategic Environmental Assessments (SEAs) as part of Sustainability Appraisals,
- River Basin Management Plans (RBMPs) and the Water Framework Directive (WFD), and
- Habitats Directive.

These have been summarised in the sections below.

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[83] Lancaster, J, Preene, M and Marshall, C (2004) *C624 Development and Flood Risk – Guidance for the Construction Industry*, CIRIA, London.
[84] DTLR (2001) *Planning Policy Guidance Note 25: Development and Flood Risk*. HMSO, London.

## 10.3 Environmental Impact Assessment (EIA) Requirements

Where a proposed development is likely to have a significant effect on the environment, an Environmental Impact Assessment (EIA) must be carried out under the Town and Country Planning (Environmental Impact Assessment) (England and Wales) Regulations 1999. The requirement for EIA comes from a European Directive (85/33/EEC as amended by 97/11/EC).

EIAs are site-specific and, therefore, if relating to a new development the EIA needs to be carried out by the Developer of the site. The Developer should contact the Local Planning Authority (LPA) as early as possible to determine whether such an assessment is required and, if so, what it should cover.

However, there are other occasions where EIAs might be required in relation to development planning, which might not fall under the responsibility of the Developer but with a public body. An example of this is land drainage improvements that are classified as permitted development under the General Permitted Development Order 1995 under the Environmental Impact Assessment (Land Drainage Improvement Works) Regulations 1999.

The impact of development on flood risk is likely to be a significant element in the EIA, particularly where it is likely to impact on designated conservation sites or compromise river and shoreline management options or biodiversity action plans (BAPs).

Further advice can be found in the DETR Circular 02/99[85] and the *Environmental impact assessment: guide to procedures*.[86]

## 10.4 Strategic Environmental Assessment (SEA) Requirements

The European Union Directive 2001/42/EC "on the assessment of the effects of certain plans and programmes on the environment" was transposed into UK legislation in July 2004 with "The Environmental Assessment of Plans and Programmes Regulations". The Directive does not use the term "Strategic Environmental Assessment", but it is generally referred to as "the SEA Directive".

Every organisation responsible for development plans, whether regional or local, has to adhere to the SEA Directive.[87] The SEA, as part of a development plan, fulfils a similar role to the EIA required for site-specific development proposals. Unlike EIAs, however, that are only required for developments likely to have a significant effect on the environment, all development plans will require a SEA.

The SEA Directive promotes an objectives-led approach and includes requirements for:

- Baseline environmental data gathering,
- Identification of environmental opportunities and constraints,
- Environmental appraisal of alternatives, and
- Consultation with environmental bodies and the public[88].

Under the Planning and Compulsory Purchase Act 2004, Sustainability Appraisals[89] are mandatory for regional and local plans. These Appraisals should meet the requirements of the SEA Directive in full, but widen the Directive's approach to include social and economic as well as environmental issues.

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85 DETR (1999) *Environmental impact assessment,* DETR Circular 02/99, HMSO, London.
86 http://www.odpm.gov.uk/index.asp?id=1143250
87 Further information can be found in ODPM (2003) *The Strategic Environmental Assessment Directive: Guidance for Planning Authorities*, ODPM, London. http://www.odpm.gov.uk/index.asp?id=1143289
88 See Guidance Note S2.4 Stakeholder Engagement
89 ODPM (2004) *Sustainability Appraisal of Regional Spatial Strategies and Local Development Frameworks*, Consultation Paper September 2004, ODPM, London. http://www.odpm.gov.uk/index.asp?id=1161341

Effectively, the SEA (in the form of an Environmental Report) will form one part of the Sustainability Appraisal.[90]

To be fully effective, the SEA must be fully integrated into the plan-making process starting as soon as a new or revised plan is first considered, and inputting at each stage where decisions are taken. Detailed records[91] of risk assessments, consultations and decisions form part of the environmental assessment.

Many of these requirements are already established in Government guidance as good practice in plan-making and Sustainability Appraisals.[92] This continues to be the case in the framework and guidance that this guidance note forms part of, as the SEA requirements have shaped the stages and many of the activities in the Generic Approach, with the intention that compliance with the Generic Approach will enable compliance with the SEA Directive.

A similar approach has been adopted for Catchment Flood Management Plans (CFMPs), which will contain an Environmental Report as described in the SEA regulations. The CFMP guidance[93] is designed to enable compliance with the SEA Directive.

Defra also recommends that operating authorities undertake an environmental appraisal of their SMPs in line with the approach of the SEA Directive. Experience from the pilot studies undertaken for testing the Interim Guidance for SMPs[94,95] suggests that the procedures are broadly compliant with the requirements of the SEA Directive and only need to be supplemented by appropriate reporting of environmental factors. This experience will be incorporated into the revised guidance.

#### 10.4.1 Roles and Responsibilities

As stated earlier, every organisation responsible for development plans, whether regional or local, has to adhere to the SEA Directive.

The ODPM is the lead Government Department on implementing the SEA Directive in both England and Wales, although responsibility for its application to plans and programmes in Wales lies with the National Assembly of Wales.

The Environment Agency has its own requirements to adhere to the SEA Directive in relation to its own plans and programmes. However, in relation to Development Planning, it acts as one of a number of statutory consultation bodies. These being:

| **England** | **Wales** |
|---|---|
| Countryside Agency | Countryside Council for Wales |
| English Heritage | Environment Agency Wales |
| English Nature | Welsh Assembly Government |
| Environment Agency | |

[90] See Activity Chart Sustainability Appraisals
[91] See Guidance Note S2.1 Reporting
[92] A guidance sheet on Sustainability Appraisals from the context of flood and coastal management can be found in Wade *et al.* (unpublished) *Sustainable Flood and Coastal Management, Technical Report, Part 1: Handbook,* Defra/EA R&D Technical Report FD2015/TR1, due to be issued December 2005.
[93] Environment Agency, Defra and The Welsh Assembly (2004) *Catchment Flood Management Plans, Guidelines Volume I1 – Processes and Procedures*, Environment Agency, Bristol.
[94] Defra (2003) *Procedural Guidance for Production of Shoreline Management Plans: Interim Guidance*, Consultation Version, May 2003.
[95] Jay, H, Hosking, A, Atkinson, A and Burgess, K (2004) *The Reality of Shoreline Management Plans*, Proceedings of the 39th Defra Flood and Coastal Management Conference 2004.

Full details of the EA's roles and responsibilities associated with the SEA Directive (plus further guidance regarding carrying out SEAs can be found on the EA's website *Good Practice Guidelines for Strategic Environmental Assessment*.[96]

## 10.5Water Framework Directive (WFD) Requirements

The purpose of the European Community Directive 2000/06/EC[97,98] (known as the Water Framework Directive) is to establish a strategic framework for managing the whole water environment (quantity, quality and economy). This includes groundwater and surface waters (defined as rivers, canals, lakes, reservoirs, estuaries and coastal waters (defined in England and Wales as 1 mile from the shore)). This is to be achieved through the production of River Basin Management Plans. The first set of plans must be published by December 2009, having consulted on a draft plan at least one year beforehand.

The purpose of RBMPs is to set out the objectives for the water bodies within each river basin district and to explain in broad terms how they are to be achieved. The plans will include a register of more detailed programmes and management strategies that have been prepared for each river basin district. These will include CFMPs, SMPs, Coastal Zone Management Plans, Water Level Management Plans, Local Environment Agency Plans, Catchment Abstraction Management Strategies, Fisheries Action Plans, etc. and will provide a solid foundation for delivering some of the actions required by the Directive.

Although the content of many existing plans and strategies were designed prior to the WFD, the principles behind them remain robust and relevant to the integrated river basin approach. Plans that have been developed since the WFD, such as CFMPs, have been specifically designed to inform and support RBMPs. As mentioned earlier CFMPs will be one of several statutory/non-statutory plans supporting the RBMPs. In particular, the CFMP will be necessary to determine appropriate actions that contribute to the Programme of Measures within RBMPs.

The WFD does not directly address flood risk and flood management issues. However, addressing water quality/ecology issues and mitigating flooding are often linked, sometimes with clear benefits for both requirements, sometimes with what at first appear to be contrary requirements. Examples include the following:

**Primarily flood risk and management driven:**

- use of SUDS, reducing the runoff signature from a development site, enabling groundwater recharge and improving water quality discharges to watercourses

- measures to improve conveyance capacity such as straightening or deepening of channels, construction of flood banks, flow structures, etc, altering the morphological state of the watercourse

**Primarily water quality/ecology driven:**

- measures to reduce soil erosion and transport into watercourses, enabling watercourses to meet water quality standards and leading to an increased conveyance capacity

- river restoration or removal of flood banks to improve ecological status, may result in a reduction in the standard of protection

[96] http://www.environment-agency.gov.uk/aboutus/512398/830672/?lang=_e&version=1&
[97] Directive 2000/06/EC of the European Parliament and of the Council establishing a framework for the Community action in the field of water policy.
[98] Implemented in England and Wales as The Water Environment (Water Framework Directive) (England and Wales) Regulations 2003.

The design of any development that might affect the natural processes within a catchment should be consistent with the requirements of the relevant RBMPs (i.e. these requirements should be considered as controlling factors in the assessment process[99]). The relevant flood defence agencies should advise Developers of the requirements held within these plans.

The RBMP requirements should also be revisited once carrying out the monitoring and review process[100], as these may influence the monitoring programme.

Further information on the WFD with respect to flood management can be found in the *Background note on the Water Framework Directive and flood and coastal erosion risk management*[101], provided with the Defra consultation exercise *Making space for water*.[102]

As of March 2005, the Environment Agency will define the objectives, structure, work programme, outputs, etc. for its WFD Programme.[103] The programme will establish the foundation for the implementation and operation of an effective River Basin Management approach in England and Wales.

## 10.6Habitats Directive Requirements

The purpose of the European Community Directive 92/43/EEC[104,105] (known as the Habitats Directive) is to contribute towards ensuring biodiversity through the conservation of natural habitats and of wild fauna and flora in the member states. It establishes a system of protection for certain fauna, flora and habitats deemed to be of European conservation importance. There is a range of measures including:

- conservation of features in the landscape that are important for wildlife
- protection of listed species from damage, destruction or over-exploitation
- surveillance of natural habitats and species
- selection, designation and protection of Special Areas of Conservation

In relation to Development Planning, the requirements of this Directive (due to proximity to certain fauna, flora, habitats or Special Areas of Conservation) primarily act as controlling factors in the assessment process[106] and would be taken into consideration as part of the SEA or EIA. The requirements of such locations should also be revisited once carrying out the monitoring and review process[107], as these may influence the monitoring programme.

Should the development be in a coastal area, it is necessary to check whether there is a Coastal Habitat Management Plan (CHaMP) for the area, prepared by English Nature and the EA. They are intended to assist in the development of sustainable coastal defence strategies in those areas where coastal defence measures have implications for internationally important wildlife sites, i.e.:

- Special areas of conservation (SACs) under the EU Habitats Directive;
- Natura 2000 sites under the EU Habitats Directive;
- Special protection areas (SPAs) under the EU Birds Directive; and

[99] See Activity Chart Process 1 – Problem Formulation
[100] See Activity Chart Process 4 – Monitoring and Review
[101] http://www.defra.gov.uk/environ/fcd/policy/strategy/wfd.htm
[102] Defra's consultation exercise *Making Space for Water (Developing a new Government strategy for flood and coastal erosion risk management in England)* http://www.defra.gov.uk/environ/fcd/policy/strategy.htm
[103] Forrow D and Knight S (2004) *Water Framework Directive Programme, Programme Definition Document & Programme Plan - Summary Version*, Draft 1.0 – August 2004, Environment Agency.
[104] European Community Directive 92/43/EEC on the conservation of natural habitats and of wild flora and fauna
[105] Implemented in England and Wales through the Conservation (Natural Habitats, etc.) Regulations 1994
[106] See Activity Chart Process 1 – Problem Formulation
[107] See Activity Chart Process 4 – Monitoring and Review

- Wetlands protected under the Ramsar convention.

CHaMPs are a new form of plan, which is currently being trialled. The aim is to integrate them into SMPs and their associated implementation strategies. It is proposed that a CHaMP would be a Management Plan under the terms of this Directive.

# 11.S3.1 CLIMATE CHANGE

**This guidance note:**

- Describes how climate change should be taken into account in development planning.
- Presents Defra/Environment Agency precautionary allowances for climate change and discusses more detailed approaches for assessing the impacts of climate change on flood risk.

## 11.1 Contents



## 11.2 Introduction

In a warming climate, rising sea levels and changing patterns in seasonal rainfall will increase pressure on flood risk management systems. There is still considerable uncertainty regarding the amounts of warming and its likely impact on flood risk over the next 100 years. Its potential impact on flood risk was assessed as part of the *Foresight* project on Future Flooding in the UK.[108] This study showed that risks increase under all climate change scenarios and to unacceptable levels for some scenarios. It demonstrated the need to develop long-term policies to adapt to an evolving and uncertain future.

The EA's long-term objective on climate change is to achieve significant cuts in the emissions of greenhouse gases and for society as a whole to take account of, and be prepared for, the probable changes to our climate. This means that climate change must be considered in planning future development to prevent increasing the risks of property damage, serious harm or deaths from flooding.[109]

## 11.3 Data and Information

### 11.3.1 Precautionary Allowances

The EA and Defra have adopted a precautionary approach in assessing the impacts of climate change on flood risk. This includes the use of standard precautionary allowances to account for rises in sea level, changes in wave height and river flows over the next 50 years. These allowances are NOT forecasts, or projections or scenarios linked to levels of greenhouse gas emissions. They are simple precautionary allowances, endorsed by Defra and based on research.[110, 111, 112]

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[108] Office of Science & Technology (2004) *Foresight Future Flooding Scientific Summary* Volumes I and II.
[109] Environment Agency (2002) *Making it Happen Corporate Strategy 2002-2007.*
[110] HR Wallingford (2003) *UK Climate Impacts Programme 2002 Climate Change Scenarios: Implementation for Flood and Coastal Defence: Guidance for Users*, R&D Technical Report W5B-029/TR
[111] HR Wallingford (2003) *UK Climate Impacts Programme 2002 Climate Change Scenarios: Implementation for Flood and Coastal Defence: User needs, scenario components and recommendations*, R&D Project Record W5B-029/PR
[112] HR Wallingford (2003) *Dependence between extreme sea surge, river flow and precipitation: a study in south and west Britain*, R&D Interim Technical Report FD2308/TR3, September 2003

Precautionary allowances for sea level rise have been used for some time and other allowances for rainfall, river flows, wind and waves were presented in EA research in 2003 (see 11.1 at the end of this guidance note). The allowances for mean sea level, rainfall and river flows are included in PPG25[113] and reference to the mean sea level rise in Wales is included in TAN15.[114] The precautionary allowances for off-shore wind speeds and waves are more recent recommendations.

Climate change impact is an area of ongoing Defra\EA research and allowances should be updated using information from detailed catchment studies every few years. There have been criticisms that the application of a broad-brush +20% for river flows and volumes is an over-simplified approach and may have significant impacts. The most recent work highlighted a wide range of uncertainty, with some catchments decreasing in flood flows due to increase soil storage following dry summers. Impacts were generally less than +20%, but as prediction of catchment behaviour to extreme rainfall is uncertain, the report suggests that the 20% allowance should remain in place as the precautionary position.[115]

These precautionary allowances have formed the basis of this guidance note. At the present time, other approaches, although more complex, are no less uncertain.

### 11.3.2 Climate Change Scenarios

The most accessible alternative approach is the use of the UK Climate Impacts Programme (UKCIP02) climate change scenarios, which consist of four alternative scenarios of how climate change may affect the UK over the next 100 years. The scenarios are labelled Low Emissions, Medium Low Emissions, Medium High Emissions and High Emissions and relate to different projections of greenhouse gas emissions. They provide information on increases in temperature and changes in rainfall patterns.

Information about climate change and several impact assessment tools, including the scenarios, can be obtained from the UK Climate Impacts Programme's (UKCIP) website.[116] The UKCIP02 Scientific Report provides detailed background information on the development of the scenarios and the possible changes in UK climate to the year 2100.[117]

There may be cases where it is felt that there might be benefits from carrying out a more complex assessment, instead of using the standard precautionary allowances, for example, for major developments where a large number of people could be at risk or sites with specific characteristics that mean that the climate change may have a major impact. However, such an assessment would still be required to undertake sensitivity testing, based on the uncertainties of the climate change assumptions.

## 11.4Roles and Responsibilities

The EA should consider climate change in all of its activities including the design, operation and maintenance of defences, flood warning and long-term strategic planning in Shoreline Management Plans (SMPs) and Catchment Flood Management Plans (CFMPs). The EA aims to work with LPAs to reduce future floods risks through preventative planning, better management of surface water and design of buildings.

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[113] DTLR (2001) *Planning Policy Guidance Note 25: Development and Flood Risk*, HMSO, London.

[114] National Assembly for Wales (2004) *Technical Advice Note 15: Development and Flood Risk*, National Assembly for Wales, Cardiff.

[115] CEH (2004) *Climate change and river flows,* Defra/EA R&D Technical Report W5-032/TR.

[116] http://www.ukcip.org.uk

[117] Hulme *et al.* (2002) *Climate Change Scenarios for the United Kingdom: The UKCIP02 Scientific Report.* Tyndall Centre for Climate Change Research, School of Environmental Sciences, University of East Anglia, Norwich, UK. 120pp.

The LPA (as stated in PPG25) should give appropriate weight to information on flood risk and how it might be affected by climate change in preparing development plans and considering individual proposals for development. This should include consideration that some existing development in areas exposed to flood hazards may not be sustainable in the longer term and may need to be replaced in safer locations. When preparing development plans and considering applications for planning permission, LPAs should consult and take into account advice from the EA, which should incorporate the latest information on climate change.

The Regional Planners should take flood risk and how it might change as a result of climate change into account in the preparation of Regional Spatial Strategies (RSS).

Developers are responsible for providing FRAs to accompany their planning applications following guidance in PPG25 and TAN15. Developers or their consultants should be aware of the most up to date national guidance on climate change, provide robust assessments of the impacts of climate change on flood risk and identify opportunities for innovative design that reduces the risks of flooding in any proposed development.

## 11.5Processes and Procedures

### 11.5.1 Process 1 - Problem Formulation

It is necessary to determine the life-span of the development in order to determine the allowance for climate change that should be applied. This allowance should be agreed with the relevant stakeholders.

In the absence of more detailed information, it is common practice to assume a life-span of 30 years for commercial development and 50 years for residential development. This is generally considered an appropriate time horizon for Developers to have to accommodate. However, once an area has become developed, it is more likely to remain developed in some form or another beyond this life-span and this should be taken into account in longer-term strategies for the area.

There is some ambiguity in current guidance regarding whether the precautionary allowances should be applied between 2000 and 2050 (or 2080 for wave heights), based on the fact that the allowances originate from this time slice, or a 50 year time horizon starting from the time of assessment, e.g. an assessment being undertaken in 2005 would apply these allowances up until 2055. Neither approach is perfect, as both are based on the assumption that the predictions being applied to present day conditions are accurate, when in fact they are based on historical data, some of which is more up to date than others.

However, a degree of perspective needs to be retained when deciding on the time horizon to be used, as the degree of uncertainty regarding climate change allowances is high. Therefore, it is important that the principles described in Auditing and Control are followed and it is paramount that it is made clear at the start of the assessment which approach will be taken. This should be determined by discussion with the relevant stakeholders, as existing assessments for the area in question may set a precedent.

The long-term flood management strategy for the area being considered should also include consideration of climate change and this should be accommodated in the spatial plan or planning application.

### 11.5.2 Process 2a – Tiered Risk Assessment

Climate change should be taken into consideration at all levels of the tiered risk assessment approach[118] to determine future risk.

[118] See Activity Chart Process 2a – Tiered Risk Assessment

There are coarse and detailed approaches to assessing climate change. In the absence of more certain scientific evidence,[119] both approaches should be precautionary. Recommended approaches, based on current scientific knowledge, are described in Table 11.2 at the end of this guidance note.

These approaches should not be confused with the tiered risk assessment approach. The level of assessment being undertaken (whether level 1, 2 or 3) does not preclude the use of any of the approaches described in Table 11.2. The selection of approach will depend on the scale of the risk and the degree of precaution that will be applied to the management of that risk. However, it is not unreasonable to envisage that more often than not, the complexity of the approach will increase if a level 2 or level 3 assessment is required.

### 11.5.3 Process 3 - Options Appraisal

The change in flood level and flood extent should be considered in all aspects of site design, including safe access and exit, floor levels, defences, bridges, culverts and other structures.

There is considerable uncertainty regarding climate change. The allowances are regarded as precautionary and certainly for river flows, more recent research has suggested that they are fairly conservative.[120] However, impacts may be lower or higher than the allowances suggest and, therefore, there are four important principles to consider when reviewing options, as described below.

#### *Sensitivity Testing*

Due to the high degree of uncertainty associated with climate change predictions, it is advisable to understand the sensitivity of the consequences of flooding to a range of pluvial, fluvial or coastal conditions, as appropriate.

As part of this risk-based approach to assessing and managing flood risk for new development, it is important to identify outcomes (including mitigation measures) that are the least sensitive to this uncertainty, as these are the most sustainable.

#### *Adaptive Management*

In future, climate and social changes may turn out to be quite different from the scenarios presented in projects such as Foresight. In practice some defences may need to be adapted by raising them further in response to greater levels of climate change or removing them in response to environmental pressures. Today's decisions need to be "future-proofed".[121] This means that:

- Development should not be allowed to encroach on existing defences making it difficult to upgrade or remove them in future, and
- Any new defences should be adaptable, e.g. with foundations that are strong enough to support higher structures in the future.

#### *Resilient Design*

Flood risk management systems must have built-in resilience. This means that:

- Defences should be robust and able to withstand more extreme events without severe damage and erosion.

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[119] R&D is currently underway that is considering the assessment of the impacts of climate change on flood risk, including AUDACIOUS, the Flood Risk Management Research Consortium, CRANIUM, etc. Further details can be found in the Information Chart and in the Project Record for FD2320.

[120] CEH (2004) *Climate change and river flows,* Defra/EA R&D Technical Report W5-032/TR.

[121] Nicholls RJ; Johnson C; Green C; Shackely S (2000) *An adaptive management framework for Climate Change*, Proceedings of SURVAS Expert Workshop on European Vulnerability and Adaptation to impacts of Accelerated Sea-Level Rise (ASLR), Hamburg, Germany, 19-21 June 2000.

- Properties should be designed to have flood resistance (water exclusion measures) and flood resilience (ability to withstand or to recover easily from flood damage).[122]
- Affected communities and the economy should have the ability to recover quickly from more extreme flood events.

This should be implemented by applying strict conditions on development e.g. with regard to floor levels, and promoting a range of measures including improved flood warning, evacuation plans and flood proofing that may reduce the consequences of flooding when existing defences are overtopped or breached by more extreme events.

*Applying the Sequential Test*

A risk-based, sequential approach should be adopted when developing development plans or determining planning applications. For example:

- If there are two sites, both of which do not flood in present day conditions, but one floods with an allowance for climate change, preference should be given to the site that does not flood with an allowance for climate change (assuming all other considerations are equal).

- If both sites are affected by climate change, however, the selection may be more complex. As there is considerable uncertainty regarding climate change, the preferred site might be where adaptive management measures would be less costly or more effective or where the sensitivity to variations in the climate change predictions is less.

### 11.5.4 Process 4 – Monitoring and Review

This process is particularly important for the future management of flood risk. There are fundamentally two aspects to monitoring climate change:

- Monitoring the actual sea level rise, change in river flows or rainfall patterns, and
- Monitoring the latest research into predicting climate change.

Results from either of these could present a need to revisit the spatial plan or the flood management system put in place as part of a project.

## 11.6Tools and Technology

### 11.6.1 EA Flood Mapping

The EA has published Flood Mapping on the internet[123], providing the 1% (if fluvial or in the case of tidal/coastal flooding 0.5%) and 0.1% annual probability flood outlines. The intention is to provide flood outlines with an allowance for climate change in the near future.

### 11.6.2 UKCIP Risk and Uncertainty Framework

The UKCIP Risk and Uncertainty framework provides guidelines on how to incorporate climate change into risk assessment and decision-making.[124]

### 11.6.3 Joint Probability Analysis

A series of research reports have been completed on joint probability analysis that are relevant to assessments where there is more than one source of flood risk, e.g. in estuaries from fluvial and tidal flooding or "tide-locked" storm-water drains. The approaches are fairly complex but many of the

[122] A new R&D project for the ODPM called *Improving the flood resistance of buildings through improved materials, methods and details* started at the end of 2004 (with CIRIA acting as lead contractor).
[123] http://maps.environment-agency.gov.uk/wiyby/
[124] Willows, R. and Connell, R.K. (Eds.) (2003) *Climate adaptation: Risk, uncertainty and decision making*. UKCIP Technical Report. UKCIP, Oxford.

outputs, such as "joint dependence" maps provide useful information on whether there is a strong correlation between sources of flooding, which is an issue that should be addressed in a detailed level FRA.[125] Limited analysis of the change in dependency caused by climate change has also been undertaken. Initial results suggest that in some areas of the UK the change in dependency is significant. Further research regarding this subject has been proposed.

### 11.6.4 River Conveyance Calculator

The River Conveyance Calculator was developed to estimate the capacity of river channels and their associated floodplains. It provides simple methods for converting flows to levels and provides information on the level of uncertainty related to this calculation. In cases where some cross-section information is available but detailed hydraulic models are not, it can be used to estimate floodplain levels for a 20% increase in flood flow.[126]

### 11.6.5 The Flood Estimation Handbook

The Flood Estimation Handbook[127] (FEH) gives guidance on rainfall and river flood frequency estimation in the UK. It does not include information on how to account for climate change, but it does provide a range of tools used in assessments that could also help to understand the impact of an increase in 20% of river flow.

### 11.6.6 A Checklist for Development

The Three Regions Climate Change Group (comprising The London Climate Change Partnership, the South East Climate Change Partnership and the East of England's Sustainable Development Roundtable) has published a document called "Adapting to Climate Change: A Checklist for Development". The checklist suggests ways for developers and their design teams to modify building designs to cope with the impacts of climate change.[128]

## 11.7Auditing and Control

Research into climate change is continuing. When undertaking an assessment of flood risk, all recommended allowances for climate change should be checked to see if they are still up to date and relevant.

As knowledge of climate change increases, methods for assessing the effects of climate change may also improve. In all cases, however, a degree of uncertainty in predicting the future will remain. Therefore, effective risk management of this will always be based on four principles. These being:

- **Precaution** – When in doubt adopt a precautionary position.
- **Sensitivity** – Understanding the relative change in aspects of the flood risk resulting from changes in climate (in particular the consequences of flooding) will enable a precautionary position to be taken with greater confidence.

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[125] Further information can be found in the following references:
HR Wallingford (2004) *Joint probability issues within estuaries – A numerical case study for the tidal Thames*, Report TR 143, August 2004, HR Wallingford
HR Wallingford (2005) *Joint Probability: Dependence Mapping and Best Practice*, Technical Report on Dependence Mapping, R&D Technical Report FD2308/TR1, March 2005.
HR Wallingford (2005) *Use of Joint Probability Methods for Flood and Coastal Defence, A Guide to Best Practice*, R&D Technical Report FD2308/TR2, March 2005.
[126] For more information see http://www.river-conveyance.net/
[127] Institute of Hydrology (1999) *The Flood Estimation Handbook* http://www.nwl.ac.uk/ih/feh/
[128] At the time of writing this is a consultation draft. The closing date for comments is 30 April 2005, with a final version due later in 2005. Copies of the Checklist can be downloaded from http://www.gos.gov.uk/gol/docs/199952/adapting_climate_change.pdf

- **Transparency** – Any allowances used and any decisions made need to be transparent, so that these can be reviewed in light of any updates in knowledge regarding climate change and so that comparisons can be made between different assessments, plans and projects.
- **Monitoring –** The only way to identify actual changes in climate is to monitor conditions. This then enables the flood risk to be reviewed and remedial actions can be taken to mitigate any unacceptable increase, i.e. adaptive management.

Application of these principles with respect to climate change should be checked in all assessments of flood risk.

**Table 11.1 Precautionary Allowances for Climate Change**[129]

| Parameter | Current Practice | Recommendation and Comments |
|---|---|---|
| 1. Mean sea level[130] | For Environment Agency Regions (between year 2000 and 2050):<br>a) 6mm/yr increase for Anglian, Thames, Southern and North East (South of Flamborough Head)<br>b) 5mm/yr increase for South West and Wales<br>c) 4mm/yr for North West and North East (North of Flamborough Head) | **No change** from current practice, but note comment below for extreme sea level |
| 2. Extreme sea level | Usually assumed to be the same as for mean sea level. | **No change** from current practice, but review if higher extreme values are supported by future climate modelling studies (especially around the Thames Estuary and Anglian Region). |
| 3. High and extreme river flow | Test sensitivity to additional 20% in peak flow or volume over 50 years[131] | **No change** from current practice regarding sensitivity allowance, but ongoing research may lead to refinements. |
| 4. High and extreme wind speeds and offshore wave conditions | None | **New recommendation:** Add 10% sensitivity allowance to offshore wind speeds and wave heights by 2080s (and 5% to wave periods). Needs to be considered in relation to depth limited conditions inshore. |

[129] See earlier HR Wallingford references.
[130] Although not a climate change issue, as part of the analysis of future conditions, future land movement should also be taken into consideration.
[131] See Process 1 in this guidance note regarding application.

**Table 11.2 Guidance on Climate Change in Different Development Contexts**

| Type of Flooding | Development Context | Guidance |
|---|---|---|
| Coastal Flooding | Coarse Approach | ▪ Add the appropriate sea level rise for the life-span of the development |
| | Detailed Approach | ▪ Add the appropriate sea level rise for the life-span of the development<br>▪ Add 10% sensitivity allowance to offshore wind speeds and wave heights by 2080s<br>▪ Add 5% sensitivity allowance to wave periods by 2080s. |
| | Development behind existing defences | ▪ The long-term strategy for the flood defence should be discussed with the relevant Flood Defence Authority.<br>▪ Development should not encroach into space required for future defence improvements and operational and maintenance requirements.<br>▪ The expected annual probability of inundation of developments should be less than or equal to that agreed as acceptable with the planning authorities (under guidance from the EA) for the life-span of the development (indicative standard recommended at present being 0.5% annual probability)[132,133]<br>▪ Planning constraints should include a range of measures to build flood resilience into new developments and their communities |
| | Development behind new defences or Undefended development | ▪ Any new defences should be designed to the precautionary allowances (as listed in Table 11.1) for the life-span of the development.<br>▪ Adaptable defences should be promoted.<br>▪ Planning constraints should include a range of measures to build flood resilience into new developments and their communities |

[132] DTLR (2001) *Planning Policy Guidance Note 25: Development and Flood Risk*, HMSO, London.
[133] National Assembly for Wales (2004) *Technical Advice Note 15: Development and Flood Risk*, National Assembly for Wales, Cardiff.

| Type of Flooding | Development Context | Guidance |
|---|---|---|
| River flooding | Coarse Approach | ▪ In the absence of a +20% flood outline for the 1% annual probability, the 0.1% flood outline provides a good surrogate map. (A check can be made by comparing the difference between the 1% and 0.1% flows according to Flood Estimation Handbook (FEH) methods.)<br>▪ Where there is no suitable estimate of the increase in level due to climate change, an additional allowance of 150 mm, above the normal allowance of 600 mm[134] is recommended on finished floor levels. |
| | Detailed Approach | ▪ Add 20% to the 1% annual probability peak flow and volume. This flow must be converted to a flood level and extent either by using a hand calculation of conveyance[135] or, alternatively, using a hydraulic model (most detailed approach). |
| | Development behind existing defences | ▪ The long-term strategy for the flood defence should be discussed with the relevant Flood Defence Authority.<br>▪ Development should not encroach into space required for future defence improvements and operational and maintenance requirements.<br>▪ The expected annual probability of inundation of developments should be less than or equal to that agreed as acceptable with the planning authorities (under guidance from the EA) for the life-span of the development (indicative standard recommended at present being 1% annual probability) [136,137]<br>▪ Planning constraints should include a range of measures to build flood resilience into new developments and their communities |
| | Development behind new defences or Undefended development | ▪ Any new defences should be designed to the precautionary allowances (as listed in Table 11.1) for the life-span of the development.<br>▪ Adaptable defences should be promoted.<br>▪ Planning constraints should include a range of measures to build flood resilience into new developments and their communities |

[134] See EA Guidance 110_04 Fluvial Floodplains and Washlands
[135] The new flood conveyance estimator provides a useful tool (see Tools and Technologies in this guidance note).
[136] DTLR (2001) *Planning Policy Guidance Note 25: Development and Flood Risk*, HMSO, London.
[137] National Assembly for Wales (2004) *Technical Advice Note 15: Development and Flood Risk*, National Assembly for Wales, Cardiff.

| Type of Flooding | Development Context | Guidance |
|---|---|---|
| Pluvial Flooding and Drainage | One Approach | ▪ Add 10% to rainfall depths for designing drainage capacity for estimating storage volumes to limit the runoff impact from a new development.[138] ▪ Undertake sensitivity testing based on the above and take a precautionary position, i.e. apply a safety factor as appropriate. |
| | General Rules of Design | ▪ Runoff issues should be considered at an early stage of planning to ensure that sufficient space is reserved for SuDS drainage components located in appropriate situations. ▪ Although not a climate change issue, as part of the analysis of future conditions, it is also recommended to increase impermeable area by 10% to represent urban creep, in recognition that extensions and additional paving are typically carried out by homeowners.[139] ▪ Conditions experienced in the surrounding area (both on the catchment surface and in the existing drainage system) should be with due consideration of climate change, as well as on-site. |
| Groundwater Flooding[140] | Coarse Approach | ▪ Assume maximum historic level (if available). |
| | Detailed Approach | ▪ Add UKCIP02 Medium High Emissions Scenario rainfall to a recharge and\or groundwater model.[141] |

## 12.S3.2 RISK TO PEOPLE BEHIND DEFENCES

**This guidance note:**

- Presents methods for assessing flood risk to people in defended areas that can be applied at the **sub-regional**, **local** and **site-specific** scales (i.e. as part of a Strategic Flood Risk Assessment (SFRA) or site-specific Flood Risk Assessment (FRA)).

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[138] HR Wallingford (2004d) *Preliminary rainfall runoff management for developments*, Defra/EA R&D Technical Report W5-074/A.
[139] See *Sewers for Scotland* 2nd Edition (Consultation Draft), WRc, Swindon.
[140] Defra/EA research has now produced draft groundwater flooding maps http://www.defra.gov.uk/environ/fcd/policy/strategy/techdocs.htm
[141] Arnell, N. (2003) *Effect of Climate Change on River Flows and Groundwater Recharge UKCIP 02 Scenarios*, Research Report 03/CL/04/2, UKWIR, London.

- Provides the Environment Agency with guidance on communicating to Local Planning Authorities (LPAs) and Developers the likely flood risk to people associated with developing behind defences, given the potential flood hazard and the condition of the defences.
- Is designed to be complementary to a separate EA guidance document[142] that provides specific guidance to EA staff regarding the EA's policies and principles for development behind defences.

**This guidance note does NOT:**

- Set parameters that dictate whether or not development should be permitted behind defences, as this is dependent on the acceptability of the residual risk after provision of suitable mitigation measures and is a decision for the LPA.
- Set parameters that dictate whether the EA should object to development behind defences, as this is a policy issue for the EA.

## 12.1Contents

Introduction
Approach
Sources of Data and Information
Roles and Responsibilities
Processes and Procedures
Tools and Technologies
Audit and Control
Implementation of this Guidance

## 12.2Introduction

Flood defences reduce the risk of flooding, but do not eliminate flood risk completely. The reduction in flood risk that the defence provides depends on the standard of protection (SoP) and the performance and reliability of the defence. Flooding may still occur in defended areas if the defence is overtopped or breached, or if flooding occurs as a result of non-fluvial sources such as groundwater flooding or poor drainage. Development behind defences should, therefore, be planned with due regard to the flood risk in the defended area.

## 12.3Approach

Flood risk behind defences is related to the probability of flooding and the magnitude of the consequence:

[142] At "draft for consultation" stage at time of writing.

risk = probability x consequence

The probability of the flood is dependent on the following:

- The defence(s) being overtopped

- The defence(s) failing by breaching, which is dependent on
  - Height of defence
  - Structure of defence
  - Condition of defence
  - Length of time water will be at a high level

The consequences of a flood include damage to assets and impacts on people. The approach described in this document bases consequences of flooding on the **danger to people**, as developed by the Flood Risks to People project[143].

This approach is adopted, because the most serious risk associated with development behind defences is the risk to people, including entering and leaving properties during a flood[144]. The safety of the public is the single most influential consideration for decision-makers.

The impact on property is not directly addressed in this approach, although it can be inferred that any property constructed in an area where there is flooding will be affected by the flooding.

*Example approach for analysing impact on property*

The impact on property can be analysed by assigning damages to properties for different flood depths. This approach has been adopted for Catchment Flood Management Plans (CFMPs) and is applied via the Modelling and Decision Support Framework (MDSF). The MDSF imports flood water levels from external models for a range of return periods and uses these data to generate flood envelopes. Damages are calculated for properties that lie within the flood envelopes for each flood return period. The damages assigned to properties flooded at different depths with different return periods are derived from the Multi-Coloured Manual (MCM)[145].

Danger to people is assessed using flood hazard, which can be expressed as a combination of **flood depth and velocity**.

[143] Ramsbottom *et al.* (2004). Flood Risk to People Phase 2 Interim Report 2. DEFRA/EA R&D Technical Report FD2321/IR1
[144] See Guidance Note S3.3 Safe Access and Exit.
[145] produced by the Flood Hazard Research Centre at Middlesex University in 2003

It should also be appreciated that even if the probability of flooding is low, the consequences can be high. For example, most of the proposed Thames Gateway developments are to be in areas protected by defences with a SoP of 0.1%. Whilst it might appear that there is a low flood risk, this is not necessarily the case. Should the defences fail, the consequences could be severe. In particular, flow depths and velocities may be very high and, therefore, the danger to people could be high if suitable mitigation measures are not put in place.

Therefore, this risk needs to be managed effectively, by understanding the following:

- Actual probability of inundation
- Characteristics of the inundation
- What and who is likely to be affected by the inundation, and
- What are the economic, social and environmental impacts.

The required approach to assessing flood risk behind defences for new development depends on:

- The level of the detail required for the decision-making process
- The type of development proposed
- The location of the development relative to the defence
- The complexity of the floodplain topography
- The complexity of the defence system.

In general, as the complexity of the site and the level of risk increases, the level of assessment should increase.

Three levels of complexity in approach are recommended in this guidance note.

- **Simple approach**, which is based on the consequences of flooding, but not the probability of inundation. This approach should be used as an initial guide.

- **Intermediate approach**, which is based on the consequences of flooding and a simple method for assessing probability of inundation. This approach can be used as the first stage to determine the likely scale of the risk.

- **Complex approach**, which is based on a more rigorous analysis of the probability and consequences of flooding. This approach should be used for defended areas with complex topography and shape and is also generally recommended for developments that fall within the high risk zones (as described in this guidance note).

These should not be confused with the tiered risk assessment approach in the Framework for Assessing and Managing Flood Risk for New Development.[146] The level of assessment being undertaken (whether level 1, 2 or 3) does not preclude the use of any of the approaches described above. The selection of approach will depend on the scale of the risk and the degree of precaution that will be applied to the management of that risk. However, it is not unreasonable to envisage that more often than not, the complexity of the analysis will increase if a level 2 or level 3 assessment is required.

It should be noted that none of these approaches takes into consideration the probability of potential sources of breach arising from human activity or failure of non-flood defence related assets, such as a damage caused by boat collisions, collapse of underground assets (e.g. sewers) or construction work. This information can be determined on a site by site basis and used to supplement the approaches described above.

## 12.4Sources of Data and Information

The data and information required to assess flood risk behind defences depends on the complexity of the approach required, as follows:

### 12.4.1 Simple approach

- Water levels at the defence(s) for suitable annual probabilities (advisable to look at the 1% and 0.1% for fluvial flooding or the 0.5% and 0.1% for tidal/coastal flooding).[147]

- Simple lookup tables relating hazard to distance behind the defence(s) are used to assess the consequences of flooding (provided in this guidance note).

### 12.4.2 Intermediate approach

- Water levels at the defence(s) for suitable annual probabilities (as described above).

- Simple lookup tables relating hazard to distance behind the defence(s) are used to assess the consequences of flooding (provided in this guidance note).

- Information on defence condition, which might be obtainable from the National Flood and Coastal Defence Database (NFCDD) [148] or from local knowledge and existing studies, where there is low confidence in the NFCDD data. This is needed to assess the probability of defence failure.

[146] See Activity Chart Process 2a – Tiered Risk Assessment
[147] Guidance of how to obtain flood levels, etc. can be found in either of the following:
FLOWS WP1biii project Modelling and Mapping of Flood Risk, currently being undertaken by Atkins on behalf of the Environment Agency, to be completed May 2005
Lancaster, J, Preene, M and Marshall, C (2004) *C624 Development and Flood Risk – Guidance for the Construction Industry*, CIRIA, London.
[148] Further information regarding the NFCDD can be found at the following website: http://www.defra.gov.uk/environ/fcd/hltarget/nfcdd.htm

### 12.4.3 Complex approach

- Detailed hydraulic modelling is used to assess the flood hazard and, therefore, the consequences of flooding can be assessed in more detail.
- Information on the defence type, structure, standard of protection, crest level and condition is required to assess the probability of breaching and overtopping. This can be obtained from the NFCDD (as long as there is high confidence in the data) or from local knowledge, existing studies and site visits.
- Detailed information of the topography of the embayment area behind the defence is required to assess the behaviour of the flood water after a breach or overtopping has occurred. This is usually provided in the form of Digital Terrain Mapping.

## 12.5Roles and Responsibilities

- The Environment Agency has ownership of the NFCDD.
- The Environment Agency and Defra have ownership of the reports containing the methodologies used in the RASP[149] and Flood Risk to People projects.
- The LPA is responsible for commissioning any survey and detailed modelling work required as part of a SFRA.
- The Developer is responsible for commissioning any surveys and detailed modelling work required as part of a FRA.[150]

## 12.6Processes and Procedures

At all levels of assessment it is necessary to define the sources, pathways and receptors of the flood. In the context of this approach, these are the following:

- Sources – Fluvial water levels or coastal water levels and waves (loads)
- Pathways – Overtopping, breaching and the conveyance of floodwaters over the floodplain
- Receptors – The development

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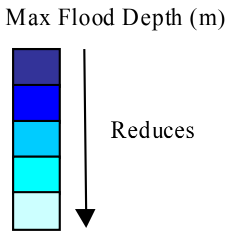
[149] HR Wallingford (2004). Risk Assessment for Flood and Coastal Defence for Strategic Planning (RASP) A Summary. DEFRA/EA R&D Technical Report W5B-030/TR. Further information can also be found at the following website: http://www.rasp-project.net/

[150] Further information regarding the responsibilities of the Developer to carry out a flood risk assessment can be found in the CIRIA publication C624 (see above for full reference).

The methodology used to determine the hazard behind the defence(s) depends on the level of assessment required, as described in the sections below.

### 12.6.1 Simple Approach

The simplest assessment of the risk behind flood defences uses information on the danger to people from flooding in defended areas. This is illustrated in Figures 12.1 and 12.2, which show how flood depths for a particular breach scenario can be interpreted as danger to people.



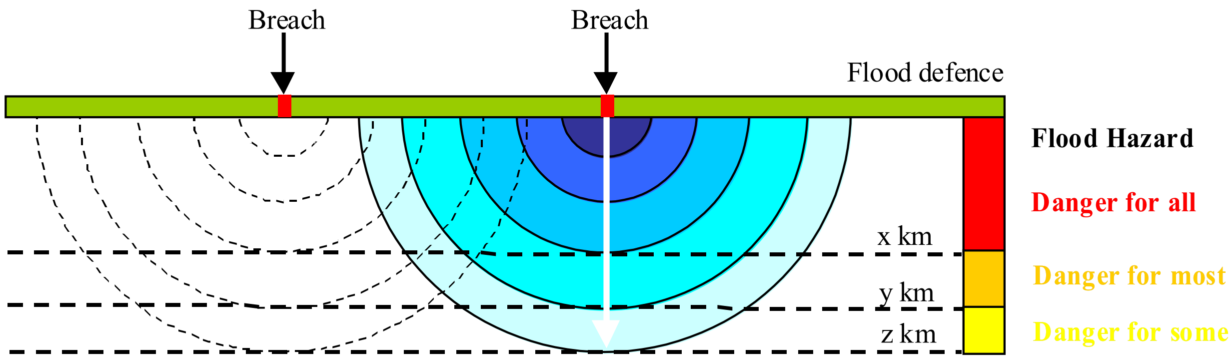



**Figure 12.1 Plan view of danger to people for a breach scenario**

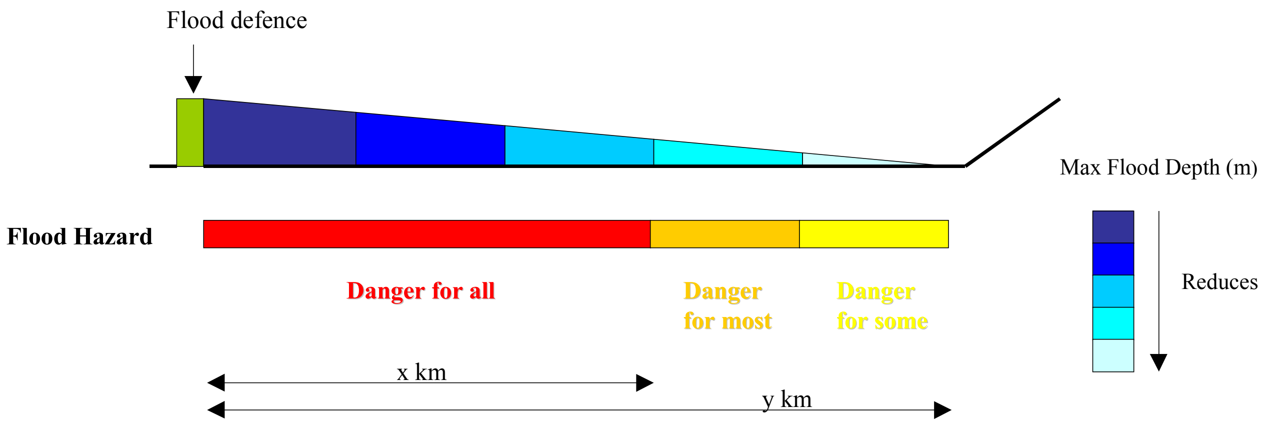



**Figure 12.2 Cross-section view of danger to people for a breach scenario**

The results of this type of modelling have been used to create generic lookup tables relating the level of danger to people to the distance from the defence for the following cases:

- Overtopping scenario, where the hazard is related to the water level above the crest level of the defence.
- Breach scenario, where the hazard is related to the water level above the floodplain.

It is advisable not to construct new buildings near to defences because of the risk to people and potential for damage to buildings, particularly on the coast. The distance depends on the likely head above crest level or breach level.

Defences with a lower SoP (the return period of the source event (or water level) that must be exceeded for overtopping to occur) are likely to be overtopped more often.

Table 12.1 and Table 12.2 are simple lookup tables that can be used as a guide to the danger to people at various distances behind flood defences for overtopping and breaching respectively (assuming that either will occur during the lifetime of the development).

These two types of failure (overtopping and breaching) should be considered together. As this simplified approach does not consider the probability of one failure type compared to the other, the precautionary approach should be to determine a composite categorisation for danger to people behind the defence(s) based on the worst case.

*Example*

> If the danger to people from overtopping is 'danger for most' and from breaching it is 'danger for some', the area should be categorised as 'danger for most'.

For details regarding the danger classifications of 'danger to all', 'danger to most' and 'danger to some' reference should be made to HR Wallingford (2005) *Flood Risks to People Phase 2, The Flood Risk to People Methodology*, Environment Agency\Defra R&D Technical Report FD2321/TR1, March 2005. However, the following provides a very simplified guide as to the groups of people that should be considered as falling into these danger classifications:

- Danger for some – includes children, the elderly and the infirm.
- Danger for most – includes the general public
- Danger for all – includes emergency services

**Table 12.1 - Danger to people from overtopping relative to distance from defence**

| Distance from defence (m) | Head above crest level (m) | | | |
|---|---|---|---|---|
| | 0.5 | 1 | 2 | 3 |
| 100 | Danger for some | Danger for all | Danger for all | Danger for all |
| 250 | Danger for some | Danger for all | Danger for all | Danger for all |
| 500 | Danger for some | Danger for most | Danger for all | Danger for all |
| 1000 | | Danger for some | Danger for all | Danger for all |
| 1500 | | Danger for some | Danger for most | Danger for all |
| 2000 | | Danger for some | Danger for most | Danger for all |
| 2500 | | | Danger for most | Danger for most |
| 3000 | | | Danger for some | Danger for most |
| 3500 | | | Danger for some | Danger for most |
| 4000 | | | Danger for some | Danger for most |
| 4500 | | | | Danger for some |
| 5000 | | | | Danger for some |

**Key:**
- Danger for some
- Danger for most
- Danger for all

**Table 12.2 - Danger to people from breaching relative to distance from defence**

| Distance from breach (m) | Head above floodplain (m) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 0.5 | 1 | 2 | 3 | 4 | 5 | 6 |
| 100 | | | | | | | |
| 250 | | | | | | | |
| 500 | | | | | | | |
| 1000 | | | | | | | |
| 1500 | | | | | | | |
| 2000 | | | | | | | |
| 2500 | | | | | | | |
| 3000 | | | | | | | |
| 3500 | | | | | | | |
| 4000 | | | | | | | |
| 4500 | | | | | | | |
| 5000 | | | | | | | |

**Key:**

- Danger for some
- Danger for most
- Danger for all

### 12.6.2 Implications of Using the Simple Approach

*General*

- In this simple approach, the danger to people decreases as the distance from the defence increases. A more detailed analysis would identify 'pinch points' on floodplains where flow velocity and, therefore, hazard can be high, for example at openings beneath embankments. A more detailed analysis would also identify areas where the hazard would be lower, for example due to localised high ground.
- These "danger to people" classifications should be considered as fairly subjective and should not be used as the decision-making mechanism to refuse development, especially as measures to mitigate residual risk could reduce risk to acceptable levels.
- These "danger to people" classifications are most suitably applied to the identification of the least risk areas within the area being considered in order to apply a sequential approach to allocating land for development and for determining suitable types of development.

*Table 12.1*

- This table has been generated for overtopping onto a flat floodplain. There may be greater spatial variation in the hazard on complex floodplains. Due to the relatively small distances from the defence of the hazard, these variations will normally have limited effect.

- The overtopping analysis has been based on a relatively static body of water, as applicable to fluvial or estuarine flooding (as long as the latter is for a significant head above crest level); wave action on open coastal defences (a significant issue for safety behind coastal defences) has not been taken into consideration.

*Table 12.2*

- This table has been generated for a breach of 100 metres wide, breaching onto a flat floodplain. There may be greater spatial variation in the hazard on complex floodplains and for different sized breaches. This uncertainty is expected to be relatively large.

- Hazard to people increases as the head of water against the defence increases.

- For small defences (say 2m high or less) the zone of high hazard only extends for the first few hundred metres if the defence is breached.

- For large defences (say 5m high or more) the zone of high hazard can extend for 2km behind the defence, if the defence is breached.

- In general, this suggests that development should be avoided within the first few hundred metres of the defence because there is a risk to all people exposed to floodwater. The distance depends on the head of water above the floodplain. In addition, the velocities in this zone will be relatively high and therefore there is a clear risk of damage to property.

- Behind large defences it would be advisable not to build within the first 500m to 1km due to the potential hazard of breaches with large heads of water. However, it is important to consider the probability of such a breach occurring.

- The breaching analysis has greater applicability to coastal defences than the overtopping analysis. However, in both cases it should be borne in mind that these tables should be used as initial guides only.

### 12.6.3 Intermediate Approach

The intermediate approach is to determine the hazard zones behind the defence in the same way as the simple approach, but include an assessment of the probability of flooding based on the reliability of the defence or defence system. This assessment can then produce zones of flood risk based on the probability of the defence failing by either overtopping or breaching.

The probability of a defence overtopping is influenced by the crest level of the defence. The probability of a defence breaching for a given load is influenced by the type of defence and its structural condition.

This can be done using information on defence condition from the NFCDD (and other local data where appropriate) to identify the defences within the defence system that are most likely to fail. The probability of failure can then be assessed by considering possible modes of failure.

*Example*

| |
|---|
| The standard of protection provided by a particular defence is to protect against the estimated 0.5% annual probability (1 in 200 year) flood. However, because of the poor condition of the defence, it is estimated that there is a 50% chance of breaching in the 2% annual probability (1 in 50 year) flood. The impact of a breach during a 2% annual probability flood can then be assessed using the lookup tables. This event will have a (0.5 x 2% =) 1% chance of occurring in any year. Thus, the impact of the breach obtained from the lookup tables has a 1% annual probability of occurrence. |

Thus, having estimated the probability of a scenario of defence failure, the lookup tables are used to plot hazard zones for each scenario.

To obtain an overall assessment of the risk associated with a defence system, it will be necessary to overlay the results from several scenarios to obtain an overall assessment of the hazard zones and probability of occurrence. The number of scenarios to be considered depends on the magnitude of the risk. These might include an overtopping scenario and a number of breaching scenarios (three, say). The overtopping scenario should have a probability of occurrence of less than the SoP.

This is a very simplified version of the RASP methodology, which estimates the overall impact of flooding by combining all possible flooding events with all possible breaching and overtopping scenarios. The development of this method for practical application is in progress. The RASP approach estimates the probability of the defence failing for various loads using the concept of a fragility curve.[151] This is a significant step forward in understanding the true probability of inundation rather than relying on the SoP only.

Combining the annual probability of inundation with the hazard behind defences can be used to provide categories of risk for development behind flood defences based on both the probability and consequences (i.e. risk) of flooding. Suggested categories are shown in Table 12.3.

**Table 12.3 Flood risk to people behind defences**

[151] Further information can be found in HR Wallingford (2004) *Risk Assessment for Flood and Coastal Defence for Strategic Planning (RASP) A Summary*, DEFRA/EA R&D Technical Report W5B-030/TR.

| Danger to people | Annual probability of inundation | | | |
|---|---|---|---|---|
| | prob. ≥ 1% | 1% > prob. ≥ 0.5% | 0.5% > prob. ≥ 0.1% | prob. ≤ 0.1% |
| Danger for all | High | High | High | Medium |
| Danger for most | High | Medium | Medium | Low |
| Danger for some | Medium | Medium | Low | Low |

An example of a risk map based on this approach is shown in Figure 12.3.

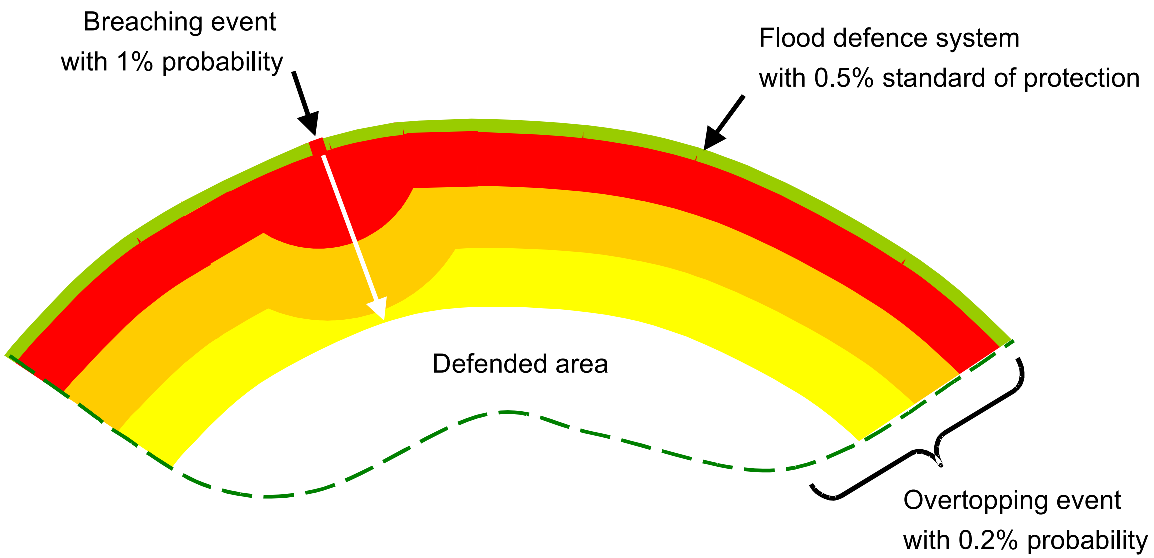



**Figure 12.3 Example risk map with one overtopping scenario and one breach scenario**

It should be noted that the magnitude of the source event that causes a breach is directly related to the head of water, hence the depths and velocities. Therefore, the lower the annual probability of a breach the greater the potential hazard (i.e. depths and velocities) when the breach occurs.

Once fluvial defences are overtopped the hazard is relatively constant (unless the defence is weakened by the flow, and breaches subsequently occur). Therefore, the greater the SoP the smaller the potential for hazard to occur by overtopping.

#### 12.6.4 Implications of Using the Intermediate Approach

- This intermediate approach, is a simplification due to the range of annual probability of inundation that might be experienced across the zone.

- If the identification of defences that are prone to failure has been based on the information held in the NFCDD (where the only information on defence structural condition is a visual assessment, which grades each defence and its components from Grade 1 ("very good") to Grade 5 ("very poor")), the results need to be treated with caution.[152]

- The condition of the defence may change during the lifetime of any development. The probability of failure is, therefore, subject to change. There is no consideration of this with this level of assessment.

#### 12.6.5 Complex Approach

The tables relating hazard to the distance behind the defence used in the simple and intermediate approaches are limited, because they have been derived for a uniform flat floodplain of infinite size in parallel to the defence and breach width of 100 metres.

Detailed assessment of a hazard at a particular site requires that:

- A more rigorous understanding of probability of overtopping and breaches (such as the RASP approach, although depending on circumstances expert judgement and local knowledge might be sufficient).

- Flood behaviour to be modelled using a 2D hydraulic model, to provide spatially varying predictions of depths and velocities. This also allows the representation of detailed topography including streets and different sizes and shapes of defended areas.

The overall approach is as follows:

1. Divide the defence system into individual elements
2. Identify the probability of breaching of the individual elements using NFCDD data, other local data (where appropriate) and site surveys where the uncertainty in available data is unacceptable.
3. Construct a 2D model of the defended area. This requires topographic data including locations of buildings.
4. Run the model for a range of events and breaching/overtopping scenarios.

[152] See Guidance Note D3.1 National Flood Risk Assessments.

5. Each model run will provide flood hazard with a particular probability of occurrence.
6. Overlay the results to produce a combined flood hazard with probability map.

Like the intermediate approach, this is a simplification of the RASP approach that is currently under development. RASP provides more rigorous methods for deciding which scenarios to test and combining the results.

An example of the results that can be obtained using a 2D hydrodynamic hydraulic model is provided in Figure 12.4. This example was generated for an event that overtops the defences.

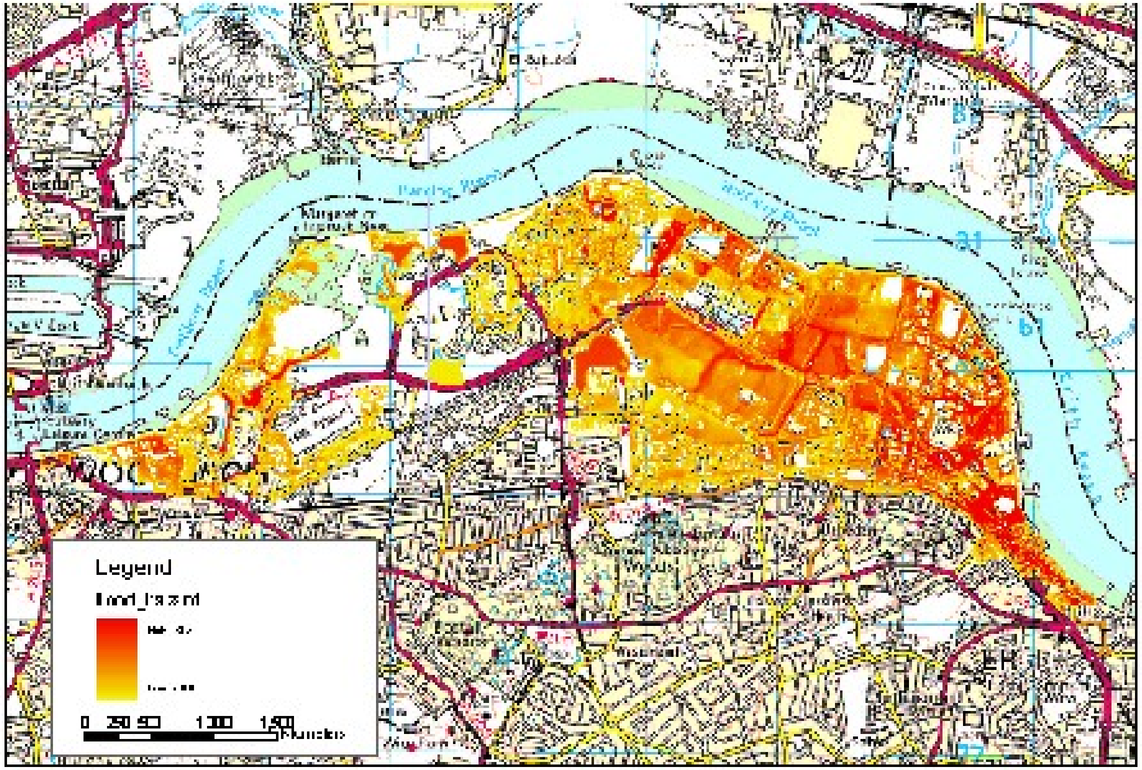



**Figure 12.4 Example of results from 2D hydrodynamic hydraulic modelling**

### 12.6.6 Implications of Using the Complex Approach

- This detailed approach is the most rigorous, but provides the best results. The decision whether to apply it will depend on the objectives of the assessment and magnitude of the risk, as it is more time-consuming and expensive than the simpler approaches. An example where this approach may be beneficial would be a complex floodplain with a series of defence systems in a built-up area.

- There remains a degree of uncertainty associated with the likelihood of defence failure[153] and management of this uncertainty within the decision-making process is still required.

## 12.7Tools and Technologies

In summary, the following is required for each level of assessment:

### 12.7.1 Simple Approach

- Lookup Table 12.1 - Danger to people from overtopping relative to distance from defence
- Lookup Table 12.2 - Danger to people from breaching relative to distance from defence

### 12.7.2 Intermediate Approach

- Lookup Table 12.1 - Danger to people from overtopping relative to distance from defence
- Lookup Table 12.2 - Danger to people from breaching relative to distance from defence
- A method for estimating the probability of defence failure when subjected to certain loads based on an assessment of the 'weak spots' within a defence system

### 12.7.3 Complex Approach

- Modelling software to determine the probability of defences being subjected to certain loads.
- A means for estimating the probability of defence failure when subjected to certain loads. This could be based on the fragility curve approach developed as part of the RASP methodology or an expert assessment of the likely performance of elements of the defence system.
- 2D modelling software suitable for modelling of defended areas.

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153 Ongoing research and development in the area of defence failure includes the Defra/EA R&D project FD2318. Further details can be found in HR Wallingford (2004) *Performance and Reliability of Flood and Coastal defences – Phase I Evaluation of the applicability of the concept of fragility to risk assessment of flood and coastal defences* R&D Interim Technical Report.

- Equation from Flood Risk to People project linking the danger to people to predicted flood depth and velocity. Alternatively, the indicative guidance on tolerable flooding consequences provided in Appendix 1, section C of TAN15 regarding depths, rate of rise, speed of inundation and velocities could be used.

## 12.8Audit and Control

With each level of approach it is essential to understand, record and communicate the degree of uncertainty inherent in the approach (as described in the preceding sections) and related to the data used to carry out the assessment.[154, 155] It is then possible to decide whether:

- A more rigorous approach is required to reduce the uncertainty,
- The uncertainty can be managed in the mitigation measures (including moving a site away from the hazards),
- The uncertainty can be managed over time.[156]

*Example*

If a development is proposed for a high risk area as identified by the intermediate approach, can the development be moved to a low risk area? If so, it may not be necessary to apply the complex approach. However, this decision should be recorded and a plan for monitoring the risk components that do have high uncertainty should be considered[157]. If the development has to be in either the medium risk or high risk areas due to other planning pressures, then a complex approach is recommended.

Even when applying the complex approach, uncertainties will remain, potentially regarding any or all of the following:

- Analysis approach,
- Input data, and
- Future conditions (including climate change[158]).

[154] FLOWS WP1biii project Modelling and Mapping of Flood Risk, currently being undertaken by Atkins on behalf of the Environment Agency, to be completed May 2005.
[155] van der Sluijs, Risbey, *et al.*, (2003) RIVM/MNP *Guidance on Uncertainty Assessment and Communication Detailed Guidance*, Utrecht University, Netherlands. Other volumes accompany this guidance and details can be found at http://www.nusap.net/sections.php?op=viewarticle&artid=17
[156] Nicholls RJ; Johnson C; Green C; Shackely S (2000) *An adaptive management framework for Climate Change*, Proceedings of SURVAS Expert Workshop on European Vulnerability and Adaptation to impacts of Accelerated Sea-Level Rise (ASLR), Hamburg, Gernany, 19-21 June 2000.
[157] See Activity Chart Process 4 – Monitoring and Review
[158] see Guidance Note S3.1 Climate Change

## 12.9Implementation of this Guidance

The recommendations provided in this guidance note are based solely on **danger to people**. When deciding whether a development behind a defence or defence system is appropriate, it is also necessary to consider the acceptability of the risk to **property** and the **environment**. At the present time, sufficient research has not been carried out regarding these issues to provide guidance in a similar form to that presented here.

Should there be a desire to develop national planning policy guidance that incorporates recommendations regarding appropriate development behind defences, it is recommended that further research in the areas of risk to property and the environment is carried out first.

Particular care needs to be taken that the guidance presented here is not misused by applying either the simple or intermediate approaches inappropriately. These approaches are best applied as initial guides for identifying whether the proximity of the development to defences is likely to be a major concern and as to whether a breach analysis is likely to be required as part of the FRA.

However, it should be recognised that a development behind a defence is considered appropriate in flood risk terms when the residual risk is agreed as being acceptable.[159] Therefore, any assessment of flood risk should be an iterative process, including an Options Appraisal stage and a consultation process with those affected, as defined in the FD2320 generic approach to assessing and managing flood risk.[160]

If accompanied by appropriately precautionary mitigation, it may be considered acceptable to carry out only the simple or intermediate approach. However, this has to take into consideration the high degree of uncertainty and would require extremely precautionary mitigation. The cost-effectiveness of this compared to carrying out the complex approach will depend on the scale of the development and the scale of the risk.

[159] Work is currently underway on behalf of the EA by Risk & Policy Analysts (RPA) Consultants looking at the acceptability of flood risk.
[160] See Activity Chart Process 3 – Options Appraisal

## 13.S3.3 SAFE ACCESS AND EXIT

**This guidance note:**

- Presents simple methods for assessing the conditions that constitute safe access and exit that can be applied at the **site-specific** scale, i.e. as part of a FRA.
- Provides the Environment Agency (EA) with a means of communicating to Local Planning Authorities (LPAs) and Developers the likely flood risk to people associated with access and exit from the site.
- Is designed to be complementary to a separate EA guidance document[161] that provides specific guidance to EA staff regarding the EA's policies and principles.

**This guidance note does NOT:**

- Set parameters that dictate whether or not development should be permitted, as this is dependent on the acceptability of the residual risk after provision of suitable mitigation measures and a decision for the LPA.
- Set parameters that dictate whether the EA should object to a development on the grounds of safe access and exit, as this is a policy issue for the EA.

### 13.1Contents



### 13.2Introduction

New developments are required to provide safe access and exit during a flood and the measures by which this will be achieved should be clear in the Flood Risk Assessment (FRA). Safe access and exit is required to enable the evacuation of people from the development, provide the emergency services with access to the development during a flood and enable flood defence authorities to carry out any necessary duties during the period of flood.

A safe access or exit route is a route that is safe for use by occupiers without the intervention of the emergency services or others.

Safe routes should be identified both inside and beyond the boundary of the new development. Even where a new development is above the floodplain and considered acceptable with regard to its impact on flood flows and flood storage, it should be demonstrated that the routes to and from the development are also safe to use.

A route can only be completely safe in flood risk terms if it is dry at all times.

[161] 114_04 Safe Access and Exit From New Development During Flood Conditions

## 13.3Requirements for Safe Access and Exit

The requirements for safe access and exit from new developments in flood risk areas are as follows, in decreasing order of preference:

- Safe dry route for people and vehicles
- Safe dry route for people
- If a dry route for people is not possible, a route for people where the flood hazard (in terms of depth and velocity of flooding) is low and should not cause a risk to people.
- If a dry route for vehicles is not possible, a route for vehicles where the flood hazard (in terms of depth and velocity of flooding) is low to permit access for emergency vehicles. However the public should not drive vehicles in floodwater.

Where a dry route is not possible and a route with low flood hazard is identified, the route should not have any service covers that could be removed, or other underwater hazards. It is often difficult to see underwater hazards even in shallow water, particularly at night or if the water is silty. In addition, the route should be clearly marked, for example using painted posts.

## 13.4Approach

For a given development, it must be decided whether safe exit and access constitutes dry access routes or depth and velocity combinations that are below appropriately precautionary thresholds.

This decision needs to be made by the LPA in consultation with the Emergency Services and will need to take into consideration the proposed use of the development, the vulnerability of the occupants and the availability of emergency services and flood forecasting.

Any raising of ground levels to ensure safe exit and access will need to be considered in the FRA to ensure that there is no obstruction to flood flow routes and that there is no loss of flood storage capacity.

Three levels of complexity in approach are recommended in this guidance note.

- **Simple Approach**, which is based on providing a dry route up to an acceptable flood level. This approach is most precautionary and generally will be most appropriate for small and relatively low risk sites.

- **Intermediate Approach**, which is intended to identify a route with acceptable flood hazard if a dry route is not possible. This approach is based on analysis of the flood hazard (a combination of depth and velocity). This approach is also precautionary and can be applied to most sites. However, costs of site design might make it worthwhile for developers to consider the detailed approach.

- **Detailed Approach**, which is based on a more rigorous analysis of the flood hazard.

Both the intermediate and detailed approaches are based on the Flood Risks to People methodology.

These three approaches should not be confused with the tiered risk assessment approach in the Framework for Assessing and Managing Flood Risk for New Development.[162] The level of assessment being undertaken (whether level 1, 2 or 3) does not preclude the use of any of the approaches described above. The selection of approach will depend on the scale of the risk and the degree of precaution that

[162] See Activity Chart Process 2a – Tiered Risk Assessment

will be applied to the management of that risk. However, it is not unreasonable to envisage that more often than not, the complexity of the approach will increase if a level 2 or level 3 assessment is required.

The approach described in this guidance note concentrates on pedestrian access, as vehicles have not been considered in the Flood Risks to People methodology. However, a limited review was undertaken as part of the Defra/EA R&D project FD2321 *Flood Risk to People Phase 2* looking at safe flood depths for vehicles. In summary, this review concluded the following:

Vehicles should not be used when:

- The presence of water stops the engine functioning;
- The vehicle floats; or
- The vehicle becomes difficult to control.

Cars will stop and/or float in water as shallow as 0.5m, whilst some emergency vehicles may survive in water of 1m. A fire engine remains controllable in depths of 0.5m up to a flow velocity of 5 m/sec, due to high-level air intakes/exhausts.

## 13.5Data and Information

The data and information required to assess safe access and exit depends on the complexity of the approach undertaken, as follows:

**Simple Approach**

- Flood levels for suitable annual probabilities (advisable to look at the 1% and 0.1% annual probabilities for fluvial flooding or the 0.5% and 0.1% for tidal/coastal flooding).[163]

- Minimum ground levels along access and exit routes.

**Intermediate Approach**

- Flood depths and velocities for suitable annual probabilities across the development site and surrounding the development site, determined from hydraulic modelling.

- Simple lookup table relating depth and velocity to danger to people (provided in this guidance note).

**Detailed Approach**

- Flood depths and velocities across the development site and surrounding the development site, determined from hydraulic modelling.
- An appropriate means for determining the hazard factor for the site should be determined from the Flood Risks to People report.[164]

## 13.6Roles and Responsibilities

- The Emergency Services are the competent authorities for providing advice on entering and evacuation through floodwater and it may be necessary for them to have an input to the FRA.

- The Developer must ensure that safe access and exit are considered in the FRA.

[163] This information should be available from the EA. Alternatively, guidance of how to obtain flood levels, etc. can be found in the section called Tools and Technologies in this guidance note.
[164] HR Wallingford *et al.* (unpublished) *Flood Risks to People Phase 2: The Risks to People Methodology*, Defra/EA R&D Project Technical Report FD2321/TR1, due March 2005.

- The role of the Environment Agency is to support planning for safe access and exit from new developments and to object to proposals that omit suitable access and exit measures.

- The LPA in consultation with the Emergency Planning team within the local authority and the Emergency Services must decide whether safe exit and access is provided.

## 13.7Processes and Procedures

### 13.7.1 Simple Approach

In the absence of hydraulic modelling to provide depths and velocities, the precautionary position would be to demonstrate that a development site has access and exit routes that are above flood levels for acceptable annual probability events.[165]

If the development is behind defences, this would be the water level at the defence. Whilst this may be conservative, prediction of the actual flood level behind defences requires hydraulic modelling. If it would be impractical to design such routes, then it is necessary to undertake hydraulic modelling or obtain the results from an existing assessment (possibly available from a SFRA for the area) and then undertake either the intermediate approach or detailed approach described below.

### 13.7.2 Intermediate Approach

Danger to people is assessed using flood hazard, which can be expressed as a combination of flood **depth** and **velocity**. Hydraulic modelling or the use of results from an existing assessment are needed to predict flood depth and velocity.

The Flood Risks to People project has developed the following equation to relate the flood hazard to flood depth and velocity:

Flood Hazard Rating = $((v + 0.5) * D) + DF$

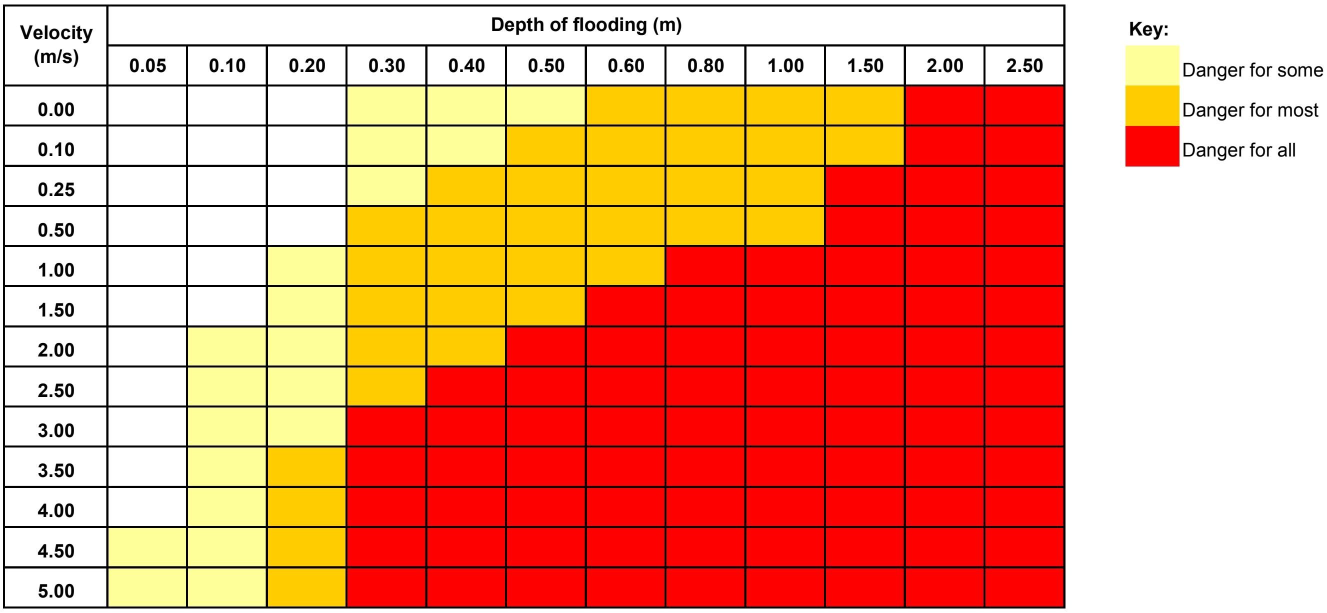
Where:
$v$ = velocity (m/s)
D = depth (m)
DF = debris factor

For this intermediate approach a precautionary approach has been adopted and a debris factor of 0.5 has been used for depths below and equal to 0.25 m and a debris factor of 1.0 has been used for depths above 0.25 m. These are conservative estimates based on an urban environment, as defined in the Flood Risks to People project. Based on this, the hazard rating equation has been applied to various combinations of flood depth and velocity to produce a matrix of hazard ratings. Applying thresholds to these hazard ratings defines the danger to people at various depths and velocities as shown in Table 13.1.

Therefore, if depths and velocities have been determined for the site, then this table can be used to estimate the danger to people.

165 This would be agreed with the LPA, based on advice from the EA.

**Table 13.1 Danger to people for different combinations of depth and velocity**




For details regarding the danger classifications of 'danger to all', 'danger to most' and 'danger to some' reference should be made to HR Wallingford (2005) *Flood Risks to People Phase 2, The Flood Risk to People Methodology*, Environment Agency\Defra R&D Technical Report FD2321/TR1, March 2005. However, the following provides a very simplified guide as to the groups of people that should be considered as falling into these danger classifications:

- Danger for some – includes children, the elderly and the infirm.
- Danger for most – includes the general public
- Danger for all – includes emergency services

The outputs of the Flood Risk to People project indicate that flood depths below 0.25 m and velocities below 0.5 m/s are generally considered low hazard. When designing safe access and exit routes, the combinations of depth and velocity on the routes should correspond to the white boxes in the above diagram. As flood depth and/or velocity increase the hazard to people increases. Combinations of depths and velocities in the white boxes (below the 'danger for some' class) are 'very low hazard', but a hazard does remain.

Depending on circumstances, alternative debris factors can be used based on the recommendations from the Flood Risks to People project.

### 13.7.3 Detailed Approach

Table 13.1 is a simple translation of a depth and velocity combination at selected points in the development site into a danger to people category. For large, complex developments this could be a time consuming exercise and difficult to test multiple options. Therefore, a more detailed approach would be to undertake flood hazard mapping across the area being considered based on the results of hydraulic modelling.

The advantage of this approach is that the mapping can also usefully inform the flood warning and emergency planning for the site.

## 13.8Tools and Technologies

### 13.8.1 Determining Flood Hazard

It is possible to use either the lookup table provided in this guidance note or refer to the Flood Risks to People project, which provides a discussion of alternative methods for calculating flood hazard and suitable variations in debris factor depending on the characteristics of the site.

### 13.8.2 Hydraulic Modelling

There are a range of hydraulic modelling methods that can be used to estimate flood depths and velocities. Methods are summarised below (in the order of least complex to most complex):

- **Existing flood maps and topographic data.** Existing maps can be used to estimate flood depth but do not provide any information on velocities. For some simple applications of the method it may be appropriate to estimate peak velocities based on normal depth calculations or even expert judgement. Any assumptions made should be conservative (assuming high velocities).

- **Conveyance calculation.** The new Conveyance Estimation System (CES) can be used to estimate velocities across a floodplain for river valleys without defences.[166]

- **One-dimensional hydraulic models** with defined flood storage areas and active floodplain channels, e.g. ISIS Flow or MIKE11 software, can be used to estimate average velocities. Maximum velocities can be significantly higher in some parts of the floodplain, e.g. where water spills over a defence, in narrow streets and any other "pinch points" in the floodplain.

- **Flow routing using a "raster" GIS system**, e.g. the JFLOW model used for the fluvial component of the EA's Extreme Flood Outline project.

- **Two-dimensional hydraulic modelling using a fixed grid**, e.g. the TUFLOW hydraulic model that has been used for modelling the floodplain of the tidal Thames or HYDRO F that was used for the tidal component of the EA's Extreme Flood Outline project.

- **Two-dimensional hydraulic modelling using a triangular mesh**, e.g. the Telemac 2D model. This can provide good velocity estimates but model run times are significantly longer than grid based models.

Outputs from the raster and two-dimensional models can be converted directly to flood hazard as they provide depth and velocity at regular intervals across the flood hazard areas.

Flood velocities produced by one and two-dimensional models will be average velocities for a cross-section or grid cell. There will be considerable variation of flow velocities within a river cross-section and for all modelling approaches peak flow velocities may be much higher than the average velocities reported for a cross-section or grid-cell. This is particularly the case in urban areas where flows may be concentrated in narrow streets and between buildings.

## 13.9Audit and Control

When checking the analysis of depths and velocities, due consideration needs to be given to the accuracy of the model predictions, which will depend on the type of model used, as listed in Tools and Technologies.

[166] See http://www.river-conveyance.net

# 14.S3.4 BROWNFIELD DEVELOPMENT

**This guidance note:**

- Provides summary guidance regarding how the generic approach should be applied to development on brownfield sites.
- Provides summary information regarding the roles and responsibilities of Local Planning Authorities (LPAs) and the Environment Agency (EA) in assessing the appropriateness of brownfield development.

**This guidance note does NOT:**

- Set parameters that dictate whether or not development should be permitted on brownfield sites, as this is a decision for the LPA.
- Set parameters that dictate whether the EA should object to a development on a brownfield site, as this is a policy issue for the EA.

The guidance presented in this note **does not** supersede the information contained in the following principal references:

- DTLR (2001) *Planning Policy Guidance Note 25: Development and Flood Risk*. HMSO, London.[167] Usually referred to as PPG25.
- National Assembly for Wales (2004) *Technical Advice Note 15: Development and Flood Risk*, National Assembly for Wales, Cardiff.[168] Usually referred to as TAN15.
- DETR (2000) *Planning Policy Guidance Note 3: Housing*, HMSO, London.[169] Usually referred to as PPG3.
- ODPM (2005) *Planning Policy Statement 1: Creating Sustainable Communities*, ODPM, London.[170] Usually referred to as PPS1.

These documents should be referenced for further guidance.

## 14.1Contents



[167] http://www.odpm.gov.uk/index.asp?id=1144113
[168] http://www.wales.gov.uk/subiplanning/content/tans/tan15/july04-tan15-e.pdf
[169] http://www.odpm.gov.uk/index.asp?id=1143941
[170] http://www.odpm.gov.uk/index.asp?id=1143805

## 14.2Introduction

LPAs should give preference to reusing previously developed sites and empty properties (i.e. brownfield sites) before the use of any greenfield sites (as specified in PPG3). However, many brownfield sites have a flood risk associated with them and, therefore, require a Flood Risk Assessment (FRA). This is sometimes perceived as conflicting with the guidance in PPG25, which states that sites of lowest flood hazard should be considered first. However, with regard to previously developed land, PPG25 recognises that a 'balanced flexible approach is required'.

The Sequential Test approach is based on the premise that all other considerations are equal.

- If there are two sites with the same probability of flooding, the brownfield site should be developed in preference to the greenfield site.

- If the brownfield site has a higher probability of flooding than the greenfield site, then a trade-off must be made between benefits and disadvantages of the two sites. Should the LPA consider that developing on the brownfield site is beneficial then appropriate mitigation measures need to be included in the design and the guidance provided in PPG25 regarding avoiding elderly and vulnerable occupants still applies.[171]

Just because a site had development on it before does not set the precedent that development should be permitted again. The decision-making process should treat the status of the site (brownfield or greenfield) as one of a number of planning consideration. The approach to the assessment and management of the flood risk is the same whether looking at brownfield or greenfield sites.

However, brownfield sites do have characteristics that can challenge Developers and LPAs when determining appropriate flood risk management. They are often located in central areas of towns and cities, which tend to have developed outwards from a water front or riverside location. They are more likely to include a change in use of existing buildings from industrial or commercial to residential use, increasing the density of occupancy, which in turn increases the risk. There are often fewer opportunities for mitigation measures, such as flood compensation (due to location) and the use of certain types of SUDS techniques (due to contaminated land).

## 14.3Data and Information

The data and information to be collected for an assessment of flood risk and the management of that risk is the same as described in guidance notes D1.3 Local Development Frameworks and D1.4 Planning Applications.

The advantage of assessing flood risk for brownfield sites is that there should be better/more historical information regarding flood events in the past. Any existing buildings can also provide clues regarding previous flooding.

## 14.4Roles and Responsibilities

The LPA is responsible for deciding whether brownfield sites should be developed. This includes carrying out the trade-off analysis between the use of brownfield and greenfield sites. The LPA must be accountable for the decisions that it makes. Therefore, transparency of the decision-making process is important and stakeholder engagement[172] can help with this.

[171] See Activity Chart Process 3 – Options Appraisal
[172] See Guidance Note S2.4 Stakeholder Engagement

The EA is one of the key consultees regarding flood risk at both the Local Development Framework and Planning Application stages and should be engaged as early as possible in the process. Issues of concern and objectives of the EA in the area under review should be identified as part of the problem formulation stage.[173] These might include:

- Learning from mistakes of the past,
- Measures to reinstate the floodplain, whether through realignment or removal of defences or compensation on adjacent land,
- Reducing flood risk by comparing the existing/previous development on the site and the new development proposals (i.e. issues of change in use),
- Ensuring the residual risk meets the minimum requirements of acceptability.

It is clear that decisions regarding whether to redevelop brownfield sites should not be limited to a site by site review, as and when planning applications are made. It is a spatial planning issue and policies should be set in place as part of the Local Development Framework (LDF).

Sewerage Undertakers are also usually an important stakeholder at both the local and site-specific scales, due to most brownfield sites being served by or adjacent to existing drainage. Therefore, they should also be consulted as early as possible in the planning process.

## 14.5Processes and Procedures

Land that is currently developed and defended is likely to be deemed by the LPA to fall into PPG25 Zone 3a[174] and development, subject to conditions, will generally be permitted. However, a sequential test should still have been undertaken to ensure that there are no candidate sites that would pose a lesser flood risk. This should be carried out as part of the LDF. If not, this should be carried out when reviewing the planning application, although this is clearly not ideal.

### 14.5.1 Local Development Frameworks

Assessment of flood risk and the management of that risk should be no different for brownfield sites as any other site. It is only once furnished with the appropriate information of flood risk and the possible means for managing that risk, that the LPA should undertake the trade-off analysis between greenfield and brownfield sites.

### 14.5.2 Planning Applications

Assessment of flood risk and the management of that risk should be no different for brownfield sites as any other site. The best practice approach for undertaking site-specific Flood Risk Assessments (FRAs) as described in the CIRIA guidance C624[175] still applies.

## 14.6Tools and Technologies

There are no tools or technologies related to the assessment and management of flood risk that are specifically designed to help decisions regarding development of brownfield sites.

## 14.7Audit and Control

Audit and control of the decision-making process is achieved through the examination process for LDFs and, in particular, by the EA acting as a consultee on both LDFs and Planning Applications.

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[173] See Activity Chart Process 1 – Problem Formulation
[174] See Table 1 of PPG25
[175] Lancaster, J, Preene, M and Marshall, C (2004) *C624 Development and Flood Risk – Guidance for the Construction Industry*, CIRIA, London.

The review of decisions relating to brownfield development should be no different from any other plan or application.

# 15.S3.5 MITIGATION MEASURES

**This guidance note:**

- Provides guidance on when and how to take into consideration mitigation measures when assessing flood risks for new developments.

**This guidance note does NOT:**

- Provide guidance on the design and implementation of specific mitigation measures.
- Set parameters that dictate the acceptability of mitigation measures, as this is a decision for the LPA.
- Set parameters that dictate whether the EA should object to the mitigation measures proposed, as this is a policy issue for the EA.

## 15.1Contents



## 15.2Introduction

This guidance describes the use of flood mitigation measures to reduce flood risks to new developments and how they should be implemented within the overall planning framework. This introduction covers commonly used terms, a description of what needs to be mitigated and how and guidance on sources of further information.

### 15.2.1 Commonly Used Terms

- **Mitigation Measures** are actions designed to reduce either the probability or the consequences of the risk, in this case flooding.
- **Flood Risk Management** combines the functions of mitigating and monitoring flood risks and may include pre-flood, flood-event or post-flood activities.
- **Residual Risk** is the risk that remains after mitigation. It may include, for example, risk due to very severe storms (above the design standard of protection) or risks from unforeseen hazards. Not to be confused with future risk.
- **Future Risk** is the estimated risk given the likely effects of sea level rise and changing weather patterns in the future. In relation to new developments, the anticipated life of the development should be taken into consideration when determining how many years into the future the risk should be estimated.
- The **Flood Defence Level** is the level to which flood defences are constructed, that is the level of the top of flood walls and embankments, expressed relative to Ordnance Datum. This is sometimes higher than the design flood defence level, see **Freeboard**.

- The **Standard of Protection** (SoP) is the flood return period event (or annual probability) above which channel or pipe capacity or flood defence level is exceeded.

- The **Probability of Inundation** is the actual likelihood of an area being flooded, which could be due to the Standard of Protection being exceeded (e.g. a defence overtopping) or due to failure of the mitigation measure (e.g. a defence breaching).

- The **Standard of Service** is the measurable performance of an option relative to a defined performance indicator, such as probability of inundation.

- **Freeboard** is the difference between the design flood defence level and the lowest point on the flood defence.[176,177] Its purpose is to provide a safety margin that ensures that the defence performs with a high degree of certainty to the required standard of protection. This allowance is dependent on three elements:

  - Physical processes that have not been allowed for in the design water level, such as waves,

  - Physical processes that have not been allowed for in the flood defence level, such as settlement, degradation, etc.

  - Uncertainty in the prediction of design water levels, such as accuracy in the flood estimation, accuracy of conveyance modelling, etc.

  It is also used in the context of raised development floor levels for the same reasons as listed above.

### 15.2.2 What are we trying to mitigate?

The purpose of flood mitigation is to prevent an overall increase in flood risk as a result of new development and, if possible, to reduce the overall flood risk (to new and existing development).

It is common to describe risk as a function of the chance of a particular event occurring (probability) and the impact that the event or hazard would have if it occurred (consequences). However, risk can also be expressed as a combination of three generic components:

- The nature and probability of the **hazard**,
- The degree of **exposure** of people, assets or the environment to the hazard, and
- The **vulnerability** of the people, assets or the environment should the hazard be realised.

For development planning, it is also necessary to distinguish between:

- The flood risk to the proposed development, and
- The change in flood risk to the surrounding area caused by the development.

### 15.2.3 How can we mitigate flood risks?

The mitigation of flood risk can be accomplished through managing one or more of the three generic components listed above. Examples of types of mitigation measures are provided in Table 15.1.

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[176] HR Wallingford (1999) *R&D Technical Report W178 Wave Overtopping of Sea Walls Design and Assessment Manual*, Environment Agency.
[177] Kirby, A. and Ash, J. (unknown) *R&D Technical Report W187 Fluvial Freeboard Guidance Note*, Environment Agency.

**Table 15.1 Examples of measures to reduce flood risk for new developments**

| Generic types of mitigation | Examples |
|---|---|
| Reduce the physical hazard (alleviation) | Flood embankments/sea defences<br>Increased capacity of channel and hydraulic structures<br>Washland storage<br>Reservoir impoundment<br>Catchment management<br>Management of development runoff |
| Reduce exposure to the hazard (avoidance) | Keep properties away from flood hazards<br>Keep vulnerable occupants away from flood hazards<br>Raise properties above flood level<br>Flood proofing of properties |
| Reduce vulnerability to the hazard | Flood warning<br>Emergency planning<br>Flood awareness of occupants<br>Insurance |

Developments that rely on mitigation measures should be avoided wherever possible. Mitigation measures should only be considered if there are no alternative sites AND the development can be justified on other sustainability grounds.[178] If the development can be justified based on sustainability objectives, it then becomes necessary to consider how to implement hazard alleviation, avoidance and reduced vulnerability. These need to be considered concurrently, so that there is a trade-off between the following:

- **Costs** – over the life-time of the development, including capital costs, maintenance and operational costs, insurance premiums, clean-up/reinstatement costs or loss of business costs should an event occur, etc.

- **Acceptability of residual risks** – recognising that a low probability but high consequences event might be less acceptable than a higher probability but lower consequences event.

- **Sustainability** – recognising the greater adaptability of some measures to uncertainties such as climate change.

Mitigation measures are often described as falling into two categories:

- Structural or Engineering Measures (usually interpreted as flood defences or other man-made features such as artificial drainage systems), and
- Non-structural Measures (including spatial planning, flood warning, emergency planning, building regulations, etc.).

It should not be assumed that spatial planners should only consider non-structural measures and developers should only consider structural measures. Both types of mitigation measures need to be considered by both parties, as appropriate, at all stages of the development planning process to obtain the most cost-effective and sustainable solution.

[178] An example of this approach can be seen in Section 6 of National Assembly for Wales (2004) *Technical Advice Note 15: Development and Flood Risk*, National Assembly for Wales, Cardiff.

### 15.2.4 Sources of Further Information

Substantial information on different types of mitigation measures is available from a number of different sources. Therefore, this is not reiterated in this guidance note. However, a good starting point is CIRIA guidance C624.[179]

Mitigation measures form an area of substantial research and some recently completed or ongoing R&D projects and initiatives are listed below. Further details of these and other projects can be found in the Information Chart that accompanies this guidance (see Appendix B).

1. Common strategies to reduce the risk of storm floods in coastal lowlands (COMRISK), INTERREG IIIB Project 2036
2. Designing for exceedance in urban drainage systems, CIRIA Research Project 699
3. Failure on demand of flood defence structures/ components, Defra/EA R&D Project W5B-031
4. Flood risk management in Estuaries (FRaME), INTERREG IIIB Project 2037
5. Flood risk management research consortium (FRMRC)
6. Improving the flood resistance of buildings through improved materials, methods and details, ODPM/EA R&D project CI 71/8/5(BD2471)
7. Kitemark Scheme for flood protection products
8. Performance and reliability of flood and coastal defence structures, Defra/EA R&D Project FD2318
9. Performance based Asset Management Systems (PAMS) (Phases 1 and 2), Defra/EA R&D Projects W5-070, W5-0205
10. Preliminary rainfall runoff management for developments, Defra/EA R&D Project W5-074/A
11. Reducing the risk of embankment failure under extreme conditions, Defra/EA R&D Project FD2411
12. Sustainable Drainage Systems (SuDS) – Updated Guidance on Technical Design and Construction CIRIA Research Project 697
13. Temporary and Demountable Flood Protection, Defra/EA R&D Project W5A-062
14. Use of SuDS in high density developments, Dti Project CI39/3/711C2425
15. Water cycle management for new developments (WaND)

There is a variety of internal EA guidance either on the Agency Management System or in preparation that describe different types of defence. Again, details can be found in the Information Chart.

Guidance regarding the use of SuDS to mitigate flood risks is also provided in the following two documents:

- DTLR (2001) *Planning Policy Guidance Note 25: Development and Flood Risk*. HMSO, London.

- National Assembly for Wales (2004) *Technical Advice Note 15: Development and Flood Risk*, National Assembly for Wales, Cardiff.

## 15.3Data and Information

As described in the Introduction, the assessment of mitigation measures has three main parts: costs, residual risk and sustainability. Therefore, appropriate data and information needs to be obtained for each of these.

### 15.3.1 Costs

Data and information on costs of mitigation measures need to consider whole-life costs, not only costs of construction. However, depending on the decision-making requirements, relative rather than absolute costs may be adequate.

[179] Lancaster, J, Preene, M and Marshall, C (2004) *C624 Development and Flood Risk – Guidance for the Construction Industry*, CIRIA, London.

Useful sources of information on relative costs can be found in the following references:

- Office of Science & Technology (2004) *Foresight Future Flooding Scientific Summary* Volumes I and II.[180]

- Lancaster, J, Preene, M and Marshall, C (2004) *C624 Development and Flood Risk – Guidance for the Construction Industry*, CIRIA, London.

### 15.3.2 Residual Risk

The data and information required to determine residual risks are similar to the requirements for determining current risks, with due consideration of the characteristics of the proposed mitigation measures.

However, it is important that a distinction is made between the residual risks when the development is first built and future residual risks, as any assessment should consider the risks associated with a new development for the life-time of that development (see Processes and Procedures).

Therefore, all of the following should be considered and appropriate information gathered:

**Hazards:** Future changes in sources of flooding should be considered, due to climate change, relative sea level changes, reductions in groundwater abstraction, increased urbanisation of the surrounding area, etc.

**Exposure:** The maintenance and operational requirements of structural mitigation measures should be considered, recognising potential deterioration in condition over time.[181] For example, mitigation measures could be designed so that they are easy to repair or can fail in a controlled manner.[182]

**Vulnerability:** Although this aspect of flood risk is the most difficult to quantify, the flood preparedness of the community over time should also be considered. It should be recognised that occupancy might change and that activities need to be undertaken throughout the life-time of the development.

By comparing different mitigation options for present day residual risks and future residual risks, an indication of the relative sustainability of the options can be obtained.

### 15.3.3 Sustainability Objectives

These are best determined through the use of sustainability indicators. Further details of example sustainability indicators and the data/information they require can be found in the parallel Defra/EA R&D project FD2015.[183]

## 15.4Roles and Responsibilities

The key roles and responsibilities for flood mitigation in new developments are as follows:

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[180] http://www.foresight.gov.uk/

[181] Ongoing research and development in the area of defence performance includes the Defra/EA R&D project FD2318. Further details can be found in HR Wallingford (2004) *Performance and Reliability of Flood and Coastal defences – Phase I Evaluation of the applicability of the concept of fragility to risk assessment of flood and coastal defences* R&D Interim Technical Report.

[182] Refer to Defra/EA R&D Project W5B-031 *Failure on demand of flood defence structures/ components* in the Information Chart.

[183] Wade *et al.* (unpublished) *Sustainable Flood and Coastal Management, Technical Report, Part 1: Handbook,* Defra/EA R&D Technical Report FD2015/TR1, due to be issued December 2005.

- At strategic planning level, the need for flood mitigation measures should be decided by the relevant planning authority (whether regional or local) in consultation with the Environment Agency.

- Proposed flood mitigation measures for new developments should be designed by Developers (or by consultants on their behalf). The designs should include calculations demonstrating the impact on flood risk and the residual risk for the development and the surrounding area.

- The Environment Agency provides advice regarding flood mitigation measures and whether the proposed flood mitigation measures are (in its view) acceptable or not.

- The Developer is normally responsible for the implementation of flood mitigation measures on a development site.

- The Local Authority and the Environment Agency should be satisfied that the flood mitigation measures have been implemented correctly.

- The ownership of the flood mitigation measures should be agreed in advance between the Developer, the Local Authority, the Environment Agency and any other relevant organisations, together with any associated financial and other agreements. This is essential to ensure that operation and maintenance of the flood mitigation measures are provided for.

Some mitigation measures, for example flood warning and flood preparedness involve a wider group of stakeholders who have responsibilities to mitigate flood risks. This group includes:

- Those who live and/or work on floodplains
- Those who are responsible for land-use/spatial planning
- Those who are responsible for flood warning, emergency planning, response and flood recovery
- Operating Authorities, including flood defence authorities and sewerage undertakers
- Policy makers and other supervisory organisations, including Defra, ODPM and the Planning Inspectorate
- Those who have assets on floodplains, such as transport infrastructure or utilities
- Private sector organisations, including developers and insurance companies

Further details of their roles are provided in Guidance Note S2.4 Stakeholder Engagement.

Some of these stakeholders are directly involved in development planning, whilst others are affected by the decisions made and should be involved in consultation, as appropriate. References to specific roles and responsibilities depending on the decision-making scale can be found in the following Guidance Notes:

- D1.1 National Development Planning
- D1.2 Regional Spatial Strategies
- D1.3 Local Development Frameworks
- D1.4 Planning Applications

## 15.5Processes and Procedures

All of the processes in the generic approach play a role in determining or implementing mitigation measures, as summarised in the sections below.

### 15.5.1 Process 1 – Problem Formulation[184]

During Process 1 it is necessary to identify the environmental objectives, sustainability objectives and flood management objectives already defined for the area in question. These can help define the specific objectives of the plan or project, referred to as the "strategy objectives" in the case of a spatial planning activity or the "project objectives" in the case of an individual development site. The "strategy objectives" or "project objectives" can then be used to compare the relative benefits of different mitigation measures during Options Appraisal (see Process 3) and to monitor the success of their implementation during Monitoring and Review (see Process 4).

Objectives should be:

- Limited in number,
- Clearly defined,
- Quantitative rather than qualitative, wherever possible, and
- Directly related to the plan or project being considered.

This is so that:

- The analysis is as quick and easy as possible, both to do (repeatedly if necessary) and to check,
- The likelihood of parameters being double-counted due to over-lapping objectives is reduced,
- The decision-making process is as transparent as possible, and
- The process can be communicated in layman's terms as easily as possible.

The following general objectives can be used as a starting point for specific strategy or project objectives:[185]

**Objective 1** – Prevent inappropriate development in flood risk areas and prevent development increasing flood risk elsewhere.

**Objective 2** – Recognising that Objective 1 is not always practicable, where structural mitigation measures are required, develop these in the context of sustainable development, working with natural processes where possible.[186]

**Objective 3** – Recognising that residual risks will remain, whether structural mitigation measures are required or not, ensure that the following non-structural mitigation measures are undertaken as appropriate:

a) Raise flood awareness,
b) Use flood resilience and resistance measures to minimise damage to properties,
c) Ensure appropriate flood warning mechanisms are in place,
d) Undertake appropriate emergency planning.

Flood risk indicators can be used to quantify residual risks. Details of useful flood risk indicators can be found in Guidance Note D2.1 Flood Risk Indicators. These should be used alongside other sustainability indicators as part of the decision-making process.[187]

With the objectives and indicators in place, it is then possible to decide on baseline conditions against which options will be assessed. Objectives and indicators should be developed in consultation with stakeholders,[188] as appropriate, and baseline conditions should be agreed, recognising that some of these may need revising/refining as the assessment process is undertaken and understanding of the

[184] See Activity Chart Process 1 – Problem Formulation
[185] This is based on Figure 3 in Defra (2004) *Making Space for Water - Developing a new Government strategy for flood and coastal erosion risk management in England*, Defra.
[186] These may have been already defined in a Catchment Flood Management Plan, Shoreline Management Plan or River Basin Management Plan (see Guidance Note S2.5 Linkage to Statutory Requirements).
[187] Wade *et al.* (unpublished) *Sustainable Flood and Coastal Management, Technical Report, Part 1: Handbook,* Defra/EA R&D Technical Report FD2015/TR1, due to be issued December 2005.
[188] See Guidance Note S2.4 Stakeholder Engagement

flood risk issues improves. Understanding the uncertainties (associated with these objectives and indicators) is also an important part of this process. Uncertainties cannot be eliminated completely, but should be identified and managed appropriately.

### 15.5.2 Process 2a – Tiered Risk Assessment[189]

This process is initially undertaken to determine existing flood risks associated with an area, considering:

a) Flood risk to the development and
b) Change in flood risk to the surrounding area caused by the development.

This process is then revisited to assess the residual risk post-development with corresponding mitigation options. Again, considering:

a) Flood risk to the development and
b) Change in flood risk to the surrounding area caused by the development.

The level of assessment that is undertaken for residual risk should be the same as that undertaken for determining existing flood risks. However, it is not always necessary to consider residual risk, for example if it were decided to avoid the flood hazard totally.

*Strategic Flood Risk Assessments (SFRAs)*

**If undertaking a SFRA as part of a spatial planning activity, the need for flood mitigation measures should be identified at this stage.**

Reference should be made to Guidance Note D3.4 Strategic Flood Risk Assessments for more details.

*Site-specific Flood Risk Assessments (FRAs)*

Site-specific FRAs should include details of any necessary flood mitigation measures together with an assessment of the residual risks after inclusion of the mitigation measures. This assessment needs to include:

1. Assessment of the frequency of flooding (post-development with mitigation).
2. Assessment of the sequence of flooding across the site, rate of rise of water level, flow velocities, depths and the duration of flood (post-development with mitigation).[190]
3. Assessment of change in conditions progressively away from the site boundary (both upstream and downstream), including volume of displaced water as well as flood levels.
4. Where new or modified structural measures are provided, an assessment should be undertaken of their behaviour during extreme events that are greater than those for which they are designed.

Reference should be made to Guidance Note D3.5 Flood Risk Assessments for more details.

### 15.5.3 Process 3 – Options Appraisal[191]

*Selecting Options*

Within any appraisal of options there are three main options that should be considered. In the context of new development, these options are effectively the following:

- **Reject the intention** – do not undertake the development because it poses unacceptable risks

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[189] See Activity Chart Process 2a – Tiered Risk Assessment
[190] If a detailed assessment is being undertaken, this might include breach analysis. However, reference should be made to Guidance Note S3.2 Risk to People behind Defences where other options are available.
[191] See Activity Chart Process 3 – Options Appraisal

- **Accept the increase in risk** – assess the flood risks associated with a new development assuming that no mitigation measures were used. This provides a clear understanding of the change in risk caused by the development.
- **Reduce the risk** – identify options that either result in no change in overall flood risk compared to before the development or reduce the flood risk to below existing levels. Considering that risk is a function of probability and consequence, the introduction of a new development in an area will change the flood risk of that area. Appropriate flood risk indicators can be used to demonstrate whether the flood risk is maintained at the pre-development level or reduced. An example of an indicator that expresses the change in risk is the calculation used in the Risks to People Calculator.[192]

In addition to these options, it is then usual practice to identify options that achieve agreed standards of protection. Government guidance offers indicative standards[193], but it is the responsibility of the LPA to decide what standard of protection is considered acceptable, based on Government guidance and advice from the EA.

Figure 15.1 provides an example of a possible decision-making hierarchy for identifying flood risk management options.

### *Evaluating Options*

There is no single evaluation approach that is suitable in all circumstances. The choice of evaluation approach (or trade-off analysis) depends on the decisions to be made, the options being considered and the level of risk. However, all appraisals should involve a systematic approach of identifying, quantifying and weighting the costs and benefits of alternative mitigation measures. The benefits should be expressed in the form of objectives, which can be quantified using flood risk, sustainability and "business" (i.e. value to the developer) indicators.

Any trade-off analysis will include assumptions and uncertainties and these also need to be accommodated within the scoring system.

Useful guidance and examples of different types of trade-off analysis can be found in the following references:

- MAFF (2000) *Flood and Coastal Defence Project Appraisal Guidance, Economic Appraisal (FCDPAG3),* MAFF,[194] provides details of how to undertake detailed cost-benefit analysis of options.

- DTLR (2000) *Multi-criteria analysis manual*[195] provides guidance on how to undertake and make best use of multi-criteria analysis for the appraisal of options for policy and other decision-making activities and covers a range of techniques.

- Entec *et al.* (2005) *Making Communities Sustainable (Managing Flood Risks in the Government's Growth Areas), Summary Report*, Association of British Insurers, provides an example of how a cost-benefit analysis could be undertaken at the regional, sub-regional or even local scale.

- DETR (2000) *Guidelines for Environmental Risk Assessment and Management, 2nd edition*, The Stationary Office, London, Institute of Environmental Health.

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[192] See D2.1 ADD2 Flood Risks to People Calculator Guidance Note
[193] See Chapter 6 of FCDPAG3 or Appendix 1 in National Assembly for Wales (2004) *Technical Advice Note 15: Development and Flood Risk*, National Assembly for Wales, Cardiff.
http://www.wales.gov.uk/subiplanning/content/tans/tan15/july04-tan15-e.pdf
[194] http://www.defra.gov.uk/environ/fcd/pubs/pagn/fcdpag3/default.htm
[195] http://www.odpm.gov.uk/index.asp?id=1142254

- MAFF (2000) *Flood and Coastal Defence Project Appraisal Guidance, Approaches to Risk (FCDPAG4),* MAFF,[196] provides useful guidance on alternative appraisal/evaluation techniques for use in flood and coastal defence project appraisals.

### 15.5.4 Process 4 - Monitoring and Review[197]

Monitoring and review is an integral part of flood risk management and key for determining and ensuring sustainable development. This process is the vital to ensure successful transition from one set of responsibilities to another within flood risk management and should not be overlooked.

At the present time, perhaps this process is more aspirational than current practice, but should be encouraged as part of a best-practice approach. Based on Defra's consultation exercise *Making Space for Water*[198], it is clear that there is a need for greater integration between flood risk management of new developments and existing development.[199] This might ultimately take the form of Integrated Drainage Plans. Further details can be found in Guidance Note D3.4 Strategic Flood Risk Assessments.

The specific requirements for monitoring and review depend heavily on the selected mitigation measures and whether this is part of a spatial planning activity or development control.

#### *Spatial Planning*

Review of the plan and the successful enforcement of planning policies and constraints should be considered. This could include the use of performance indicators and will be influenced by the objectives set for the plan during Process 1.

The need to revise strategies in the light of new information, for example on climate change, is particularly important.

It is also common for assessments of flood risk to have a limited scope due to time or cost constraints. Therefore, it may be decided that the assessment will require revision or extension as and when resources permit or when the information comes available. In this case a mechanism needs to be put in place so that this does happen.

#### *Development Control*

When reviewing individual planning applications, it is important to consider the management of residual flood risk during the life-time of the development. This includes asking the following questions:

- Are there any maintenance or operational issues that might affect residual risks over time?
- Is there a need to confirm that the mitigation measures are meeting their objectives or required standards?
- Is there a need for an alert mechanism if adverse impacts occur?
- Are any of the mitigation measures sensitive to changes in future conditions and, therefore, may require adaptive management?

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[196] http://www.defra.gov.uk/environ/fcd/pubs/pagn/fcdpag4.pdf
[197] See Activity Chart Process 4 – Monitoring and Review
[198] Defra (2004) *Making Space for Water - Developing a new Government strategy for flood and coastal erosion risk management in England*, Defra.
[199] This is currently being considered as part of several ongoing R&D projects, including WaND, AUDACIOUS and the Flood Risk Management Research Consortium. Further details can be found in the Information Chart or the Project Record for FD2320.

Examples of when these questions will be particularly important include:

- Developments behind defences, as the defences will require maintenance and will deteriorate over time.
- Developments with SuDS, as inadequate maintenance could increase flood risk to the development itself or to the surrounding area and have water quality implications.
- Developments with residual flood risks that are sensitive to climate change.
- Developments with residual flood risks that are sensitive to changes in the broader flood management or water resources strategies for the area.
- Developments where flood warning and flood preparedness will be used to reduce vulnerability of occupants and their properties.

Further details can be found in Guidance Note D3.5 Flood Risk Assessments.

## 15.6 Tools and Technologies

### 15.6.1 Hydraulic Modelling

Hydraulic modelling is the normal technique used to assess the flood hazard and the effectiveness of structural flood mitigation measures. The risk can be assessed in terms of economic damages and social impacts using the modelling results.

### 15.6.2 Risk Register

The use of a Risk Register should be considered the primary tool to assess the merits of and to monitor appropriate mitigation measures. This is a particularly valuable tool for identifying actions (whether pro-active or remedial) and responsibilities for mitigation measures during the life-time of the development.

Depending on the level of assessment undertaken, it might be difficult to estimate the probabilities and consequences of the residual risk, even if a relatively coarse scoring system is used. However, where there is great uncertainty, this can be identified and appropriate resources can be allocated to manage the uncertainty, such as an adaptive management approach or a review of the assessment.

An example of a risk register for inclusion in a site-specific FRA is provided in CIRIA guidance C624[200] Appendix A5.

FCDPAG4[201] provides a detailed description of the purpose of risk registers and gives examples of how these can be used in different circumstances.

### 15.6.3 Appraisal Tools

CIRIA guidance C624 includes check-lists for different types of mitigation measures to assist in the assessment of their likely acceptability. These are designed for use as part of site-specific FRAs.

Reference should be made to FCDPAG3, FCDPAG4 and the DTLR *Multi-criteria analysis manual*, as listed earlier in Process 3, for details of different types of appraisal tools.

[200] Lancaster, J, Preene, M and Marshall, C (2004) *C624 Development and Flood Risk – Guidance for the Construction Industry*, CIRIA, London.
[201] http://www.defra.gov.uk/environ/fcd/pubs/pagn/fcdpag4.pdf

## 15.7 Audit and Control

Audit and control of the selection of appropriate mitigation measures are integral parts of the relevant decision-making and assessment processes and reference should be made to the relevant Decision Guidance provided as part of this framework and the Guidance Note S2.3 Auditing and Control.

Audit and control of the successful implementation of mitigation measures is the responsibility of the Planning Authorities and Developers in the first instance, which could be undertaken by reviewing the actions on the Risk Register (described above). Over time, it then becomes the responsibilities of the Operating Authorities and other supervisory organisations and part of the ongoing performance reviews within these organisations.

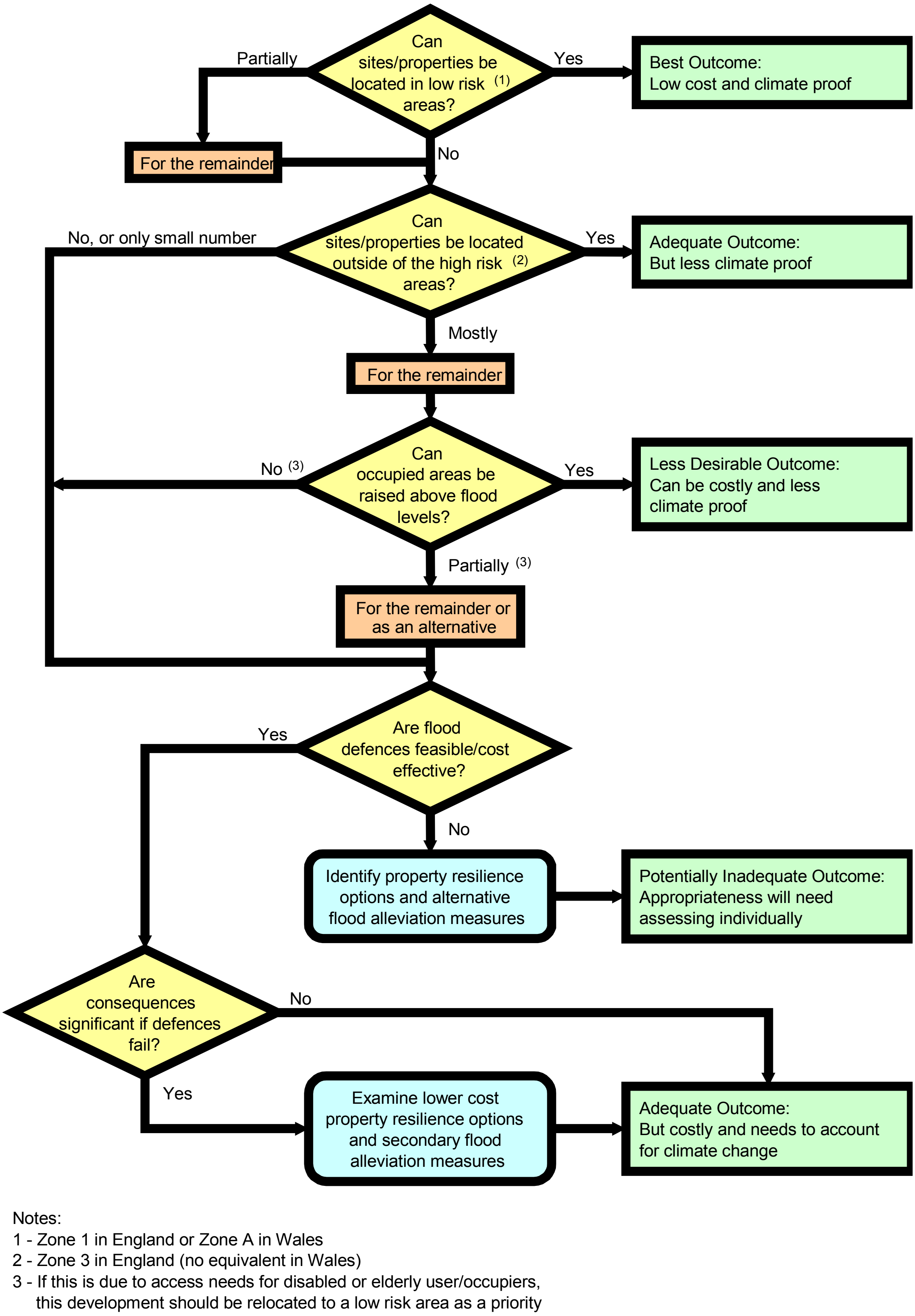


**Figure 15.1 Decision-Making Hierarchy for Identifying Flood Risk Management Options**[202]

[202] This is based on Figure 2.1 from Entec *et al.* (2005) *Making Communities Sustainable (Managing Flood Risks in the Government's Growth Areas), Summary Report*, Association of British Insurers. http://www.abi.org.uk/housing

# PART B – DECISION GUIDANCE

## 16.D1.1 NATIONAL DEVELOPMENT PLANNING

**This guidance note:**

- Provides an overview of how flood risk should be considered for national development planning purposes.

**This guidance note does NOT:**

- Set parameters that dictate the extent of development that should be planned for different regions, as this is a decision for the relevant Government Offices.

### 16.1 Contents



### 16.2 Introduction

#### 16.2.1 What is National Development Planning?

National Development Planning is undertaken by central Government to decide the quantity and distribution of new housing and other development in the country.

Flood risk is one of the many factors to be considered in National Development Planning. There is no formal method of assessing flood risk for development planning on a national basis. This document provides an overview of how to undertake an assessment of flood risk for National Development Planning.

#### 16.2.2 Key Questions

There are two key questions that should be answered at the national scale when considering development planning. These are:

1. What impact will the national demand for new housing have on flood risk?
2. What actions can be taken to minimise impacts?

There are fundamentally three potential actions:

1. **Avoidance** – by keeping development away from the flood hazards, by varying the regional distribution of development and the distribution of development within regions
2. **Alleviation** – by increasing the investment in flood defence and other infrastructure to reduce the likelihood of flooding
3. **Reduced vulnerability** – by setting planning policies that require flood warning measures and emergency planning for occupants, prevent inappropriate occupancy, and require appropriate flood resilience and resistance measures for properties

In order to answer these questions and to determine the best trade-off between these different types of actions (in the context of environmental, social and economic sustainability), it is necessary to undertake an assessment of flood risk.

### 16.2.3 Experience from the Sustainable Communities

In Nick Starling's forward to the summary report of The Association of British Insurers' (ABI) study, *Making Communities Sustainable*[203], he says "The Government's plans for a step-change in housing supply are essential to the economic and social well-being of this country. But they present challenges."

One of the biggest challenges is flood risk management. The ABI report concludes that a strong planning policy could reduce flood risks to negligible levels in Ashford, the M11 corridor and the South Midlands and could halve flood risks in the Thames Gateway. This can only be achieved through the application of all three types of flood risk management actions described above.

However, in the future, as the lowest flood hazard areas will already have been used, further development in these growth areas could be significantly more costly in flood risk management terms. In which case, it will become more pressing to consider the possibility of restricting development in some areas of the country and encouraging development in lower risk regions.

### 16.2.4 Recommendations from Foresight

Looking at the longer-term, the Foresight Flood and Coastal Defence project[204] was commissioned by the Office of Science and Technology to consider the following:

- How might the risks of flooding and coastal erosion change in the UK over the next 100 years?
- What are the best options for Government and the private sector for responding to the future challenges?

Two key messages came out of this study:

- Continuing with existing policies is not an option.
- The risks need to be tackled across a broad front.

As a nation we must either invest more in sustainable approaches to flood and coastal management or learn to live with increased flooding.

Nearly 2 million properties in floodplains along rivers, estuaries and coasts in the UK are potentially at risk of flooding. 80,000 properties are at risk in towns and cities from flooding caused by heavy rainfall that overwhelms urban drainage. In England and Wales, over 4 million people and properties valued at over £200 billion are at risk.

If flood risk management policies and expenditure continue unchanged, annual losses will increase. The rate of increase, however, depends on which potential future socio-economic model is realised in combination with the four UKCIP02 climate change scenarios.[205]

The Foresight project considered a wide range of responses and one of the key responses was found to be land use planning. Effective and appropriate planning would reduce flood risk, was identified as having environmental benefits and could be made sustainable with careful implementation.

[203] Entec *et al.* (2005) *Making Communities Sustainable (Managing Flood Risks in the Government's Growth Areas)*, Summary Report, February 2005, Association of British Insurers. http://www.abi.org.uk/housing
[204] Office of Science & Technology (2004) *Foresight Future Flooding Executive Summary*, Office of Science & Technology.
[205] Hulme *et al.* (2002) *Climate Change Scenarios for the United Kingdom: The UKCIP02 Scientific Report*, Tyndall Centre for Climate Change Research, School of Environmental Sciences, University of East Anglia. http://www.ukcip.org.uk

One of the benefits of the Foresight project is that it has provided science-based estimates of the risks and costs of responses, which can help decision-makers to gauge the relative importance of different aspects of flood risk management compared to the many other factors to be considered in long-term planning. These estimates are a valuable source of information that should be used in national development planning.

## 16.3Data and Information

### 16.3.1 Types of Flooding

All types of flooding should be considered as part of a national scale assessment of flood risk for national development planning. These being:

1. Fluvial flooding
2. Coastal and tidal flooding
3. Estuarial flooding and watercourses affected by tide-locking
4. Groundwater flooding
5. Flooding from overland flow
6. Flooding from artificial drainage systems
7. Flooding from infrastructure failure

Types 1, 2 and 3 can be assessed using the approach set out in this guidance note (see Process 2a – Tiered Risk Assessment. The assessment of other types of flooding would be limited to published regional figures, if available.

### 16.3.2 Data Availability and Proportionality

National scale assessments of flood risk depend on the use of data that is readily available. This should have full coverage of the country and, ideally, be in a format that can be input automatically into a Geographic Information System (GIS).

At the present time this type of data is limited, but it is the aspiration of the key stakeholders that databases such as the National Flood and Coastal Defence Database (NFCDD) will act as primary data sources for national, as well as regional, local and site-specific scales of assessment.

The key data for assessments of flood risk for national development planning are:

- Flood extent maps
- Location and standard of flood defences
- Information on future development

The flood extent maps shown on the Environment Agency website are available for the whole country. In some cases these maps also show the location of flood defences. The NFCDD currently holds some information on the location and standard of flood defences, but the database is still being populated.

Further information on fluvial, tidal and coastal flood risk at a national scale can be obtained from the National Flood Risk Assessment (NaFRA), which is described in a separate guidance note D3.1 National Flood Risk Assessments. It should be noted that the NaFRA is intended for flood management planning, not development planning. Reference can also be made to the Foresight project where other types of flooding were also taken into consideration.[206]

[206] Office of Science & Technology (2004) *Foresight Future Flooding Scientific Summary* Volumes I and II.

As more data becomes available in the future, choosing the range and detail of the data/information that should be collected for consideration at the national scale should depend on the extent of flood hazard in regions and the relative scale of the proposed development.

#### 16.3.3 Planning Time-scale

Existing and long-term projections of flood risk should be considered, taking into consideration issues such as climate change[207], long-term sea level changes, changes in investment in flood management and existing regional strategies (spatial, economic, etc.). The analysis approach adopted in the Foresight project provides a working example, although it is based on theoretical future scenarios and not a 'best estimate' of what might actually happen. Therefore, it is not specifically designed for making decisions regarding planning.

#### 16.3.4 Flood Risk Indicators

Data/information regarding flood risk can be summarised by the use of flood risk indicators. Flood risk indicators are quantified during the process of carrying out assessments of flood risk.

A separate guidance note has been produced regarding flood risk indicators[208] and their suitability to different decision scales (i.e. national, regional, local or site-specific) and levels of assessment (see Processes and Procedures, Process 2a).

### 16.4Roles and Responsibilities

Key roles and responsibilities that are specifically related to the flood risk aspects of development planning at the national scale are summarised below.

#### 16.4.1 Office of the Deputy Prime Minister (ODPM)

- Provides policies and guidance on development and flood risk for England (including the ownership of PPG25[209]).
- Issues Regional Spatial Strategies (RSSs) (superseding the Regional Planning Guidance (RPGs)) for each region (drafted by the Regional Assemblies).

#### 16.4.2 Department of the Environment, Food and Rural Affairs (Defra)

- Provides national policies for England and Wales regarding flood and coastal defence, reservoir safety, groundwater and water quality.
- Acts as the central government sponsor for the Environment Agency (EA) in England.
- Provides funding for flood defence work in England.

#### 16.4.3 National Assembly of Wales / Welsh Assembly Government

- Provides policies and guidance on development and flood risk for Wales (including TAN15[210]).
- Provides funding for flood defence work in Wales.
- Sponsors the EA in Wales.

[207] See Guidance Note S3.1 Climate Change
[208] See Guidance Note D2.1 Flood Risk Indicators
[209] DTLR (2001) *Planning Policy Guidance Note 25: Development and Flood Risk*, HMSO, London.
[210] National Assembly for Wales (2004) *Technical Advice Note 15: Development and Flood Risk*, National Assembly for Wales, Cardiff.

### 16.4.4 Regional Government Offices

- Represent government departments in the regions (including Defra, the Department for Transport and the Department for Trade and Industry)
- Report to the ODPM

### 16.4.5 Regional Development Agencies

- Report to the Department of Trade and Industry
- Report to the relevant Regional Assembly
- Prepare Regional Economic Strategies

### 16.4.6 Regional Assemblies

- Set strategic priorities and decisions that affect their region
- Prepare draft Regional Spatial Strategies (RSSs), which are submitted to the ODPM

### 16.4.7 Environment Agency

- Reports nationally on flood risk to Defra, in order to achieve Defra's High Level Target 5A.[211]
- Carries out National Flood Risk Assessments (NaFRA) (with the assistance of consultants) for flood management planning.
- Advises Government on issues of flood risk.

### 16.4.8 Association of British Insurers (ABI)

- As a key stakeholder group, provides recommendations to Government, Planning Authorities and Developers regarding managing flood risk appropriately, so that property owners and occupants can be offered affordable flood insurance.[212]

Guidance Note S2.4 Stakeholder Engagement provides further details of possible stakeholders and their roles and responsibilities.

## 16.5Processes and Procedures

The generic approach to assessing and managing flood risk can be equally applied to national planning as for any other scale of decision-making.[213] A possible interpretation of this approach at the national scale is summarised in the following sections.

### 16.5.1 Process 1 - Problem Formulation[214]

Before starting an assessment of flood risk to support the decision-making process, it is necessary to carry out the following:

- Define the purpose/objectives of the national development planning exercise
- Define the objectives of the assessment of flood risk to inform this planning exercise
- Identify boundaries to the planning exercise
- Identify boundaries to the assessment of flood risk

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211 http://www.defra.gov.uk/environ/fcd/hltarget/default.htm

212 Association of British Insurers (2003) *Statement of Principles on the Provision of Flood Insurance*, ABI. http://www.abi.org.uk/Display/File/Child/228/Statement.pdf

213 See Guidance Note D3.4 Strategic Flood Risk Assessments and go to the section called *The Future of SFRAs*

214 See Activity Chart Process 1 – Problem Formulation

- Identify controlling factors of the planning exercise (including existing national policy and guidance)
- Identify stakeholders for consultation
- Identify potential flood risk components (i.e. possible sources, pathways and receptors),
- Identify flood risk indicators to be used and likely acceptability criteria
- Decide baseline conditions for the assessment

### 16.5.2 Process 2a – Tiered Risk Assessment[215]

*Level 1 – Coarse Assessment*

In order to carry out the risk-based approach, it is necessary to understand the comparative flood risk across the country. The level of detail required for such an assessment depends on the answers to the following questions:

- What is the probability of flooding in the absence of defences across the country (high/medium or low)?
- What proportion of areas with high flood probability is already taken up by development, which is, therefore, at risk?
- What is the probability of inundation with existing flood defences across the country (significant, moderate or low)?
- How much new development is required on a region by region basis?

Answers to these questions can be reported in the format shown in Tables 16.1 and 16.2 for England and Wales respectively.

**Table 16.1 Level 1 Questions (for England)**

| Question | Area ($km^2$) | % of Area |
|---|---|---|
| Total plan area | | N/A |
| **Area in Zone 3 (High flood risk)** | | % of total area |
| **Area in Zone 2 (Moderate flood risk)** | | % of total area |
| **Existing development in Zone 3** | | % of Zone 3 |
| **Existing development in Zone 2** | | % of Zone 2 |
| **Area of Zone 3 that is defended** | | % of Zone 3 |
| Total developed area | | % of total area |
| Required new development | | % of total area |
| **Likely new development in Zones 3 and 2** | | % of Zones 3 and 2 |

**Table 16.2 Level 1 Questions (for Wales)**

| Question | Area ($km^2$) | % of Area |
|---|---|---|
| Total plan area | | N/A |
| **Area in Zone C1 (defended)** | | % of total area |
| **Area in Zone C2 (undefended)** | | % of total area |
| **Existing development in Zone C1** | | % of Zone C1 |
| **Existing development in Zone C2** | | % of Zone C2 |
| Total developed area | | % of total area |
| Required new development | | % of total area |
| **Likely new development in Zone C1** | | % of Zone C1 |
| **Likely new development in Zone C2** | | % of Zone C2 |

[215] See Activity Chart Process 2a – Tiered Risk Assessment

The items in bold in the tables are flood risk indicators[216] and by answering these questions and plotting flood risk areas on maps, it is possible to have an indication of the following:

- Which regions have a significant flood hazard;
- How much of each region is protected by flood defences;
- Whether new development in each region is likely to add to the existing flood risk; and, therefore,
- Whether flood risk needs to be considered in more detail.

In essence, this is a screening study at the national scale. The first iteration of Process 3 – Options Appraisal would then be carried out to estimate the distribution of housing across regions.

**It might be sufficient to determine answers to these questions from the national maps. Alternatively, the same tables can be used on a region by region basis or the results from regional assessments of flood risk could be used, if these had been undertaken using compatible approaches and in compatible formats.**[217]

Should the results of the Options Appraisal indicate that any of the following might be true, it is recommended to proceed to a more detailed level of assessment:

- The spatial extent of the potential flood hazard could significantly influence the housing allocations for certain regions.
- The proposed development allocations across regions might affect the flood risk for existing development.

### *Level 2 - Intermediate Assessment*

Where the flood hazard is a significant issue in relation to future development in certain regions, a better understanding of the actual flood risk associated with new development (rather than only the hazard) across these regions could be obtained to enable the more detailed options appraisal described later. This would consider present day flood risk and future flood risk (taking into consideration climate change, relative sea level changes, etc.).

This more detailed assessment might include:

- A review of flood risk information available in existing plans, such as Catchment Flood Management Plans (CFMPs)[218] and Shoreline Management Plans (SMPs).[219] This would be the most reliable source of information at this scale, if available.
- Using results from the latest National Flood Risk Assessment (NaFRA)[220], which provides information on flood hazard and flood risk associated with existing development.
- Using results from the Foresight project[221], although this is based on a range of future scenarios rather than a best estimate of what is most likely to happen, and should be reviewed before use for applicability.

### *Level 3 – Detailed Assessment*

A detailed assessment at the national scale need not be undertaken. Remaining uncertainties would be dealt with at the regional or local scales.

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[216] As described in Guidance Note D2.1 Flood Risk Indicators
[217] See Guidance Note D1.2 Regional Spatial Strategies
[218] See Guidance Note D3.2 Catchment Flood Management Plans
[219] See Guidance Note D3.3 Shoreline Management Plans
[220] See Guidance Note D3.1 National Flood Risk Assessments.
[221] Office of Science & Technology (2004) *Foresight Future Flooding Scientific Summary* Volumes I and II.

### 16.5.3 Process 3 - Options Appraisal[222]

***If only a Level 1 – Coarse Assessment has been carried out:***
It is recommended that housing allocations are limited to levels that can be readily accommodated outside areas with a high/medium flood hazard.

***If a Level 2 – Intermediate Assessment has been carried out:***
If it is likely that high/medium flood hazard areas cannot be avoided, then this stage would include a review of the following:

- Existing flood risk in relevant regions,
- The change in risk caused by development allocations, if current flood risk management levels were maintained,
- The increase in investment in flood risk management required to maintain or reduce existing levels of flood risk.

This stage would also need to take into consideration planning policies to be implemented by the relevant regions.

### 16.5.4 Process 4 - Monitoring and Review[223]

Monitoring and review of the plan and the successful implementation of planning policies should be included in the overall process.

The need to revise plans in the light of developing information, for example on climate change, is particularly important.

## 16.6Tools and Technology

### 16.6.1 Flood Risk Indicators

Guidance Note D2.1 Flood Risk Indicators provides two tables:

- Table A provides a list of recommended flood risk indicators and this can be used to identify which indicators could be used for different levels of assessment.

- Table B provides supporting information, which can be used to help plan the assessment with links to other tools and technologies as appropriate.

### 16.6.2 Sustainability Indicators

The Defra/EA R&D project FD2015[224] on sustainable flood and coastal management provides a list of example sustainability indicators and recommendations regarding how to develop appropriate indicators for different decision-making needs, based on stakeholder engagement.[225] (See Roles and Responsibilities for key stakeholders at this planning scale.)

## 16.7Audit and Control

Audit and control of the assessment process is covered in Guidance Note S2.3 Auditing and Control.

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[222] See Activity Chart Process 3 – Options Appraisal
[223] See Activity Chart Process 4 – Monitoring and Review
[224] Wade *et al.* (unpublished) *Sustainable Flood and Coastal Management, Technical Report, Part 1: Handbook,* Defra/EA R&D Technical Report FD2015/TR1, due to be issued December 2005.
[225] See Guidance Note S2.4 Stakeholder Engagement

# 17.D1.2 REGIONAL SPATIAL STRATEGIES (RSS)

**This guidance note:**

- Provides an overview of what information on flood risk and flood management should be provided for **regional** planning and **sub-regional** planning
- Provides an overview of what constitutes an appropriate assessment of flood risk for development planning at the regional or sub-regional scales, with cross-references to other more detailed guidance documents for best practice.

**This guidance note does NOT:**

- Set parameters that dictate whether or not development should be planned for particular parts of a region, as this is a decision for the relevant planning bodies.
- Set parameters that dictate whether the Environment Agency (EA) would choose to object to a RSS, as this is a policy issue for the EA.

The recommendations presented in this guidance note **do not** supersede the information contained in the following principal references:

- Planning and Compulsory Purchase Act 2004, HMSO, May 2004.[226] Subsequently referred to in this note as PCPA2004.
- ODPM (2005) *Planning Policy Statement 1: Creating Sustainable Communities*, ODPM, London.[227] Usually referred to as PPS1.
- ODPM (2004) *Planning Policy Statement 11: Regional Spatial Strategies*, HMSO, London.[228] Usually referred to as PPS11.
- DTLR (2001) *Planning Policy Guidance Note 25: Development and Flood Risk*, HMSO, London.[229] Usually referred to as PPG25.
- National Assembly for Wales (2004) *Technical Advice Note 15: Development and Flood Risk*, National Assembly for Wales, Cardiff.[230] Usually referred to as TAN15.

These documents should be referenced for further information.

## 17.1Contents



[226] http://www.legislation.hmso.gov.uk/acts/acts2004/20040005.htm
[227] http://www.odpm.gov.uk/index.asp?id=1143805
[228] http://www.odpm.gov.uk/embedded_object.asp?id=1143844
[229] http://www.odpm.gov.uk/index.asp?id=1144113
[230] http://www.wales.gov.uk/subiplanning/content/tans/tan15/july04-tan15-e.pdf

## 17.2 Introduction

### 17.2.1 What is a Regional Spatial Strategy?

Regional Planning Guidance has been replaced by statutory Regional Spatial Strategies (RSS). The main purpose of a RSS is to provide a spatial framework within which Local Development Frameworks (LDFs) and Local Transport Plans can be prepared. There should be a two-way relationship with the RSS informing as well as taking account of other strategies, including the Regional Development Authorities' regional economic strategies and strategies regarding air quality, energy, climate change, biodiversity, sustainability and water resources, in so far as these are relevant at the regional scale.

The RSS provides a spatial planning framework for the region over a 15 to 20 year period. The aim is an integrated, strategic approach with regional and sub-regional priorities for housing being formulated together with priorities for environmental protection and improvement, transport, other infrastructure, economic development, agriculture, minerals and waste treatment and disposal.[231]

### 17.2.2 What is Sub-Regional Spatial Planning?

Because Structure Plans have been abolished, the RSSs will include sub-regional strategies (where necessary) to bridge the gap between the regionally strategic level and the more detailed local planning level. These will tend to be for areas of significant change to policy or substantial change in land use. In some cases there may be a need for separate sub-regional strategies (as required for Thames Gateway, which cuts across three regions).

### 17.2.3 Assessments of Flood Risk

Although the LPAs are the primary planning bodies to determine development locations, it is essential that the RSSs take due consideration of the implications of flood risk across the region, in order to set realistic strategies (effectively housing allocations) for LPAs to comply with. This requires regional scale assessments of flood risk.

Assessments of flood risk usually have three levels of detail, as defined in the generic approach to assessing and managing flood risk.[232] These are:

- Level 1 – Coarse Assessment
- Level 2 – Intermediate Assessment
- Level 3 – Detailed Assessment

More broad-brush, large scale planning (national and regional) tends not to require the detailed assessment approach, as this is resolved by the smaller scale studies (local or site-specific). Therefore, only the requirements for Level 1 and Level 2 assessments for regional planning are presented in this guidance note.

As development planning is not only concerned with assessing flood risk, but with managing that risk, all of the following processes should be carried out as part of the planning process. These being:

Process 1 – Problem Formulation
Process 3 – Options Appraisal
Process 4 – Monitoring and Review

These processes, as required for regional planning, are described in later sections of this guidance note.

[231] ODPM (2004) *Making the system work better: planning at regional and local levels* http://www.odpm.gov.uk/index.asp?id=1143134
[232] See Activity Chart Process 2a – Tiered Risk Assessment

## 17.3Data and Information

### 17.3.1 Information Required for the RSS

Information on flood risk for inclusion in a RSS should include the following:

- Areas at risk from flooding
- Floodplain land use
- Main existing flood defences, such as location, standard of protection (where known)
- Flood management policies and proposed flood management measures (where known)
- Areas covered by flood warning schemes

Much of the above information is spatial and best provided in a GIS format.

### 17.3.2 Proportionality

The range and detail of the data/information regarding flood risk that needs to be collected for consideration at the regional scale will depend on the extent of flood hazard in the region and the extent of the development proposed.

### 17.3.3 Types of Flooding

All types of flooding (as listed below) should be considered as part of a regional or sub-regional scale assessment. However, time and cost implications may limit the extent of the assessment over large geographical areas.

- Fluvial flooding
- Coastal and tidal flooding
- Estuarial flooding and watercourses affected by tide-locking
- Groundwater flooding
- Flooding from overland flow
- Flooding from artificial drainage systems
- Flooding from infrastructure failure

### 17.3.4 Flood Risk Indicators

Data/information regarding flood risk can be summarised by the use of flood risk indicators. Flood risk indicators are quantified during the process of carrying out assessments of flood risk.

A separate guidance note has been produced regarding flood risk indicators[233] and their suitability to different decision scales (i.e. national, regional, local or site-specific) and levels of assessment (see Processes and Procedures, Process 2a).

### 17.3.5 Use of Existing Assessments of Flood Risk

Whenever possible, existing assessments of flood risk should be used. This can not only reduce costs and time implications associated with new assessments, but also provides continuity of approach and, hence, continuity of decision-making.

In particular, reference should be made to Catchment Flood Management Plans (CFMPs)[234] and Shoreline Management Plans (SMPs).[235] This serves two purposes, because not only can these plans provide information regarding flood risk, but they also bring together a number of the other strategies, plans and programmes that impact on spatial planning, including (in the future) River Basin Management Plans.

[233] See Guidance Note D2.1 Flood Risk Indicators
[234] See Guidance Note D3.2 Catchment Flood Management Plans
[235] See Guidance Note D3.3 Shoreline Management Plans

The Activity Chart[236] provided as part of this framework includes a section called *How assessments of flood risk are used*. This shows the potential data flows between different assessments in the three main contexts for their use. These being:

- Development planning
- Flood management planning
- Sustainability appraisals

However, care needs to be taken that the information provided by these existing assessments of flood risk is up to date and sufficiently accurate for decisions to be made with confidence.

## 17.4Roles and Responsibilities

Key roles and responsibilities that are specifically related to the flood risk aspects of developing a RSS are summarised below.

- The Regional Planning Body (more commonly referred to as the Regional Assembly) is responsible for drafting the RSS (which should include stakeholder engagement and carrying out a sustainability appraisal[237]) and implementing national and regional planning policy for the region, which means that they can object to the draft policies/programmes of other bodies if they are not in general conformity with the RSS

- County Councils (or Unitary Authorities) assist the Regional Planning Body with the preparation and review of the RSS. They also take the lead in setting up and running sub-regional working groups with LPAs and other stakeholders, should sub-regional strategies be required.

- The Secretary of State may appoint a Panel to hold a Public Examination in to the draft Strategy. The Secretary of State will then consult on changes to the RSS and issue the final version.

- The Environment Agency is a stakeholder for the RSS and sub-regional working groups, and may provide advice on how to carry out an appropriate assessment of flood risk and may provide data for an assessment of flood risk.

Guidance Note S2.4 Stakeholder Engagement provides further details of possible stakeholders and their roles and responsibilities.

## 17.5Processes and Procedures

There is currently no particular type of assessment of flood risk that has been associated with RSSs. However, an approach similar to that applied to spatial planning at the local scale, i.e. the Strategic Flood Risk Assessment (SFRA) could be applied at the regional scale.[238]

This would follow the generic approach and include a tiered risk assessment, proportionate the decision-making requirements, the scale of the risk and the scale of the development. A possible interpretation of this approach at the regional scale is summarised below.

### 17.5.1 Process 1 - Problem Formulation[239]

Before starting an assessment of flood risk to support the decision-making process, it is necessary to carry out the following:

[236] Go to Activity Chart Overview
[237] See Guidance Note S2.5 Linkage to Statutory Requirements
[238] See Guidance Note D3.4 Strategic Flood Risk Assessments and go to the section called *The Future of SFRAs*
[239] See Activity Chart Process 1 – Problem Formulation

- Define the purpose/objectives of the RSS
- Define the objectives of the assessment of flood risk
- Identify boundaries to the RSS (including consideration of neighbouring regions and their RSSs)
- Identify boundaries to the assessment of flood risk
- Identify controlling factors of the RSS (including national policy and guidance)
- Identify stakeholders (wide consultation will be expected for the RSS, those with a stake in flood risk need to be identified)
- Identify potential flood risk components (i.e. possible sources, pathways and receptors),
- Identify initial flood risk indicators to be used and likely acceptability criteria
- Decide baseline conditions for the assessment

### 17.5.2 Process 2a – Tiered Risk Assessment[240]

#### *Level 1 – Coarse Assessment*

In order to carry out the risk-based approach, it is necessary to understand the comparative flood risk across the region. The level of detail required for such an assessment depends on the answers to the following questions:

- What is the probability of flooding in the absence of defences across the region (high, medium or low)?
- What proportion of area with a high flood probability is already taken up by development, which is, therefore, at risk?
- What is the probability of inundation with existing flood defences across the region (significant, medium or low)?
- How much new development is required in the region?

Answers to these questions can be reported in the format shown in Tables 17.1 and 17.2 for England and Wales respectively.

The items in bold in the tables are flood risk indicators[241] and by answering these questions and plotting flood risk areas on maps of the region, it is possible to have an indication of the following:

- Whether existing flood risk is a significant issue in the region;
- Where in the region the problem of flood risk is likely to be the greatest;
- How much of the region is protected by flood defences;
- Whether new development in the region is likely to add to that risk; and, therefore,
- Whether flood risk needs to be considered in more detail or whether it is possible to proceed to the Options Appraisal stage.

In essence, this is a screening study at the regional scale and should be carried out for all regions.

Should the results indicate that any of the following might be true, it is recommended to proceed to a more detailed (Level 2) assessment:

- It is likely that development in high flood risk areas cannot be avoided.
- It is likely that significant development will take place in moderate flood risk areas.
- The spatial extent of the potential flood hazard significantly influences the housing allocations for the region as a whole or for specific sub-regions.
- The proposed developments affect the flood risk for existing development.

**Table 17.1 Level 1 Questions (for England)**

[240] See Activity Chart Process 2a – Tiered Risk Assessment
[241] As described in Guidance Note D2.1 Flood Risk Indicators

| No. | Question | Area ($km^2$) | % of Area |
|---|---|---|---|
| 1 | Size of planning area | | N/A |
| **2** | **Area in Zone 3 (High flood risk)** | | % of total area |
| **3** | **Area in Zone 2 (Moderate flood risk)** | | % of total area |
| **4** | **Existing development in Zone 3** | | % of Zone 3 |
| **5** | **Existing development in Zone 2** | | % of Zone 2 |
| **6** | **Area of Zone 3 that is defended** | | % of Zone 3 |
| 7 | Total developed area | | % of total area |
| 8 | Required new development | | % of total area |
| **9** | **Likely new development in Zones 3 and 2** | | % of Zones 3 and 2 |
| **10** | **Area affected by drainage problems** | | % of total area or % of new development areas |
| **11** | **Area affected by groundwater flooding** | | % of total area or % of new development areas |
| **12** | **Area affected by overland flows** | | % of total area or % of new development areas |

**Table 17.2 Level 1 Questions (for Wales)**

| No. | Question | Area ($km^2$) | % of Area |
|---|---|---|---|
| 1 | Size of planning area | | N/A |
| **2** | **Area in Zone C (Flood risk)** | | % of total area |
| **3** | **Area in Zone B (Flood risk should be checked)** | | % of total area |
| **4** | **Existing development in Zone C2** | | % of Zone C2 |
| **5** | **Existing development in Zone C1** | | % of Zone C1 |
| **6** | **Existing development in Zone B** | | % of Zone B |
| 7 | Total developed area | | % of total area |
| 8 | Required new development | | % of total area |
| **9** | **Likely new development in Zone C2** | | % of Zone C2 |
| **10** | **Likely new development in Zone C1** | | % of Zone C1 |
| **11** | **Likely new development in Zone B** | | % of Zone B |
| **12** | **Area affected by drainage problems** | | % of total area or % of new development areas |
| **13** | **Area affected by groundwater flooding** | | % of total area or % of new development areas |
| **14** | **Area affected by overland flows** | | % of total area or % of new development areas |

### *Level 2 - Intermediate Assessment*

If flood risk is a significant issue in the region (or sub-region), or there is not enough information to determine this, the relative risk across the region (or sub-region) should be reviewed in more detail. This would consider present day flood risk and future flood risk (taking into consideration climate change, relative sea level changes, etc.).

This more detailed assessment might include:

- A review of flood risk information available in existing plans and assessments, such as Catchment Flood Management Plans (CFMPs)[242], Shoreline Management Plans (SMPs)[243] and SFRAs.[244] This would be the most reliable source of information at this scale, if available.[245]
- Using results from the latest National Flood Risk Assessment (NaFRA)[246], which provides information on flood hazard and flood risk associated with existing development.
- Using results from the Foresight project[247], although this is based on a range of future scenarios rather than a best estimate of what is most likely to happen, and should be reviewed before use for applicability.
- Any further investigations deemed necessary to define the flood risk problem in relation to new development.

If significant development is proposed in a particular area (e.g. a new 'sustainable community'), then it is recommended to look at the implications of this at the sub-regional scale. This would provide an opportunity to find an alternative location for the development or would highlight the issues that would need consideration by the affected LPAs should the development go ahead. Again, this might be achieved by looking at the outputs from relevant CFMPs and SMPs. If the development does go ahead and the flood risk is significant, this information should then be subsequently taken up and used for a sub-regional scale Strategic Flood Risk Assessment (SFRA), rather than carrying out individual SFRAs for each LPA.[248]

*Level 3 – Detailed Assessment*

A detailed assessment at the regional scale usually need not be undertaken. Remaining uncertainties would be dealt with at the local scale.

### 17.5.3 Process 3 - Options Appraisal[249]

Whichever level of assessment is required for flood risk, all assessments will be followed by an Options Appraisal stage.

***If only a Level 1 – Coarse Assessment has been carried out:***
It is recommended to limit housing allocations to levels that can be readily accommodated outside of areas with a high flood risk.

***If a Level 2 – Intermediate Assessment has been carried out:***
If it is likely that high flood risk areas cannot be avoided, then this stage would include a review of flood risk for different scenarios, such as varying the spatial distribution of development inside and outside high risk areas.

This stage would also need to take into consideration planning policies to be implemented by the LPAs within the region.

### 17.5.4 Process 4 - Monitoring and Review[250]

Monitoring and review of the strategy and the successful implementation of planning policies should be included in the overall process.

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[242] See Guidance Note D3.2 Catchment Flood Management Plans
[243] See Guidance Note D3.3 Shoreline Management Plans
[244] See Guidance Note D3.4 Strategic Flood Risk Assessments
[245] It should be noted that regional boundaries can cross several CFMP and SMP boundaries and a single RSS can cover several CFMPs or SMPs.
[246] See Guidance Note D3.1 National Flood Risk Assessments.
[247] Office of Science & Technology (2004) *Foresight Future Flooding Scientific Summary* Volumes I and II.
[248] See Guidance Note D3.4 Strategic Flood Risk Assessments
[249] See Activity Chart Process 3 – Options Appraisal
[250] See Activity Chart Process 4 – Monitoring and Review

The need to revise strategies in the light of developing information, for example on climate change, is particularly important.

## 17.6Tools and Technology

### 17.6.1 Flood Risk Indicators

Guidance Note D2.1 Flood Risk Indicators provides two tables:

- Table A provides a list of recommended flood risk indicators and this can be used to identify which indicators could be used for different levels of assessment.

- Table B provides supporting information, which can be used to help plan the assessment with links to other tools and technologies as appropriate.

### 17.6.2 Sustainability Indicators

The Defra/EA R&D project FD2015[251] on sustainable flood and coastal management provides a list of example sustainability indicators and recommendations regarding how to develop appropriate indicators for different decision-making needs, based on stakeholder engagement.[252]

## 17.7Audit and Control

Audit and control of the RSS is achieved through the Public Examination process, as commissioned by the Secretary of State.

Audit and control of the assessment process is covered in Guidance Note S2.3 Auditing and Control.

[251] Wade *et al.* (unpublished) *Sustainable Flood and Coastal Management, Technical Report, Part 1: Handbook,* Defra/EA R&D Technical Report FD2015/TR1, due to be issued December 2005.
[252] See Guidance Note S2.4 Stakeholder Engagement

## 18.D1.3 LOCAL DEVELOPMENT FRAMEWORKS (LDFS)

**This guidance note:**

- Provides an overview of what information on flood risk and flood management should be provided for local development planning.

**This guidance note does NOT:**

- Set parameters that dictate whether or not development should be planned for particular areas within a planning district, as this is a decision for the Local Planning Authority (LPA).

- Set parameters that dictate whether the Environment Agency (EA) should object to a LDF, as this is a policy issue for the EA.

The recommendations presented in this guidance note **do not** supersede the information contained in the following principal references:

- Planning and Compulsory Purchase Act 2004[253], HMSO, May 2004. Subsequently referred to in this note as PCPA2004.

- ODPM (2005) *Planning Policy Statement 1: Creating Sustainable Communities*, ODPM, London.[254] Usually referred to as PPS1.

- ODPM (2004) *Planning Policy Statement 12: Local Development Frameworks,* HMSO, London.[255] Usually referred to as PPS12.

- DTLR (2001) *Planning Policy Guidance Note 25: Development and Flood Risk*, HMSO, London.[256] Usually referred to as PPG25.

- National Assembly for Wales (2004) *Technical Advice Note 15: Development and Flood Risk*, National Assembly for Wales, Cardiff.[257] Usually referred to as TAN15.

These documents should be referenced for further information.

### 18.1Contents



[253] http://www.legislation.hmso.gov.uk/acts/acts2004/20040005.htm
[254] http://www.odpm.gov.uk/index.asp?id=1143805
[255] http://www.odpm.gov.uk/index.asp?id=1143847
[256] http://www.odpm.gov.uk/index.asp?id=1144113
[257] http://www.wales.gov.uk/subiplanning/content/tans/tan15/july04-tan15-e.pdf

## 18.2 Introduction

### 18.2.1 What is a Local Development Framework?

Local Development Frameworks (LDFs) are portfolios of Local Development Documents (LDDs), Supplementary Planning Documents and others that define the spatial planning strategy for local authorities. These documents were introduced as a result of the PCPA2004 and accompanying regulations.[258] These frameworks replace the existing system of structure, local and unitary development plans.

LPAs have two functions in relation to new developments. These are:

- Spatial Planning
- Regulation and Control

The land use planning system traditionally focused on regulation and control of land use. This is still one of the functions of a LDF, but added to this is the aim to bring together and integrate with other strategies, plans and programmes that have an impact on spatial development (at both local and regional levels). These might include:

- Community strategies
- Employment and economic development/regeneration
- Education
- Health
- Crime prevention
- Waste and recycling
- Transport
- Biodiversity
- Environmental protection
- **AND** Flooding and coastal erosion management

The LDF should identify sufficient land for new development to meet needs identified through the relevant Regional Spatial Strategy (RSS) (including adjoining regions, if necessary) as well as taking account of community and other stakeholder aspirations in terms of the location of development.

All LDDs should be consistent with national planning policy and should be in general conformity with the RSS. Unlike previous regional planning guidance, RSSs have development plan status. Therefore, it is important that there is a consistency of approach for assessing and managing flood risk at the national, regional and local scales. All LDDs are guided throughout by the requirements of the Strategic Environmental Assessment (SEA) Directive and Sustainability Appraisals.[259]

Supplementary Planning Documents are also produced, which may cover a range of issues, both spatial and site specific, which may expand policy or provide further detail to policies in the LDDs. They are not used to allocate land, which is undertaken in the LDDs. Supplementary planning documents may take the form of design guides, area development briefs, master plan or issue-based documents, which supplement policies in the LDDs. Areas where flooding issues have been identified and, therefore, will need to be addressed (usually referred to as flood risk areas) should be accompanied by appropriate policies and/or constraints. These can be provided in the Supplementary Planning Documents.

Further guidance on LDFs can be found in ODPM (2004) *Creating Local Development Frameworks A companion guide to PPS12*, HMSO, London.

[258] Town and Country Planning (Local Development) (England) Regulations 2004 and Town and Country Planning (Transitional Arrangements) (England) Regulations 2004

[259] See Guidance Note S2.5 Linkage to Statutory Requirements

### 18.2.2 What is the Sequential Test?

The Sequential Test is referred to in paragraph 30 of PPG25. The concept is a simple risk-based approach to development and flood risk and has two applications:

- When drawing up development plans and allocating sites for development, LPAs should give priority to sites in ascending order of flood hazard[260] (assuming all other considerations are equal), i.e. planners should select areas with the lowest likelihood of flooding first and so forth.

- When determining planning applications, LPAs should give priority to sites in ascending order of flood hazard (assuming all other considerations are equal).

This should be based on an understanding of current and future flooding over the life-time of the development, taking into consideration issues such as climate change and changes in sea level.[261]

The Sequential Test is the means by which a LPA can fulfil its obligations to consider flood risk appropriately when undertaking spatial planning, if used in conjunction with the other material planning considerations

PPG25 covers more than just this, however, as it also provides guidance regarding the appropriateness of certain types of development in areas where it would have a flood risk. This is summarised in Table 1 of PPG25. Sensitive, critical or vulnerable developments should be avoided wherever possible and only be permitted if there are compelling reasons. In all cases, the development design needs to be sufficiently robust to provide an acceptable level of residual risk and a suitably low degree of uncertainty. This guidance provides the basis for subsequent planning policies and constraints set by the LPA.

It should be noted that Table 1 of PPG25 only considers fluvial, tidal and coastal flooding. However, as mentioned in Paragraph 30 of PPG25, the LDF should in fact consider all types of flooding (see Data and Information later in this guidance note) and the concept of the Sequential Test can be equally applied to any type of flooding. For example:

- An area with no known groundwater flooding problems should be chosen in preference to an area with a history of groundwater flooding.
- An area which would drain into a public sewerage system with no known flooding problems should be chosen in preference to an area which would have to drain into a public sewerage system with capacity problems and a history of foul/combined flooding.[262]
- An area with no known flooding from overland flows should be chosen in preference to an area which is either located on an overland flow route or is a low-lying location where overland flows are stored during extreme events (generally more applicable for new developments within an existing urban area).

It should also be noted that Table 1 of PPG25 is only a simplified appreciation of the variation in flood risk across a LPA area. PPG25 recognises that in reality there is a continuum from virtually no risk to high risk. The principle of the Sequential Test (as described at the beginning of this section) can still be applied in low-lying areas of the country where the majority of a LPA area may be within Zone 3, according to Table 1. The principle can also be applied within development areas, which is known as development zoning.[263]

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[260] Refer to Guidance Note D2.1 Flood Risk Indicators for a definition of flood hazard as opposed to flood risk.
[261] See Guidance Note S3.1 Climate Change
[262] Even though the Developer would be responsible for funding (either partially or fully) an upgrade to the public sewerage system, it should be the responsibility of the LPA as part of the spatial planning process to keep potential risks to a minimum.
[263] See Guidance Note S3.5 Mitigation Measures

### 18.2.3 What is different about TAN15?

The objectives and principles behind TAN15 are very similar to PPG25. The requirement to undertake assessments of flood risk for new developments is the same, except that in TAN15 this is referred to as an assessment of flooding consequences.

However, the spatial planning approach to demonstrate due consideration of flood risk is different from PPG25 and this has been summarised in Table 18.1.

**Table 18.1 Summary of planning approaches in PPG25 and TAN15**

| Approach | PPG25 | TAN15 |
|---|---|---|
| Zoning | *Zones 1, 2 and 3*<br>Based on fluvial, tidal and coastal flood extent in the absence of defences | *Zones A, B and C*<br>Based on fluvial, tidal and coastal flood extent in the absence of defences, supplemented by the British Geological Survey alluvial deposit data (additional precautionary approach) |
| Division of high risk zone | *Zones 3a, 3b and 3c*<br>Based on current land use and floodplain function | *Zones C1 and C2*<br>Based on whether served by significant flood defence infrastructure (if yes C1, if no C2) |
| Mapping | EA's Flood Maps | Welsh Assembly Government's Development Advice Map (DAM) |
| Development categories | Residential, industrial or commercial development is generally treated the same, with identified exceptions | All residential and some industrial developments are categorised as highly vulnerable, whilst other industrial and commercial developments are categorised as less vulnerable |
| Decision-making process | Sequential Test | Precautionary Framework (see below) |

### 18.2.4 The Precautionary Framework

The Precautionary Framework described in TAN15 can be summarised as the following questions (reference should be made to the original document for full details):

1. The proposed developments are in which DAM Zone?
2. The proposed developments are in which Development Categories?
3. Can the locations of the proposed developments be justified?
   - Emergency Services or Highly Vulnerable Development cannot be justified in Zone C2
   - Any Development Category can only be justified in Zones C1 or C2 if:
     - It is part of a regeneration initiative or required to enable the social and economic sustainability objectives of the area to be maintained, AND
     - It meets the definition of previously developed land
4. If question 3 is satisfied, are the consequences of the flooding acceptable?

This framework is used for both forward planning and development control purposes.

It should be noted that questions 1 to 3 in this framework only consider fluvial, tidal and coastal flooding at the site, and although defended areas are identified, the standard of protection or actual probability of inundation is not considered. Question 4 includes consideration of flood risk behind defences, surface water runoff and the impact of the new development on the surrounding area.

### 18.2.5 Sustainable Flood Risk Management

A parallel Defra/EA R&D project FD2015[264] sets out 8 principles of sustainable flood and coastal erosion risk management. These can be applied to spatial planning, as follows:

1. **Risk Management** – reduce flood risks to people, property, the economy and the environment.

2. **Adaptation** – take account of climate change[265] and other long-term uncertainties in decision-making and design.

3. **Integration** – develop plans that integrate with catchment and coastal zone management objectives (as identified in Catchment Flood Management Plans (CFMPs), Shoreline Management Plans (SMPs), Estuary Management Plans (EMPs), Coastal Habitat Management Plans (CHaMPs), Integrated Coastal Zone Management Plans, etc.).

4. **Engagement** – work with those individuals and organisations that will be affected by the plan.[266]

5. **Appraisal** – adopt appraisal methods that are rigorous, coherent and open and consider long-term social, environmental and economic costs and benefits. This is implemented by undertaking the Sustainability Appraisal to accompany the LDF.[267]

6. **Environment –** protect and enhance the natural environment by identifying environmental objectives and existing problems and opportunities.

7. **Consumption and Production –** promote sustainable consumption and production in all flood risk management activities (e.g. minimise waste, use renewable resources, promote re-use of materials and use of recycled materials, minimise energy costs in transportation and construction, etc.)

8. **Knowledge** – develop the knowledge, skills and awareness to promote sustainable development.

These principles should be followed as part of the initial problem formulation process[268] to help identify controlling factors, stakeholders and baseline conditions. These will then be revisited during the options appraisal process, when options will be evaluated.[269]

## 18.3Data and Information

### 18.3.1 Flood Risk Information Required for the LDF

Information on flood risk for inclusion in a LDF should include the following:

- Areas at risk from flooding and the probability of flooding (present and future)
- Floodplain functions and corresponding zones (if development pressures require this increased detail)
- Existing flood defences (location, standard of protection and condition)
- Flood management policies and proposed flood management measures (where known)
- Flood emergency planning, including areas covered by flood warning schemes and approximate warning times
- Other floodplain issues, opportunities and constraints (conservation, recreation, etc.)

[264] Wade et al. (unpublished) *Sustainable Flood and Coastal Management, Technical Report, Part 1: Handbook,* Defra/EA R&D Technical Report FD2015/TR1, due to be issued December 2005.
[265] See Guidance Note S3.1 Climate Change
[266] See Guidance Note S2.4 Stakeholder Engagement
[267] See Guidance Note S2.5 Linkage to Statutory Requirements
[268] See Activity Chart Process 1 – Problem Formulation
[269] See Activity Chart Process 3 – Options Appraisal

Much of the above information is best provided in a GIS format that can be added directly to the maps used by the planners.[270] This information is provided by undertaking Strategic Flood Risk Assessments (SFRAs).[271]

### 18.3.2 Proportionality

The range and detail of the data/information that needs to be collected for consideration at the local scale will depend on the extent of flood risk in the area concerned and the extent or type of the development proposed. Further details are provided in the section called Processes and Procedures of this guidance note.

When scoping an assessment, it should also be recognised that if the level of uncertainty remains relatively large due to limitations of data/information this can be accommodated by applying an appropriately precautionary approach to the subsequent decision-making processes. This is the precautionary principle. The cost-effectiveness of limiting the scope of the assessment (and hence limiting the data/information available for decision-making) will depend on the scale of the planned development and the scale of the risk.

### 18.3.3 Types of flooding

All types of flooding should be considered, as appropriate. These being:

- Fluvial flooding
- Coastal and tidal flooding
- Estuarial flooding and watercourses affected by tide-locking
- Groundwater flooding
- Flooding from overland flow
- Flooding from artificial drainage systems
- Flooding from infrastructure failure

Detailed descriptions of these types of flooding can be found in the CIRIA guidance C624.[272] The extent to which these should be considered will vary and depend on whether they are considered as significant at the spatial planning scale and in setting constraints on development in certain areas. Consideration of types of flooding that are not influential for the Sequential Test or in setting constraints on development can be deferred until the site-specific Flood Risk Assessment (usually referred to as a FRA).

### 18.3.4 Flood Risk Indicators

Data/information regarding flood risk can be summarised by the use of flood risk indicators. In some cases these can be presented spatially on proposal maps. An example of a flood risk indicator is the proportion of the planning area that lies within the flood zones as defined in Table 1 of PPG25. This gives an indication of the magnitude of the flood risk in the planning area. Flood risk indicators are quantified during the process of carrying out assessments of flood risk.

Which indicators can or should be used for decision-making depends on the scale of the risk and the scale of the planned development. A separate guidance note has been produced regarding flood risk indicators[273] and their suitability to different decision scales (i.e. national, regional, local or site-specific) and levels of assessment (see Processes and Procedures).

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[270] Further guidance on how and why these issues should be considered and presented can be found in Appendix D (Information on flood risks to be included in Local Plans) in the Defra/EA R&D Project FD2010/TR *Guide to the Management of Floodplains to Reduce Flood Risks, Stage 1: Development Draft*, February 2003.

[271] See Guidance Note D3.4 Strategic Flood Risk Assessments

[272] Lancaster, J, Preene, M and Marshall, C (2004) *C624 Development and Flood Risk – Guidance for the Construction Industry*, CIRIA, London.

[273] See Guidance Note D2.1 Flood Risk Indicators

### 18.3.5 Use of Existing Assessments of Flood Risk

Whenever possible, use of existing assessments of flood risk to provide flood risk information should be encouraged. This not only reduces costs and time implications associated with new assessments, but also provides continuity of approach and, hence, continuity of decision-making.

In particular, reference should be made to Catchment Flood Management Plans (CFMPs)[274] and Shoreline Management Plans (SMPs).[275] This serves two purposes, because not only can these plans provide information regarding flood risk, but also bring together a number of the other strategies, plans and programmes that impact on spatial planning, including (in the future) River Basin Management Plans.

The Activity Chart[276] provided as part of this framework includes a section called *How assessments of flood risk are used*. This shows the potential data flows between different assessments in the three main contexts for their use. These being:

- Development planning
- Flood management planning
- Sustainability appraisals

However, care needs to be taken that the information provided by these existing assessments of flood risk is up to date and sufficiently accurate for decisions to be made with confidence.

## 18.4Roles and Responsibilities

Key roles and responsibilities that are specifically related to the flood risk aspects of developing a LDF are summarised below.[277]

- The LPA is responsible for carrying out the spatial planning and developing the LDDs and Supplementation Planning Documents. The LPA is, therefore, also responsible for carrying out the assessment of flood risk, although this is often delegated to a specialist consultant.

- Other Local Authority departments are responsible for flood defence and emergency response and should be included in the stakeholder engagement.
- The County Council provides advice and information to the LPA on behalf of the Regional Assembly. It also produces mineral and waste plans for the LDF and identifies strategic planning requirements regarding transport, education, etc.
- The EA is responsible for providing advice regarding how to carry out an appropriate assessment of flood risk, providing data for an assessment of flood risk and acting as a consultee for the LDF.

- The Regional Assembly is responsible for producing the RSS and providing guidance from a national and regional policy perspective.

- The Community is also engaged on flood risk issues through the LDF.

## 18.5Processes and Procedures

As described earlier, there are two functions undertaken by the LPA that need to be reflected in the LDF and that need to consider flood risk, namely spatial planning and regulation and control. Table 18.2 summarises the LDF processes for considering flood risk.

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[274] See Guidance Note D3.2 Catchment Flood Management Plans
[275] See Guidance Note D3.3 Shoreline Management Plans
[276] Go to Activity Chart Overview
[277] Reference should also be made to Guidance Note S2.4 Stakeholder Engagement

**Table 18.2 LDF processes for considering flood risk**

<table>
<tr><th>Function</th><th colspan="2">Spatial Planning</th><th>Regulation and Control</th></tr>
<tr><td>Implementation Approach</td><td colspan="2">Local Development Documents</td><td>Supplementary Planning Documents</td></tr>
<tr><td rowspan="3">Assessment Type</td><td colspan="3">Strategic Flood Risk Assessment (SFRA)</td></tr>
<tr><td colspan="2">Part 1</td><td>Part 2</td></tr>
<tr><td>Level 1</td><td>Level 2</td><td>Level 3</td></tr>
<tr><td>Coverage</td><td colspan="2">Full coverage of LPA area[278]</td><td>Planned development areas only (as required)</td></tr>
</table>

Both functions can be supported by undertaking a SFRA. SFRAs have three levels of detail, corresponding with the generic approach.[279] These are:

- Coarse Assessment (Part 1) – This corresponds to a Level 1 SFRA in the generic approach.
- Intermediate Assessment (Part 1 expanded as required) – This corresponds to a Level 2 SFRA in the generic approach.
- Detailed Assessment (Part 2 as required) – This corresponds to a Level 3 SFRA in the generic approach.

This approach allows proportionate effort depending on the extent and severity of the flood risk within the LPA administrative area. The requirements for each level of assessment are presented in Guidance Note D3.4 Strategic Flood Risk Assessments.

All LPAs should carry out a Level 1 assessment to accompany the LDDs. The results of this assessment will determine whether a more detailed assessment is required. This should involve consultation with the EA, with wider stakeholder consultation, if appropriate.

As the development planning progresses, additional stages can be undertaken to inform the LPA better regarding flood risk. These will be at increasing levels of detail, as appropriate. Again, it is important that the EA is consulted during Level 2 and Level 3 SFRAs.

It is recommended that at least a Level 1 SFRA is carried out prior to areas being designated for development, in order to fulfil the requirement to undertake the Sequential Test. However, development planning is a continuous process and it is common for LPAs to have areas already identified for development potential and there could already be a number of stakeholders with expectations for those areas. This requires a trade-off analysis to be undertaken with due consideration of the LPAs sustainability objectives.[280] However, these proposed development areas should not dictate the spatial extent of the first part of the SFRA or the Sequential Test, i.e. Part 1 of the SFRA should cover the whole of the LPA area and should NOT be limited to the areas that have already been defined for development.

[278] Alternatively this might cover more than one LPA area, if it is decided that this would be beneficial by neighbouring LPAs.
[279] See Activity Chart Process 2a – Tiered Risk Assessment
[280] See Activity Chart Process 3 – Options Appraisal

## 18.6 Tools and Technology

### 18.6.1 GIS mapping

The key tool for providing Planners with the information they require to develop the LDDs is GIS mapping. The case studies presented in the guidelines for the North West Region[281] provide good examples of how this can be used.

### 18.6.2 Flood Risk Indicators

Guidance Note D2.1 Flood Risk Indicators provides two tables:

- Table A provides a list of recommended flood risk indicators and this can be used to identify which indicators could be used for different levels of assessment.

- Table B provides supporting information, which can be used to help plan the assessment with links to other tools and technologies as appropriate.

### 18.6.3 Sustainability Indicators

The Defra/EA R&D project FD2015[282] on sustainable flood and coastal management provides a list of example sustainability indicators and recommendations regarding how to develop appropriate indicators for different decision-making needs, based on stakeholder engagement.[283]

### 18.6.4 Standing Advice

The EA has produced Standing Advice[284] for England to enable LPAs to make decisions on low risk planning applications where flood risk is an issue without directly consulting the EA for an individual response. It also identifies those higher risk development situations where case by case consultation with the EA should be sought.

It is based on a Flood Risk Matrix, which categorises applications based on development type, location and scale/size. If an application falls within a grey or green box, then Standing Advice is provided. This includes recommended planning constraints that could be incorporated into a Supplementary Planning Document. If an application falls in a red box, EA advice should be sought.

Similar advice for Wales, reflecting TAN15 requirements, is planned by the EA in the near future.

Alternatively or in addition to this, a bespoke flood planning response matrix developed as a result of a SFRA, has been found to be a very useful tool by a number of LPAs for development control purposes.[285]

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[281] Environment Agency (NW Region) and NW Regional Assembly (2004) *Meeting the Sequential Flood Risk Test: Guidelines for the North West Region*.
[282] Wade *et al.* (unpublished) *Sustainable Flood and Coastal Management, Technical Report, Part 1: Handbook,* Defra/EA R&D Technical Report FD2015/TR1, due to be issued December 2005.
[283] See Guidance Note S2.4 Stakeholder Engagement
[284] Environment Agency (2003) *National Standing Advice to Local Planning Authorities for Planning Applications - Development and Flood Risk*, Environment Agency. http://www.pipernetworking.com/floodrisk/index.html
[285] Environment Agency (Yorkshire Region) and Yorkshire & Humber Assembly (2004) *At risk? Planning for Flood Risk in Yorkshire and Humber*.

## 18.7 Audit and Control

The "Examination" stage of LDFs will act as the audit and control of the decision-making process.

Stakeholder engagement, which must be undertaken prior to the adoption of a LDF to comply with the Statement of Community Involvement[286], can also act as part of the review process. However, it is recommended that appropriate stakeholder engagement is carried out prior to and during the assessment of flood risk, rather than relying on the review process and formal objections that will cause delays to the adoption of the LDF.

The Local Development Scheme (LDS) is a public statement that identifies which Local Development Documents will be produced and when. Therefore, this can be used as the basis for the "required" approach that the "actual" LDF is checked against. A new document called *Local Development Framework Monitoring: A Good Practice Guide*[287] has just been published by the ODPM, which will provide guidance regarding how to monitor LDFs in terms of document preparation and policy implementation.

Audit and control of the assessment process is covered in other guidance notes D3.4 Strategic Flood Risk Assessments and S2.3 Auditing and Control.

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[286] This is included in the LDF and is a statement made by the LPA, which should set out the LPA's policy for involving the community in the preparation and revision of local development documents and planning applications. Further details can be found in Guidance Note S2.4 Stakeholder Engagement.
[287] http://www.odpm.gov.uk/embedded_object.asp?id=1143906

## 19.D1.4 PLANNING APPLICATIONS AND DECISIONS

**This guidance note:**

- Provides an overview of the requirements to assess the flood risk associated with planning applications for new development.

**This guidance note does NOT:**

- Set parameters that dictate whether or not a planning application should be approved, as this is a decision for the Local Planning Authority (LPA).
- Set parameters that dictate whether the Environment Agency (EA) should object to a planning application, as this is a policy issue for the EA.

The recommendations presented in this guidance note **do not** supersede the information contained in the following principal references:

- DTLR (2001) *Planning Policy Guidance Note 25: Development and Flood Risk*, HMSO, London.[288] Usually referred to as PPG25.
- National Assembly for Wales (2004) *Technical Advice Note 15: Development and Flood Risk*, National Assembly for Wales, Cardiff.[289] Usually referred to as TAN15.
- ODPM (2004) *Consultation Paper on Planning Policy Statement 1: Creating Sustainable Communities*, ODPM, London.[290] Usually referred to as PPS1.

These documents should be referenced for further information.

### 19.1Contents



### 19.2Introduction

Flood risk is a material consideration to be taken into account by LPAs when determining planning applications. The planning process requires an assessment to be made of any flood risks related to proposed developments. Separate planning policy guidance is provided for England and Wales. These are PPG25 and TAN15 respectively.

These assessments are usually referred to as site-specific Flood Risk Assessments (FRAs), although TAN15 describes them as Flood Consequences Assessments (FCAs) and they are also sometimes known as Project Flood Risk Assessments. For simplicity, these are collectively referred to as FRAs in the remainder of this guidance note and in all of the other guidance notes produced as part of the FD2320 project.

[288] http://www.odpm.gov.uk/stellent/groups/odpm_planning/documents/page/odpm_plan_606931.hcsp
[289] http://www.wales.gov.uk/subiplanning/content/tans/tan15/july04-tan15-e.pdf
[290] http://www.odpm.gov.uk/stellent/groups/odpm_planning/documents/page/odpm_plan_027494.pdf

## 19.3Data and Information

### 19.3.1 What information is needed to determine a planning application?

It is the responsibility of those choosing to develop a site (i.e. submitting the planning application) and, therefore, generating the risk (either for the site itself or for the surrounding area) to demonstrate the extent of the risk and how the risk will be managed.

This information needs to be provided in sufficient detail for a decision to be made by the LPA with confidence.[291] This is a risk-based approach, whereby the acceptability of a coarse assessment compared to a detailed/more rigorous assessment depends on understanding the remaining uncertainty and providing appropriately precautionary mitigation measures to manage the risk. The cost-effectiveness of only carrying out a coarse assessment will depend on the scale of the development and the scale of the risk and, hence the scale of the required mitigation. In general, the coarser the assessment, the more precautionary any mitigation measures will need to be.

### 19.3.2 What information does a FRA provide?

A FRA provides the following information:

- Whether the development itself will be subject to a flood risk, and
- Whether the development will increase the flood risk elsewhere.

This includes demonstrating how the flood risk will be managed or mitigated and should consider the flood risk for the life-time of the development. Therefore, issues such as climate change, long-term sea level changes, deterioration in defence condition, etc. need to be taken into consideration.

A FRA should assess risks associated with all types of flooding. These being:

- Fluvial flooding
- Coastal and tidal flooding
- Estuarial flooding and watercourses affected by tide-locking
- Groundwater flooding
- Flooding from overland flow
- Flooding from artificial drainage systems
- Flooding from infrastructure failure

Detailed descriptions of these types of flooding can be found in the CIRIA guidance C624.[292]

The results of the FRA will depend on a variety of factors, including the location of the development, its proposed design and its usage. In general, as the complexity of the site design and the level of risk increases, the detail of the assessment should increase. Further details of this are provided in Guidance Note D3.5 Flood Risk Assessments.

### 19.3.3 When is a FRA needed?

If a development falls outside the flood zones identified on the Flood Maps produced by the EA[293] or the Development Advice Map produced by the Welsh Assembly Government[294], it should not be assumed that a FRA is not required for two reasons:

- There are many inaccuracies in the mapping and they should only be treated as indicative,
- Other potential types of flooding are not considered.

[291] See Activity Chart Process 3 – Options Appraisal
[292] Lancaster, J, Preene, M and Marshall, C (2004) *C624 Development and Flood Risk – Guidance for the Construction Industry*, CIRIA, London.
[293] http://maps.environment-agency.gov.uk/wiyby/
[294] These can be viewed at the local planning offices and libraries.

Based on the best practice approach recommended in CIRIA guidance C624, a FRA is needed for ALL planning applications. However, the level of detail required will depend on a number of factors. These being:

- The nature and probability of the flood hazard,
- The vulnerability of the proposed development,
- The potential impact of the development on flooding elsewhere (including consideration of discharge consents),
- The amount of existing information,
- Whether the proposed mitigation measures are suitably precautionary, depending on the level of understanding of the flood risk.

This means that a FRA might produce a single page of text for small (such as house extensions), low risk developments or a large in-depth report undertaken by specialist consultants, including hydraulic modelling, etc. (for larger, higher risk developments).

### 19.3.4 Types of Planning Application

*Outline Application*

For a new building or buildings, developers can make an outline application to establish whether the development is acceptable in principle. This is considered advantageous in some circumstances, as it can reduce the risk of accumulating unnecessary costs on a detailed design only to have the application turned down.

*Reserved Matters*

Once outline permission has been granted, approval is still required for the details (reserved matters) before work can start. The reserve matters comprise siting, design, external appearance, means of access and landscaping and some of these may be fixed at outline stage. The final design must be consistent with the outline permission; otherwise it is necessary to reapply.

*Full Application*

A full planning application requires the submission of all details of the proposed development. This is appropriate if the developer wishes to change the use of land or buildings or if they want to start work quickly.

*Which type of application needs a FRA?*

As stated in CIRIA guidance C624 "…any application for outline planning permission, where flood risk is likely to be a material consideration, will need to be supported by a flood risk assessment (FRA) which provides sufficient information to enable the LPA to determine the application **in principle**."

This means that depending on the scale of the flood risk, a detailed FRA might still be required at the outline planning stage. To obtain clarification regarding which type of application may be considered acceptable, the developer should initially consult the LPA and then carry out the Level 1 assessment (Screening Study) (see section called Processes and Procedures later in this guidance note) to determine whether there are any flood risk issues.

### 19.3.5 Use of Existing Assessments of Flood Risk

Whenever possible, use of information from existing assessments of flood risk that cover the area in question (such as a Strategic Flood Risk Assessment) should be encouraged. This not only reduces costs and time implications associated with new assessments, but also provides continuity of approach and, hence, continuity of decision-making.

The Activity Chart[295] includes a section called *How assessments of flood risk are used*. This shows the potential data flows between different assessments in different contexts. Those that have relevance to planning applications are “Development planning” and “Flood management planning”. However, care needs to be taken that the information provided by these existing assessments of flood risk is up to date and sufficiently accurate for decisions to be made with confidence.

Ideally, FRAs should be carried out after the LPA has carried out the Sequential Test and SFRA for the relevant local authority area. This enables the FRA to start from the premise that the development will be permitted on the site and the assessment must demonstrate how the flood risk will be managed. However, this is not always possible, in which case the Developer may be required to justify the requirement for the development if it is in an area of flood hazard.

## 19.4Roles and Responsibilities

There are three main parties involved in FRAs (although other stakeholders should be consulted as appropriate[296]). These are:

- The Developer
- The Local Planning Authority
- The Environment Agency

The primary roles and responsibilities of the three main parties are summarised below.

### 19.4.1 The Developer

- Consult with the LPA and EA to obtain advice/guidance and information.
- Carry out the FRA in order to:
    - Determine/understand the extent of the flood risk posed at the site and elsewhere.
    - Demonstrate how the flood risk associated with a proposed development will be mitigated or managed.
- Submit the FRA with the planning application.
- Employ a suitably qualified professional to carry out these tasks.

### 19.4.2 The Local Planning Authority

- Provide advice to the Developer regarding the requirements for a FRA.
- Provide information to the Developer regarding planning policy.
- Seek advice from the EA, which is subsequently treated as a material planning consideration.
- Review the FRA, if using the EA’s Standing Advice (see below)
- Decide whether the flood risk is at an acceptable level.
- Take into account all material planning considerations, flood risk being one of these.
- Decide whether the development can take place, imposing conditions if necessary.

### 19.4.3 The Environment Agency

- Encourage best practices to be adopted for assessing the risk, managing the risk and deciding whether the risk is acceptable.

[295] Go to Activity Chart Overview
[296] See Guidance Note S2.4 Stakeholder Engagement

- Provide advice to the Developer regarding how to carry out an appropriate FRA.
- Provide data and information to the Developer, if available, regarding the local conditions.
- Provide information to the Developer regarding relevant flood risk management and environmental objectives/plans.
- Review FRAs on the request of the LPA.
- Choose to object to the planning application, if it considers that the FRA has not been carried out appropriately.
- Choose to object to the planning application, if it considers that the residual risk is not acceptable.

The Developer should involve both the LPA and EA as early as possible in the assessment process. Early consultation should help to prevent cost and disappointment for the Developer where an application is turned down by the LPA at a later stage in the process. If the FRA is carried out appropriately, it should also reduce (but not eliminate) the likelihood that the EA will object to the application.

**Box 1 Roles and Responsibilities according to PPG25**

Paragraph 60 of PPG25 states:
"In preparing their proposals, applicants should discuss with the local planning authority the requirements they will be expected to meet to satisfy the authority on flood risk and the run-off implications of the development proposed. They should consult the Environment Agency on the potential risks to their development, on the likely effects of their proposals on flood risk to others and on whether mitigation would be likely to be effective and acceptable. They should carry out an assessment of flood-risk and the run-off implications of their proposals that is appropriate to the scale and nature of the development and the risks involved and submit this with the application. Failure to do so may lead to delay in determining the application and could, in some cases, be a reason for refusal…"

*Standing Advice*

The EA has produced Standing Advice[297] for England to enable LPAs to make decisions on low risk planning applications where flood risk is an issue without forwarding the FRA the EA for an individual response. It also identifies those higher risk development situations where case by case referral to the EA should be sought. The Standing Advice can be treated as if it were EA advice via a direct response and a material planning consideration in determining the application. It remains a matter for the LPA to decide what weight it attaches to this standing advice having regard to this and all the other material considerations involved. Similar advice for Wales, reflecting TAN15 requirements, is planned by the EA in the near future.

## 19.5Processes and Procedures

Site-specific FRAs have three levels of detail. These are:

- Level 1 – Coarse Assessment (referred to as the Screening Study in C624)
- Level 2 – Intermediate Assessment (referred to as the Scoping Study in C624)
- Level 3 – Detailed Assessment

This approach allows proportionate effort with regard to the individual characteristics of the site. The requirements for each level of assessment for a planning application are presented in Guidance Note D3.5 Flood Risk Assessments.

[297] Environment Agency (2003) *National Standing Advice to Local Planning Authorities for Planning Applications - Development and Flood Risk*, Environment Agency.

All sites should carry out a Level 1 assessment. The results of this assessment will determine whether a more detailed assessment is required.

It is recommended that at least a Level 1 FRA is carried out as soon as a site is considered for development. This should involve consultation with the LPA and EA at the very least, with wider stakeholder consultation, if appropriate.

As development proposals progress, additional stages can be undertaken to inform the design process. These will be at increasing levels of detail, as appropriate. Again, it is important that the LPA and EA are consulted during Level 2 and Level 3 FRAs.

Figure 5.1 in CIRIA guidance C624 summarises the FRA process for development proposals, identifying the points in the process when advise/information should be sought from the LPA and EA and when FRAs (whether Level 1, 2 or 3) should be submitted to the LPA. The detailed processes involved in undertaking the FRAs are described in Guidance Note D3.5 Flood Risk Assessments.

## 19.6Tools and Technologies

### 19.6.1 Checking local development policies

A growing number of Local Plans and LDFs can be accessed via the planning portal website.[298]

### 19.6.2 Deciding whether to refer FRAs to the EA

The EA Standing Advice[299] is accompanied by a Flood Risk Matrix, which categorises sizes and types of development into those that can be given a standard response and those that need referral to the EA. It should be noted that consultation with the EA during the preparation of a FRA is still recommended even if the final FRA will not be referred to the EA.

### 19.6.3 Deciding whether the FRA has been carried out appropriately

- If the FRA can be reviewed using the Standing Advice (i.e. the development falls into one of the green or grey boxes on the matrix), information regarding the minimum requirements for these FRAs can be found behind the relevant box.

- Whether reviewing an FRA via the Standing Advice or not, the Milestone Points provided in Table 27.4 of Guidance Note D3.5 Flood Risk Assessments give minimum requirements for each of the processes.[300] If these have not been reached, this would provide an indication that either insufficient information has been provided with the Planning Application or the FRA has not been carried out appropriately and, therefore, not fulfilling the requirements of PPG25 or TAN15.

- The EA's internal AMS Documents 111_04 FRA Checklist and 112_04 Flood Risk Assessments Matrix can also be used to determine the EA's minimum requirements for FRAs.

- The Assessment Check-List[301] for the generic approach can be applied to FRAs to determine how well the assessment complies with best-practice.

### 19.6.4 Deciding whether the development is acceptable

- Checklist A of the Level 1 FRA recommended by C624, can be used to check the key issues when deciding whether a development is likely to be suitable in flood risk terms.

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[298] A list of the plans currently available online (or will be available soon) can be found at the following address: http://www.planningportal.gov.uk/england/professionals/en/1106655528620.html
[299] http://www.pipernetworking.com/floodrisk/index.html
[300] Further information regarding milestone points and how these should be applied can be found in Guidance Note S2.3 Auditing and Control
[301] See the Assessment Check-List

## 19.7 Audit and Control

As described in Box 2, it is essential that a suitably qualified professional is employed to carry out the assessment. The assessment approach adopted, in combination with suitably precautionary solutions, needs to be robust enough to stand up to scrutiny at a public inquiry.

**Box 2 Use of Professional Services according to PPG25**

Paragraph 72 of PPG25 states:

The assessment of the significance of flooding issues requires careful professional judgement. The developer is responsible for ensuring the safe development and secure future occupancy of his site and should ensure that appropriate expertise is available to carry out any necessary investigations and to design and execute any necessary flood alleviation works. While the local planning authority will need to consider flooding issues in the public interest, it is entitled to require the developer to provide at application stage suitable expert advice from an appropriately qualified competent person on such matters. To inform a developer's assessment, the Environment Agency should make available any relevant flood-risk information subject to their normal charging policy. The Agency should also be aware of the reliance that developers and their experts may place on the information provided in terms of local flooding conditions and flood risk. A local planning authority is not required to carry out its own assessment of flood risk but may rely on the developer's information, subject to any views expressed by consultees, particularly those of the Environment Agency, in determining the application and any necessary conditions. Those providing such expert advice should be aware of the reliance that may be placed on it.

# 20.D2.1 FLOOD RISK INDICATORS

**This guidance note:**

- Explains what flood risk indicators are, and
- Describes a selection method for identifying the most suitable indicators for different planning purposes.

**The tables that accompany this guidance note:**

- Outline recommended flood risk indicators for use in development planning (as the national, regional and local scales),
- Provide information on the application of these indicators, and
- List tools that are currently available for practitioners to calculate indicators.

**The guidance note and tables do NOT:**

- Identify which indicators should be used in site-specific FRAs. However, many of the indicators listed might be appropriate, depending on the specifics of the site.

## 20.1Contents



## 20.2Introduction

### 20.2.1 Definition of Flood Risk

There is potential for misunderstanding in technical terminology associated with risk assessment, since technical distinctions are made between words that in common usage are normally treated as synonyms. Most important is the distinction between the words "*hazard*" and "*risk*".

A further difficulty with the language of risk is that it has been developed across a wide range of disciplines and activities. It is common to describe risk as a combination of the chance of a particular event and the impact that the event or hazard would cause if it occurred. Evaluating risks involves identifying the hazards, i.e. what in a particular situation could cause harm or damage, and then assessing the likelihood that harm will actually be experienced by a particular population and what the consequences would be.

Thus to evaluate the risk, separate consideration needs to be made of the three generic components:

- The nature and probability of the hazard,
- The degree of exposure of people and assets to the hazard (referred to later as area vulnerability), and
- The vulnerability of the people, assets, etc. to damage should the hazard be realised.

In terms of flooding, a description of the nature of the hazard may include considering the following questions:

1. Can the land flood?
2. What area is affected?
3. What causes the flooding?
4. How often does flooding occur?
5. How deep is the flooding?
6. How rapidly does the flood rise?
7. How fast does the water flow?
8. How long does the flooding last?

Answering any of these questions (either separately or in combination) can provide an "*indication*" of flood hazard, even though it might not give the whole picture.

It is important to recognise that flood risks are wholly a human or societal concern rather than being an inherent characteristic of the natural system. The mitigation of flood risk can be accomplished through managing one or more of the hazard, exposure and vulnerability. Broadly speaking, flood hazard may be reduced through engineering or "structural" measures, which alter the frequency (i.e. the probability) of flooding in an area. The exposure and vulnerability of a community to flood loss can be mitigated by "non-structural" measures, for example, through changing or regulating land use, through flood warning and effective emergency response, and through flood resistant construction techniques.

Therefore, although "risk" and "hazard" are sometimes used as synonyms, this is not strictly true. For example, wherever the "risk" is quantified by an annual percentage of occurrence, such as 1%, this is actually referring to the flood hazard.

### 20.2.2 Definition of a Flood Risk Indicator for Development Planning

A flood risk indicator for development planning is a measurable attribute of the existing flood risk or the impact of a development on flood risk. Flood risk indicators are used (usually in combination) to inform the decision-making process, but they do not define what is or is not acceptable. Flood risk indicators can relate to

- The flood hazard,
- The degree of expose of development to flooding,
- The vulnerability of development to flooding, or
- The overall flood risk.

This guidance, therefore, uses the term *flood risk indicators* when it is referring to flood hazard, exposure, vulnerability or overall flood risk.

## 20.3Data and Information

Flood Risk Indicators (FRIs) suitable for development planning have been chosen based on the following criteria:

**Effectiveness:** the effectiveness of the indicator in giving clear information about flood risk. Indicators generally give information about one or both of the following aspects:

- **Statement** about existing flood risk, which gives information about the risk the new development will be subjected to.

- **Changes** that result from the planned development. This provides information on the impact of the new development on flood risk.

**Data requirements:** how much data is required; how easy it is to collect; how accurate is the data; whether the data is already collected for other purposes and therefore readily accessible.

**Quantification of the indicator:** how the indicator is quantified, how easy it is to calculate and how accurate is the answer.

**Uncertainty:** the level of uncertainty associated with the input data and the calculated indicator.

**Relevance to decision-making:** a range of indicators has been selected to cover various decision-making criteria, including economic, social and environmental considerations.

**Relevance to different scales of decision-making:** a range of indicators has been selected to cover national, regional and local scales.

**Application:** it is desirable to ensure that recommended indicators consider the procedures of existing assessments. If the indicator is already used in another assessment then the concept should already be familiar to decision-makers and the information will be readily accessible.

### 20.3.1 Table A - Recommended Flood Risk Indicators: Selection Guide

Table A provides a list of indicators. Each indicator has been categorised according to whether the information it gives is primarily about the flood hazard, area characteristics or people characteristics.

This corresponds with the approach adopted by the Flood Risks to People project[302] that looks at answering the following equation:

**Risks to People** = Function of (Hazard, Area Vulnerability, People Vulnerability) * Number of people at risk

Further details of this approach are provided in D2.1 ADD2 Flood Risks to People Calculator Guidance Note.

In most cases the indicators refer to new development sites, but there are some cases where the indicators provide information about the surrounding area.

Table A also gives guidance on:

- General suitability of the flood risk indicator at each planning scale, these being:
  - **A = Very good -** A good and relatively easy to use indicator that gives useful information for understanding flood hazard or risk.
  - **B = Good** - The indicator is good but either the interpretation of it is difficult, the relationship to risk is less strong, it requires significant amounts of data or calculation of it is not very accurate.
  - **C = Fair -** It is useful to include the indicator on the list, but its use is restricted by the amount of data or the ease of access to data required to assess it, the difficulty of computation and/or interpretation, and/or the value of information it gives about flood hazard or risk

- Type of indicator i.e. whether it
  - provides a STATEMENT about existing flood hazard or risk, or
  - assesses a CHANGE in flood hazard or risk caused by the development,

- Type of information the indicator provides

[302] Ramsbottom *et al.,* (2004) *Flood Risk to People Phase 2 Interim Report 2*, DEFRA/EA R&D Technical Report FD2321/IR1

    - economic
    - social
    - environmental

- Suitability of the indicator at each planning scale for the three levels of assessment, these being:
    - Coarse
    - Intermediate
    - Detailed

  To be identified on a case by case basis initially as part of the problem formulation stage (Process 1) and reviewed as appropriate throughout the tiered risk assessment stages (Processes 2a and 2b).

The method of calculation and sources of information for each indicator will vary depending on the scale of the decision-making exercise. For national planning, it is necessary for the indicator to give information for all parts of the country. For regional and local planning, the indicator must be calculated for the regional or local area.

### 20.3.2 Table B - Recommended Flood Risk Indicators: Principles of Application

Table B provides support information for Table A by summarising the principles of application for each flood risk indicator. These being:

- Information Provided (by the indicator)
- Usage for Decision-Making
- How to Calculate
- Data and Information Required
- Roles and Responsibilities
- Available Tools and Technologies
- Auditing and Accuracy

## 20.4Selecting Flood Risk Indicators

A process for selecting flood risk indicators is outlined below. However, every plan or project has unique conditions, controlling factors and objectives. Therefore, this approach should not be considered prescriptive and should not prevent the use of alternative indicators, if deemed appropriate by the relevant stakeholders.

### 20.4.1 Step 1 – Identify the indicators applicable to the planning scale

The indicators should be suitable for the scale of the planning decision. Table A shows the suitability of each indicator to the three planning scales. Note that some of the indicators are applicable to either England or Wales. Clearly only those relevant to each country should be selected.

*Filter the table by selecting the "Y"s under the appropriate "Relevant Country" column. Select the appropriate planning scale column under "General suitability at each planning scale". Then filter the table by selecting the "NonBlanks" for that column. This will result in a reduced list.*

### 20.4.2 Step 2 – Identify the indicators applicable to the level of assessment

The list of indicators from Step 1 can then be reduced further by determining which level of detail (coarse, intermediate or detailed) is being considered at this time. For the coarse assessment, all indicators remaining from Step 1 should be considered. For the intermediate and detailed level assessments, different options for indicating different types of flooding become available and steps 3 to 5 should help the user to make choices based on available information, available tools, etc.

*Select the appropriate level of detail column under the relevant planning scale. While retaining the previous filters from Step 1, filter the table again by selecting the "Y" for this new column.*

### 20.4.3 Step 3 – Review general suitability of indicators

The list of indicators from Step 2 should then be reviewed by assessing the suitability of "A" grade, "B" grade and then "C" grade indicators in order. It is not intended that every indicator be applied to every development. Depending on circumstances some indicators are easier to calculate than others and Table B can be used to help determine this, as described in Steps 4 and 5.

### 20.4.4 Step 4 – Review applicability of indicators to the decision-makers needs

Review the guidance provided in Part A of Table B, this being:

- Information Provided
- Usage for Decision-Making

Indicators should be selected that cover the most important concerns for the decision-making exercise. It is recommended that a range of indicators are selected from each of the following groups:

- Flood hazard, area characteristics and people characteristics
- Type 1 and Type 2 indicators
- Economic, social and environmental consequences

If presented with a choice over the indicators to use, the number of indicators required will depend on the size of the development and the stage of the assessment. For example, a preliminary assessment of a minor development may only require a small number of indicators to be calculated. Therefore, there is a need to prioritise the indicators.

### 20.4.5 Step 5 – Review practicalities of calculating indicators

Review the guidance provided in Part B of Table B, this being:

- How to Calculate
- Data and Information Required
- Roles and Responsibilities
- Available Tools and Technologies
- Auditing and Accuracy

The primary concern is to have enough information for decision-making, but measures can be taken to optimise the amount of effort required and time needed for calculating indicators. As far as possible, indicators should be selected that can be calculated using existing information and models that have already been constructed for planning and design purposes. Undertaking significant new work should be avoided wherever possible. Who holds the data and models should also be taken into consideration in planning the assessment, as accessibility and the timely provision of information can prove to be controlling factors for the assessment.

At the end of these five steps, the user will have a list of indicators that:

- Meet the decision-makers needs
- Provide sufficient information (or this information can be readily collected)
- Can be calculated based on available data, tools and technologies
- Have roles and responsibilities defined, and
- Can be checked appropriately to ensure confidence in the results.

Example indicator sets are provided in the boxes below. These examples illustrate that very different sets of indicators can be used for relatively similar situations. The selection process described above will help users to reduce the list to a certain extent, but then a degree of intuitive (or common-sense) selection is required to refine this list.

**Example 1**

The intention is to undertake an Intermediate Level Strategic Flood Risk Assessment to inform a LPA as part of their spatial planning activities (i.e. Local Scale). A Coarse Assessment has already been undertaken, which confirmed that the area within the plan is at risk from fluvial flooding, but defences are present. The quantity of data available is good and this is considered reliable. Budget and technical skills are available to undertake hydraulic modelling. Therefore, the following indicators are selected:

- FRI 17 - Expected annual probability of inundation with existing defences, which provides a statement on the likelihood that the development area will flood.
- FRI 29 - Flood Hazard Rating, which provides an indication of where risks to people should be a concern (See D2.1 ADD2 Flood Risks to People Calculator Guidance Note).
- FRI 35 - Expected annual damages – residential and commercial, which provides a measure of the change in economic risk for the area as a whole caused by the development.
- FRI 36 – Expected annual damages – agricultural, which should be used with FRI 35 to provide a measure of the overall change in economic risk for the area.
- FRI 37 - Change in economic damages outside the development area, which provides an indication of where impacts of the new development on existing development should be a concern.

**Example 2**

The intention is to undertake an Intermediate Level Strategic Flood Risk Assessment to inform to inform a LPA as part of their spatial planning activities (i.e. Local Scale). A Coarse Assessment has already been undertaken, which confirmed that the area within the plan is at risk from fluvial flooding, but defences are present. The quantity of data available is poor and budget and time constraints mean that hydraulic modelling is not possible. This assessment is for part of England. Therefore, the following indicators are selected:

- FRI 5 and FRI 6 -Total NEW development in Flood Zones 3 and 2 respectively.[303]
- FRI 28 - Speed of onset of flood (based on expert opinion of whether it is slow or rapid), which provides an indication of flood risk to people.
- FRIs 31 to 34 - Number of properties at risk from flooding, which provides an indication of the change in economic risk caused by the development.
- FRI 41 - Investment in flood defence, which indicates whether or not the new development will be defended.
- FRI 47 - Number of people in zones 3 and 2, which indicates the change in social risk caused by the development.
- There is no simple indicator for assessing impacts of a new development on existing development. Therefore, precautionary planning constraints alone are used to control the impact of the development on the surrounding area.

## 20.5Implementation of this Guidance Note

This guidance should be updated in the future when new and tested tools become available.

[303] As defined in DTLR (2001) *Planning Policy Guidance Note 25: Development and Flood Risk*. HMSO, London.

This guidance should be pilot tested for different scales of decision-making and different levels of assessment prior to adoption as a standard approach.

# 21.D2.1 ADD1 RISK ASSESSMENT FOR STRATEGIC PLANNING (RASP) – A SUMMARY

The RASP analysis provides a decision-support technique/methodology developed by Defra and the Environment Agency (EA) for the development of flood management policy, allocation of resources and monitoring the performance of flood mitigation activities at national, regional and local scales. The RASP methods are therefore rapidly becoming the basis for decision-making in all of these areas. It is also being used to support policy development to address strategic or overarching issues such as:

- What are the probability and consequences of flooding, and how do they vary within the floodplain?
- What is the appropriate level of spending on flood defence (fluvial, tidal and coastal) to ensure risk is reduced, including the possible effects of climate change?
- What combination of risk management measures provides the best value?
- What is the 'residual risk' remaining after all risk management measures?

In particular, RASP provides a hierarchy of methods to support the assessment of flood risk at a range of scales (national, regional, local) and levels of detail, as described in Table 21.1.

Therefore, regardless of the level of detail of the analysis the RASP methodology delivers consistent and progressively less uncertain results, including an estimate of:

- Failure probabilities for individual defences
- Failure probabilities for a defined system of the defences protecting a given floodplain
- A flood depth (velocity at the more detailed levels) versus probability relationship for an identified area within the floodplain
- Total flood risk (defined by any appropriate quantitative risk metric: e.g. number of people exposed to flooding more frequently than once in 200 years on average; expected annual damages etc) for an identified area within the floodplain.
- An indication of the contribution to flood risk or risk reduction made by each defence within the defence system
- Expected annual damage
- Social impacts: as a product of the probability of flooding to a given depth and Social Flood Vulnerability Index (SFVI)
- Associated uncertainties on all outputs.

Further information can be found in the following references:

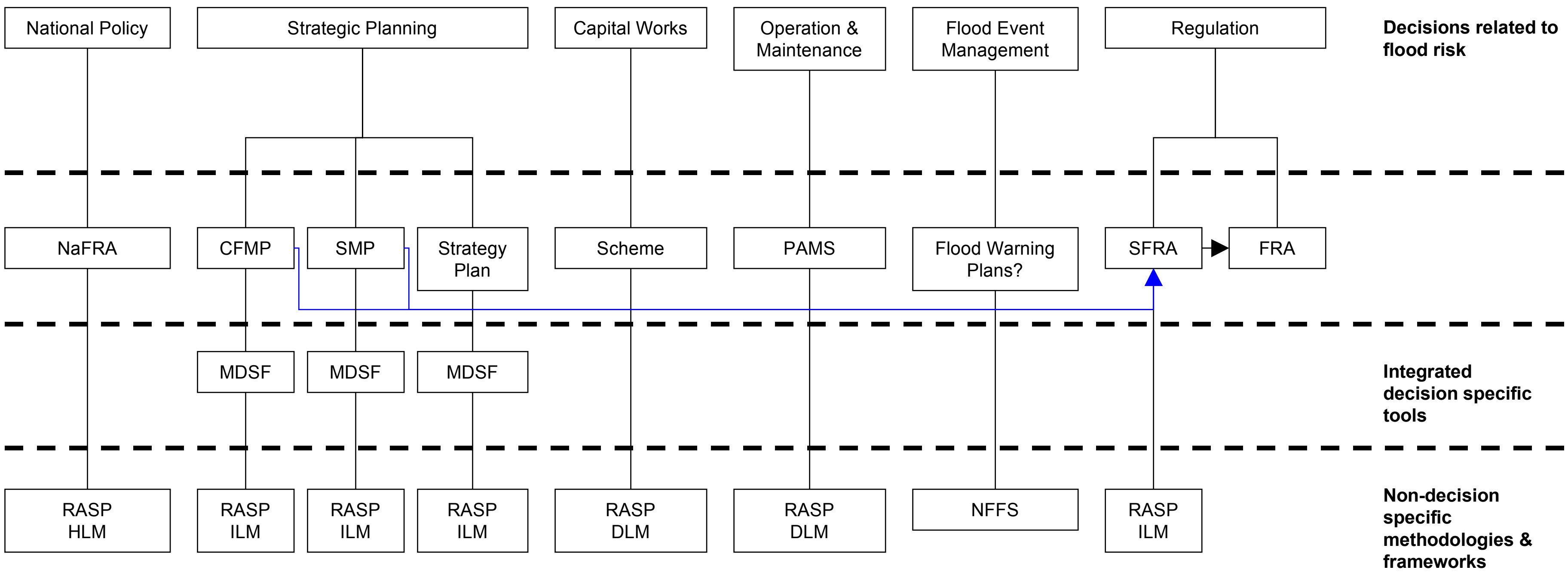
HR Wallingford (2004) *Risk Assessment for Flood and Coastal Defence for Strategic Planning (RASP) A Summary*, R&D Technical Report W5B-030/TR, Defra/Environment Agency.

Office of Science and Technology (2004) *Foresight Future Flooding Scientific Summary: Volume I - Future Risks and their Drivers*, Office of Science and Technology.

**Table 21.1 Hierarchy of RASP methodologies, decision support and data required**

| **Level of Methodology** | **Decisions to inform** | **Data Sources** | **Methodologies** |
|---|---|---|---|
| High<br>(RASP HLM) | National assessment of economic risk, risk to life of environmental risk<br>Initial prioritisation of expenditure across all functions<br>Regional Planning<br>Flood Warning Planning | Defence type<br>Condition grades<br>Standard of Service<br>Indicative flood plain maps<br>Socio-economic data<br>Land use mapping | Generic probabilities of defence failure based on condition assessment and Standard of Protection<br>Assumed dependency between defence sections<br>Empirical methods to determine likely flood extent |
| High +<br>(RASP HLM+) | *As above* | *Above plus:*<br>Digital Terrain Maps (DTM)<br>Quantitative loading<br>Floodplain depths in the absence of defences | *As above*, with improved estimate of flood depth using DTM |
| Intermediate<br>(RASP ILM) | *Above plus:*<br>Flood defence strategy planning<br>Regulation of development<br>Regional prioritisation of expenditure across all functions<br>Planning of flood warning | *Above plus:*<br>Defence crest level and other dimensions where available<br>Joint probability load distributions<br>Flood plain topography<br>Detailed socio-economic data | Probabilities of defence failure from reliability analysis<br>Systems reliability analysis using joint loading conditions<br>Modelling of limited number of inundation scenarios |
| Detailed<br>(RASP DLM) | *Above plus:*<br>Scheme appraisal and optimisation | *Above plus:*<br>All parameters required describing defence strength<br>Synthetic time series of loading conditions | Simulation-based reliability analysis of system<br>Simulation modelling of inundation |

**Figure 21.1 How RASP can be applied across the Environment Agency flood related functions (INDICATIVE ONLY – CURRENTLY UNDER DEVELOPMENT**




**Notes:** PAMS will also use less detailed methods as appropriate. This is under development as part of the Defra/EA R&D Project W5-0205 PAMS Phase II.

**Key:**
RASP HLM = RASP High Level Methodology
RASP ILM = RASP Intermediate Level Methodology
RASP DLM = RASP Detailed Level Methodology
NaFRA = National Flood Risk Assessment
CFMP = Catchment Flood Management Plan

SMP = Shoreline Management Plan
MDSF = Modelling and Decision Support Framework
PAMS = Performance-based Asset Management System
NFFS = National Flood Forecasting System
SFRA = Strategic Flood Risk Assessment
FRA = Flood Risk Assessment (site-specific)

# 22.D2.1 ADD2 FLOOD RISKS TO PEOPLE CALCULATOR

**This guidance note:**

- Summarises the Flood Risks to People Phase 2 method.
- Describes the contents of a spreadsheet tool that evaluates the "Risks to People", referred to as the Flood Risks to People Calculator, and how to use the Calculator.

**This guidance note does NOT:**

- What should be considered as an acceptable risk for development planning, as this is the responsibility of the planning authorities.

**The Calculator can be used:**

- To test whether a development will increase the risks of harm or death in an extreme flood,
- To support the consideration of outline planning applications,
- To check or reinforce decisions made based on Flood Risk Assessments (FRAs).

**The Calculator should NOT be used:**

- As the sole tool to determine a planning decision.

## 22.1Contents



## 22.2Introduction

An overarching objective of flood risk management is to reduce the risks to people of death or serious harm. A range of methods for estimating and mapping "Risks to People" are under development as part of the Defra and Environment Agency Flood Risk R&D programme.

Phase 1 of the "Risks to People" project was completed in July 2003 and provided a simple method for combining information on flood hazards with information on the vulnerability of areas and people at risk from flooding.[304] A second phase of the project was completed in March 2005 and included revised methods for assessing and mapping risks to people.[305]

## 22.3Approach

[304] HR Wallingford (2003) *Flood Risks to People Phase 1*. Environment Agency\Defra R&D Technical Report FD2317/TR. July 2003.

[305] HR Wallingford *et al.* (2005) *Flood Risks to People Phase 2: The Risks to People Methodology*, Defra/EA R&D Project Technical Report FD2321/TR1.

The methodology is based on three concepts, Flood Hazard, Area Vulnerability and People Vulnerability. Information on these three concepts is combined using a scoring system in order to provide an estimate of the number of injuries or deaths for a given flood.

The number of deaths/injuries in an extreme flood is calculated using the following equation:

***Equation No. 1***

| | |
|---|---|
| **Number of deaths/injuries (NI)** = N * X * Y | |
| Where: | |
| NI | = number of deaths/injuries |
| N | = population within the floodplain area being considered |
| X | = proportion of the population exposed to a risk of death/injury (for a given flood) |
| Y | = proportion of those at risk who will suffer death/injury |

In order to calculate NI, population estimates and methods to calculate X and Y are required. These are discussed later in this guidance note.

This method has been tested against 7 case studies and has been shown to work well, giving a reasonably realistic number of deaths compared to the statistics.[306] Despite this, some experts have still raised concerns that this method might over-estimate deaths. However, it is inevitable that a high degree of uncertainty will remain with this method, due to the few events available to calibrate against. Bearing this in mind, this method performs as well as can be expected for a simple approach and, in general, can be considered as precautionary.

This method's application is most appropriate in comparing options. It should never be used as the sole tool in decision-making, as there are many other economic, environmental and social factors that should also be taken into consideration.

[306] Details are presented in R&D Technical Report FD2321/TR1 (reference as above).

## 22.4Data and Information

Information is required on the existing flood risk, the proposed development and any mitigation measures proposed (see Table 22.1).

**Table 22.1 Risks to people concepts and sources of information**

| Concept | Description | Information Sources |
|---|---|---|
| Flood Hazard Rating | This is dependent on the physical characteristics of flooding. These being velocity, depth and the presence of debris. | • Flood mapping<br>• Ordnance Survey maps (contours)<br>• Strategic or site-specific Flood Risk Assessments<br>• Local knowledge (EA Development Control and Hydrology functions)<br>• *(& this guidance note)* |
| Area Vulnerability | This is related to location characteristics, such as the nature of the housing stock (e.g. low or high rise buildings) or the use and effectiveness of flood warning. | • Local knowledge (EA Development Control, Hydrology and Flood Warning functions)<br>• Local Planning Authority (LPA)<br>• *(& this guidance note)* |
| People Vulnerability | This is related to the age and health of people in the flood risk area. | • MDSF (population and Social Flood Vulnerability Index)<br>• Local knowledge (EA Development Control)<br>• Local authority (Planning, Social Services and Emergency Planning departments) in particular population or household numbers<br>• Emergency Services<br>• Census data<br>• *(& this guidance note)* |

## 22.5The Calculator

Two versions of the Calculator have been provided:
- Blank version
- A completed version for Example A (a printed copy is provided in Appendix E)

The Calculator provides a template and some supporting guidance for the input of values and scores for Flood Hazard, Area Vulnerability and People Vulnerability. Data input, calculation and result fields are colour coded as follows:

| | |
|---|---|
| (yellow) | **Required input** |
| (light green) | **Calculation** |
| (cyan) | **Results** |
| (white) | **Additional comments** |

The user can only edit yellow and white boxes.

The Calculator is designed to make broad-brush assessments of the “risks to people” at the scale of a single area or site within the floodplain e.g. the “red-line” area that forms part of a planning application or a single area designated for development by the LPA within its Local Development Documents (LDDs).

Ideally, the problem can be simplified by assuming a uniform flood depth and velocity across the site. In practice, it is likely the level of flood hazard will vary across a site due to floodplain slope or other features such as flood defences that divide the area into distinct flood hazard zones. In these cases, if there is sufficient information, the calculation can be completed separately for distinct flood hazard zones and then summed in a separate worksheet. (See Section 5: Risks to people calculation)

The Calculator is divided into 5 sections:

1. A summary of the calculation including quality assurance data and the outcome of the assessment.

2. Information about current flood hazards including flood depths, population numbers and the type of housing.

3. Information about the proposed development, such as the number of houses and population.

4. The impact of the development on flood risk.

5. The Risks to People calculation.

In Sections 3 and 4 there is a second column for mitigation measures that include conditions that the LPA may wish to enforce, following advice provided by the EA. For example, these may include a mandatory constraint that developments have a "safe refuge" above the maximum flood level or raised walkways to enable safe exit.

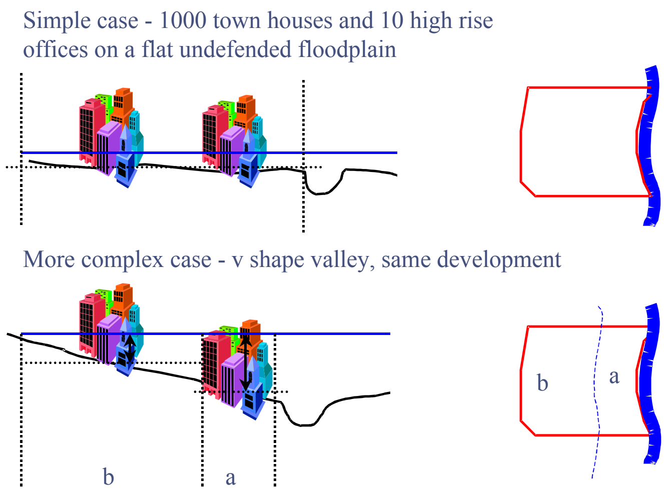
**Box 1 – Introduction to the Examples**

In this guidance note two examples are used to illustrate the Calculator:

**Example A** – A proposal for 1000 homes and 10 offices on a greenfield site in a flat undefended floodplain around a fenland village with a population of 3000 people.

**Example B** – A similar proposal, except in a V-shaped valley, with the existing population of 3000 located at the edge of the floodplain and the proposed homes stretching from the existing village towards the river (50:50 in each flood hazard area). See Figure 22.1 below.

**Figure 22.1 Example developments in the undefended 1% annual probability (1 in 100 year) floodplain in (a) a flat floodplain and (b) a V-shaped valley**




0.1% annual probability (1 in 1000 year) floods:

d = 1.5 m; v = 1 m/s
For existing development the Area and People Vulnerability scores are average. New development includes some retirement homes.

(a) d = 1.5 m; v = 2 m/s
(b) d = 0.5 m; v = 2m/s

The existing village is in flood area (b) and existing Area and People Vulnerability scores are average.

**Box 2 – Criteria for "acceptability"**

| |
|---|
| The EA flood risk policy aims to reduce flood risk, but the risk of death from flooding cannot be eliminated completely. Many thousands of people already live and work in the floodplain and people are subjected to a range of risks on a day to day basis. Therefore, the concept of a "tolerable" or "acceptable risk" is useful to set a threshold on the flood risks that are acceptable or unacceptable in comparison to other risks.<br><br>A summary of the risks of death in the UK, as reported in the Flood Risks to People Phase 1, is given below:<br><br>▪ 1 in 100 per year: Risk of dying at age 60<br>▪ 1 in 1,000 per year: Risk of employee being killed in high hazard industry<br>▪ 1 in 10,000 per year: Risk of being killed in car accident or being killed at work (construction industry)<br>▪ 1 in 100,000 per year: Risk of being murdered or being killed as a pedestrian<br>▪ 1 in 1 million per year: Risk of contracting (non-BSE linked) CJD<br>▪ 1 in 10 million per year: Risk of being killed by lightning<br><br>In the Risks to People Calculator, the outcome is defined as "Acceptable" or "Unacceptable" according to the following criteria related to annual average individual risk:-<br><br>▪ The development must not "*significantly*" increase the individual risk of death. Significance is taken as a greater than 1.5 increase in individual risk.<br>▪ The probability of death must be less than 0.0001% or 1 in 10,000 per year.<br><br>In addition, criteria can be developed for average annual societal risk by estimating the risk of injury or harm per unit area. If greater numbers of people are located on the floodplain, significant increases in societal risks are almost inevitable, so risks to people should be balanced with other economic, social and environmental criteria.<br><br>**It should be noted that these are only suggestions and used as examples in the Calculator. It is the responsibility of the planning authorities to decide what level of risk is acceptable.** |

## 22.6Section 1: Calculation Summary

This section of the Calculator includes some basic information about the calculation. It is important that the cells describing the development and the design event are completed, because these are used elsewhere in the calculations.

This section also summarises whether the development is acceptable or unacceptable from a risks to people perspective based on the criteria discussed in Box 2. This information is provided in the Calculator as a guide only and should be used alongside EA policy and other standard criteria to inform the decision-making process.

| 1. Calculation Summary | |
|---|---|
| | |
| Development (sub area) | Example A |
| Reference | A |
| Design event ~ probability. 1 in x years | 1000 |
| Risk pathway (no defence, overtopping or breach) | no defence |
| Calculation completed by | SDW |
| Date | 21 st March 2005 |
| Approved by | HUC |
| Date | 28 th March 2005 |

## 22.7Section 2: Estimating Current Flood Risks

This section requires some information about the existing Flood Hazard, Area Vulnerability and People Vulnerability. Individual criteria and guidance for classification into low, medium and high risk categories are described in the following sections.

| 2. Information about current flood hazards & vulnerability | Development | Comments\Source of information |
|---|---|---|
| Depth (D) (m) | 1.5 | Insert average depth (must be greater than 0) |
| Velocity ($v$) (m/s) | 1 | Insert typical or median velocity |
| Debris Factor (DF) | 0.5 | 0 = none (e.g. groundwater flooding), 0.5 = possible (e.g. forested) and 1 = likely (e.g. urban) |
| Flood Warning Score | 2.15 | Equation No. 3 in guidance note |
| Speed of Onset | 2 | Refer to guidance note.<br>1=low risk, 2= medium risk, 3=high risk |
| Nature of Area | 2 | Refer to guidance note.<br>1=low risk, 2= medium risk, 3=high risk |
| Area of Zone (ha) | 1000 | |
| Population (N) | 3000 | |
| The very old (75 years or over) (%) | 10 | |
| Infirm/disabled/sick (%) | 9 | |

### 22.7.1 Determining the Flood Hazard

Flood Hazard is estimated as a function of flood velocity, depth and the presence of debris using the following equation.

***Equation No. 2***

**Flood Hazard Rating (HR)** = $((v + 0.5) * D) + DF$

Where:

$v$ = Flood velocity (m/s)

D = Flood depth (m)

DF = Debris factor

**Flood depth** can be estimated based on flood levels and topographic data. The accuracy and detail of this information will depend on the nature and size of development. In PPG25 there is a requirement for Flood Risks Assessments to plot flood levels on sections across the proposed development. Other sources of data include river hydraulic models, Section 105 maps or EA Flood Plain Information Systems (in some Regions). In the absence of such information, an approximate estimate can be made from the EA's Flood Mapping[307] and Ordnance Survey maps that show levels (1:1250; 1:2500) or contours (1:25000).

**Flood velocity** information may be available from similar sources. In the absence of detailed information the following velocities are sufficient for comparative "before" and "after development" calculations:

- 0.5 m/s for lowland flat floodplains
- 2.0 m/s for steeper catchments

**The debris factor** accounts for additional hazards presented by floating debris. The presence or absence of debris depends upon the nature of the floodplain and upstream areas[308], but as a general rule the following scores can be considered suitably precautionary:

[307] Flood maps and flood warnings areas are available at the following web site: http://www.environment-agency.gov.uk/subjects/flood/826674/829803/

[308] Further details are provided in HR Wallingford *et al.* (2005) *Flood Risks to People Phase 2: The Risks to People Methodology*, Defra/EA R&D Project Technical Report FD2321/TR1.

- 0 for groundwater flooding that tends to be clear water and not of sufficient velocity to entrain and transport debris
- 0.5 for fluvial and coastal flooding in rural catchments or coastal zones
- 1.0 for fluvial and coastal flooding in urban areas

### 22.7.2 Determining Area Vulnerability

The numbers of people exposed to a flood event is estimated based on the following three factors:

- Flood warning
- Speed of onset
- Nature of the area (type of housing, presence of parks, etc.)

Defence overtopping and breaching is a special case, where the speed of onset can be rapid and, whilst severe conditions may be forecasted, there may not be any warning of the actual flooding. The Calculator can be used in conjunction with the guidance provided in Guidance Note S3.2 Risk to People behind Defences to estimate risks to people behind defences. However, separate calculations are required for different breach or overtopping scenarios.

It should be noted that actual numbers of people exposed will vary for different events based on a number of additional factors, such as the time of the flood, but these factors have not been used in the Risks to People methodology.

The scoring system for Area Vulnerability is summarised below.

#### *Flood Warning*

Flood Warning is summarised using a score generated from the following equation:

***Equation No. 3***

| |
|---|
| **Flood Warning Score** = 3 - (P1 * (P2 + P3))<br><br>Where:<br>P1 = % of Warning Coverage Target Met<br>P2 = % of Warning Time Target Met<br>P3 = % of Effective Action Target Met |

In this context, flood warning includes emergency planning, awareness and preparedness of the affected population; and preparing and issuing flood warnings.

The targets used in Equation No. 3 are based on the Key Performance Indicators used by the Environment Agency. Further details can be found in The Risks to People Methodology.[309] Flood Warning Scores for each region of the EA, based on the latest available data, are provided in the table below.

In the absence of such data, an alternative approach would be to apply simplified scores based on the following:[310]

- Flood Warning Score of 1 = Effective tried and tested flood warning and emergency plans
- Flood Warning Score of 2 = Flood warning system present but limited
- Flood Warning Score of 3 = No flood warning system

[309] HR Wallingford *et al.* (2005) *Flood Risks to People Phase 2: The Risks to People Methodology*, Defra/EA R&D Project Technical Report FD2321/TR1.
[310] HR Wallingford (2003) *Flood Risks to People Phase 1*. Environment Agency\Defra R&D Technical Report FD2317/TR. July 2003.

**Table 22.1 Flood Warning Scores for Environment Agency Regions**

| Environment Agency Region | % of Warning Coverage Target Met (80%) = P1 | % of Warning Time Target Met (100%) = P2 | % of Effective Action Target Met (75%) = P3 | Flood Warning Score = 3 - (P1 x (P2 +P3)) |
|---|---|---|---|---|
| Anglian | 0.69 | 0.75 | 0.48 | 2.15 |
| Midlands | | | | |
| - East | 0.16 | 0.54 | 0.48 | 2.83 |
| - West | 0.34 | 0.54 | 0.48 | 2.66 |
| North East | | | | |
| - Yorkshire & Humber | 0.94 | 0.88 | 0.48 | 1.73 |
| - North East | 0.66 | 0.88 | 0.48 | 2.10 |
| North West | 0.81 | 0.00 | 0.48 | 2.61 |
| Southern | 0.76 | 0.65 | 0.48 | 2.14 |
| South West | 0.76 | 0.61 | 0.48 | 2.17 |
| Thames | 0.76 | 0.65 | 0.48 | 2.14 |
| **England** | **0.76** | **0.63** | **0.48** | **2.15** |
| Wales | 0.56 | 0.63 | 0.73 | 2.23 |

### *Speed of Onset*

Speed of onset is summarised using the following scoring system:

1 – Low risk area is where the onset of flooding is very gradual (many hours)
2 – Medium risk area is where the onset of flooding is gradual (an hour or so)
3 – High risk area is where there is a risk of rapid flooding

### *Nature of Area*

The nature of the area is represented using the following scoring system:

1 – Low risk area would generally consist of multi-storey apartments
2 – Medium risk area would consist of typical residential 2-storey homes and commercial and industrial properties
3 – High risk area would include bungalows, mobile homes, busy roads, parks, single storey schools, campsites, etc.

High and low scores are intended to reflect the judgement of the assessor as to whether there are particular features of the area in question which will make people significantly more or less at risk than those in a “medium risk area”.

The sum of these factors provides an indication of the vulnerability of the area (as opposed to that of the people) and will have a value of between 3 and 9, i.e.:

***Equation No. 4***

**Area Vulnerability (AV)** = Speed of Onset Score + Nature of Area Score + Flood Warning Score

This Area Vulnerability score can then be multiplied by the Flood Hazard Rating (described earlier) to generate an estimation of the percentage of people exposed to the risk, i.e.:

***Equation No. 5***

| |
|---|
| **% of people exposed to the risk (X)** = Flood Hazard Rating (HR) * Area Vulnerability (AV) |

**Box 3 – Populations exposed to hazard for Examples A and B**

| |
|---|
| For Example A, approximately 29% of the population is exposed to the hazard.<br><br>For Example B approximately 38% of the population is exposed to the hazard in the area close to the river (a) and 17% of people are exposed to the hazard in the area at the edge of the floodplain (b). |

### 22.7.3 Determining Numbers of Deaths or Injuries

The final stage is to calculate the number of deaths/injuries. This is achieved by multiplying the number of people exposed to the risk by a factor "Y", which is based on the vulnerability of the people exposed.

People Vulnerability (PV) is a function of two parameters:

- The presence of the very old, and
- Those who are at risk due to disabilities or sickness.

***Equation No. 6***

| |
|---|
| **People Vulnerability (PV)** = % of residents with long-term illness + % of residents aged 75 or over |

Estimates of the numbers of injuries (Ninj) and fatalities (Nf) can be made using the following equations:

***Equation No. 7***

| |
|---|
| **Number of Injuries (Ninj)** = 2 * N * HR * (AV/100) * PV<br><br>Where:<br>N = Population within the floodplain area being considered<br>HR = Flood Hazard Rating *(Equation No. 2)*<br>AV = Area Vulnerability *(Equation No. 4)*<br>PV = People Vulnerability *(Equation No. 6)* |

Therefore, only a small proportion of vulnerable people are injured during the event being assessed.

The probability of injury during the event is Ninj / N.

***Equation No. 8***

| |
|---|
| **Number of Fatalities (Nf)** = 2 * Ninj * (HR/100)<br><br>Where:<br>Ninj = Number of injuries *(Equation No. 7)*<br>HR = Flood Hazard Rating *(Equation No. 2)* |

Therefore, only a proportion of those suffering injuries will result in fatalities.

The probability of death during the event is Nf / N.

These numbers can be calculated for a range of return periods, as shown in the example provided in Box 4 (over the page).

Societal risk is also calculated, which provides a useful indicator for mapping purposes, if undertaking spatial planning activities. It is less relevant for individual sites. This is calculated as the following:

***Equation No. 9***

| |
|---|
| **Societal Risk** = Nf / Az<br><br>Where:<br>Nf = Number of fatalities *(Equation No. 8)*<br>Az = Area of the zone being considered |

**Box 4 - Existing flood risks to people for Example A**

| 5. Risks to People calculation | | | | Flood characteristics | | | |
|---|---|---|---|---|---|---|---|
| Calculation No. | Development | Return Period | | Depth | Velocity | Debris | Flood hazard |
| 1 | Example A | 20 | Existing Situation | 0.20 | 0.1 | 0 | 0.12 |
| 2 | Example A | 50 | Existing Situation | 0.50 | 0.2 | 0 | 0.35 |
| 3 | Example A | 100 | Existing Situation | 0.70 | 0.5 | 0.5 | 1.20 |
| 4 | Example A | 500 | Existing Situation | 1.00 | 0.7 | 0.5 | 1.70 |
| 5 | Example A | 1000 | Existing Situation | 1.50 | 1 | 0.5 | 2.75 |

| Area Vulnerability | | | | People at risk | | |
|---|---|---|---|---|---|---|
| Flood warning | Speed of onset | Nature of area | AV score | Population (N) | People at risk (X) | People exposed to risk N(ZE) |
| 2.15 | 2 | 2.00 | 6.15 | 3000 | 0.01 | 22.14 |
| 2.15 | 2 | 2.00 | 6.15 | 3000 | 0.02 | 64.58 |
| 2.15 | 2 | 2.00 | 6.15 | 3000 | 0.07 | 221.40 |
| 2.15 | 2 | 2.00 | 6.15 | 3000 | 0.10 | 313.65 |
| 2.15 | 2 | 2.00 | 6.15 | 3000 | 0.17 | 507.38 |

| People Vulnerability | | | Injuries and deaths | | |
|---|---|---|---|---|---|
| The very old | Infirm / disabled / sick | Vulnerable people | Injuries | Fatality Rate | Deaths |
| 10.00 | 9.00 | 0.19 | 8 | 0.00 | 0 |
| 10.00 | 9.00 | 0.19 | 25 | 0.01 | 0 |
| 10.00 | 9.00 | 0.19 | 84 | 0.02 | 2 |
| 10.00 | 9.00 | 0.19 | 119 | 0.03 | 4 |
| 10.00 | 9.00 | 0.19 | 193 | 0.06 | 11 |

## 22.8Section 3: Information on the Proposed Development

This section collates information on the proposed development available in the Masterplan, provided by the LPA, or the planning application, provided by the Developer.

| 3. Information about the proposed development | Development | Comments\Source of info |
|---|---|---|
| Proposed Development | Newtown | |
| Number of Domestic Properties | 1000 | Masterplan A |
| Nature of Area | 2 | Refer to guidance note.<br>1=low risk, 2= medium risk, 3=high risk |
| Occupancy Rate | 2.2 | Masterplan A |
| Household populations | 2200 | |
| Includes Elderly? | Yes | Masterplan A |
| Includes Infirm? | Yes | Masterplan A |
| Number of Industrial Units | 10 | Masterplan A |
| Number of Workers | 500 | Masterplan A |
| Working Population | 125 | 0.25*No. of workers |
| Total Population | 2325 | |

The type of buildings proposed can be classified according to the "nature of the area" as described earlier. Basic information on household numbers, population and facilities should be available from Masterplans, Planning Applications or Environmental Statements.

If the proposal includes sheltered housing or hospital facilities, then this should be recorded in the "Including Elderly?" and "Including Infirm?" rows which will have the affect of increasing the people vulnerability (PV) score.

This section of the Calculator also introduces further columns for mitigating risks that may inform any conditions placed on the development. For example, conditions may include ensuring no sheltered housing within the floodplain or insisting that buildings have a safe refuge, which will affect the area vulnerability (AV) score. The change in flood risks to people caused by the development without mitigation and then with mitigation can be compared in Section 5 of the Calculator.

## 22.9Section 4: Impacts of the Development on Flood Hazard

This section requires information on the likely impact of the development on flood risks. This information may be presented in a Strategic or site-specific Flood Risk Assessment or, in the absence of any information, estimated by EA hydrology or engineering staff based on experience or hand calculations.

| 4. Impact of development on flood risk | | |
|---|---|---|
| Development will increase flood levels by (%) | 10% | FRA |
| Development will increase velocity by (%) | 10% | No info |
| Improve flood warning & emergency planning | | |

As in Section 3 of the Calculator, there are further columns for mitigation where the impact of flood levels can be reduced e.g. by introducing compensatory storage or improved flood warning and emergency planning.

## 22.10Section 5: Risks to People Calculation

In this section, data entries from Sections 1 to 4 are used to calculate Flood Hazards, Area Vulnerability, People Vulnerability scores and the individual risks of injury and death and societal risk. Three columns provide calculations for the existing situation, post development and post development with mitigation.

These can be calculated for a range of return periods, as already illustrated for the existing situation in Box 4 (Example A), and for each zone (as required for Example B).

After a calculation for a particular return period or a particular zone has been carried out, the "Transfer Data to Record" button (as show below) can be used to copy calculation details into a second worksheet.


This creates an audit trail and can be used to combine results together for different return periods to produce an estimate of annual average risk. In order to calculate average annual individual risk (AAIR) (whether injury or fatality), a further calculation is required based on the outputs in the "Calculation Record".

***Equation No. 10***

AAIR injury = Sum (df * Ninj / N) for events 2 to n

Where:

df = Frequency interval, which is the difference between two flood events, e.g. the difference between a 1000 year and 250 year flood is 1.0E-03 minus 4.0E-03 which equals 3.0E-03

Ninj = Number of injuries *(Equation No. 7)*

N = Population within the zone being considered

***Equation No. 11***

AAIR fatality = Sum (df * Nf / N) for events 2 to n

Where:

Nf = Number of fatalities *(Equation No. 8)*

Calculations of AAIR (both for injuries and fatalities) for Example A are provided in Box 5. Note that AAIR will be greater than the individual risk for a single event, because it considers a range of possible flood events.

**Box 5 – AAIR calculations for Example A (Existing Situation)**

| Ninj | N | Return Period | Frequency per year (f) | Interval | Frequency interval (df) | df * Ninj / N |
|---|---|---|---|---|---|---|
| 8 | 3000 | 20 | 0.05 | | | |
| 25 | 3000 | 50 | 0.02 | 20-50 | 0.03 | 0.000245 |
| 84 | 3000 | 100 | 0.01 | 50-100 | 0.01 | 0.000280 |
| 119 | 3000 | 500 | 0.002 | 100-500 | 0.008 | 0.000318 |
| 193 | 3000 | 1000 | 0.001 | 500-1000 | 0.001 | 0.000064 |
| | | | | | **AAIRinj =** | **0.000908** |

| Nf | N | Return Period | Frequency per year (f) | Interval | Frequency interval (df) | df * Nf / N |
|---|---|---|---|---|---|---|
| 0 | 3000 | 20 | 0.05 | | | |
| 0 | 3000 | 50 | 0.02 | 20-50 | 0.03 | 0.000002 |
| 2 | 3000 | 100 | 0.01 | 50-100 | 0.01 | 0.000007 |
| 4 | 3000 | 500 | 0.002 | 100-500 | 0.008 | 0.000011 |
| 11 | 3000 | 1000 | 0.001 | 500-1000 | 0.001 | 0.000004 |
| | | | | | **AAIRf =** | **0.000023** |

Criteria for "acceptable" or "tolerable" risk may be developed for comparison to individual event risks or AAIR and for injury and fatalities. The choice of criteria is a matter for policy makers and whatever thresholds are chosen, risks to people should be considered alongside other economic, environmental and social criteria

A more detailed example of how the Calculator can be used to compare "before" and "after" development scenarios is provided below.

**Example A - Risks to People "before" and "after" development: Outputs from Calculation Record based on 5 return periods**

| | 5. Risks to People calculation | | | | Flood characteristics | | | |
|---|---|---|---|---|---|---|---|---|
| | Calculation No. | Development | Return Period | | Depth | Velocity | Debris | Flood hazard |
| a | 1 | Example A | 20 | Existing Situation | 0.20 | 0.1 | 0 | 0.12 |
| b | 1 | Example A | 20 | Post development | 0.22 | 0.11 | 0 | 0.13 |
| c | 1 | Example A | 20 | Mitigation | 0.20 | 0.1 | 0 | 0.12 |
| d | 2 | Example A | 50 | Existing Situation | 0.50 | 0.2 | 0 | 0.35 |
| e | 2 | Example A | 50 | Post development | 0.55 | 0.22 | 0 | 0.40 |
| f | 2 | Example A | 50 | Mitigation | 0.50 | 0.2 | 0 | 0.35 |
| g | 3 | Example A | 100 | Existing Situation | 0.70 | 0.5 | 0.5 | 1.20 |
| h | 3 | Example A | 100 | Post development | 0.77 | 0.55 | 0.5 | 1.31 |
| I | 3 | Example A | 100 | Mitigation | 0.70 | 0.5 | 0.5 | 1.20 |
| j | 4 | Example A | 500 | Existing Situation | 1.00 | 0.7 | 0.5 | 1.70 |
| k | 4 | Example A | 500 | Post development | 1.10 | 0.77 | 0.5 | 1.90 |
| l | 4 | Example A | 500 | Mitigation | 1.00 | 0.7 | 0.5 | 1.70 |
| m | 5 | Example A | 1000 | Existing Situation | 1.50 | 1 | 0.5 | 2.75 |
| n | 5 | Example A | 1000 | Post development | 1.65 | 1.1 | 0.5 | 3.14 |
| o | 5 | Example A | 1000 | Mitigation | 1.50 | 1 | 0.5 | 2.75 |

*Flood risk mitigation measures keep flood hazard to "greenfield" score.*

| | Area Vulnerability | | | |
|---|---|---|---|---|
| | Flood warning | Speed of onset | Nature of area | AV score |
| a | 2.15 | 2 | 2.00 | 6.15 |
| b | 2.15 | 2 | 2.00 | 6.15 |
| c | 2.15 | 2 | 1.56 | 5.71 |
| d | 2.15 | 2 | 2.00 | 6.15 |
| e | 2.15 | 2 | 2.00 | 6.15 |
| f | 2.15 | 2 | 1.56 | 5.71 |
| g | 2.15 | 2 | 2.00 | 6.15 |
| h | 2.15 | 2 | 2.00 | 6.15 |
| I | 2.15 | 2 | 1.56 | 5.71 |
| j | 2.15 | 2 | 2.00 | 6.15 |
| k | 2.15 | 2 | 2.00 | 6.15 |
| l | 2.15 | 2 | 1.56 | 5.71 |
| m | 2.15 | 2 | 2.00 | 6.15 |
| n | 2.15 | 2 | 2.00 | 6.15 |
| o | 2.15 | 2 | 1.56 | 5.71 |

| | People at risk | | |
|---|---|---|---|
| | Population (N) | People at risk (X) | People exposed |
| a | 3000 | 0.01 | 22 |
| b | 5325 | 0.01 | 44 |
| c | 5325 | 0.01 | 37 |
| d | 3000 | 0.02 | 65 |
| e | 5325 | 0.02 | 130 |
| f | 5325 | 0.02 | 106 |
| g | 3000 | 0.07 | 221 |
| h | 5325 | 0.08 | 429 |
| I | 5325 | 0.07 | 365 |
| j | 3000 | 0.10 | 314 |
| k | 5325 | 0.12 | 621 |
| l | 5325 | 0.10 | 517 |
| m | 3000 | 0.17 | 507 |
| n | 5325 | 0.19 | 1028 |
| o | 5325 | 0.16 | 837 |

*Numbers exposed to hazard increase with development.*

*Mitigation measures can reduce Area Vulnerability score.*

| | People Vulnerability | | | Injuries and deaths | | |
|---|---|---|---|---|---|---|
| | The very old | Infirm / disabled / sick | Vulnerable people | Injuries | Fatality Rate | Deaths |
| a | 10.00 | 9.00 | 0.19 | 8 | 0.00 | 0 |
| b | 14.37 | 13.80 | 0.28 | 25 | 0.00 | 0 |
| c | 10.00 | 9.44 | 0.19 | 14 | 0.00 | 0 |
| d | 10.00 | 9.00 | 0.19 | 25 | 0.01 | 0 |
| e | 14.37 | 13.80 | 0.28 | 73 | 0.01 | 1 |
| f | 10.00 | 9.44 | 0.19 | 41 | 0.01 | 0 |
| g | 10.00 | 9.00 | 0.19 | 84 | 0.02 | 2 |
| h | 14.37 | 13.80 | 0.28 | 241 | 0.03 | 6 |
| I | 10.00 | 9.44 | 0.19 | 142 | 0.02 | 3 |
| j | 10.00 | 9.00 | 0.19 | 119 | 0.03 | 4 |
| k | 14.37 | 13.80 | 0.28 | 350 | 0.04 | 13 |
| l | 10.00 | 9.44 | 0.19 | 201 | 0.03 | 7 |
| m | 10.00 | 9.00 | 0.19 | 193 | 0.06 | 11 |
| n | 14.37 | 13.80 | 0.28 | 579 | 0.06 | 36 |
| o | 10.00 | 9.44 | 0.19 | 325 | 0.06 | 18 |

*Deaths likely in extreme events only.*

| | Probabilities during event (NOT individual risk) | | | | | Societal risk |
|---|---|---|---|---|---|---|
| | Probability of injury | Probability of death | Probability of event | Individual Risk 1 in | Risk factor (>1 | Risk factor (>1 = |
| a | 0.00 | 0.00 | 20 | 2971521 | | |
| b | 0.00 | 0.00 | 20 | 1602574 | 1.85 | 3.29 |
| c | 0.00 | 0.00 | 20 | 3126753 | 0.95 | 1.69 |
| d | 0.01 | 0.00 | 50 | 873263 | | |
| e | 0.01 | 0.00 | 50 | 460122 | 1.90 | 3.37 |
| f | 0.01 | 0.00 | 50 | 918883 | 0.95 | 1.69 |
| g | 0.03 | 0.00 | 100 | 148576 | | |
| h | 0.05 | 0.00 | 100 | 84284 | 1.76 | 3.13 |
| I | 0.03 | 0.00 | 100 | 156338 | 0.95 | 1.69 |
| j | 0.04 | 0.00 | 500 | 370155 | | |
| k | 0.07 | 0.00 | 500 | 200507 | 1.85 | 3.28 |
| l | 0.04 | 0.00 | 500 | 389492 | 0.95 | 1.69 |
| m | 0.06 | 0.00 | 1000 | 282908 | | |
| n | 0.11 | 0.01 | 1000 | 146364 | 1.93 | 3.43 |
| o | 0.06 | 0.00 | 1000 | 297688 | 0.95 | 1.69 |

*Risks can be assessed according to individual or societal risk .criteria*

# 23.D3.1 NATIONAL FLOOD RISK ASSESSMENT (NAFRA)

**This guidance note:**

- Provides summary information regarding National Flood Risk Assessments (NaFRAs).
- Links the NaFRA process to the generic approach for assessing and managing flood risk for new development.

**This guidance note does NOT:**

- Provide guidance on how to undertake a national-scale assessment of flood risk for national development planning. This is provided in Guidance Note D1.1 National Development Planning.

## 23.1Contents



## 23.2Introduction

### 23.2.1 What is the purpose of National Flood Risk Assessments?

The objective of the NaFRA studies is to gain a better understanding of the existing risk arising from fluvial, tidal and coastal flooding[311] and the investment levels that might be necessary to deal with this at a national or regional scale.

In particular, the NaFRA studies help to decide policy and actions at a national scale, such as:

- Construction of flood defences where they are most needed to protect people and property,
- Maintaining and operating defences and defences systems to minimise flood hazard,
- Flood forecasting and warning to minimise consequences in the event of flooding,
- Restricting development in flood risk areas so as not to add to flood risk.

To make decisions on the above actions, the following questions have to be answered:

- What is the national risk from flooding?
- Which flood defence systems pose the greatest risk on a national scale?
- Where are the maintenance priorities?
- Where are the flood warning priorities?
- Where are the flood defence capital investment priorities?
- What impact might climate change have on the above?

[311] All subsequent references to flooding in this guidance note refer exclusively to fluvial, tidal and coastal flooding.

## 23.3Data and Information

### 23.3.1 What is required as input?

*Flood hazard*

- The hydraulic condition that might instigate the flooding, and its frequency of occurrence (river levels, coastal wave and water levels)
- The likelihood that flooding will occur, depending upon the degree of protection and adequacy of any defence.
- The characteristics of the area at risk and the manner in which this may become affected by an event (land use mapping, digital terrain maps, Flood Zones mapping)

*Existing defences*

- Location and type of defences
- Standard of protection, condition grades and residual risk behind defences
- Replacement and maintenance costs for individual defences / defence type.

*Assets valuation*

- Location of assets that lie within flood hazard areas: people, property, environment- including address point data
- The economic value attached to the loss or damage of those assets (e.g. average property values)
- The probability that those assets may be lost or damaged.

An initiative to consolidate all data on flood and coastal defences and risk areas in England and Wales has lead to the National Flood and Coastal Defence Database (NFCDD).[312]

### 23.3.2 What is provided as output?

The NaFRA 2004 results provide zones of flood risk based on the probability of the defence failing by either overtopping or breaching, as shown in Table 23.1. These are available in the public domain as 'significant', 'moderate' or 'low' when a specific location within a 100m grid square is pointed to on the EA's website flood map.[313] They are not available as a flood map in their own right. However, the full results are held by the EA.

**Table 23.1 NaFRA 2004 zones**

| NaFRA 2004 Zone | Inundation Criteria |
|---|---|
| Low | The chance of flooding in any year is 0.5% (1 in 200) or less |
| Moderate | The chance of flooding in any year is 1.3% (1 in 75) or less, but greater than 0.5% (1 in 200) |
| Significant | The chance of flooding in any year is greater than 1.3% (1 in 75) |

Table 23.2 provides a summary of the other outputs that can be obtained from the NaFRA analysis.

[312] More information can be found at the following website: http://www.defra.gov.uk/environ/fcd/hltarget/nfcdd.htm

[313] Flood maps and flood warnings areas are available at the following web site: http://www.environment-agency.gov.uk/subjects/flood/826674/829803/

**Table 23.2 NaFRA Outputs**

| Type of database | Content of databases |
|---|---|
| Probability | Probability of flooding to a number of different depths (relative to the average threshold level) |
| Economic | Expected Annual Damages (commercial) £/ha |
| | Expected Annual Damages (residential) £/ha |
| | Expected Annual Damages (agricultural) £/ha |
| | Contribution to overall EAD by defence |
| Socio Economic | Properties at risk (number per hectare) |
| | People at risk (number per hectare) |
| Probability of Defence Failure | Probability of structural defence failure (breaching) |
| | Annual probability of structural defence failure[314] |
| | Probability of non-structural defence failure (overtopping) |
| | Annual probability of non-structural defence failure |

### 23.3.3 How these outputs are subsequently used

The Environment Agency (EA) uses the NaFRA outputs to report nationally on flood risk, in order to achieve Defra's High Level Target 5A[315]. The NaFRA outputs are also used to assist with the scoping of CFMPs and SMPs.

Defra uses the results from the latest NaFRA to make decisions on policy and actions at the national scale (as described above).

### 23.3.4 How can the outputs be used for development planning?

Currently NaFRA outputs should only feed into national or regional planning, as illustrated on the Activity Chart.[316] The current levels of uncertainty in the results (see later) prevent them from being reliable at smaller scales. This may change in the future.

However, local planning authorities, developers and consultants can use the results that have been incorporated into the EA's Flood Maps (see Table 23.1) to assist with the screening of risks[317] as part of local or site-specific assessments.

## 23.4 Roles and Responsibilities

- The Environment Agency (EA) carries out NaFRA studies (with the assistance of consultants).

- Defra uses the results from the latest NaFRA to make decisions on policy and actions at the national scale (as described above).

[314] This combines the probability of structural defence failure with the load's expected number of occurrences per year.
[315] http://www.defra.gov.uk/environ/fcd/hltarget/default.htm
[316] See Activity Chart Development Planning
[317] See Activity Chart Process 2a – Tiered Risk Assessment

## 23.5Processes and Procedure

### 23.5.1 How are these results determined?

A NaFRA analysis examines the following issues:

- Evaluation of the potential national economic impact of flooding;
- Identification and estimation of the degree of risk reduction based on current national investment in flood defence activities;
- Examination of alternative investment scenarios;
- Identification of methods for prioritising a national investment strategy;
- Identification of methods for measurement and monitoring of the effectiveness of investment in achieving policy aims;
- Identification of areas of uncertainty in the analysis and recommendations for further work to reduce or quantify the uncertainties.

The procedure that is followed to undertake a NaFRA analysis is as follows:

**Step 1 –** Identify scope of flooding system (fluvial or coastal)

**Step 2 –** Establish impact zones (Impact zones divide the natural floodplain into defined grids. The size of an individual grid square varies with the detail of the analysis, becoming progressively smaller as the detail of the analysis increases. The flood probability and flood risks (economic, social impact, etc.) are calculated for each impact zone.)

**Step 3 –** Gather input data (Data needs can be increased depending on the detail of the analysis required, but will include for example floodplain digital terrain mapping, defence data, address point data, etc.)

**Step 4 –** Predict incident loading conditions i.e. Sources

**Step 5 –** Establish defence fragility i.e. Pathways (i) (At the national scale, standard fragility curves are used based on expert judgement and assumptions are made regarding defence condition where data is missing.)

**Step 6 –** Identify flood events and their probability of occurrence

**Step 7 –** Establish resultant inundation i.e. Pathways (ii)

**Step 8 –** Establish resultant flood risk i.e. Receptors (Using the estimate of flood depth and where available velocity, an estimate of the resulting damage is established for each Impact Zone. This, for example, can be based on the depth versus damage relationships provided in the Multi-Coloured Manual[318])

**Step 9 –** Summarise and display/transfer results

This is based on the stages of risk assessment illustrated in Figure 23.1.[319]

[318] Flood Hazard Research Centre, 2004
[319] Also expressed in Activity Chart Process 2b – Stages of Risk Assessment

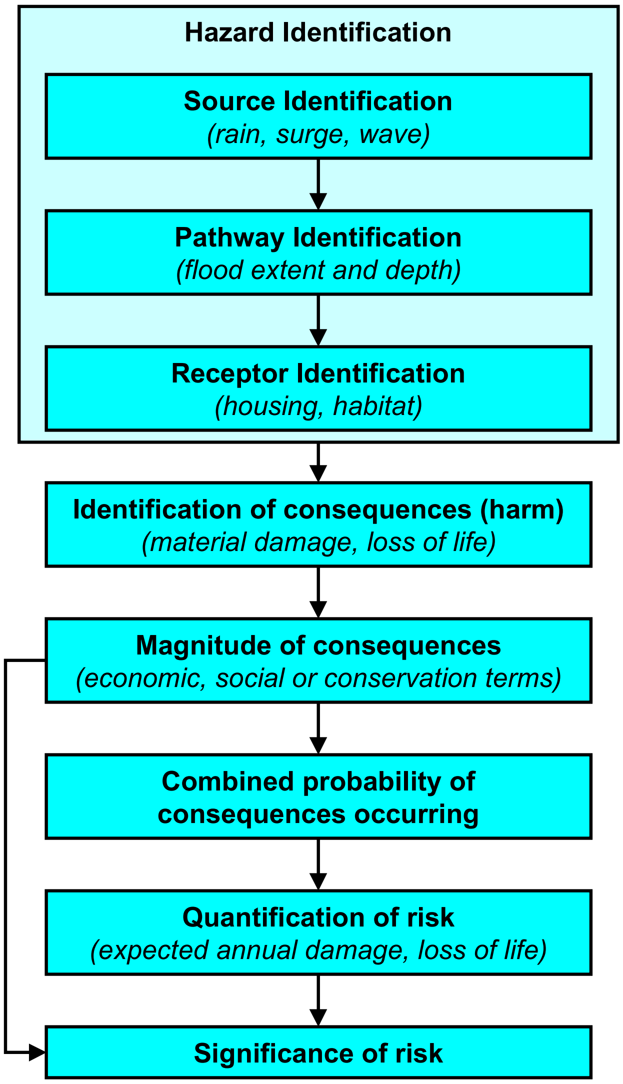



**Figure 23.1 Stage of Risk Assessment**

## 23.6Tools and Technologies

The best information and methodologies available at the time are used to undertake a NaFRA study.

In 1999-2000 initial research on the National Appraisal of Assets at Risk of Flooding and Coastal Erosion was undertaken. In 2000-2001 this analysis was reworked and extended to consider climate change and was the first time a national quantitative estimate of our exposure to flood and erosion risks had been undertaken. While these studies used the best information and methodologies available at the time, they significantly simplified many processes, including the influence of defences on reducing flood risk.

Therefore, in 2002, a methodology that better represented flood risk including the influence of defences and their likelihood of failure was used to complete NaFRA 2002. This methodology is known as the Risk Assessment for Strategic Planning (RASP) High Level Methodology (HLM).[320]

[320] Sayers P.B., Hall, J.W., Dawson, R.J. Rosu, C., Chatterton, J. and Deakin, R. Risk assessment for flood and coastal defence systems for strategic planning (RASP)- a high level methodology, in Proceeding of the 37th DEFRA Flood and Coastal Management Conference, Keele, UK, September 16-17, 2002,m p.p.4.4.1-4.4.12.

With the advent of the NFCDD data, some modifications were made to the RASP HLM resulting in RASP HLM+, which was used to carry out NaFRA 2004.[321]

Details of RASP and its application for different levels of assessment are provided in a separate document.[322]

#### 23.6.1 What confidence can be given to the NaFRA outputs?

Due to the current incompleteness of the NFCDD there are areas of the country where the details of the defences had to be assumed. Reliable data on actual damages during flooding is also yet to be established.

Therefore, although absolute values of probability, economic damages, etc. are provided, due to the high level of uncertainty, relative values are more important and results should be used in this manner.

The RASP HLM+ applied for NaFRA is by no means a perfect reflection of reality. However, it provides useful tool to undertake an analysis of flood risk at a national scale and can be considered sufficiently robust to provide insights into trends and spatial patterns.

It is the role of the smaller scale assessments of flood risk (CFMPs, SMPs, SFRAs and FRAs) to investigate flood risk in more detail, should the scale of the risk warrant a lower level of uncertainty for decision-making.

### 23.7Audit and Control

#### 23.7.1 How are the results from RASP checked?

The results from the RASP HLM+ analysis are checked by EA local officers against local knowledge and records from flood events.

#### 23.7.2 Will there be updates to NaFRA2004?

The NaFRA assessment is undertaken on a yearly basis. The NFCCD is being continuously populated. For NaFRA2005, the latest version available at the time will be used, which will be more complete than the database used for NaFRA2004. In addition to this, the methods used by RASP are being continuously developed.

[321] Hall, J.W, Dawson, R.J., Sayers, P.B., Rosu, C., Chatterton, J.B. and Deakin, R.A., Methodology for national-scale flood risk assessment. Water and Maritime Engineering. Vol.156, No3 (September 2003) pp.235-247.
[322] See D2.1 ADD1 Risk Assessment for Strategic Planning (RASP) – A Summary

# 24.D3.2 CATCHMENT FLOOD MANAGEMENT PLANS (CFMPS)

**This guidance note:**

- Provides summary information regarding Catchment Flood Management Plans (CFMPs).
- Links the CFMP process to the generic approach for assessing and managing flood risk for new development.

**This guidance note does NOT:**

- Supersede the information contained in the following references:

1. Environment Agency, Defra and The Welsh Assembly (2004) *Catchment Flood Management Plans, Volume I – Policy Guidance*, Environment Agency, Bristol.
2. Environment Agency, Defra and The Welsh Assembly (2004) *Catchment Flood Management Plans: Guidelines Volume II – Processes and Procedures* (Fourth Draft - April 2004), Environment Agency, Bristol.

These documents should be referenced for further information.

## 24.1Contents



## 24.2Introduction

### 24.2.1 What is the purpose of a Catchment Flood Management Plan?

Catchment Flood Management Plans (CFMPs) are high-level strategic planning studies through which the Environment Agency (EA) aims to work in partnership with other key decision-makers within a river catchment to explore and define long-term sustainable policies for flood risk management.

The CFMP programme is meant to support one of the EA's main goals, which is to reduce flood risk from rivers and the sea to people, property and the natural environment by supporting and implementing government policies. CFMP roll-out has only recently started. Details of coverage are provided in Volume 1 of the guidance referenced above.

A CFMP aims to understand the causes of flooding at a catchment scale and to co-ordinate action to reduce both the probability and impact of flooding (flood risk).

There are four stages that the EA uses to deliver fluvial flood risk management:

- **NaFRA** (National Flood Risk Assessment) covers the whole of England and Wales.[323]
- **CFMPs** provide full geographic coverage of England and Wales, through approximately 80 plans.
- **Strategy Plans** (identifying preferred management measures to deliver CFMP policies) are only required for specific areas identified in CFMPs

[323] Described in the separate Guidance Note D3.1 National Flood Risk Assessments

- **Projects** (delivering the preferred flood risk management measures for a specific location within the catchment) are only required to implement specific flood risk management measures identified by the Strategy Plans.

Each stage requires an understanding of the flood risk processes at work, environmental considerations, planning issues and current and future land uses, etc. but at a level of detail appropriate to the stage.[324]

## 24.3Data and Information

### 24.3.1 What is needed as input?

The initial data collection and review during the inception stage of a CFMP focuses on known flood risk issues, in order to develop an understanding on the current flood risk and how it is managed. This data is available from the steering group members (see section Roles and Responsibilities later in this guidance note) or holders identified by the steering group.

During the inception stage a report will be produced to detail further data gathering needed to development a better catchment understanding.

Key information includes the following:

- flood mapping data, which is used as the core data set to identify flood risk
- location and standard/level of defences
- socio-economic data[325]

For more information about data sources, key knowledge holders and significant national datasets, refer to the CFMP Guidelines Volume II or the Modelling and Decision Support Framework (MDSF) Procedures[326] for the core data supplied by the EA.

### 24.3.2 What is provided as output?

The outputs from a CFMP provide the following for a river catchment:

- A definition in general terms of the current flood risks
- Identification of scenarios likely to affect flood risk over the next 50 to 100 years (including relative sea-level rise, climate change, land use changes, etc.)
- Identification of preferred ‘catchment policies’ for managing the flood risks
- Identification of consequences of implementing preferred policies
- Guidance for future land use and development planning in the catchment
- Recommendations for protecting and enhancing the human and natural environment
- Recommendations for establishing procedures for monitoring effectiveness of policies
- Identification of the requirements and scope of work for Strategy Plans
- Identification of priority actions

Flood risk is expressed in terms of:

- Expected annual economic damage
- Population affected and the social vulnerability of populations affected by the flooding
- Broad environmental impacts

[324] These stages are illustrated in Activity Chart Flood Management Planning
[325] provided with the MDSF, see Tools and Technologies later in this guidance note
[326] See Appendix A of Defra/Environment Agency (2004) *MDSF Procedures Version 3.0*, July 2004.

The results include estimated values of economic damages and social impacts. The uncertainty of this analysis is high, but relative values can be used to assess the relative impacts of different flood management policies.[327]

#### 24.3.3 How are these outputs subsequently used?

CFMPs identify policies (no intervention, increase, reduce, maintain or sustain flood risk) and must comply with Defra policies. Consultation is essential to determine acceptability of proposed policies.

Examples of types of policies that might come out of a CFMP include:

- Reduce flood risk management actions for a particular subcatchment (i.e. allow flood risk to increase).
- Maintain flood risk management measures for a particular town (i.e. accept that flood risk may increase over time).
- Take actions to sustain the current level of flood risk for a particular area into the future, thus responding to potential increases in risk from climate change, etc.
- Take action to reduce the flood risk for a particular town, taking account of the potential increases in risk from climate change, etc.
- Take action to increase flood risk for a particular floodplain area.

These might be implemented by undertaking measures such as the following:

- Provision of flood storage in upper parts of the catchment
- Local solutions for major flood risk areas
- Floodplain zoning
- Enhanced flood warning in lower parts of the catchment
- No increase in runoff from developments should be permitted in identified areas
- Combinations of the above

#### 24.3.4 How can the outputs be used for development planning?

CFMPs primarily feed into regional or local planning, as illustrated on the Activity Chart.[328] They provide information on future flood risk and future flood management policies, which are among the key items of flood risk information required for Regional Spatial Strategies (RSSs) and Local Development Frameworks (LDFs). However, the boundaries for RSSs and LDFs do not match those for CFMPs. Several CFMPs may contribute information to a RSS or LDF.

In order to assess the impact of development on flood risk at the catchment scale, the following main tasks need to be carried out:

- Identify future developments across the catchment
- Model using CFMP approach
- Identify changes in river flows and flood risk areas
- Identify new developments in flood risk areas
- Identify impacts on economic damages and people at risk

These tasks are normally carried out within a CFMP using available information on future development from planning authorities. The time horizon of development planning is 15 to 20 years, whereas a CFMP is 50 to 100 years. The CFMP Guidance documents contain a simple method for estimating future development for the longer time horizon.

[327] CFMP Guidelines Volume II Section 7 and Appendix D give further details regarding calculating flood risk and the MDSF Procedures (see earlier for reference) describe how uncertainty issues are taken into consideration.
[328] See Activity Chart Development Planning

Groundwater flooding and urban drainage flooding should be acknowledged at the catchment scale. However these are mostly local issues and should be analysed as such.

*Regional planning*
The information on future flood risk, flood management policies and the impacts of development on flood risk (based on development plans available at the time of preparing the CFMP) produced by CFMPs can be fed into the regional assessments of flood risk for RSSs. In general, the impacts of development are small at the catchment scale and a 'broad-brush' approach to assessing the impacts at this scale can be adopted. Assumptions regarding urban runoff (e.g. the response of SUDS) are not significant for making region-wide policies.

*Local planning*
The same information can be fed into local assessments of flood risk for LDFs (i.e. Strategic Flood Risk Assessments). However, impacts of development can be larger in local areas and, therefore, CFMP results should only be considered as indicative. CFMPs can be useful for assessing the impacts of very large developments[329], whilst smaller developments need more detail. However, the data collected for the CFMP analysis can often be valuable for SFRAs. Therefore, data and information might include:

- Present and future flows
- Information on future flood management
- Databases on existing properties, economic damages and social impacts can also be used (but the level of detail may require improving)

The MDSF can be used to support both SFRAs and CFMPs, although the level of detail required for a SFRA is likely to be greater than for a CFMP.

## 24.4Roles and Responsibilities

### 24.4.1 Who undertakes CFMPs?

- The EA promotes CFMPs with support from Defra and the Welsh Assembly.

- The EA is responsible for developing the CFMPs, working in partnership with other flood defence/land drainage operating authorities, English Nature, Regional Planning Boards and the Welsh Assembly, and in consultation with key stakeholders and the general public.

- The detailed analysis carried out as part of the CFMPs is carried out by specialist consultants, working on behalf of the EA.

- To guide the technical delivery of a CFMP a Steering Group is constituted. A typical Steering Group would be formed by:

  - EA project manager
  - EA area flood defence manager
  - EA development control officer
  - EA Environmental Impact Assessment (EIA) officer
  - Defra or Welsh Assembly representative
  - Appropriate Local Authority representation
  - Internal Drainage Board representative (if appropriate)
  - Representative from other operators/service providers (such as sewerage undertakers, British Waterways, etc.)
  - Representative from English Nature / Country Side Council for Wales
  - Representative from the delivery team (such as the Consultant project manager).

[329] See Guidance Note D1.2 Regional Spatial Strategies regarding sub-regional spatial planning

### 24.4.2 Who provides input data and information for undertaking CFMPs?

As mentioned previously, during the inception stage data and information are provided by the Steering Group or those known to the Steering Group. During the data collation stage, the main data sources are identified as well as the key knowledge holders within each of the main data source organisation.

The four main sources are:

- National EA core data sets. These are available for CFMPs via EA Regional Offices.
- Regional and Area offices for other EA regional and local data
- The Steering Group and key knowledge holders
- Consultees; and
- Site visits

### 24.4.3 Who uses the results?

- The EA uses the results to plan more detailed studies that will then guide investment in flood risk management activities and support other activities within the catchment (e.g. River Basin management planning under the Water Framework Directive).

- Defra and the Welsh Assembly use the results for planning future funding and policy development across all functions.

- Regional Assemblies, the Welsh Assembly and Local Authorities use the results to inform spatial planning activities, Sustainability Appraisals/Strategic Environmental Assessments and emergency planning.

- Internal Drainage Boards, Local Authorities and Water Companies use the results to inform the planning of their activities as Operating Authorities in the wider context of the catchment.

## 24.5Processes and Procedures

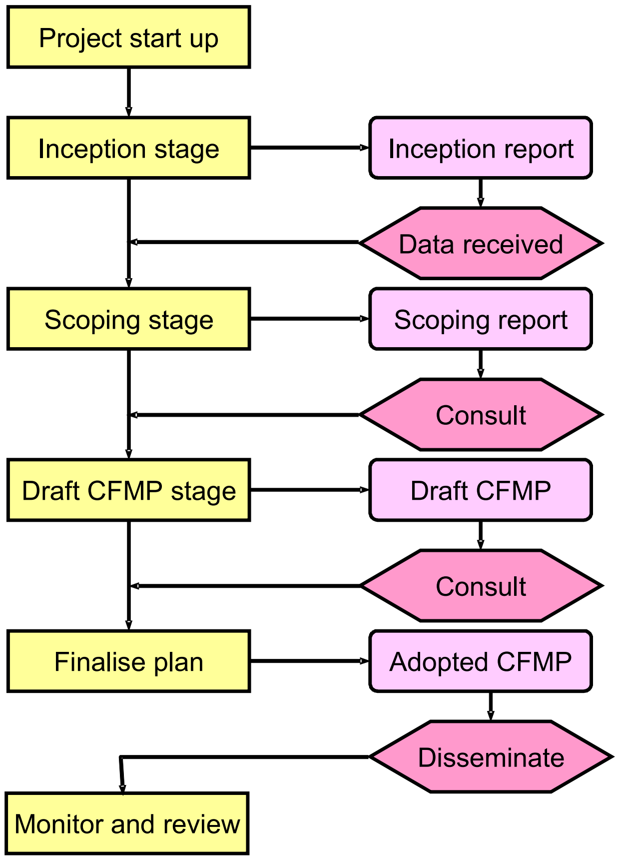
### 24.5.1 How are CFMPs carried out?

The EA in collaboration with Defra and the Welsh Assembly have produced guidelines to inform practitioners on the concept and scope of CFMPs and to provide guidance on their production and development.

The Guidelines are published in two volumes:

- Volume I provides policy guidance on what is required to produce a CFMP.
- Volume II set out procedures for each step of the process and contains practical guidance on appropriate methodologies for the various aspects of CFMP development.

The stages of a CFMP are shown in Figure 24.1. The CFMP methodology follows the main processes described by the generic approach, as summarised in Table 24.1, found at the end of this guidance note.




| | |
|---|---|
| **1. Project start up** | 0.5 months |
| **2. Inception stage**<br>Establish steering group, data collection, understand catchment inception report | 1.5 months |
| **3. Scoping stage**<br>Review existing plan, understand current flood risk, scope future scenarios,producing scoping report | 4 months |
| **Consultation** | 3 months |
| **4. Draft CFMP stage**<br>Review response, finalise scenarios, appraise policies, produce draft CFMP | 4 months |
| **Consultation** | 3 months |
| **5. Finalise plan**<br>Produce final CFMP | 2 months |
| **Monitor and review** | |

**Figure 24.1 Outline Approach to Catchment Flood Management Planning**

## 24.6Tools and Technology

A flood Modelling and Decision Support Framework (MDSF) has been developed, which is used to support the production of all CFMPs. The MDSF is a software tool based on Geographical Information System (GIS) technology that assists the analysis of data at the various stages of production of a CFMP. The MDSF does not include hydrological or hydraulic modelling. It takes results from external models and uses them to calculate present and future flood risk in terms of economic damages and social impacts, including the number of people at risk.[330]

In the future, the Risk Assessment for Strategic Planning Intermediate Level Methodology (RASP ILM) will contribute to Stage 3 Scoping (present day risk) and Stage 4 Draft CFMP (future risk and options appraisal)[331] for assessing flood risk in defended areas.

Also in the future it is intended that the National Flood and Coastal Defence Database (NFCDD)[332] will provide the required flood defence information. When the use of RASP ILM is implemented, this will require more detailed defence information than currently used, but this has already been taken account of in the development of the NFCDD.

[330] More detailed information on the application of MDSF to CFMPs can be found at www.mdsf.co.uk.
[331] For further information refer to D2.1 ADD1 Risk Assessment for Strategic Planning (RASP) – A Summary
[332] More information can be found at the following web sites:
http://www.defra.gov.uk/environ/fcd/hltarget/nfcdd.htm
http://www.environment-agency.gov.uk/subjects/flood/351291/211196/

## 24.7 Audit and Control

The Steering Group agrees on the actions that will ensure that the Action and Monitoring Plan is developed and implemented.  The objectives of the monitoring programme are three-fold:

- to review and report on the performance of CFMP flood risk management policies
- to enable adaptation of flood risk management policies/activities as and when new information becomes available or when there are significant changes in flood risk in the catchments. When this is the case a formal review of the CFMP should take place.
- to develop/improve the generic CFMP process further

A CFMP is a ‘living’ document that should be used and maintained by the EA between official revisions.  A CFMP will generally have a life-span of about 6 years.

**Table 24.1 The CFMP Methodology compared to the Generic Approach**

| GENERIC APPROACH | CFMP METHODOLOGY | | | | | |
|---|---|---|---|---|---|---|
| | Project Start-upStage 1 | Inception StageStage 2 | Scoping StageStage 3 | Draft CFMP StageStage 4 | Finalise PlanStage 5 | Monitor and review |
| **Process 1 – Problem Formulation** | | | | | | |
| 1.1 Define intention | ● | | ● | | | |
| 1.2 Justify intention | | | ● | | | |
| 1.3 Set boundaries | ● | | ● | | | |
| 1.4 Identify controlling factors | | | ● | | | |
| 1.5 Develop conceptual model | | ● | ● | | | |
| **Process 2a – Tiered Risk Assessment** | | | | | | |
| 2a.1 Carry out high level assessment | | ● | | | | |
| 2a.2 Prioritise risks | | ● | | | | |
| 2a.3 Carry out intermediate level assessment | | | ● | | | |
| 2a.4 Carry out detailed level assessment | | | | ● | | |
| **Process 2b – Stages of Risk Assessment** | | | | | | |
| 2b.1 Identify hazards | | ● | ● | | | |
| 2b.2 Identify consequences | | ● | ● | | | |
| 2b.3 Determine magnitude of consequences | | | ● | ● | | |
| 2b.4 Determine probability of consequences | | | ● | ● | | |
| 2b.5 Determine significance of risk | | | | ● | | |
| **Process 3 – Options Appraisal** | | | | | | |
| 3.1 Identify options | | | | ● | | |
| 3.2 Evaluate options | | | | ● | | |
| 3.3 Apply risk assessment to options | | | | ● | | |
| 3.4 Review options | | | | ● | | |
| 3.5 Re-evaluate options (if required) | | | | ● | ● | |
| 3.5 Select preferred option | | | | | ● | |
| **Process 4 – Monitoring and Review** | | | | | | |
| 4.1 Decide what to monitor | | | | | ● | |
| 4.2 Design monitoring programme | | | | | ● | |
| 4.3 Carry out monitoring | | | | | | ● |
| 4.4 Review monitoring results | | | | | | ● |
| 4.5 Report any lessons learnt | | | | | | ● |
| 4.6 Review monitoring programme | | | | | | ● |

## 25.D3.3 SHORELINE MANAGEMENT PLAN (SMPS)

**This guidance note:**

- Provides summary information regarding Shoreline Management Plans (SMPs).
- Links the SMP process to the generic approach for assessing and managing flood risk for new development.

**This guidance note does NOT:**

- Supersede the information contained in the following references:

1. Defra (2001) *Shoreline Management Plans: A guide for coastal defence authorities*, Defra PB5519.[333]
2. Defra (2003) *Procedural Guidance on the Production of Shoreline Management Plans, Interim Guidance*, Defra.[334]
3. Department of the Environment and the Welsh Office (1992) *Planning Policy Guidance 20: Coastal Planning*, HMSO, London.[335] Usually referred to as PPG20.
4. Department of the Environment and the Welsh Office (1990) *Planning Policy Guidance 14: Development on Unstable Land*, HMSO, London.[336] Usually referred to as PPG14.

These documents should be referenced for further information.

Final procedural guidance is due to be issued by Defra in the near future, following review of 3 pilot SMPs: Kelling to Lowestoft Ness, South Foreland to Beachy Head and Beachy Head to Selsey Bill. This may result in changes regarding each of the topics discussed in this guidance note, in particular the processes and procedures. Therefore, at the present time this guidance note should be considered as interim guidance only.

### 25.1Contents



333 http://www.defra.gov.uk/environ/fcd/pubs/smp/revisedsmpguidancefinal.pdf
334 http://www.defra.gov.uk/corporate/consult/smpguidance/index.htm
335 http://www.odpm.gov.uk/stellent/groups/odpm_planning/documents/page/odpm_plan_606907.pdf
336 http://www.odpm.gov.uk/stellent/groups/odpm_planning/documents/page/odpm_plan_606899.pdf

## 25.2 Introduction

### 25.2.1 What are Shoreline Management Plans?

SMPs are strategic documents that provide "a large-scale assessment of the risks associated with coastal processes and presents a policy framework to reduce these risks to people and the developed, historic and natural environment in a sustainable manner".[1] The entire coastline of England and Wales is covered by first generation SMPs and these are currently being revised.

A SMP aims to identify policies to reduce risk. SMPs provide the basis for sustainable shoreline management policies over 50 years within a sediment cell or sub-cell(s) and set the framework for future management of risk along the coastline from flooding and coastal erosion, including cliff instability.

Although not directly implemented in order to undertake development planning, SMPs help inform the planning process, strengthening the move to prevent development in flood risk areas or areas at risk from coastal erosion (see PPG20).

The EA use SMPs as an integral part of its delivery mechanism for coastal flood risk management.[337] There are four stages in all:

- **NaFRAs** (National scale Flood Risk Assessments) cover the whole of England and Wales.[338]

- **SMPs** provide full geographic coverage of the coastline of England and Wales, based on 11 coastal cells (containing between them 49 sub-cells).

- **Strategy Plans** (identifying preferred management measures based on economic, social and environmental factors to deliver SMP policies) are only required for specific areas identified in SMPs.

- **Projects** (delivering the preferred flood risk management measures for a specific location within the coastal cell or sub-cell) are only required to implement specific flood risk management measures identified by the Strategy Plans.

Each stage requires an understanding of coastal processes, coastal defence needs, environmental considerations, planning issues and current and future land use, but at a level of detail appropriate to the stage.[339] The assessment of risks is an integral part of the appraisal process at each stage to ensure that decisions taken at that time are robust, and based on an awareness of the consequences and appropriate mitigation measures.

### 25.2.2 What is the difference between coast protection and sea defence?

Sea defences protect low-lying land from flooding, whilst coast protection protects land from erosion, which tends to be relatively higher land. However, both flooding and coastal erosion can occur individually or in combination along stretches of coastline.

The shoreline of England is about 3,000 km long. It has approximately 1,900 km of man-made defences, 900 km of which primarily provide coastal protection and 1,000 km with the primary purpose of acting as sea defences. The remaining 1,100 km of shoreline is of natural frontage such as cliffs. At least a third of England's coastline is designated for its scenic or natural beauty and 24% of the coastal fringe is ecologically important salt marsh. Current estimates show that more than 1 million properties are at risk from sea and tidal flooding, which is over 10 times more than from coastal erosion.[340]

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[337] The EA has no responsibilities for coastal erosion, see Roles and Responsibilities later in this guidance note.
[338] Described in the separate Guidance Note D3.1 National Flood Risk Assessments
[339] These stages are illustrated in Activity Chart Flood Management Planning

## 25.3Data and Information

### 25.3.1 What is needed as input?

All the data available to address the five key issues in the appraisal of shoreline management policies must be collated. These key issues are:

- Coastal processes, including:
  - The historic and future evolution of the coastline,
  - Existing coastal data and studies (see Other Plans below);
- **The coastal defences, including:**
  - The purpose and ownership/responsibility of defences,
  - The condition, performance and residual life of existing defences, and
  - Other factors such as the availability of beach recharge material to meet present and future needs;
- Current and future land use, including:
  - Current and future development proposals (see Other Plans below),
  - Agricultural and forestry issues,
  - Ports and harbour operations,
  - Aggregate and other dredging operations,
  - Recreation and tourism;
- Historic and archaeological features recorded in Sites and Monuments Records[341] and areas of high archaeological potential, including
  - Maritime archaeological features,
  - Scheduled monuments,
  - Listed buildings,
  - Registered battlefields;
- The natural environment, including:
  - Implications of The Conservation (Natural Habitats, etc.) Regulations 1994[342]
  - Biodiversity targets on shoreline management,
  - Landscape interests.

*Other Plans*

There are other plans that are undertaken independently of SMPs, but should be taken into consideration by the SMP or be influenced by the latest SMP. These should also be taken into consideration in development planning. These include the following:

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[340] All figures quoted from Defra (2004) *Making Space for Water - Developing a new Government strategy for flood and coastal erosion risk management in England*, Defra.

[341] A public environmental record, which is used for the purposes of land use planning, conservation, research, education and general interest, held by County Councils.

[342] http://www.opsi.gov.uk/si/si1994/Uksi_19942716_en_1.htm

- **Strategy Plans** developed since the last SMP can provide valuable information, but there are issues regarding strategies running concurrently or where they have not been approved.[343]

- **Estuary Management Plans (EMPs)** arose from an initiative by English Nature and are intended to bring together all stakeholders with an interest in an estuary to reach a consensus on the sustainable use of the estuary. These cover all of the major estuaries in England.

- **Harbour Management Plans** have a similar purpose with the intention of reaching a consensus on the appropriate management of the harbour to promote sustainable use for conservation, recreation and economic activity.

- **Coastal Habitat Management Plans (CHaMPs)** are intended to assist in the development of sustainable coastal defence strategies in those areas where coastal defence measures have implications for internationally important wildlife sites.[344]

- **Heritage Coast Management Plans** are prepared by Local Authorities together with The Countryside Agency and the involvement of other relevant stakeholders. Their aim is to guide management to achieve the heritage coast objectives of conservation, recreation, rural economic development and environmental health.

- **Integrated Coastal Zone Management Plans** are prepared by a variety of organisations. They are aimed at encouraging the sustainable management of all aspects of the human use of the coast.

### 25.3.2 What is provided as output?

A SMP results in a shoreline management policy, which is a combination of operations and management activities necessary for the following 50 years to reduce risks to people and the developed, historic and natural environment in a sustainable manner.

This is based on predictions of the likely future evolution of the coast and knowledge of coastal processes within the coastal cell. A range of strategic coastal defence options is assessed and preferred approaches for sections of coast (management units) are identified.

The generic options for such sections of coast are the following:

- Do nothing;
- Hold the existing defence line by maintaining or changing the standard of protection;
- Advance the existing defence line; and
- Retreat the existing defence line (managed retreat or realignment).

The latest pilot studies have indicated that the baseline response assessments of 'do nothing' and 'hold the existing defence line' should not be just coarse assessments. These should be undertaken as full scenario assessments, as they are very useful at demonstrating the long-term impact of policy decisions.[345]

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[343] Jay, H, Hosking, A, Atkinson, A and Burgess, K (2004) *The Reality of Shoreline Management Plans*, Proceedings of the 39th Defra Flood and Coastal Management Conference 2004.

[344] See Guidance Note S2.5 Linkage to Statutory Requirements

[345] Jay, H, Hosking, A, Atkinson, A and Burgess, K (2004) *The Reality of Shoreline Management Plans*, Proceedings of the 39th Defra Flood and Coastal Management Conference 2004.

### 25.3.3 How can the outputs be used for development planning?

SMPs should inform and be informed by the development planning process. SMPs should primarily feed into regional or local planning, as illustrated on the Activity Chart.[346] However, the subsequent policies should also be taken into consideration in determining planning applications.

Where the preferred option is either non-intervention or retreat, development planning policies should strongly discourage further development in low-lying areas behind present shorelines. Additional development in such areas could unnecessarily commit flood defence authorities to expensive and unsustainable policies, which may in turn adversely affect biodiversity or other areas of the coast.[347]

Specific data outputs of use in other assessments of flood risk include:

- Present and future flood extents and levels,
- Databases on existing properties, economic damages and social impacts can also be used (but the level of detail may require improving).

## 25.4Roles and Responsibilities

### 25.4.1 General responsibilities for flooding and erosion of the coast

- **The Environment Agency** has no responsibilities for coastal erosion, but has permissive powers to undertake flood management works on the coast.

- **Maritime Local Authorities** have permissive powers to protect against coastal erosion and the resultant inundation from the sea and to address coastal and tidal flooding issues.

- **Defra** provides funding for both the EA and Local Authorities in the form of grant aid. This can contribute to the preparation of SMPs, as well as any subsequent schemes under Defra's prioritisation system.

- **Private Landowners** own a significant proportion of the coast in England and Wales. These include the National Trust, industries and private individuals. These landowners generally fund and maintain their own coastal erosion and flood risk management measures, but require consent from the relevant Flood Defence Authorities and comply with planning regulations.
- **Coastal Groups**[348] are voluntary groups that include the following members (as appropriate):
  - Maritime Local Authorities
  - The Environment Agency (including those responsible for strategic planning, flood defence, development control, Environmental Impact Assessments)
  - Defra or Welsh Assembly
  - Internal Drainage Boards
  - English Nature or Country Side Council for Wales
  - English Heritage
  - National Trust
  - National Park Authorities
  - Port Authorities
  - Highways Agency
  - Railtrack

  The purpose of these groups is to influence and support member of the group to manage the coast for the benefit of the whole coastal cell. This is achieved by developing compatible management

[346] See Activity Chart Development Planning
[347] DTLR (2001) *Planning Policy Guidance Note 25: Development and Flood Risk*, HMSO, London.
[348] There are 18 groups covering 98% of the coastline of England and Wales. Large Coastal Groups often have sub-cell groups. http://www.defra.gov.uk/environ/fcd/policy/coastalgroups.htm

policies within the coastal cell or sub-cells, working with other Coastal Groups, providing data and access to national, regional and local information, and assisting Defra in the development of national coastal defence policies.

#### 25.4.2 Who undertakes SMPs?

- Coastal Groups usually guide the delivery of a SMP.

- One coastal defence operating authority is nominated as lead authority to assume overall responsibilities for the SMP, working in partnership with other flood defence/land drainage operating authorities, English Nature, Regional Planning Boards and the Welsh Assembly, and in consultation with key stakeholders and the general public.

- Specialist consultants, working on behalf of the lead authority usually carry out the detailed analysis required for the SMPs.

Reference should be made to a separate Guidance Note S2.4 Stakeholder Engagement for guidance on the effective involvement of stakeholders.

#### 25.4.3 Who provides input data and information for undertaking SMPs?

Data and information is provided by the Coastal Group or those known to the Coastal Group. During the data collation stage, the main data sources are identified as well as the key knowledge holders within each of the main data source organisations.

#### 25.4.4 Who uses the results?

- The EA uses the results to guide investment in flood risk management activities (e.g. strategic planning, asset management and flood event management) and support other planning activities (e.g. River Basin management planning under the Water Framework Directive).

- The Maritime Local Authorities also use the results to develop or update strategic plans covering those management units within their area of responsibility where significant works or management activities are required.

- Defra and the Welsh Assembly use the results for planning future funding and policy development across all functions.

- Regional Assemblies, the Welsh Assembly and Local Planning Authorities use the results to inform spatial planning activities and sustainability appraisals/strategic environmental assessments.

- Internal Drainage Boards and Water Companies use the results to inform the planning of their activities within the coastal cell.

### 25.5Processes and Procedures

#### 25.5.1 How are SMPs carried out?

The production of a SMP can be split into four stages as summarised below.[349]

*Stage 1 – Data collection, analysis and policy revision*

- Notify and consult with interested parties
- Collate and analyse new data
- Review boundaries
- Define management unit issues
- Review policies

[349] Defra (2001) *Shoreline Management Plans: A guide for coastal defence authorities*, Defra PB5519.

- Assess compatibility of policies
- Identify provisional policies
- Identify longer-term implications
- Prepare Policy Appraisal Report

*Stage 2 – Public examination*

- Circulate Policy Appraisal document and management unit summaries
- Undertake public meetings
- Undertake seminars and workshops
- Advertise in local press
- Place copies of Plan for inspection
- Consult with Local Planning Authorities

*Stage 3 – Plan preparation*

- Collate consultees' responses
- Identify and confirm preferred option
- Resolve conflicts
- Assess uncertainties and risks
- Identify need for further studies
- Assess implications for European site and biodiversity
- Assess implications for land use/spatial planning
- Produce SMP
- Produce action plan
- Adoption

*Stage 4 – Plan dissemination*

- Plan format and availability
- Set up databases/GIS
- Undertake public meetings
- Undertake seminars and workshops
- Liaise with Local Planning Authorities

These stages follow the main processes described by the generic approach, as summarised in Table 25.1.

Following production of the SMP and the associated Action Plan, individual operating authorities develop or update strategic plans covering those management units within their area of responsibility where significant works or management activities are required. These strategic plans provide a detailed assessment of the SMP policies for each management unit[350] and will entail a rigorous examination of all the options, including benefit-cost analysis in line with the FCDPAG3.[351]

[350] See MAFF (2001) *Flood and Coastal Defence Project Appraisal Guidance, Strategic Planning and Appraisal (FCDPAG2)*, MAFF.
[351] MAFF (2000) *Flood and Coastal Defence Project Appraisal Guidance, Economic Appraisal (FCDPAG3)*, MAFF.

**Table 25.1 The SMP Methodology compared to the Generic Approach**

| GENERIC APPROACH | SMP METHODOLOGY | | | | |
|---|---|---|---|---|---|
| | Stage 1 | Stage 2 | Stage 3 | Stage 4 | processMonitor & review |
| **Process 1 – Problem Formulation** | | | | | |
| 1.1 Define intention | ● | | | | |
| 1.2 Justify intention | ● | | | | |
| 1.3 Set boundaries | ● | | | | |
| 1.4 Identify controlling factors | ● | | | | |
| 1.5 Develop conceptual model | ● | | | | |
| **Process 2a – Tiered Risk Assessment** | | | | | |
| 2a.1 Carry out high level assessment | ● | | | | |
| 2a.2 Prioritise risks | ● | | | | |
| 2a.3 Carry out intermediate level assessment | ● | | | | |
| 2a.4 Carry out detailed level assessment | | | | | |
| **Process 2b – Stages of Risk Assessment** | | | | | |
| 2b.1 Identify hazards | ● | | | | |
| 2b.2 Identify consequences | ● | | | | |
| 2b.3 Determine magnitude of consequences | ● | | | | |
| 2b.4 Determine probability of consequences | ● | | | | |
| 2b.5 Determine significance of risk | ● | ● | | | |
| **Process 3 – Options Appraisal** | | | | | |
| 3.1 Identify options | ● | | | | |
| 3.2 Evaluate options | ● | | | | |
| 3.3 Apply risk assessment to options | ● | | | | |
| 3.4 Review options | | ● | | | |
| 3.5 Re-evaluate options (if required) | | | ● | | |
| 3.5 Select preferred option | | | ● | | |
| **Process 4 – Monitoring and Review** | | | | | |
| 4.1 Decide what to monitor | | | ● | | |
| 4.2 Design monitoring programme | | | ● | | |
| 4.3 Carry out monitoring | | | | | ● |
| 4.4 Review monitoring results | | | | | ● |
| 4.5 Report any lessons learnt | | | | | ● |
| 4.6 Review monitoring programme | | | | | ● |

## 25.6Tools and Technologies

The Modelling and Decision Support Framework (MDSF) is a software tool based on Geographical Information System (GIS) technology that assists the analysis of data at the various stages of production of a SMP. The MDSF does not include models; it takes in modelling results for analysis and presentation. MDSF is the tool that calculates risk in terms of economic damages and people at risk. MDSF is used for both CFMPs and SMPs and could also be applied to Strategic Flood Risk Assessments for development planning purposes.[352]

The key features of the SMP version of MDSF are:

- Consistency and flexibility
- Data storage
- Metadata
- Floodplain mapping using the national DTM
- Calculation of flood damages
- Calculation of socio-economic impacts of flooding
- Calculation of erosion damages
- Economic implications of intervention options
- Ability to deal with multiple risk areas
- Ability to handle a variety of geographic data
- Mapping of outputs.
- Ability to incorporate defence residual lives for 'do nothing' calculations
- Encourages assessment of uncertainty

In the future, the Risk Assessment for Strategic Planning Intermediate Level Methodology (RASP ILM) will contribute to the Stage 1 and 3 analysis.[353]

Also in the future the National Flood and Coastal Defence Database (NFCDD)[354] will provide all of the required defence information. When the use of RASP ILM is implemented, this will require more detailed defence information than currently used, but this has already been taken account of in the development of the NFCDD.

## 25.7Audit and Control

Once Stage 1 of the process to develop a SMP has been finished, the provisional policy appraisal report is publicised and consultations are sought with relevant stakeholders. The objective of this consultation process is to identify and collect the views of all the parties about the policy for managing the shoreline over the next 50 years

Following the preparation of the Plan, the Coastal Group makes arrangements for its on-going implementation. This includes:

- Implementing the action plan programme of strategic plans, stand-alone schemes and monitoring studies (monitoring of particular management activities to assess their effectiveness and how appropriate they continue to be[355]);

- Undertaking on-going strategic coastal monitoring. This will assist with SMP preparation and future SMP revisions. Details of current monitoring should be included in the SMP with an outline of future monitoring requirements.[356]

- Consulting on a regular basis with Local Planning Authorities, interested bodies and relevant stakeholders on shoreline management issues;

[352] More detailed information on the application of MDSF to SMPs can be found at www.mdsf.co.uk or www.defra.gov.uk/corporate/consult/smpguidance/
[353] For further information refer to D2.1 ADD1 Risk Assessment for Strategic Planning (RASP) – A Summary
[354] More information can be found at the following website: http://www.defra.gov.uk/environ/fcd/hltarget/nfcdd.htm
[355] See Activity Chart Process 4 – Monitoring and Review
[356] More information can be found in Defra (2001) *Shoreline Management Plans: A guide for coastal defence authorities*, Defra PB5519 and Millard and Sayers (2000) *Maximising the use and exchange of coastal data: a guide to best practice* (CIRIA Publication C541), CIRIA, London.

SMPs are working documents that are reviewed and, where necessary, revised at appropriate intervals to incorporate up-to-date information and reflect changes in policy guidance. This tends to be a 5-year cycle. Plans should be reviewed if local conditions change or when relevant studies or plans are produced (such as Development Plans, CHaMP[357], etc.) This leads to the production of successive generations of each SMP.

[357] See Guidance Note S2.5 Linkage to Statutory Requirements

# 26.D3.4 STRATEGIC FLOOD RISK ASSESSMENTS (SFRAS)

**This guidance note:**

- Provides an overview of what constitutes an appropriate assessment of flood risk and the management of that risk for development planning at the local scale.
- Provides summary guidance regarding the required content of Strategic Flood Risk Assessments (SFRAs) with cross-references to other more detailed guidance documents for best practice.
- Provides summary information regarding the roles and responsibilities of the Local Planning Authorities (LPAs) and the Environment Agency (EA) with regard to SFRAs.
- Shows how SFRAs fit into the overall framework for assessing and managing flood risk for new development.

**This guidance note does NOT:**

- Set parameters that dictate whether or not development should be planned for particular areas within a local planning authority boundary, as this is a decision for the LPA.
- Set parameters that dictate whether the EA should object to these plans, as this is a policy issue for the EA.

The recommendations presented in this guidance note **do not** supersede the information contained in the following principal references:

- DTLR (2001) *Planning Policy Guidance Note 25: Development and Flood Risk*. HMSO, London. Usually referred to as PPG25.
- National Assembly for Wales (2004) *Technical Advice Note 15: Development and Flood Risk*, National Assembly for Wales, Cardiff. Usually referred to as TAN15.

These documents should be referenced for further information.

In addition, SFRA guidance is in the process of development. This guidance note builds on the guidance already in the public domain, but also recognises that future guidance might supersede this particular note. Therefore, at the present time this note should be considered as **interim guidance only**.

**Recently published guidance:**

- Environment Agency (NW Region) and NW Regional Assembly (2004) *Meeting the Sequential Flood Risk Test: Guidelines for the North West Region*.
- Environment Agency (Yorkshire Region) and Yorkshire & Humber Assembly (2004) *At risk? Planning for Flood Risk in Yorkshire and Humber*.

**Future guidance:**

As part of the FLOWS project (Floodplain Land-use Optimising Workable Sustainability), there are two new guidance documents currently under development (both due for completion in 2005):

- FLOWS WP1biii project *Guidance on Strategic Flood Risk Assessments for Low-lying Areas*

▪ FLOWS WP1biii project *Modelling and Mapping of Flood Risk*

## 26.1 Contents



## 26.2 Introduction

### 26.2.1 What is a Strategic Flood Risk Assessment?

A Strategic Flood Risk Assessment (SFRA) is the term currently used for the type of assessment of flood risk undertaken to inform the spatial planning process at the local scale.

SFRAs enable LPAs to designate areas for development following the Sequential Test.[358] They can be used to set planning constraints within these development areas and, if desired, beyond in the event of windfall planning applications. SFRAs can also be used within urban areas to identify the potential future impacts of climate change and uncontrolled development and the actions that may be taken to mitigate these.

A SFRA is not a spatial plan or a planning policy, but it informs the planning process of:

a) Present flood risks and future flood risks (without new development), and
b) Residual flood risks, both present and future (with new development for the life-time of that development).

Because of this, it is part of an iterative process and should not be considered in isolation from the flood risk management requirements resulting from the spatial plan.[359]

Future risks are based on a number of parameters. Some of these may be uncontrollable, i.e. due to climate change[360] or urban creep[361] or long term sea level changes, or they may be controllable, i.e. due to management of assets and infrastructure (including operation and maintenance of defences) or by controlling development. Given that we cannot control the uncontrollable, we have to manage what we can control or alter our expectations. Therefore, a SFRA should provide the necessary information for planners to be able to take the strategic decisions that identify the amount of development that may be permitted, how the drainage of that development should function and how vulnerable areas should be protected and/or adapted.

A SFRA should assess risks associated with all types of flooding.[362] These being:

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[358] As described in PPG25
[359] See Activity Chart Process 3 – Options Appraisal
[360] See Guidance Note S3.1 Climate Change
[361] The process whereby the impermeability of the urban area increases over time, due to modifications to individual properties as a result of permitted development under the Town and Country Planning (General Permitted Development) Order 1995.
[362] Not only individually, but also in combination, if a detailed assessment is required. Consideration of combined effects can be undertaken using joint probability techniques. Reference should be made to Hawkes, P (2005) *Use of Joint Probability Methods in Flood Management, A Guide to Best Practice*, Defra/EA R&D Technical Report FD2308/TR2.

- Fluvial flooding
- Coastal and tidal flooding
- Estuarial flooding and watercourses affected by tide-locking
- Groundwater flooding
- Flooding from overland flows (considering both flood routes/paths and storage)
- Flooding from artificial drainage systems
- Flooding from infrastructure failure

Detailed descriptions of these types of flooding can be found in the CIRIA guidance C624.[363] The extent to which these should be considered will vary and depend on whether they are considered as influential for the Sequential Test and in setting constraints on development in certain areas. Consideration of types of flooding that are not influential for the Sequential Test or in setting development briefs or for undertaking master plans can be deferred until the site-specific Flood Risk Assessment (usually referred to as a FRA).

The Activity Chart provided as part of this framework includes a section called *How assessments of flood risk are used*. This shows where SFRAs can be used to inform:

- Development Planning
- Flood Management Planning
- Sustainability Appraisals

## 26.3Requirements

### 26.3.1 Why are SFRAs needed?

Flood risk management is an important factor to be taken into account when creating sustainable communities. A SFRA furnishes a LPA or group of LPAs with appropriate information on flood risk, so that due consideration is given to flood risk when undertaking spatial planning, defining planning policies, setting planning constraints or development briefs or for undertaking master plans.

### 26.3.2 When should SFRAs be carried out?

Paragraph 4.11 of PPS12[364] states "At the earliest stage in the preparation of the development plan document, and particularly for preparation of the core strategy, the local planning authority should gather evidence about their area. This may include studies to be undertaken or commissioned on for example…**areas at risk of flooding**…. This evidence will be relied upon by the local planning authority in testing the soundness of the development plan document at independent examination. Local planning authorities should seek the involvement of relevant groups and organisations in the development of this information base as this will help them to identify the issues which the development plan document needs to address and the options which are available to deal with those issues."

This paragraph is describing an assessment of flood risk at the local scale (in other words a SFRA). PPG25 expands on this and recognises the need to carry out an assessment of flood risk to be able to carry out the Sequential Test[365] satisfactorily.

In existing urban areas, it is also appropriate to carry out SFRAs where there are known areas of flood vulnerability and the probability of flooding will increase due to climate change and uncontrolled urbanisation.

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[363] Lancaster, J, Preene, M and Marshall, C (2004) *C624 Development and Flood Risk – Guidance for the Construction Industry*, CIRIA, London.
[364] ODPM (2004) *Planning Policy Statement 12: Local Development Frameworks,* HMSO, London.
[365] See Guidance Note D1.3 Local Development Frameworks for information on the Sequential Test

### 26.3.3 What area does a SFRA cover?

As described in Guidance Note D1.3 Local Development Frameworks, LPAs have two functions. These are (a) spatial planning and (b) regulation and control. This means that there can be 2 parts to a SFRA fulfilling each function. These requirements are summarised in Table 26.1 and described more fully in the section Processes and Procedures later in this guidance note.

**Table 26.1 LDF processes for considering flood risk**

| **Function** | **Spatial Planning** | | **Regulation and Control** |
|---|---|---|---|
| **Implementation Approach** | Local Development Documents | | Supplementary Planning Documents |
| **Assessment Type** | Strategic Flood Risk Assessment (SFRA) | | |
| | Part 1 | | Part 2 |
| | Level 1 | Level 2 | Level 3 |
| **Coverage** | Full coverage of LPA area[366] | | Planned development areas only (as required) |

Both functions can be supported by undertaking a SFRA. SFRAs have three levels of detail, corresponding with the Generic Approach.[367] These are:

- Coarse Assessment (Part 1) – This corresponds to a Level 1 SFRA in the Generic Approach.
- Intermediate Assessment (Part 1 expanded as required) – This corresponds to a Level 2 SFRA in the Generic Approach.
- Detailed Assessment (Part 2 as required) – This corresponds to a Level 3 SFRA in the Generic Approach.

This approach allows proportionate effort depending on the extent and severity of the flood risk within the LPA administrative area.

For a LPA to fulfil its obligation regarding spatial planning (including the Sequential Test), Part 1 of a SFRA should cover the whole of the administrative area.

If, as part of a Regional Spatial Strategy (RSS)[368], significant development is proposed in a particular area (e.g. a new "growth area"), then it is recommended to look at the implications of this at the sub-regional scale. This would provide an opportunity to find an alternative location for the "growth area" or would highlight the issues that would need consideration by the affected LPAs should the "growth area" go ahead. This information should then be used for a sub-regional scale Strategic Flood Risk Assessment (SFRA), rather than carrying out individual SFRAs for each LPA.

## 26.4Data and Information

### 26.4.1 Information required for a SFRA

The quantity of information required for a SFRA depends on which part of the SFRA is being undertaken as summarised in Table 26.2. A summary list of potential data sources is provided in the North West guidance for undertaking the Sequential Flood Risk Test.[369] A useful word of warning that accompanies this list is that "the collation of this information can become labour intensive for all

366 Alternatively this might cover more than one LPA area, if it is decided that this would be beneficial by neighbouring LPAs.
367 See Activity Chart Process 2a – Tiered Risk Assessment
368 See Guidance Note D1.2 Regional Spatial Strategies

parties if not carefully targeted". The tiered approach (as described in Processes and Procedures) is designed specifically to facilitate proportionate effort, as is the approach described in the North West guidance.

**Table 26.2 Typical Sources of Information**

| SFRA Part | Typical Sources of Information |
|---|---|
| **Part 1** | ▪ National planning policy statements and guidance<br>▪ Regional policy statements and guidance (e.g. the appropriate Regional Spatial Strategy)<br>▪ Previous local policy statements or guidance (provided by a Local Plan or Local Development Framework)<br>▪ A variety of existing data and information regarding local conditions (such as historical flooding problems, existing drainage, structures and defences, etc.), primarily available from the EA, the Local Authority, Internal Drainage Boards and Sewerage Undertakers[370]<br>▪ Existing assessments of flood risk available for the area (e.g. Catchment Flood Management Plans and Shoreline Management Plans)<br>▪ Existing models, primarily available from the EA (only required if undertaking Level 2 or Level 3 assessments) |
| **Part 2** | ▪ Walkover survey of development areas to assess:<br>  ▪ Potential sources of flooding<br>  ▪ Likely routes for flood waters<br>  ▪ The site's key features, including flood defences, and their condition<br>▪ Site surveys or existing data sources used to determine:<br>  ▪ General ground levels across the site<br>  ▪ Levels of any formal or informal flood defences relevant to the site<br>▪ Consultation with the EA and other bodies, which may have relevant information on flood risk |

### 26.4.2 Information provided by a SFRA

*Part 1 SFRA*

This part of a SFRA is intended to inform the spatial planning process and enable the LPA to undertake the Sequential Test. Therefore, information should be provided as GIS based maps showing the following:

1. OS mapping (background layer)
2. LPA area boundary
3. Main rivers
4. Ordinary watercourses
5. General topography
6. Locations of flood defences (including standard of protection and condition, if known)
7. Other assets/structures acting as flood defences
8. Areas with flood warnings/emergency planning

[370] Reference should be made to the North West guidance or to Guidance Note D2.1 Flood Risk Indicators

9. Zone 3 (fluvial) boundary and delineation within this boundary as required (see Processes and Procedures)
10. Zone 3 (tidal or coastal) boundary and delineation within this boundary as required (see Processes and Procedures)
11. Zone 2 boundary
12. Localised flooding problems (e.g. areas affected by drainage flooding, groundwater flooding and overland flows)[371]
13. Areas with flood management strategies
14. Environmental problems and/or strategies that are sensitive to flood management activities
15. Existing land uses
16. Location of proposed development areas

An example format for these types of maps is provided in the North West guidance.

### *Part 2 SFRA*

This part of a SFRA is intended to inform development briefs or master plans, which may form some of the Supplementary Planning Documents in a LDF. The type of information provided from a Part 2 SFRA is similar to that produced by a site-specific FRA[372], although it may cover larger areas than individual planning applications and the level of detail will be limited as the design of the developments will not have been specified.

The following provides a suggested list of requirements. However, it should be remembered that the level of detail required for any type of assessment of flood risk depends on its use. Therefore, if the information provided for the LDF is limited then this should not be considered as problematic, but should be matched by policies that are appropriately precautionary.

### *Plans*

1. A plan of proposed development areas, including geographical features, street names and all water bodies.
2. A plan identifying the location of existing defences or other flood alleviation measures, with reference to known standards of protection and condition.
3. A plan of any known structures that may influence hydraulic conditions within the proposed development areas or for the surrounding area, with reference to maintenance and operation.
4. A plan of available historic flood information, such as recorded levels, flood extent, dates, photos, etc. Any changes to the area since the last event should be identified, if possible.
5. A plan identifying safe access and exit routes to the development areas (but not within the areas).

### *Results*

1. A broad assessment of potential sources of flooding.
2. A broad assessment of the hydraulic performance of the existing artificial drainage (both storm and foul) system.
3. An assessment of the existing frequency of flooding.
4. A broad assessment of the behaviour of existing flooding across development areas (sequence, rate of rise of water level, flow velocities, depths and the duration of flood).[373]

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[371] See Guidance Note D2.1 Flood Risk Indicators
[372] as described in PPG25 and Guidance Note D3.5 Flood Risk Assessments
[373] If behind defences, the simple or intermediate approaches described in Guidance Note S3.2 Risk to People behind Defences are recommended.

5. A broad assessment of likely change in conditions progressively away from the development boundaries (both upstream and downstream), which might include an estimate of the volume of runoff likely to be generated by the development (with or without SuDS).
6. A broad assessment of the potential impact on fluvial or coastal morphology and long-term stability and sustainability.
7. A broad assessment of the residual risks after inclusion of any necessary mitigation measures.[374]

It is recommended that the results of the Part 2 SFRA should be made available to Developers as well as details of the resultant outcome, as this will lead to consistency of approach and speed up the planning process. However, it is important to remember that the responsibility remains with the Developer to provide a comprehensive FRA to accompany the planning application and, to that end, should not assume that all risks within a development area have been identified by the LPA.

### 26.4.3 General rules for all SFRA reports[375]

- The report should be written in such a way as to be understandable for those who will be reading it and auditable for those who will be checking it.
- Sources of data and information should be documented and the reliability/authenticity of the information verified.
- Assessment methods adopted should be documented, including technical descriptions of any models used and their application. Where checklists, flow charts, etc. have been used these should be included in an appendix.
- Assumptions and uncertainties in data, assessment methods and results should be clearly identified and the precautionary approach adopted to manage such uncertainties should be explained.

Useful examples of a tabular method for describing the data collection and review process for Part 1 of a SFRA is provided in the North West guidance.

## 26.5Roles and Responsibilities

Key roles and responsibilities that are specifically related to SFRAs are summarised below.[376]

- The LPA is responsible for carrying out the spatial planning and developing the LDF. The LPA is, therefore, also responsible for carrying out the SFRA, although this is often delegated to a specialist consultant.
- Other Local Authority departments are responsible for flood defence and emergency response and should be included in the stakeholder engagement.
- The EA provides advice regarding how to carry out an appropriate SFRA, providing data and acting as a consultee for the LDF.
- The Regional Assembly is responsible for producing the RSS and providing guidance and advice from a national and regional policy perspective.
- The Community should be engaged via the Community Strategy in particular during the Options Appraisal stage.[377]

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[374] See Section 3.4.3 in Environment Agency (NW Region) and NW Regional Assembly (2004) *Meeting the Sequential Flood Risk Test: Guidelines for the North West Region*.
[375] Further details can be found in Guidance Note S2.1 Reporting
[376] Reference should also be made to Guidance Note S2.4 Stakeholder Engagement
[377] See Activity Chart Process 3 – Options Appraisal

## 26.6Processes and Procedures

The processes described below correspond with the generic approach to assessing and managing flood risk.[378]

### 26.6.1 Process 1 - Problem Formulation[379]

Before starting an assessment of flood risk to support the decision-making process, it is necessary to carry out the following:

- define the objectives of the LDF
- define the objectives of the SFRA
- identify boundaries to the LDF (including planning horizon as well as spatial extent)
- identify boundaries to the SFRA
- identify controlling factors of the LDF
- identify stakeholders
- identify potential flood risk components (i.e. possible sources, pathways and receptors), and
- decide baseline conditions for the assessment of flood risk

On occasions, there can be time or budget constraints restricting the extent of the assessment and these should be identified during this process (identify boundaries to the SFRA). This can sometimes mean that not all hazards can be fully defined and some or all of the consequences might only be assessed qualitatively. By comparing these restrictions with the potential hazards and potential consequences, a decision should be made at this point in consultation with the EA regarding which flood risk indicators will be used in the decision-making process and how remaining uncertainties will be mitigated within the plan. This will require the precautionary principle to be applied, as described in Guidance Note D1.3 Local Development Frameworks. It may be agreed that the SFRA will require revision or extension as and when resources permit and this would be determined during Process 4 – Monitoring and Review.

The 8 principles of sustainable flood risk management, as described in Guidance Note D1.3 Local Development Frameworks, should be referred to as part of Process 1 to help identify controlling factors, stakeholders and baseline conditions. These will then be revisited during Process 3 – Options Appraisal (see below), when options will be evaluated.

### 26.6.2 Process 2a – Tiered Risk Assessment

These sub-sections should be read in parallel to Figure 26.2, which provides a simplified representation of how the levels of assessment can be undertaken in sequence and the subsequent completion of the Sequential Test and setting of planning policies or constraints.

#### *Level 1 – Coarse Assessment*

A Level 1 assessment should be carried out for all LPA areas, as it is necessary for the LPA to understand the comparative flood hazard across its administrative area in order to carry out the risk-based approach specified in PPG25 and TAN15.

Whether a more detailed assessment is subsequently required depends on the answers to the following questions:

- What is the probability of flooding (in the absence of defences) across the LPA area (high, medium or low)?
- What proportion of area with a high probability of flooding is already taken up by development, which is, therefore, at risk?
- How much new development is required in the LPA area?

[378] See Activity Chart Overview
[379] See Activity Chart Process 1 – Problem Formulation

▪ Answers to these questions can be reported in the format show in Tables 26.3 and 26.4.

**Table 26.3 Level 1 Questions (for England)**

| No. | Question | Area ($km^2$) | % of Area |
|---|---|---|---|
| 1 | Size of planning area | | N/A |
| **2** | **Area in Zone 3 (High flood risk)** | | % of total area |
| **3** | **Area in Zone 2 (Moderate flood risk)** | | % of total area |
| **4** | **Existing development in Zone 3** | | % of Zone 3 |
| **5** | **Existing development in Zone 2** | | % of Zone 2 |
| **6** | **Area of Zone 3 that is defended** | | % of Zone 3 |
| 7 | Total developed area | | % of total area |
| 8 | Required new development | | % of total area |
| **9** | **Likely new development in Zones 3 and 2** | | % of Zones 3 and 2 |
| **10** | **Area affected by drainage problems** | | % of total area or % of new development areas |
| **11** | **Area affected by groundwater flooding** | | % of total area or % of new development areas |
| **12** | **Area affected by overland flows** | | % of total area or % of new development areas |

**Table 26.4 Level 1 Questions (for Wales)**

| No. | Question | Area ($km^2$) | % of Area |
|---|---|---|---|
| 1 | Size of planning area | | N/A |
| **2** | **Area in Zone C (Flood risk)** | | % of total area |
| **3** | **Area in Zone B (Flood risk should be checked)** | | % of total area |
| **4** | **Existing development in Zone C2** | | % of Zone C2 |
| **5** | **Existing development in Zone C1** | | % of Zone C1 |
| **6** | **Existing development in Zone B** | | % of Zone B |
| 7 | Total developed area | | % of total area |
| 8 | Required new development | | % of total area |
| **9** | **Likely new development in Zone C2** | | % of Zone C2 |
| **10** | **Likely new development in Zone C1** | | % of Zone C1 |
| **11** | **Likely new development in Zone B** | | % of Zone B |
| **12** | **Area affected by drainage problems** | | % of total area or % of new development areas |
| **13** | **Area affected by groundwater flooding** | | % of total area or % of new development areas |
| **14** | **Area affected by overland flows** | | % of total area or % of new development areas |

The items in bold in the tables are flood risk indicators[380] and by answering these questions and plotting flood risk areas on maps of existing and proposed development, the LPA will have an indication of the following:

▪ Whether existing flood risk is a significant issue in the LPA area;
▪ Where the problem of flood risk is likely to be the greatest in the LPA area;
▪ Whether new development in the LPA area is likely to add to that risk; and, therefore,

[380] As described in Guidance Note D2.1 Flood Risk Indicators

- Whether flood risk needs to be considered in more detail or whether it is possible to proceed to the Options Appraisal stage.

If it is apparent at this stage that some of the development will have to be in flood risk areas, it will be necessary to continue to a Level 2 assessment.

If there is too high a degree of uncertainty in the information available on the extent of the flood hazard to clearly mark areas as low risk (so that development can be planned in these areas with confidence)[381], it is recommended to continue to a Level 2 assessment.

### *Level 2 – Intermediate Assessment*

Should the results of the Level 1 assessment indicate that there is an issue of flood risk, then it will be necessary to consider the need for this more detailed assessment of flood risk.

The purpose of the Level 2 - Intermediate Assessment is to collect further information on the spatial distribution of flood hazard and look at more indicators of flood risk[382] to decide:

- Whether there is a sufficiently reduced degree of uncertainty in the information available on the extent of the flood hazard to clearly mark areas as low flood hazard, so that development can be planned in these areas with confidence.
- If development will have to take place in areas of flood hazard, which aspects of flood risk will need to be assessed in more detail (see Level 3).

Level 1 flood risk indicators are entirely based on the flood hazard in the absence of defences. During this level of assessment, an understanding of actual probability of inundation with due consideration of both man-made and natural defences may be required.

Therefore, this level of assessment could involve any of the following activities, as considered appropriate:

***If the reason for undertaking a Level 2 assessment is high uncertainties:***

- Sub-dividing the medium and high flood hazard areas (Zones 2 and 3 in PPG25) (Zones C and B in TAN15) into areas of relative uncertainty (i.e. low uncertainty and high uncertainty) or the inclusion of 'buffer zones'. Where there is an identified uncertainty, for example whether an area should be considered as Zone 2/Zone 3 or Zone B/Zone C, the worst case should be assumed.[383]

- Alternatively, undertaking hydraulic modelling to improve accuracy/confidence in the flood extents.

***If the reason for undertaking a Level 2 assessment is high risk:***

- Sub-dividing the high flood hazard area (Zone 3) into the 3 planning response areas as described in Table 1 of PPG25 (applicable to England only). These being:
  - 3a – Developed Areas,
  - 3b – Undeveloped and sparsely developed areas, and
  - 3c – Functional floodplains

[381] In Wales, if development may be required in Zone B, then it is necessary to review the flood hazard in this area in more detail to determine whether it is low risk or not. Depending on the results of this assessment, this guidance note recommends that the area should be treated in the same was as Zone A or Zone C, as appropriate.
[382] See Guidance Note D2.1 Flood Risk Indicators
[383] This can also be used as a simple means for allowing for climate change. For example, a conservative approximation of the 1% fluvial flood extent in the future (Zone 3) might be to use the existing 0.1% flood extent (Zone 2). However, this should be reviewed on a case by case basis.

- Sub-dividing the high flood hazard area (Zone 3) into defended and undefended areas, with identification of standards of protection (SoP) provided by defences (applicable to England only, as the Development Advice Map (DAM) for Wales already provide this).

- Recategorising the medium and high flood hazard areas into actual probability of inundation with appropriate consideration of defence standards of protection and performance. This may include analysis of breaching and overtopping of defences.[384] This is equally applicable for England and Wales.

- Within urban areas, identifying levels of service of the artificial drainage system (sometimes referred to as the minor system) and the current flood management strategies for the natural drainage system in combination with the urban surfaces (sometimes referred to as the major system). Again, this is equally applicable for England and Wales. The modelling tools and information required to carry out a detailed analysis area in their infancy.[385] However, it is possible to make reasonable assumptions based on best practice guidance and local knowledge.

*Level 3 - Detailed Assessment*

A detailed assessment is advisable for development in areas of flood hazard (whether protected by defences or not). In this case, the actual risk would be quantified to enable development briefs or master planning to be undertaken. This is part of an iterative process and would usually be undertaken after the first stage of Process 3 – Options Appraisal (see Figure 26.2).

The information to be provided by this level of assessment is listed in Data and Information. It can be seen that this information is similar to that required for a site-specific Flood Risk Assessment (FRA)[386], except that the assessment can only be broad-brush, as the actual development design is not specified.

The extent to which each type of flooding should be considered will vary and depend on whether they are considered as influential in setting development briefs or undertaking master planning or whether they can be deferred until the site-specific FRA.

A detailed assessment should also be considered if the development is of sufficient size and location to increase the flood risk to the surrounding area. Although in some cases (generally smaller areas) planning constraints could be set regarding the use of SuDS to limit the runoff response, etc. there are circumstances when such constraints could be too onerous and unsustainable. Neglect of this at this stage of the planning process could lead to difficulties later for Developers. As development planning includes encouraging development in some areas, as well as discouraging development in others, this could be counter-productive.

### 26.6.3 Process 3 - Options Appraisal[387]

This stage constitutes the appraisal of development options, taking all planning issues into account (not just those associated with flood risk) including sustainability objectives.

Carrying out the Sequential Test is the first part of this process. If it proves acceptable to place all developments outside of areas where they would be subjected to a high flood risk, this stage may not need to be extensive. However, when areas of high flood hazard cannot be avoided, then this stage will also need to take into consideration planning constraints to control the residual risk. This can be summarised as follows:

[384] Breaching and overtopping technologies are in their infancy and the need is not yet established in some circumstances. See Guidance Note S3.2 Risk to People behind Defences for discussion of different levels of detail that could be adopted.
[385] This is currently being addressed by a series of research projects, including the Building Knowledge for a Changing Climate research portfolio and the Flood Risk Management Research Consortium. Further details can be found in the Information Chart.
[386] See Guidance Note D3.5 Flood Risk Assessments
[387] See Activity Chart Process 3 – Options Appraisal

***If an Intermediate Assessment has not been carried out:***
- New development should only be planned in areas where there is a flood hazard < 0.1% annual probability,
- Planning constraints need to be applied preventing new development from causing an increase in flood risk for existing development.

***If an Intermediate Assessment has been carried out:***
- New development should be planned in areas of lowest flood hazard first (assuming all other considerations being equal) and residual risks for the new development should be at acceptable levels,[388]
- Planning constraints need to be applied preventing new development from causing an increase in flood risk for existing development.

Residual risk is likely to be considered acceptable if the recommendations in Table 26.4 (which is based on PPG25) are followed and appropriate mitigation measures are imposed. In addition, policies for land use should be developed for different zones of the floodplain.

All spatial planning should promote sustainable development[389] and the evaluation of options should be accompanied by a Sustainability Appraisal.[390]

In setting planning policies and constraints, it will be necessary to consider the following:

- Flood warning
- Emergency planning
- Flood resilient building design
- Provision of new defences, defence improvements or developer contributions
- Appropriate use of other flood risk mitigation measures
- Drainage requirements (including the use of SuDS)
- Adaptation options for vulnerable areas, due to uncertainties in the analysis of flood risk, such as the inherent uncertainties in climate change projections and its impact.[391]

As each of these issues can have an impact on the residual risk, it is sometimes necessary to undertake an iterative approach to the assessment of flood risk to understand the trade-off between these means of mitigation versus alternative spatial planning decisions.[392]

### 26.6.4 Process 4 - Monitoring and Review[393]

Review of the plan and the successful enforcement of planning constraints should be included in the overall process.

The need to revise strategies in the light of developing information, for example on climate change, is particularly important and it may be decided that the SFRA will require revision or extension as and when resources permit or when the information comes available.

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[388] Indicative standards are referred to in PPG25 and TAN15.
[389] See paragraphs 9 to 13 of PPG25 or paragraphs 2.10 and 2.11 in TAN15.
[390] See Guidance Note S2.5 Linkage to Statutory Requirements
[391] See Guidance Note S3.1 Climate Change
[392] See Guidance Note S3.5 Mitigation Measures
[393] See Activity Chart Process 4 – Monitoring and Review

## 26.7 Tools and Technologies

### 26.7.1 Providing the required information to undertake the Sequential Test

- Environment Agency (NW Region) and NW Regional Assembly (2004) *Meeting the Sequential Flood Risk Test: Guidelines for the North West Region* is the best document currently available for guiding practitioners through the Sequential Test. This includes flow-charts and case studies, which can be worked through.

### 26.7.2 Choosing appropriate analysis techniques for Level 2 and Level 3 assessments

- CIRIA guidance C624 provides guidance on a variety of analysis techniques that can be used to assess flood risk in a range of situations.

- The tables provided in support of Guidance Note D2.1 Flood Risk Indicators are a useful tool for choosing appropriate indicators and also provide links to other tools and technologies that can be used for determining values for the indicators. Of these, the most readily available tool and the starting point for any assessment of flood risk is the flood mapping available from the EA website.[394]

- The Modelling and Mapping of Flood Risk project being carried out as part of FLOWS[395] is currently developing a simple matrix or lookup table to enable users at a quick glance to see the acceptable levels of uncertainty for different scales and types of development. This may prove helpful for Level 2 and Level 3 SFRAs.

- A recently completed Defra/EA R&D project has carried out a benchmarking study of hydraulic river modelling software packages.[396]

- The EA is currently writing guidance that sets out preferred modelling approaches for FRAs.[397] This may prove helpful for Level 2 and Level 3 SFRAs.

- Guidance aimed at Regulators, Developers and LPAs providing advice on the management of stormwater drainage for developments and in particular to assist in sizing of storage elements for the control and treatment of stormwater runoff[398] has been developed into a simple spreadsheet for use by EA staff.

- Guidance Note S3.2 Risk to People behind Defences provides simple lookup tables that can be used as a guide to the danger to people at various distances behind flood defences for overtopping and breaching respectively (assuming that either will occur during the lifetime of the development).

- Guidance Note S3.3 Safe Access and Exit provides a simple look up table that can be used as a guide to the danger to people at various flood depths and flow velocities.

### 26.7.3 Determining monitoring and review requirements

- A risk register can be used to systematically define the operational, maintenance and monitoring requirements. This should include remedial actions and responsibilities.

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[394] Flood maps and flood warnings areas are available at the following web site: http://www.environment-agency.gov.uk/subjects/flood/826674/829803/

[395] FLOWS WP1biii project *Modelling and Mapping of Flood Risk*

[396] Crowder *et al.* (2004) *Benchmarking of hydraulic river modelling software packages, Project Overview*, R&D Technical Report W5-105/TR0

[397] This is initially intended as internal guidance for the EA, but the intention is that this would eventually form external guidance.

[398] HR Wallingford (2004) *Preliminary rainfall runoff management for developments* R&D Technical Report W5-074/A, Environment Agency, February 2004

### 26.7.4 Checking whether the SFRA has been carried out appropriately

- The Assessment Check-List for the generic approach can be applied to SFRAs to determine how well the assessment complies with best-practice.

### 26.7.5 Checking whether the development is likely to be suitable

- Checklist A of the toolkit in CIRIA guidance C624, can be used to check the key issues when deciding whether a proposed development location is likely to be suitable in flood risk terms. This should be used in conjunction with PPG25 and TAN15.

## 26.8Audit and Control

The following tools described above form part of the audit and control process:

- The Assessment Check-List
- Checklist A from C624

Further details of the recommended auditing and control process can be found in Guidance Note S2.3 Auditing and Control.

Reference should also be made to Guidance Note D1.3 Local Development Frameworks. This describes the audit and control requirements for LDFs, which should be undertaken in conjunction with the audit and control of the assessment process itself.

## 26.9The Future of SFRAs

The term "strategic", however, could equally be applied to other assessments of flood risk that could be undertaken in order to inform other scales of planning, i.e. national, regional or sub-regional scales. This has been illustrated in Figure 26.1.

This aspirational model recognises that with every scale of planning an appropriate flood risk assessment should be undertaken by the relevant decision-making organisation, as this is the best means to take full account of current and future flood risks (as recommended in PPG25).

It also recognises that although National Flood Risk Assessments (NaFRAs), Catchment Flood Management Plans (CFMPs) and Shoreline Management Plans (SMPs) can provide valuable information for use at the larger scales, they are not designed to answer the specific questions posed at these planning scales. This would be the purpose of the "strategic" flood risk assessments.

Summary details of the questions that should be answered at the national, regional and sub-regional scales have been provided in the following guidance notes:

- D1.1 National Development Planning
- D1.2 Regional Spatial Strategies

The Defra consultation exercise *Making Space for Water*[399] specifically asks the question whether it should be a statutory requirement that RSSs and LDFs include assessments of flood risk, where they cover areas of flood risk, as defined in PPG25.[400] However, the SFRAs as described above could also align with or become part of the Sustainability Appraisals required to accompany such plans, which in

[399] Defra (2004) *Making Space for Water - Developing a new Government strategy for flood and coastal erosion risk management in England*, Defra.
[400] Question 7.3b in Making Space for Water

turn will fulfil the requirements of the Strategic Environmental Assessment (SEA) Directive.[401] In which case, it may prove possible to promote SFRAs without the need for primary legislation.

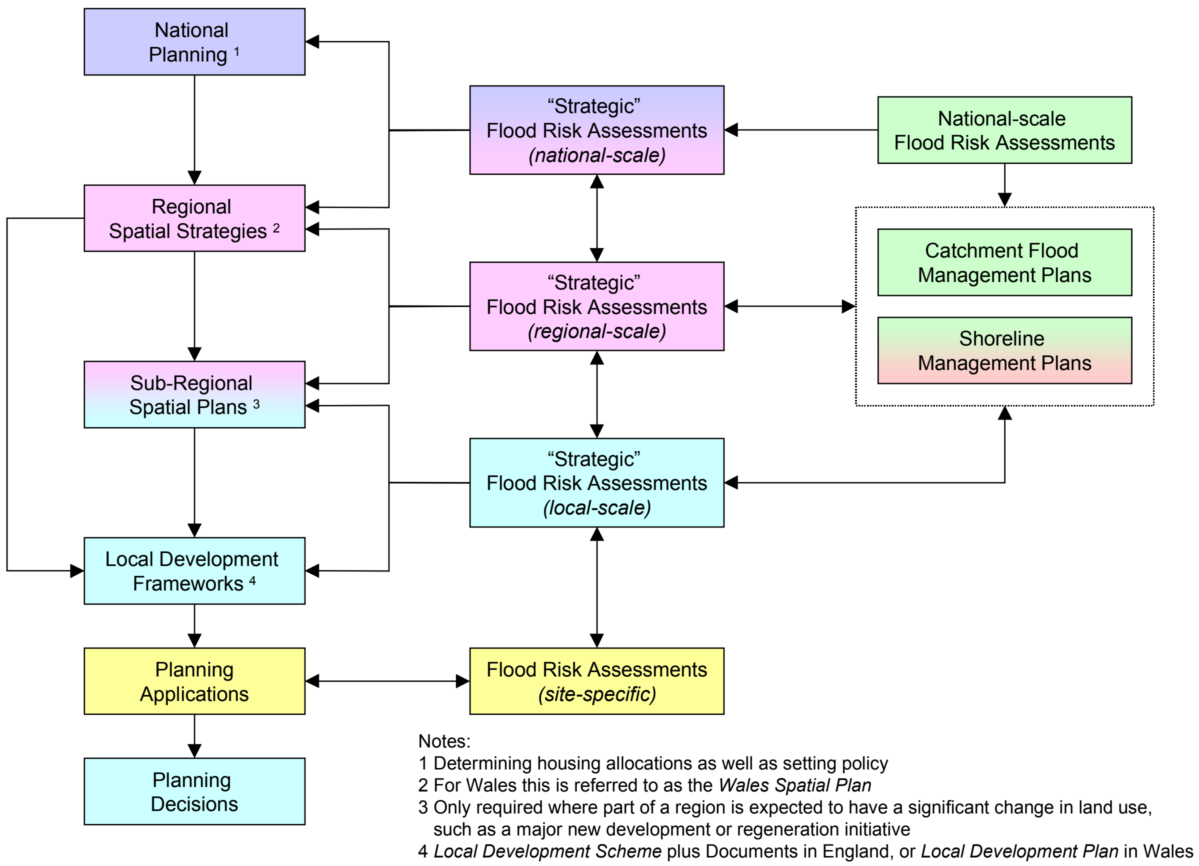



**Figure 26.1 Development Planning in the Future (Aspirational Model)**

A further development of this model for urban areas could be to undertake Integrated Drainage Plans, as suggested in the Defra consultation exercise. This would also constitute a "strategic" approach to urban flood risk management and would include spatial planning.

Recent experience gained in Bradford[402] and Glasgow[403] give early indications that these plans should encompass the following:

- Combined and surface water sewerage systems operated by the Sewerage Undertaker
- Ordinary watercourses
- Surface pathways and receptors for runoff (i.e. water that has not yet entered a drainage system) and flood waters (i.e. water that has come out of a drainage system due to lack of capacity or system failure)
- Land drainage into the urban area
- Developed land within the urban area
- Open space within the urban area
- Interactions with groundwater, main rivers and coastal waters

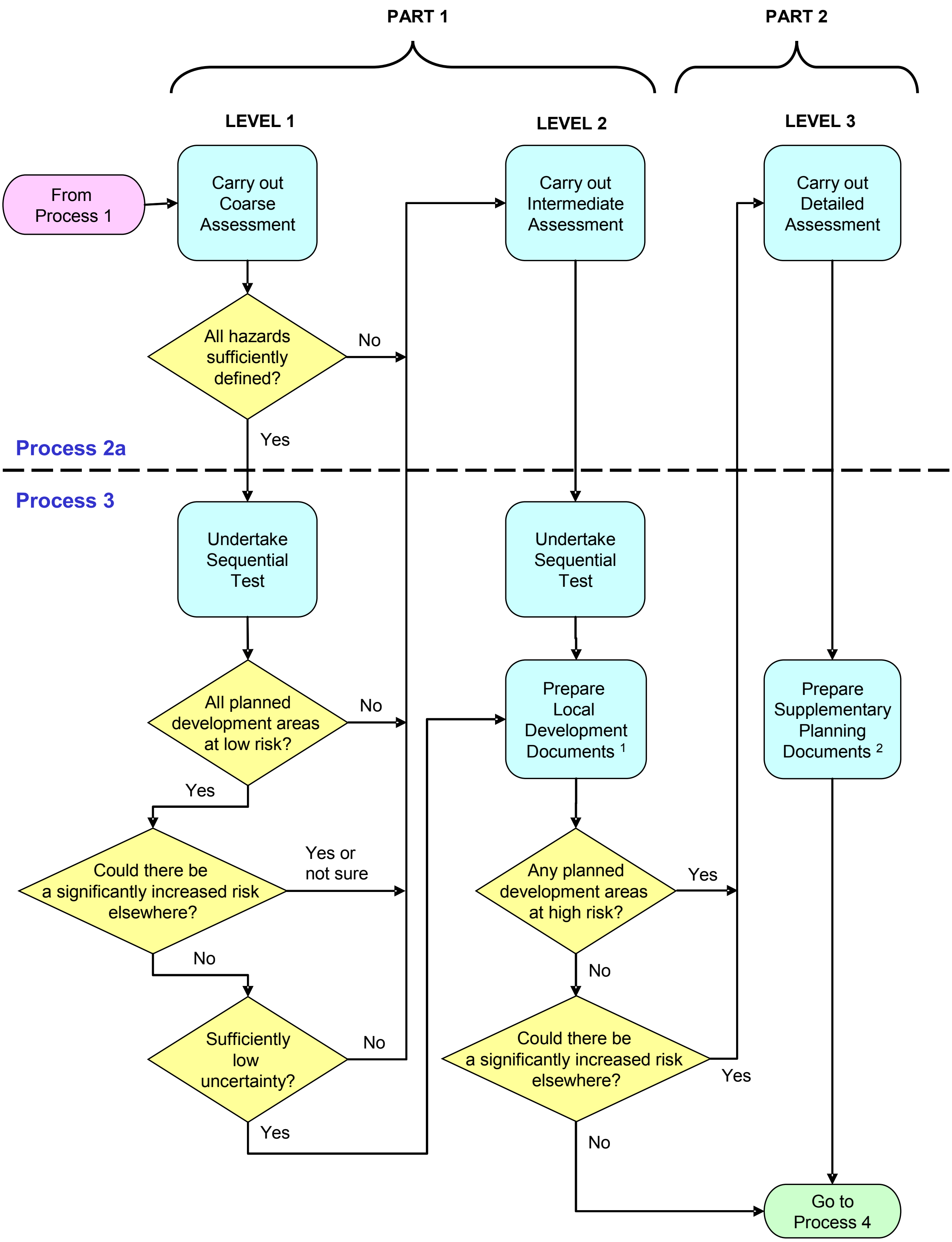
[401] See Guidance Note S2.5 Linkage to Statutory Requirements
[402] Blanksby *et al.* (yet to be published) *Framework for Water and Flood Risk Management in the City of Bradford*, 10th International Conference on Urban Drainage, Copenhagen, Denmark, 21-26 August 2005.
[403] Akornor A. and Page D. (2004) *Glasgow Strategic Drainage Plan Stage 1, Overview and Case Study*, WaPUG Scottish Meeting, Dunblane, 17 June 2004.

The plans should focus on and be prioritised by:

- Known flooding incidents
- Potential impacts of spatial development plans (within the relative short-term)
- Potential impacts of future urbanisation and climate change (longer-term)

The plans should also specify responses to pressures including:

- Enhancements to the “minor system”, comprising pipes, channels, storage facilities and infiltration devices with limited capacity.
- Flood management strategies for the “major system”, comprising natural drainage and urban surfaces, which has considerable capacity, although its operation may cause flooding.
- Emergency responses.
- Limitations on and requirements for development.




Notes:
1 Set Site Specific Allocations and Generic Development Control Policies based on National and/or Regional Guidance and the Core Strategy for the LDF.
2 These may take the form of design guides, area development briefs, master plan or issue-based documents, which supplement policies in the development plan document.

**Figure 26.2 Simplified Version of Processes 2a and 3 for SFRAs**

**Table 26.4 Recommended Land Use Policies**

| | | | | | | |
|---|---|---|---|---|---|---|
| ***Degree of Flood Hazard*** | | Low | Medium (1) | High | | |
| ***Annual Probability of Inundation*** | Tidal: | < 0.1% | 0.1% - 0.5% | > 0.5% | | |
| | Non-tidal: | < 0.1% | 0.1% - 1.0% | > 1.0% | | |
| ***Floodplain Characteristics*** | | N/A | N/A | Non-functional Floodplain | | Functional Floodplain |
| | | | | Already Developed | Sparsely Developed or Undeveloped | |
| ***Land Use*** | Open space/recreation | ✔ | ✔ | ✔ | ✔ | ✔ |
| | Essential transport and utilities | ✔ | ✔ | ✔ (2) | ✔ (2) | ✔ (2) |
| | Residential | ✔ | ✔ | ✔ (3) | (4) | |
| | Commercial/industrial | ✔ | ✔ | ✔ (3) | (4) | |
| | Caravan parks | ✔ | ✔ | ✔ (3) | | |
| | Public institutions | ✔ | ✔ | | | |
| | Hospitals | ✔ | | | | |
| | Homes for the elderly | ✔ | | | | |
| | Schools | ✔ | ✔ (5) | | | |
| | Police | ✔ | | | | |
| | Telephone exchanges | ✔ | | | | |
| | Emergency service | ✔ | | | | |

Notes:

(1) These recommendations are on the basis of flood risk only. It is recognised that other factors may over-rule the flood risk recommendations in the interests of overall sustainability objectives.

(2) Should be operational in a flood. Compensation works needed to avoid an increase in flood risk elsewhere.

(3) Assuming appropriate flood defences are provided.

(4) Limited developments permitted in certain circumstances as specified in PPG25 and TAN15 (e.g. boatyards, marinas, facilities for canal operatives, etc.)

(5) But not main school buildings and access routes.

## 27.D3.5 FLOOD RISK ASSESSMENTS (FRAS)

**This guidance note:**

- Provides an overview of what constitutes an appropriate assessment of flood risk for new developments and the management of that risk at the site-specific scale for submission with planning applications.
- Provides summary guidance regarding the required content of Flood Risk Assessments (FRAs) with cross-references to other more detailed guidance documents for best practice.
- Provides summary information regarding the roles and responsibilities of the Developer, Local Planning Authorities (LPAs) and the Environment Agency (EA) as part of the FRA process.
- Shows how FRAs fit into the overall framework for assessing and managing flood risk for new development.

**This guidance note does NOT:**

- Set parameters that dictate whether or not a development should be permitted, which is a decision for the LPA.
- Set parameters that dictate whether the EA should object to a Planning Application, which is a policy issue for the EA.

The recommendations presented in this guidance note **do not** supersede the information contained in the following principal references:

- Lancaster, J, Preene, M and Marshall, C (2004) *C624 Development and Flood Risk – Guidance for the Construction Industry*, CIRIA, London.
- DTLR (2001) *Planning Policy Guidance Note 25: Development and Flood Risk*. HMSO, London. Usually referred to as PPG25.
- National Assembly for Wales (2004) *Technical Advice Note 15: Development and Flood Risk*, National Assembly for Wales, Cardiff. Usually referred to as TAN15.
- Environment Agency (2004) *National Standing Advice to Local Planning Authorities for Planning Applications - Development and Flood Risk*, Environment Agency.

These documents should be referenced for further information.

### 27.1Contents

## 27.2 Introduction

### 27.2.1 What is a Flood Risk Assessment?

The term flood risk assessment is often used generically for any type of investigative study to determine flood risk, which can be carried out by a number of different organisations for different purposes. The term is also used to refer to a specific type of study that is required with planning applications.

A Flood Risk Assessment (FRA), as referred to in this guidance note and throughout the rest of project FD2320, is site-specific and is the recognised best practice approach for determining the following:

- Actual flood risk to the development site
- Change in flood risk to the surrounding area caused by the development site
- Residual risk once flood management/mitigation measures are in operation to both the development itself and the surrounding area

This type of assessment is also known by the following names:

- Flood Consequences Assessment, as used in TAN15
- Site-based Flood Risk Assessment
- Project Flood Risk Assessment

A FRA should assess risks associated with all types of flooding, not only individually but also in combination.[404] These being:

- Fluvial flooding
- Coastal and tidal flooding
- Estuarial flooding and watercourses affected by tide-locking
- Groundwater flooding
- Flooding from overland flows (considering flood routes/paths and storage)
- Flooding from artificial drainage systems
- Flooding from infrastructure failure

Detailed descriptions of these types of flooding can be found in the CIRIA guidance C624.[405]

## 27.3 Requirements

### 27.3.1 Why are FRAs needed?

The Environment Agency's document *Policy and practice for the protection of flood plains*[406] sets out the general principles to be applied to management of floodplains including the effects of development.

Specific objectives of this policy as stated in paragraph 2.2 of the document include:

- *development should not take place which has an unacceptable risk of flooding leading to danger to life, damage to property and wasteful expenditure on remedial works*

- *development should not create or exacerbate flooding elsewhere*.

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404 Consideration of combined effects can be undertaken using joint probability techniques. Reference should be made to Hawkes, P (2005) *Use of Joint Probability Methods in Flood Management, A Guide to Best Practice*, Defra/EA R&D Technical Report FD2308/TR2.

405 Lancaster, J, Preene, M and Marshall, C (2004) *C624 Development and Flood Risk – Guidance for the Construction Industry*, CIRIA, London.

406 Environment Agency (1997) *Policy and Practice for the Protection of Floodplains,* Environment Agency.

PPG25 also states the following:

*The planning system should ensure that new development is safe and not exposed unnecessarily to flooding…It should seek where possible to reduce and certainly not to increase flood risk. It should help ensure that flood plains are used for their natural purposes, continue to function effectively and are protected from inappropriate development.*

It is in these contexts that the impact of a proposed development on flood risk should be assessed.

It should be noted that the guidance provided in both PPG25 and TAN15 may be material to decisions on planning applications and will be taken into account by the Planning Inspectorate (working on behalf of the ODPM) and the National Assembly of Wales in the determination of appeals and called-in applications. Further details are provided in Guidance Note D1.4 Planning Applications and Decisions.

### 27.3.2 When should FRAs be carried out?

Ideally, FRAs should be carried out after the LPA has carried out the Sequential Test and SFRA[407] for the area being considered. This enables the FRA to start from the pretext that the development will be permitted on the site and the assessment must demonstrate how the flood risk will be managed. Further details of this are given in the section below.

However, this is not always possible. Therefore, if a Developer is undertaking an FRA to accompany a planning application in these circumstances, the CIRIA best practice guidance (C624)[408] suggests that they undertake a coarse flood risk assessment (referred to as a Screening Study) based on similar criteria to the Sequential Test. This initial FRA is to review the choice of location at the outset, to decide if it is likely to be acceptable prior to conducting a more costly detailed assessment. Where any ambiguity exists at this stage, C624 recommends consultation with the Local Authorities. Ideally, the initial FRA would be carried out before the Developer purchases the land to prevent unnecessary expense.

### 27.3.3 What area does a FRA cover?

A development can range from a house extension to an area the size of Thames Gateway. The extent of a FRA is related to the scale and location of the development being considered. It is not limited to the boundary of the development itself, however, but by the hydraulic area of influence.

The hydraulic area of influence is the extent of any change in flow or flood level caused by the development, either upstream or downstream. Identification of the hydraulic area of influence needs to be determined on a case by case basis, based on model results.

Although mitigation measures might reduce the hydraulic area of influence and reduce the impact of the development on the surrounding area, the hydraulic area of influence alone does not determine whether a new development is acceptable or not. For example, if existing development falls within the hydraulic area of influence, the actual change in flood risk for the existing development caused by the change in flow or flood level should also be considered.

Figure 27.1 provides examples of the different scales of FRA that might be required, depending on the scale and location of the development. These examples have been illustrated on a hypothetical Flood Map, similar to that provided by the EA on their website.[409] It should be noted that in Wales that the TAN15 Development Advice Map should be used rather than the Flood Map for land use planning purposes.

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[407] See Guidance Note D3.4 Strategic Flood Risk Assessments
[408] Lancaster, J, Preene, M and Marshall, C (2004) *C624 Development and Flood Risk – Guidance for the Construction Industry*, CIRIA, London.
[409] http://maps.environment-agency.gov.uk/wiyby/

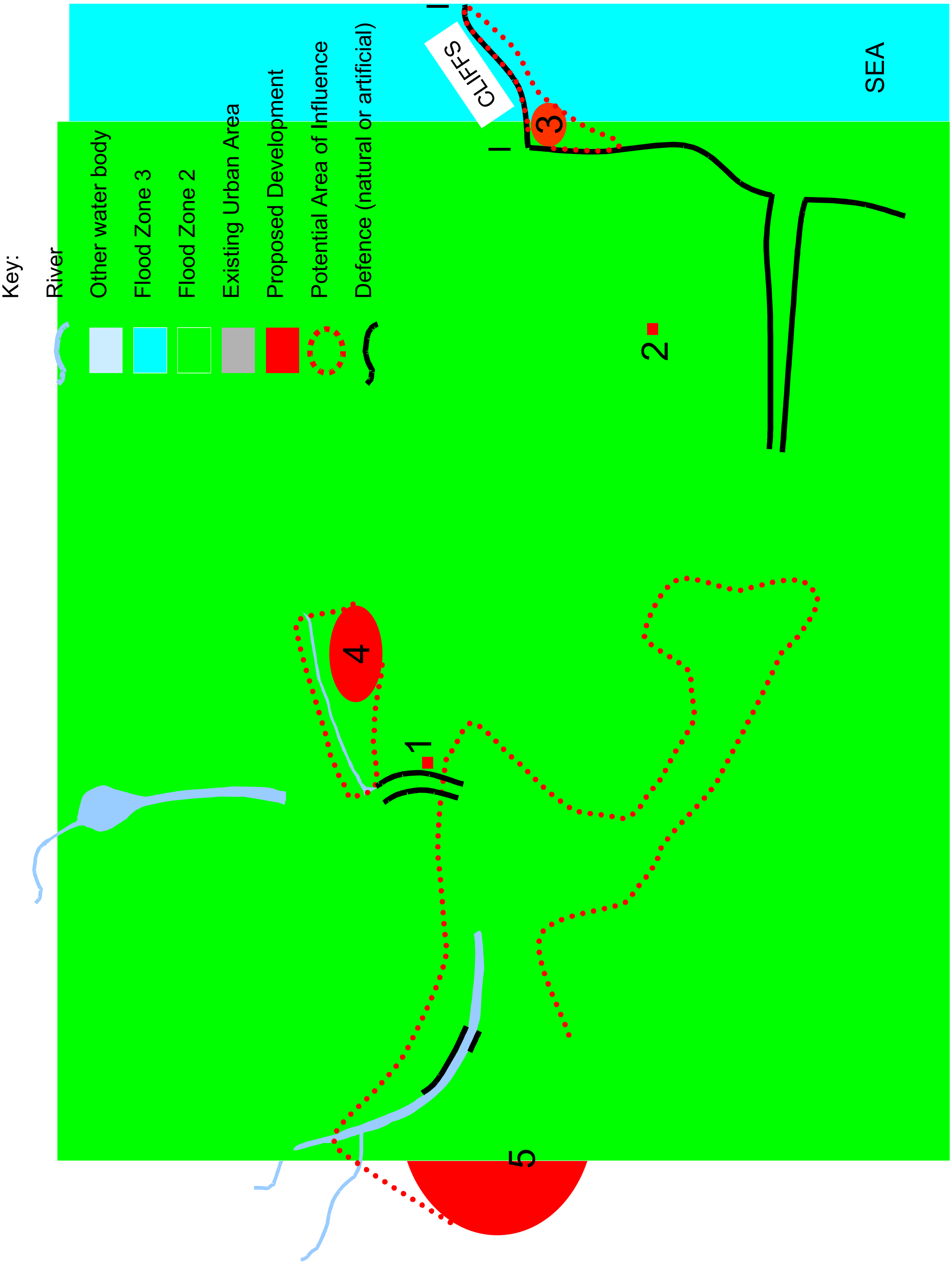


**Figure 27.1 Examples of FRA Scales**

Figure 27.2 then shows these developments in relation to the following boundaries:

- Catchment boundary, which defines the extent of the Catchment Flood Management Plan[410] (CFMP)
- Coastal cell, which defines the extent of the Shoreline Management Plan[411] (SMP)
- Administrative boundaries, which define the authorities responsible for development planning and development control and, therefore, define the extent of Local Development Frameworks[412] (LDFs) and which might also be used to define the extent of Strategic Flood Risk Assessments[413] (SFRAs)

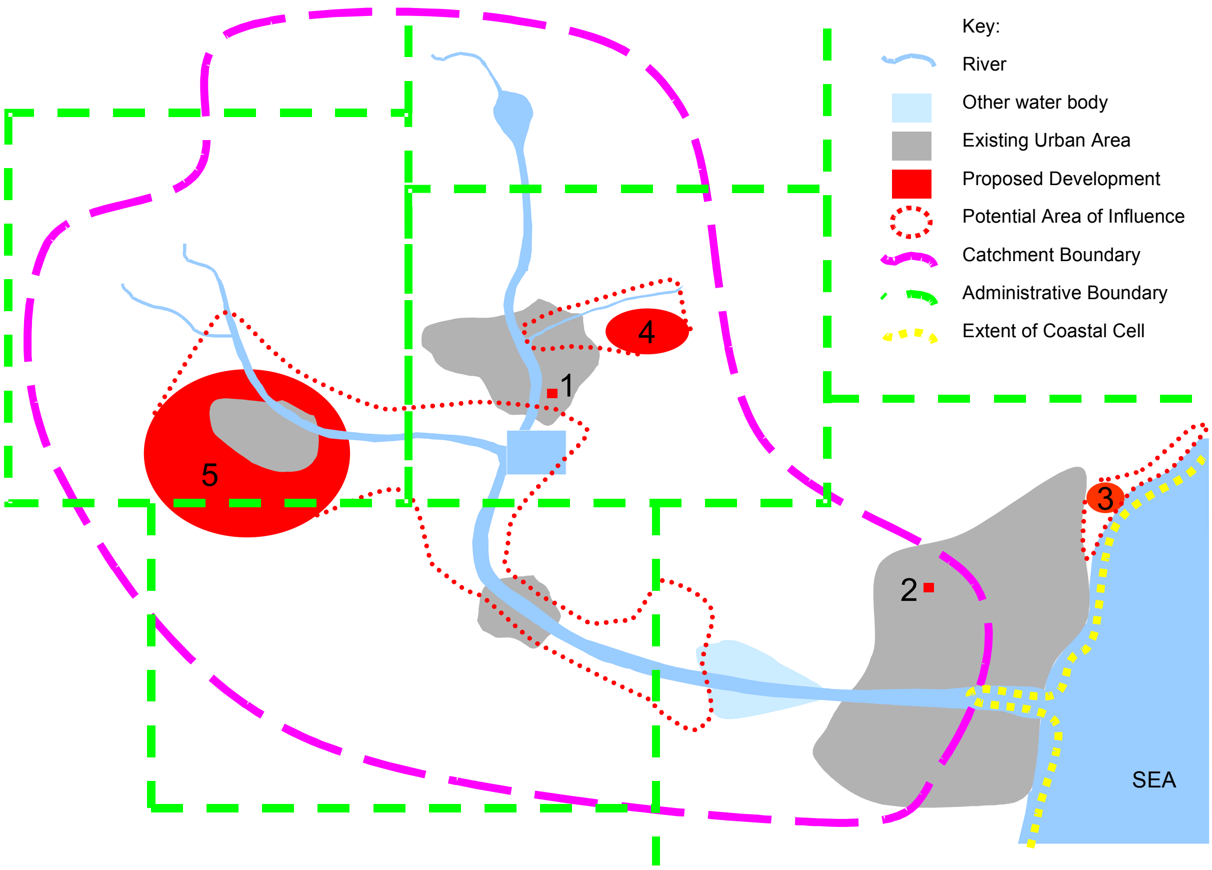


**Figure 27.2 Examples of Influencing Boundaries for FRAs**

Five different scales and locations of development are shown in Figure 27.1. These are described below.

- **Location 1 - A small development within Zone 3**[414] (i.e. within the 1% annual probability fluvial flood extent, ignoring defences). This development is at risk from river flooding, but protected by flood defences. It could also be susceptible to flooding from other sources including groundwater, overland flow or urban drainage. This development might fall within the green areas on the EA's

[410] See Guidance Note D3.2 Catchment Flood Management Plans
[411] See Guidance Note D3.3 Shoreline Management Plans
[412] See Guidance Note D1.3 Local Development Frameworks
[413] See Guidance Note D3.4 Strategic Flood Risk Assessments
[414] Zone 3a based on Table 1 in PPG25

Standing Advice Flood Risk Matrix (see Processes and Procedures), if it is less than 1 hectare as well as being in a reduced risk area (due to the defences).

- **Location 2 - A small development in Zone 1** (i.e. less than 0.1% annual probability of fluvial or tidal flooding). Although the development is outside the floodplain, it does not mean that there is no flood risk associated with the site. For example, there could be groundwater, overland flow or urban drainage flooding issues. Also, there are inherent inaccuracies in the flood maps (particularly in flat low-lying areas), which should be taken into consideration. This development is likely fall within the grey or green areas on the EA's Standing Advice Flood Risk Matrix.

- **Location 3 – A medium scale development in Zone 3**[415] (i.e. within the 0.5% annual probability tidal/coastal flood extent). This development is at risk from flooding from the sea and is unprotected, as it is positioned between the natural flood defence of the cliffs and the shoreline. The development itself and any new defences are likely to impact on the management of the shoreline in the vicinity (including coastal erosion and sediment movement) and consequences of flooding could be significant due to limited access and escape, etc. The SMP would be able to provide broad-scale information on flooding and coastal erosion management for this area. In addition, there could still be groundwater, overland flow or urban drainage flooding issues. This development falls within the red zone on the EA's Standing Advice Flood Risk Matrix.

- **Location 4 - A fairly large-scale development in Zone 1**, which may drain into a local watercourse, potentially impacting on both the local watercourse and the main river in the immediate vicinity of the confluence. This falls entirely within a single administrative boundary. Therefore, it involves only one LPA. This development would fall within the red areas on the EA's Standing Advice Flood Risk Matrix, which would require the LPA to consult with the EA. Due to its size, it is likely only to be permitted if the area is within a development zone identified in the LDF (or Local Plan). This should have been considered to a certain extent by a Strategic Flood Risk Assessment (SFRA) or at the very least by carrying out the Sequential Test, which would have covered the administrative area.[416]

- **Location 5 - A major new community with areas in Zones 1, 2 and 3** that without suitable measures to limit runoff could have an impact on a large section of the floodplain. Not only does the development cross over administrative boundaries, but the potential hydraulic area of influence crosses an additional boundary (see Figure 27.2). This development would fall within the red areas on the EA's Standing Advice Flood Risk Matrix, which would require the LPAs to consult with the EA. The decision to develop such a large new community will have been the result of a major housing allocation defined in the Regional Spatial Strategy[417] (RSS). The CFMP, covering the whole of the defined catchment area, (if completed) would be able to provide broad-scale information on flooding and information regarding the impact of such a land-use change might also be available. However, the RSS should have identified the need for a Sub-Regional Spatial Plan, which would require a SFRA covering more than one administrative area. This SFRA would enable the planning authorities to determine the 'least risk' location for the development, following the Sequential Test approach. This would be carried out prior to the FRA. The FRA would then be carried out for the proposed development and include detailed consideration of the required mitigation measures. If a sub-regional SFRA has not been carried out as part of the RSS and/or Local Development Framework, the requirements of the FRA are likely to be significantly more onerous.

[415] This development could potentially be in Zone 3c based on Table 1 in PPG25, in which case development should be wholly exceptional and limited to essential transport and utilities infrastructure.
[416] As described in PPG25
[417] See Guidance Note D1.2 Regional Spatial Strategies

## 27.4Data and Information

### 27.4.1 Information required for a FRA

The quantity of information required for a FRA depends on the level of assessment being undertaken (see Processes and Procedures) as summarised in the table below. Reference should be made to CIRIA guidance C624 for a more complete list and further details.

**Table 27.1 Typical Sources of Information**

| FRA Level | Typical Sources of Information |
|---|---|
| 1 | ▪ A review of national planning policy statements and guidance<br>▪ A review of any regional or local policy statements or guidance (e.g. Regional Spatial Strategies, Local Development Frameworks)<br>▪ Consultation with the LPA and EA to identify in broad terms what issues related to flood risk need to be considered<br>▪ A review of publicly available data and information regarding local conditions<br>▪ A review of existing assessments of flood risk available for the area (e.g. Catchment Flood Management Plans, Shoreline Management Plans, Strategic Flood Risk Assessments, etc.) |
| 2 | ▪ Walkover survey to assess:<br>    ▪ Potential sources of flooding<br>    ▪ Likely routes for flood waters<br>    ▪ The site's key features, including flood defences, and their condition<br>▪ Site survey to determine:<br>    ▪ General ground levels across the site<br>    ▪ Levels of any formal or informal flood defences relevant to the site<br>▪ Consultation with the LPA, EA and other bodies, which may have relevant information on flood risk<br>▪ Confirmation of the required standard of protection for the site<br>(For a full list see Appendix A2 of CIRIA guidance C624.) |
| 3 | ▪ Detailed topographical survey<br>▪ Detailed hydrographic survey<br>▪ Monitoring to assist with model calibration/verification<br>▪ Continued consultation with the LPA and EA<br>(Most information required for this level of assessment should have been collected during Level 1 and Level 2.) |

Further information regarding the suitability of this information and data for assessment purposes is described in the FLOWS WP1biii project *Modelling and Mapping of Flood Risk*, which is currently being undertaken by Atkins on behalf of the Environment Agency and is to be completed in 2005.

### 27.4.2 Information provided by a FRA

The planning policy guidance or statement relevant to the development's location in England or Wales should be referred to for exact details, but in general the following are the standard requirements for a detailed FRA to accompany a planning application.

*Plans and cross-sections*

1. A site location plan, including geographical features, street names and all water bodies.
2. A topographical plan of the existing site.
3. A topographical plan of the site post-development.
4. A plan identifying the location of existing defences or other flood alleviation measures, with reference to standards of protection and condition.
5. A plan of any structures that may influence hydraulic conditions at the site or the surrounding area, with reference to maintenance and operation.
6. A plan of available historic flood information, such as recorded levels, flood extent, dates, photos, etc. Any changes to the site since the last event should be identified.
7. A plan identifying safe access and exit routes.
8. Cross-sections of post-development finished floor and road levels relative to flood levels.

*Results*

1. Assessment of all potential sources of flooding.
2. Estimate of the volume of runoff likely to be generated by the development.
3. Assessment of the hydraulic performance of the artificial drainage (both storm and foul) system, whether existing or proposed.
4. Assessment of the frequency of flooding (existing and post-development).
5. Assessment of the sequence of flooding across the site, rate of rise of water level, flow velocities, depths and the duration of flood (existing and post-development).[418]
6. Assessment of change in conditions progressively away from the site boundary (both upstream and downstream), including volume of displaced water as well as flood levels.
7. Assessment of the potential impact on fluvial or coastal morphology and long-term stability and sustainability.
8. Assessment of the residual risks (including a review of items 3 to 6 above) after inclusion of any necessary mitigation measures. Where new or modified structural measures are provided, an assessment of their behaviour in extreme events greater than those for which they are designed should be provided.

### 27.4.3 General rules for all FRA reports[419]

- The report should be written in such a way as to be understandable for those who will be reading it and auditable for those who will be checking it.
- Sources of data and information should be documented and the reliability/authenticity of the information verified.

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[418] If a detailed assessment is being undertaken, this might include breach analysis. However, reference should be made to Guidance Note S3.2 Risk to People behind Defences where other options are available.

[419] Further details can be found in Guidance Note S2.1 Reporting

- Assessment methods adopted should be documented, including technical descriptions of any models used and their application. Where checklists, flow charts, etc. have been used these should be included in an appendix.
- Assumptions and uncertainties in data, assessment methods and results should be clearly identified and the precautionary approach adopted to manage such uncertainties should be explained.

## 27.5Roles and Responsibilities

Risk is the product of probability and consequence. In simple terms, if there is no development, there are no consequences and, therefore, no risk. This means that a new development in an area with a flood hazard will always increase the risk, if there are no additional flood management measures. It is the responsibility of those choosing to develop a site and, therefore, generating the risk to demonstrate how the risk will be managed. It is the responsibility of the relevant authorities to decide whether this is acceptable.

Therefore, there are three main parties involved in FRAs. These are:

- The Developer
- The Local Planning Authority
- The Environment Agency

These are not the only stakeholders within the process, but to ensure brevity and clarity these are the only ones referred to in the remainder of this guidance note. For details of other parties involved in flood risk and planning, refer to Section 4.3 in C624 and Guidance Note S2.4 Stakeholder Engagement.

The primary roles and responsibilities of the three main parties are summarised below:

- The Developer must determine/understand the extent of the flood risk at the site or caused by the site for which they wish to apply for planning permission. This includes a requirement to demonstrate how the flood risk associated with a proposed development will be managed.

- The LPA decides whether the risk would be managed to acceptable levels and decides whether the development can take place. In determining individual planning applications, it must take into account all material planning considerations, including the advice from the EA.

- The EA encourages best practices to be adopted for assessing the risk, managing the risk and deciding whether the risk is acceptable. The EA can choose to object to a planning application if it considers that a FRA has not been carried out appropriately or if it considers that the proposed development is not appropriate. The EA does not decide whether this risk is acceptable and, therefore, the development can take place. Instead, it provides advice to the LPA regarding generally recognised boundaries of acceptability, if they exist. Therefore, if it considers the LPA is making a decision that is outside these boundaries (hence the development is inappropriate), it can choose to object.

The LPA and EA responsibilities of providing available information/data and advice to the Developer are crucial in enabling the Developer to carry out the FRA as accurately as required and as efficiently as possible. Therefore, as stated above the Developer should involve both parties as early as possible in the assessment process. Early consultation should help to prevent the cost and disappointment for the Developer where an application is turned down by the LPA at a later stage in the process. It should also reduce the likelihood that the EA will object to the application.

When undertaking a site-specific FRA to accompany a planning application there are 5 roles performed by the 3 main parties as summarised below.

| | |
|---|---|
| **Undertake** | Carry out the process |
| **Inform** | Provide available information and data for those undertaking the process |
| **Advise** | Provide advice (either to those undertaking the process, checking the process or making a decision) regarding issues to be considered as part of the process and how to carry out the process |
| **Check** | Check that the process has been carried out appropriately and that the science/answers are correct |
| **Decide** | Decision point in the assessment process, needed to enable the process to proceed |

Who carries out each of these roles with respect to each part of the process is indicated in Table 27.5 of this guidance note.

### 27.5.1 Standing Advice

The EA has produced Standing Advice[420] for England to enable LPAs to make decisions on low risk planning applications where flood risk is an issue without directly consulting the EA for an individual response. It also identifies those higher risk development situations where case by case consultation with the EA should be sought.

It is based on a Flood Risk Matrix, which categorises applications based on development type, location and scale/size. If an application falls within a grey or green box, then Standing Advice is provided. If an application falls within a red box, then the application and accompanying FRA should be referred to the EA.

Therefore, in Table 27.5, the role '**Check**' has been split between developments that fall in a green or grey box and those that fall in a red box.

Similar advice for Wales, reflecting TAN15 requirements, is planned by the EA in the near future. In the meantime, when using Table 27.5, all developments should be considered as falling into a red box.

## 27.6Processes and Procedures

The best practice methodology for carrying out FRAs for planning applications is described in CIRIA guidance C624. It is recommended that reference is made to the CIRIA document, rather than relying on the information contained in this guidance note, which only provides an overview of the requirements.

The best practice methodology is a three tiered approach, as summarised in Table 27.2 below, similar to the generic approach for assessing and managing flood risk provided as part of the FD2320 framework. This approach allows proportionate effort with regard to the individual characteristics of the site.

All sites should carry out a Level 1 assessment. The results of this assessment will determine whether a more detailed assessment is required. The following will influence how many levels of assessment will have to be undertaken:

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[420] Environment Agency (2003) *National Standing Advice to Local Planning Authorities for Planning Applications - Development and Flood Risk*, Environment Agency. http://www.pipernetworking.com/floodrisk/index.html

- The nature of the flood hazard,
- The vulnerability of the proposed development,
- The potential impact of the development on flooding elsewhere, and
- The amount of existing information.

Table 27.3 summarises the links between the generic approach and the C624 methodology. Table 27.4 provides an interpretation of the generic approach for FRAs required for planning applications, by providing additional notes and milestones.

The Modelling and Mapping of Flood Risk project being carried out as part of FLOWS[421] provides a report that consolidates knowledge on best practice in modelling and mapping flood extent. This report also tackles the issue of acceptable levels of uncertainty and accuracy of different approaches.

**Table 27.2 Levels of FRA (courtesy of CIRIA)**

| FRA Level | Description |
|---|---|
| **1** | **Screening study** to identify whether there are any flooding issues related to the development site that may warrant further consideration. |
| **2** | **Scoping study** to be undertaken if the Level 1 study indicates that the site may lie within an area that is at risk of flooding or that the site may increase flood risk due to increased runoff, to confirm the possible sources of flooding that may affect the site. The study should include the following objectives:<br>▪ Assessment of the availability and adequacy of existing information;<br>▪ Qualitative assessment of the flood risk to the site, and the impact of the site on flood risk elsewhere;<br>▪ Assessment of the possible scope for appropriate development design and to scope additional work required. |
| **3** | **Detailed study** to be undertaken if the Level 2 study concludes that quantitative analysis is required to assess flood risk issues related to the development site. The study should include:<br>▪ Quantitative assessment of the potential flood risk to the development;<br>▪ Quantitative assessment of the potential impact of the development on flood risk elsewhere;<br>▪ Quantitative demonstration of the effectiveness of any proposed mitigation measures. |

[421] FLOWS WP1biii project *Modelling and Mapping of Flood Risk*

## 27.7 Tools and Technologies

### 27.7.1 Checking local development policies

A growing number of Local Plans and LDFs can be accessed via the planning portal website.[422]

### 27.7.2 Determining which level of FRA is required

In addition to providing guidance on how to carry out FRAs, C624 includes a Flood Risk Assessment Toolkit[423], which consists of:

- Flowchart 1, which takes users through the steps of a Level 1 FRA
- Flowchart 2, which takes users through the steps of a Level 2 FRA
- Flowchart 3, which takes users through the steps of a Level 3 FRA

If these flowcharts are followed then the FRA process can be taken to the appropriate level of detail.

C624 also provides a table[424] that can be used to summarise the results from a Level 1 FRA and descriptions and examples[425] of how to apply each level of assessment depending on circumstances.

### 27.7.3 Choosing appropriate analysis techniques

- C624 provides guidance on a variety of techniques that can be used to assess flood risk in a range of situations.

- The Modelling and Mapping of Flood Risk project being carried out as part of FLOWS[426] is currently developing a simple matrix or lookup table to enable users at a quick glance to see the acceptable levels of uncertainty for different scales and types of development.

- A recently completed Defra/EA R&D project has carried out a benchmarking study of hydraulic river modelling software packages.[427]

- The EA is currently writing guidance that sets out preferred modelling approaches for FRAs.[428]

- Guidance aimed at Regulators, Developers and LPAs to advise on the management of stormwater drainage for developments and in particular to assist in sizing of storage elements for the control and treatment of stormwater runoff[429] has been developed into a simple spreadsheet for use by EA staff.

- Guidance Note S3.2 Risk to People behind Defences provides simple lookup tables that can be used as a guide to the danger to people at various distances behind flood defences for overtopping and breaching respectively (assuming that either will occur during the lifetime of the development).

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[422] A list of the plans currently available online (or will be available soon) can be found at the following address: http://www.planningportal.gov.uk/england/professionals/en/1106655528620.html
[423] See C624 Section 6 *Flood Risk Assessment Toolkit*. This is currently available to download free of charge from the CIRIA website.
[424] see C624 Table A2.1 *Level 1 FRA Summary*
[425] see C624 Appendix A2 *Technical Guidance on Flood Risk Assessment*
[426] FLOWS WP1biii project *Modelling and Mapping of Flood Risk*
[427] Crowder *et al* (2004) *Benchmarking of hydraulic river modelling software packages, Project Overview*, R&D Technical Report W5-105/TR0
[428] This is initially intended as internal guidance for the EA, but the intention is that this would eventually form external guidance.
[429] HR Wallingford (2004) *Preliminary rainfall runoff management for developments* R&D Technical Report W5-074/A, Environment Agency, February 2004

- Guidance Note S3.3 Safe Access and Exit provides a simple look up table that can be used as a guide to the danger to people at various flood depths and flow velocities.

### 27.7.4 Determining monitoring and review requirements

- A risk register, such as that recommended in C624 Appendix A5, can be used to systematically define the operational, maintenance, monitoring and public information (including signage) requirements. This should include pro-active and remedial actions and responsibilities.

### 27.7.5 Checking whether the FRA has been carried out appropriately

- The Milestone Points provided in Table 27.4 of this guidance note give minimum requirements for each of the processes.[430] If these have not been reached, this would provide an indication that either insufficient information has been provided with the Planning Application or the FRA has not been carried out appropriately.

- The Assessment Check-List for the generic approach can be applied to FRAs to determine how well the assessment complies with best-practice.

### 27.7.6 Checking whether the development is likely to be suitable

- Checklist A of the toolkit in C624, can be used to check the key issues when deciding whether a development is likely to be suitable in flood risk terms. This should be used in conjunction with PPG25 in England and TAN15 in Wales.

## 27.8Audit and Control

The following tools described above form part of the audit and control process:

- Milestone Points in Table 27.4
- The Assessment Check-List
- Checklist A from C624

Further details of the recommended auditing and control process can be found in Guidance Note S2.3 Auditing and Control.

[430] Further information regarding milestone points and how these should be applied can be found in Guidance Note S2.3 Auditing and Control

**Table 27.3 Summary of the FRA methodology as detailed in CIRIA guidance C624**

| GENERIC APPROACH | C624 FRA METHODOLOGY | | |
|---|---|---|---|
| | **Level 1 FRA** | **Level 2 FRA** | **Level 3 FRA** |
| **Process 1 – Problem Formulation** | | | |
| 1.1 Define intention | ● | | |
| 1.2 Justify intention | ● | | |
| 1.3 Set boundaries | ● | | |
| 1.4 Identify controlling factors | ● | | |
| 1.5 Develop conceptual model | ● | | |
| **Process 2a – Tiered Risk Assessment** | | | |
| 2a.1 Carry out coarse assessment | ● | | |
| 2a.2 Prioritise risks | | ● | |
| 2a.3 Carry out intermediate assessment | | ● | |
| 2a.4 Carry out detailed assessment | | | ● |
| **Process 2b – Stages of Risk Assessment** | | | |
| 2b.1 Identify hazards | ● | ● | ● |
| 2b.2 Identify consequences | ● | ● | ● |
| 2b.3 Determine magnitude of consequences | ● | ● | ● |
| 2b.4 Determine probability of consequences | ● | ● | ● |
| 2b.5 Determine significance of risk | ● | ● | ● |
| **Process 3 – Options Appraisal** | | | |
| 3.1 Identify options | ● | ● | ● |
| 3.2 Trade-off analysis | ● | ● | ● |
| 3.3 Apply risk assessment to options | | ● | ● |
| 3.4 Review options | | ● | ● |
| 3.5 Revisit trade-off analysis (if required) | | ● | ● |
| 3.6 Select preferred option | ● | ● | ● |
| **Process 4 – Monitoring and Review** | This process is not detailed in C624, but is still required for the management of the residual flood risk during the life-time of the development. | | |
| 4.1 Decide what to monitor | | | |
| 4.2 Design monitoring programme | | | |
| 4.3 Carry out monitoring | | | |
| 4.4 Review monitoring results | | | |
| 4.5 Report any lessons learnt | | | |
| 4.6 Review monitoring programme | | | |

● Indicates a match between the generic approach and the C624 methodology

**Table 27.4 Interpretation of the generic approach for FRAs for planning applications**

This table should be read in conjunction with the generic approach illustrated on the Activity Chart. If using the digital version of this table, it is possible to click on the relevant process heading to jump to the appropriate box.
Notes in red refer to PPG25, as used in England. Notes in green refer to TAN15, as used in Wales.

| | FRA Level 1 | FRA Level 2 | FRA Level 3 | **Notes of specific relevance to Planning Applications**<br>These notes should be read **in addition** to the tasks provided with the generic assessment processes (see Activity Chart Overview). | **Milestone Point** |
|---|---|---|---|---|---|
| **Process 1 – Problem Formulation** | | | | | |
| 1.1 Define intention | ● | | | What is the proposed purpose of the development? What is the development category?<br>What is the purpose of the FRA?<br>Who might have an interest in the outcome of the FRA or the development? | The following should be provided **as a minimum** before proceeding to Process 2a:<br>1. A plan showing the location of the site relative to existing development<br>2. A site survey, including a plan with levels (App F items 1 & 2) (App A item 1 – in part only, item 2)<br>3. Details of development type and number of units or occupancy<br>4. Compelling reasons for the development have been identified and agreed with the LPA on sustainability grounds. This may be inferred from the LDF, if the development site is located within the designated development areas. (The LDF having been based on a Sequential Test) (Section 6 'Justification Test')<br>5. All controlling factors, such as local bylaw conditions for Main Rivers, proximity to Ordinary Watercourses, protected habitats, etc. have been identified and appropriately taken into consideration |
| 1.2 Justify intention | ● | | | Is the site within a development area as defined by the LDF?<br>If not, is it likely that the development would have a case on social, economic and/or environmental grounds?<br>Should the answers to both be 'no', it might be recommended that the Developer proceed no further with the planning application.<br>Is the development in conflict with the flood management objectives for the area?<br>If so, it might be recommended that the Developer proceed no further with the planning application. | |
| 1.3 Set boundaries | ● | | | Has the extent of the area that will need consideration in the FRA been defined (incl. both the site itself and an initial estimate of the hydraulic area of influence)? | |
| 1.4 Identify controlling factors | ● | | | Does the LDF or LPA specify any planning constraints at the site?<br>Is the development likely to have a significant effect on the environment and, therefore, an Environmental Impact Assessment will also be required? | |
| 1.5 Develop conceptual model | ● | | | The conceptual model presents the hypothetical risk components and their relationships. The conceptual model should include possible sources, receptors and pathways. Actual sources, receptors and pathways will be identified during Process 2a. | |

**Table 27.4 Interpretation of the generic approach for FRAs for planning applications continued**

This table should be read in conjunction with the generic approach illustrated on the Activity Chart. If using the digital version of this table, it is possible to click on the relevant process heading to jump to the appropriate box.
Notes in red refer to PPG25, as used in England. Notes in green refer to TAN15, as used in Wales.

| | FRA Level 1 | FRA Level 2 | FRA Level 3 | **Notes of specific relevance to Planning Applications**<br>These notes should be read **in addition** to the tasks provided with the generic assessment processes (see Activity Chart Overview). | **Milestone Point** |
|---|---|---|---|---|---|
| **Process 2a – Tiered Risk Assessment** | | | | | |
| 2a.1 Carry out coarse assessment | ● | | | C624 Level 1 Screening Study<br>Go to Process 2b. | The following should be provided **as a minimum** before proceeding to Process 3:<br>1. A coarse assessment for ALL SITES (see C624 regarding Level 1 Screening Study)<br>2. An intermediate assessment for ALL SITES WITH FLOOD RISK, as identified by the coarse assessment (see C624 regarding Level 2 Scoping Study)<br>3. A detailed assessment for ANY SITE REQUIRING A QUANTITATIVE ASSESSMENT (due to existing information not being adequate), as determined by the intermediate assessment (see C624 regarding Level 3 Detailed Study)<br>See C624 Section 5.3 Flood Risk Assessment Methodology for details of best practice.<br>NOTE: If a SFRA has not been carried out, the likelihood of a Level 3 FRA being required is higher than if a SFRA has been carried out. Larger developments are also more likely to require a Level 3 FRA. However, these are not the only criteria; the type of receptor and potential consequences are also important and reference should be made to C624. |
| 2a.2 Prioritise risks | ● | | | Can certain risks be confirmed as non-existent at this stage to require no further investigation?<br>Which risks might be present and, therefore, require further assessment? (See Process 2b) | |
| *Decision: Sufficient information for intention?* | ● | | | *Are all risks sufficiently low either to require no further investigation or enable a precautionary decision to be applied with confidence, yet remain cost-effective?* | |
| 2a.3 Carry out intermediate assessment | | ● | | C624 Level 2 Scoping Study<br>Go to Process 2b except not required if sufficient information is obtained in the Level 1 Screening Study. | |
| *Decision: Sufficient information for intention?* | | ● | | *Are all risks quantified sufficiently to enable a precautionary decision to be applied with confidence, yet remain cost-effective?* (See Process 2b) | |
| 2a.4 Carry out detailed assessment | | | ● | C624 Level 3 Detailed Study<br>Go to Process 2b except not required if sufficient information is obtained in the Level 2 Scoping Study. | |

**Table 27.4 Interpretation of the generic approach for FRAs for planning applications continued**

This table should be read in conjunction with the generic approach illustrated on the Activity Chart. If using the digital version of this table, it is possible to click on the relevant process heading to jump to the appropriate box.
Notes in red refer to PPG25, as used in England. Notes in green refer to TAN15, as used in Wales.

<table>
<tr><th></th><th>FRA Level 1</th><th>FRA Level 2</th><th>FRA Level 3</th><th>Notes of specific relevance to Planning Applications<br>These notes should be read in addition to the tasks provided with the generic assessment processes (see Activity Chart Overview).</th><th>Milestone Point</th></tr>
<tr><td colspan="6">Process 2b – Stages of Risk Assessment</td></tr>
<tr><td>2b.1 Identify hazards</td><td>●</td><td>●</td><td>●</td><td>What are the potential types of flooding that might effect the site?<br>What are the potential types of flooding that the development might cause?<br>This process part is revisited at Level 2 at which point the different types of hazard should be sufficiently understood not to require revisiting again at Level 3.</td><td rowspan="4">The following should be provided as a minimum at each level of assessment:<br>Level 1 FRA<br>1. Identification of all potential sources of flooding (App F item 4) (App A item 5)<br>2. Assessment of existing and proposed drainage (App F item 10) (App A item 11)<br>3. Assessment of the likely impact of runoff from the development site (App F item 11) (App A item 12)<br>Level 2 FRA (in addition to the above)<br>4. Details of any existing defences and local structures – location, condition and standard of protection (App F item 3) (App A item 3)<br>5. Details of all known historical flood events (App F item 5) (App A item 6)<br>6. Details of any local structures – location, condition and hydraulic performance (App F item 6) (App A item 7)<br>7. Assessment of the probability of extent and depth of flooding (App F item 7) (App A item 8)<br>8. Cross-section showing flood levels (App F item 8) (App A item 9)<br>Level 3 FRA (in addition to the above)<br>9. Assessment of speed and route of flood flows (App F item 7) (App A item 8)<br>10. Assessment of speed of onset duration and impact (App F item 9) (App A item 10)<br>11. Assessment of impact of displaced water (App F item 12) (App A item 13)<br>12. Assessment of impact on morphology and sustainability (App F item 13) (App A item 14)<br>13. Assessment of impact of climate change (App F item 14) (App A item 15)<br>Reference should be made to C624 for details of best practice at each level. See Section 6 Flood Risk Assessment Toolkit and refer to Flowchart 1, 2 or 3 depending on which level of assessment is being carried out.<br>These notes should also be read in conjunction with AMS Document 111_04 FRA Checklist and AMS Document 112_04 Flood Risk Assessments Matrix.</td></tr>
<tr><td>2b.2 Identify consequences</td><td>●</td><td>●</td><td>●</td><td>What might be effected should flooding occur?<br>This process part is revisited at Level 2 at which point the different types of consequences should be sufficiently understood not to require revisiting again at Level 3.</td></tr>
<tr><td>2b.3 Determine magnitude of consequences</td><td>●</td><td>●</td><td>●</td><td>What would be the scale of the effects of flooding, if it did occur?</td></tr>
<tr><td>2b.4 Determine probability of consequences</td><td>●</td><td>●</td><td>●</td><td>What is the likelihood that flooding will occur?<br>What is the likelihood that there will be negative effects should flooding occur? (Issues include risk to life, property and the environment, disruption to commerce, etc.) This would be answered more fully in a Level 3 assessment than a Level 2 assessment.</td></tr>
<tr><td>2b.5 Determine significance of risk</td><td>●</td><td>●</td><td>●</td><td>Revisit the acceptability criteria defined during Process 1.3.<br>How is the risk (i.e. probability * consequences) perceived by society and the individual as regards acceptability? Are people willing to live with the likelihood of flooding occurring to this extent and are people willing to live with the consequences should the flooding occur? (Issues include insurability of properties.)<br>This is achieved by comparing risks with baseline conditions and with available standards and consultation with stakeholders.</td><td>The following should be provided as a minimum before proceeding to Process 3:<br>1. Comparison of risks with agreed baseline conditions and available standards</td></tr>
</table>

**Table 27.4 Interpretation of the generic approach for FRAs for planning applications continued**

This table should be read in conjunction with the generic approach illustrated on the Activity Chart. If using the digital version of this table, it is possible to click on the relevant process heading to jump to the appropriate box.
Notes in red refer to PPG25, as used in England. Notes in green refer to TAN15, as used in Wales.

| | FRA Level 1 | FRA Level 2 | FRA Level 3 | **Notes of specific relevance to Planning Applications**<br>These notes should be read **in addition** to the tasks provided with the generic assessment processes (see Activity Chart Overview). | **Milestone Point** |
|---|---|---|---|---|---|
| **Process 3 – Options Appraisal** | | | | | |
| 3.1 Identify options | ● | ● | ● | Refer to<br>▪ Guidance Document S3.5 Mitigation Measures<br>▪ C624 Appendix A3 Mitigation measures for flood risk management<br>▪ Preliminary rainfall runoff management for developments R&D Technical Report W5-074/A | The following should be provided **as a minimum** before proceeding to Process 4:<br>1. Plan showing access and evacuation routes (App A item 4)<br>2. All controlling factors, such as main river bylaw conditions, protected habitats, etc. have been appropriately taken into consideration<br>3. Assessment of residual risks (App F item 15) (App A item 16)<br>4. A comparison between residual risks and baseline conditions.<br>5. A comparison between residual risks and agreed acceptability criteria.<br>6. Should mitigation measures be required as part of the development, full details of these measures are also required. |
| 3.2 Evaluate options | ● | ● | ● | Selection of an appropriate trade-off analysis (such as cost-benefit analysis or multi-criteria analysis) will depend on the agreed flood risk indicators (see Guidance Document D2.1 Flood Risk Indicators) and acceptability criteria, as defined during Process 1.3.<br>Depending on the proposed development, this might include an Environmental Impact Assessment.<br>C624 Checklist A can be used to check the key issues when deciding whether a development is likely to be suitable in flood risk terms. | |
| *Decision: Sufficient information for intention?* | | | | | |
| *Decision: Is residual risk acceptable?* | | | | In many cases this question cannot be answered without carrying out Process 3.3, in which case the answer to the previous questions 'Sufficient information for intention' should have been 'no'. | |
| 3.3 Apply risk assessment to options | | ● | ● | Revisit Process 2a in order to assess residual risk. This will commence at whichever level of assessment was reached previously, but may subsequently proceed to a more detailed level depending on the impact of the proposed development and any mitigation measures on the flood risk. | |
| *Decision: Is residual risk acceptable?* | | | | Compare with acceptability criteria initially defined in Process 1.3 and refined in Process 2b.5. | |
| 3.4 Review options | | ● | ● | Based on improved information, review Process 3.1 | |
| 3.5 Re-evaluate options (if required) | | ● | ● | Based on improved information, review Process 3.2 | |
| 3.6 Select preferred option | ● | ● | ● | This process concludes with the Developer submitting their full Planning Application and the LPA determining the application.<br>Check C624 Appendix A3 and Checklist A. | |

**Table 27.4 Interpretation of the generic approach for FRAs for planning applications continued**

This table should be read in conjunction with the generic approach illustrated on the Activity Chart. If using the digital version of this table, it is possible to click on the relevant process heading to jump to the appropriate box.
Notes in red refer to PPG25, as used in England. Notes in green refer to TAN15, as used in Wales.

| | FRA Level 1 | FRA Level 2 | FRA Level 3 | **Notes of specific relevance to Planning Applications**<br>These notes should be read **in addition** to the tasks provided with the generic assessment processes (see Activity Chart Overview). | **Milestone Point** |
|---|---|---|---|---|---|
| **Process 4 – Monitoring and Review** | | | | | |
| 4.1 Decide what to monitor | | | | Are there any maintenance or operational issues that might effect the residual risk?<br>Is there a need to confirm that the assessment and management options are meeting their desired aims?<br>Is there a need for an alert mechanism if adverse impacts occur? | This process is not usually required to determine whether a development can go ahead. However, this process is required for the management of the residual flood risk within the life-time of the development. This includes consideration of duty of care under the Health and Safety at Work etc. Act (see Guidance Note S2.5 Linkage to Statutory Requirements and refer to Appendix G in PPG25). Therefore, it should be carried out in time to influence the constraints imposed on the development as part of the determination.<br>Examples of when this process will be particularly important include:<br>▪ Developments behind defences, as the defences will require maintenance and will deteriorate over time.<br>▪ Developments with a residual flood risk that is sensitive to climate change.<br>▪ Developments with SUDS, as inadequate maintenance could increase flood risk to the development itself or to the surrounding area and have water quality implications.<br>▪ Developments where flood warning will be used to provide additional protection against the residual risk. |
| 4.2 Design monitoring programme | | | | This should include the production of a risk register (see C624 Appendix A5) | This process can be carried out after the determination of the Planning Application, but before completion of the detailed design. |
| 4.3 Carry out monitoring | | | | Who carries out the monitoring depends on the purpose of the monitoring. | These processes are carried out during the life-time of the development. |
| 4.4 Review monitoring results | | | | Who reviews the monitoring depends who has carried out the monitoring and who is responsible for any remedial actions. | |
| *Decision: Are results usable?* | | | | Carry out quality control checks of the data. | |
| *Decision: Are results acceptable?* | | | | Compare with standards for compliance as decided in Process 4.2.<br>If the results indicate that the residual risk is not acceptable, then it will be necessary to review the need for a new assessment of flood risk. Hence, the need to go back to Process 1. | |
| 4.5 Report any lessons learnt | | | | Carry out any remedial actions that can be identified without a new assessment, as identified in Process 4.2.<br>Provide information to improve practices in the future. | |
| 4.6 Review monitoring programme | | | | Depending on the quality control checks of the data and the results provided from the monitoring, decide whether the monitoring is effective and modify accordingly. | |
| *Decision: Is monitoring still needed?* | | | | During the life-time of the development, it is unlikely that monitoring will be no longer needed unless the residual risk has reduced. Identification of this reduction in residual risk, however, may require a new assessment of flood risk. | |

**Table 27.5 Summary of roles and responsibilities for FRAs for planning applications**

This table should be read in conjunction with the generic approach illustrated on the Activity Chart. If using the digital version of this table, it is possible to click on the relevant process heading to jump to the appropriate box.
Note: * Box colour on the EA's Standing Advice Matrix (relevant to England only, for Wales only consider 'Red' box)

| | Undertake | Inform | Advise | Check | | Decide | Responsibilities | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Red* | Green/ Grey* | | D - Developer | P - Local Planning Authority | A - Environment Agency |
| **Process 1 – Problem Formulation** | | | | | | | | | |
| 1.1 Define intention | D | A | A | A | P | D P | • Define purpose, location and scale of development (including number of units)<br>• Provide a location plan<br>• Carry out site survey and provide a report | • Check that a location plan and site survey have been provided<br>• Check development category (i.e. size and usage)<br>• Check flood risk zone<br>• Check whether the development falls within a red box on the Flood Risk Matrix<br>• Decide whether to refer the FRA to the EA (referral recommended if the development within a red box on the Flood Risk Matrix) | • Provide flood mapping<br>• Provide advice regarding EA policies on flood risk in the area in question<br>• If FRA has been referred to the EA,<br>  • Check development category (i.e. size and usage)<br>  • Check flood risk zone |
| 1.2 Justify intention | D | P A | A | | | D | • Consult with LPA and refer to the Local Development Framework (or Local Plan)<br>• Compare development with sustainability and flood management objectives for the area | • Make available Local Development Framework Documents (or Structure Plans and Local Plans), including any supplementary planning guidance<br>• Make available the Strategic Flood Risk Assessment (SFRA)<br>• Inform developer of known sustainability objectives (incl. Community Strategies)<br>• Check that there are compelling reasons for the development to go ahead | • Provide Flood Risk Policy Statement<br>• Provide information of known flood management objectives, based on a Catchment Flood Management Plan (CFMP) or Shoreline Management Plan (SMP)<br>• Advise on sustainability measures |
| 1.3 Set boundaries | D | | P A | | | D P | • Define life-time of development<br>• Define realistic programme for FRA<br>• Assess need for external resources, such as specialist Consultants<br>• Estimate spatial extent of FRA | • Advise developer of likely weight of decision to which the FRA will contribute<br>• Decide which flood risk indicators and acceptability criteria to be used (initial decision) | • Advise on likely spatial extent of FRA required<br>• Advise on flood risk indicators and acceptability criteria to be used (initial view only) |

**Table 27.5 Summary of roles and responsibilities for FRAs for planning applications continued**

This table should be read in conjunction with the generic approach illustrated on the Activity Chart. If using the digital version of this table, it is possible to click on the relevant process heading to jump to the appropriate box.
Note: * Box colour on the EA's Standing Advice Matrix (relevant to England only, for Wales only consider 'Red' box)

| | Undertake | Inform | Advise | Check | | Decide | Responsibilities | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Red* | Green/ Grey* | | D - Developer | P - Local Planning Authority | A - Environment Agency |
| **Process 1 – Problem Formulation** | | | | | | | | | |
| 1.4 Identify controlling factors | D | P A | P A | A | P | D | • Check legislative requirements<br>• Estimate cost of FRA<br>• Check environmental objectives, problems and opportunities with the EA<br>• Check flood management strategy with relevant Flood Defence Authorities<br>• Check location relative to main rivers<br>• Identify stakeholder requirements and plan necessary involvement<br>• Identify any other potential controlling factors | • Inform developer of existing planning constraints<br>• Advise developer of legislative requirements<br>• Advise developer of likely stakeholder requirements (including the public)<br>• Check location relative to main rivers<br>• Check for other controlling factors known to the LPA<br>• Advise on likely need for an Environmental Impact Assessment (EIA) | • Inform developer of known environmental objectives and problems<br>• Inform developer of main river by-law constraints<br>• Inform developer of defence access requirements<br>• Inform developer of other potential flood defence requirements, such as standard of protection, freeboard, etc.<br>• If the FRA has been referred to the EA<br>  • Check location relative to main river<br>  • Check for other controlling factors know to the EA |
| 1.5 Develop conceptual model | D | | A | | | P | • Identify hypothetical flood risk components<br>• Relate components<br>• Identify potential consequences<br>• Identify areas of uncertainty and assumptions<br>• Get agreement for baseline conditions from LPA | • Decide baseline conditions | • Advise on likely flood risk components |
| **Process 2a – Tiered Risk Assessment** | | | | | | | | | |
| 2a.1 Carry out coarse assessment<br>*Level 1 Screening Study* | D | P A | A | A | P | D | • Obtain available information from LPA, EA and others, e.g. Internal Drainage Boards, sewerage undertakers, British Waterways, etc. (see C624 Table A2.2 for information that might held by organisations)<br>• Carry out Level 1 Screening Study (see C624 Flowchart 1)<br>• Decide whether to proceed further with the planning application | • Provide available information (see C624 Table A2.2 for information held by the LPA that can be used for this level of assessment)<br>• If using Standing Advice, check the following:<br>  • All potential sources of information have been used to identify hazards<br>  • Existing and proposed drainage have been identified<br>  • All types of flood risk have been identified | • Provide available information (See C624 Table A2.2 for information held by the EA that can be used for this level of assessment)<br>• Provide advice regarding EA requirements for this level of assessment<br>• Provide advice on general approach<br>• If the FRA has been referred to the EA, check the following:<br>  • All potential sources of information have been used to identify hazards<br>  • Existing and proposed drainage have been identified<br>  • All types of flood risk have been identified |

**Table 27.5 Summary of roles and responsibilities for FRAs for planning applications continued**

This table should be read in conjunction with the generic approach illustrated on the Activity Chart. If using the digital version of this table, it is possible to click on the relevant process heading to jump to the appropriate box.
Note: * Box colour on the EA's Standing Advice Matrix (relevant to England only, for Wales only consider 'Red' box)

| | Undertake | Inform | Advise | Check | | Decide | Responsibilities | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Red* | Green/ Grey* | | D - Developer | P - Local Planning Authority | A - Environment Agency |
| **Process 2a – Tiered Risk Assessment** | | | | | | | | | |
| 2a.2 Prioritise risks | D | | A | A | P | | • Determine which risks need further assessment | • If using Standing Advice, check risks needing further assessment have been correctly identified | • Provide advice regarding whether certain risks require further assessment<br>• If the FRA has been referred to the EA, check risks needing further assessment have been correctly identified |
| *Decision: Sufficient information for intention?* | D | | A | A | P | P | • Consult with LPA and EA<br>• If there is no need to proceed to a Level 2 assessment, proceed to Process 3 | • If using Standing Advice, check that an appropriate decision has been made regarding whether to continue to a Level 2 assessment<br>• Decide whether all risks are sufficiently low to require no further investigation or a precautionary decision can be applied with confidence | • If the FRA has been referred to the EA, check that an appropriate decision has been made regarding whether to continue to a Level 2 assessment<br>• Provide advice regarding whether all risks are sufficiently low either to require no further investigation or enable a precautionary solution to be applied to mitigate the risk |
| 2a.3 Carry out intermediate assessment<br>*Level 2 Scoping Study*<br>(Not required if sufficient information is obtained in the coarse assessment) | D | P A | A | A | P | D | • Obtain available information from LPA, EA and others (see C624 Table A2.2 and Section 5.3.4)<br>• Carry out Level 2 Scoping Study (see C624 Flowchart 2)<br>• Decide whether to proceed further with the planning application | • Provide available information (see C624 Table A2.2 for information held by the LPA that can be used for this level of assessment, also see Section 5.3.4)<br>• If using Standing Advice, check that all types of flood risk have been quantified or a need to progress to a Level 3 assessment has been identified | • Provide available information (See C624 Table A2.2 for information held by the EA that can be used for this level of assessment, also see Section 5.3.5)<br>• Provide advice regarding EA requirements for this level of assessment<br>• If the FRA has been referred to the EA, check that all types of flood risk have been quantified or a need to progress to a Level 3 assessment has been identified |
| *Decision: Sufficient information for intention?* | D | | A | A | P | P | • Consult with LPA and EA<br>• If there is no need to proceed to a Level 3 assessment, proceed to Process 3 | • If using Standing Advice, check that an appropriate decision has been made regarding whether to continue to a Level 3 assessment<br>• Decide whether all risks are quantified sufficiently to enable a precautionary decision to be applied with confidence | • Provide advice regarding whether all risks are quantified sufficiently to enable a precautionary solution to be applied to mitigate the risk<br>• If the FRA has been referred to the EA, check that an appropriate decision has been made regarding whether to continue to a Level 3 assessment |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 2a.4 Carry out detailed assessment<br>*Level 3 Detailed Assessment*<br>(Not required if sufficient information is obtained in the intermediate assessment) | D | P A | A | A | P | D | • Obtain available information from LPA, EA and others (see C624 Section 5.3.5)<br>• Carry out Level 3 Detailed Study (see C624 Flowchart 2)<br>• Decide whether to proceed further with the planning application<br>• Proceed to Process 3 | • Provide available information (see C624 Table A2.2 for information held by the LPA that can be used for this level of assessment, also see Section 5.3.4)<br>• If using Standing Advice, check that all types of flood risk have been quantified with the degree of uncertainty identified | • Provide available information (See C624 Table A2.2 for information held by the EA that can be used for this level of assessment, also see Section 5.3.5)<br>• Provide advice regarding EA requirements for this level of assessment<br>• If the FRA has been referred to the EA, check that all types of flood risk have been quantified with the degree of uncertainty identified |

**Table 27.5 Summary of roles and responsibilities for FRAs for planning applications continued**

This table should be read in conjunction with the generic approach illustrated on the Activity Chart. If using the digital version of this table, it is possible to click on the relevant process heading to jump to the appropriate box.
Note: * Box colour on the EA's Standing Advice Matrix (relevant to England only, for Wales only consider 'Red' box)

| | Undertake | Inform | Advise | Check | | Decide | Responsibilities | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Red* | Green/ Grey* | | D - Developer | P - Local Planning Authority | A - Environment Agency |
| **Process 2b – Stages of Risk Assessment** | | | | | | | | | |
| 2b.1 Identify hazards | D | | A | A | P | | • Identify the potential types of flooding that might effect the site<br>• Identify the potential types of flooding that the development might cause | • If using Standing Advice, check that the minimum requirements for each level of assessment (as listed in Table 4 of this guidance note) have been met | • Provide advise on the general approach<br>• Provide advice on Specific technical issues, including (but not limited to):<br>• Climate change<br>• Defence failure<br>• Risks to people<br>• If the FRA has been referred to the EA, check that the minimum requirements for each level of assessment (as listed in Table 27.4 of this guidance note) have been met |
| 2b.2 Identify consequences | D | | A | A | P | | • Identify what or whom might be effected should flooding occur | | |
| 2b.3 Determine magnitude of consequences | D | | A | A | P | | • Determine the scale of the effects of flooding, if it did occur | | |
| 2b.4 Determine probability of consequences | D | | A | A | P | | • Determine the likelihood that flooding will occur<br>• Determine the likelihood of negative effects should flooding occur | | |
| 2b.5 Determine significance of risk | D | | A | | | P | • Determine how these risks compare with the acceptability criteria defined during Process 1.3<br>• Review how these risks will be perceived by society and the individual<br>• Review the insurability of the development and consult the insurance industry, if uncertain | • Decide whether the acceptability criteria defined during Process 1.3 are still appropriate<br>• Decide new acceptability criteria, if necessary | • Provide advice regarding the continuing appropriateness of flood risk indicators and acceptability criteria agreed in Process 1.3 |
| **Process 3 – Options Appraisal** | | | | | | | | | |
| 3.1 Identify options | D | | A | | | | • Consult LPA and EA regarding likely acceptable options<br>• Assess implications of 'do nothing' and 'maintain existing levels of risk' options<br>• Identify alternative options to achieve a residual risk that matches existing levels or reduces risk further<br>• Check implications of controlling factors<br>• Review technical feasibility of options | | • Provide advice on the following:<br>• Safe access and exit<br>• Floor levels<br>• Flood proofing<br>• SUDS<br>• Flood warning<br>• Compensatory storage<br>• Developer contributions<br>• Hydraulic structures<br>• Development zoning<br>• Adaptive management |

**Table 27.5 Summary of roles and responsibilities for FRAs for planning applications continued**

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Note: * Box colour on the EA's Standing Advice Matrix (relevant to England only, for Wales only consider 'Red' box)

| | Undertake | Inform | Advise | Check | | Decide | Responsibilities | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Red* | Green/ Grey* | | D - Developer | P - Local Planning Authority | A - Environment Agency |
| **Process 3 – Options Appraisal** | | | | | | | | | |
| 3.2 Evaluate options | D | | A | | | | • Select an appropriate trade-off analysis method, with due consideration of the agreed flood risk indicators and acceptability criteria<br>• Determine limitations of method, assumptions used in the analysis and uncertainties in the results for the flood risk indicators<br>• Compare residual risks for options<br>• Compare options against sustainability objectives | • Determine if there is a need for an Environmental Impact Assessment (as this will include a trade-off analysis) | • Provide advice regarding methods to apply acceptability criteria as agreed in Process 1.3 |
| *Decision: Sufficient information for intention?* | D | | A | | | P | • Consult with LPA and EA | • Decide whether the Developer has provided enough information for determining the planning application | • Advise whether there is sufficient information for the EA to review the planning application |
| *Decision: Is residual risk acceptable?* | D | | A | | | P A | • Consult with LPA and EA | • Decide whether the residual risk is acceptable | • Advise whether residual flood risk falls within the generally recognised boundaries of acceptability as identified by the scientific community or specified in government guidance<br>• Decide whether to object to the planning application due to the residual risk being higher than the agreed acceptability criteria |
| 3.3 Apply risk assessment to options | D | | A | | | | • Got back to Process 2a and assess residual risk | | • Provide advise on general approach |
| *Decision: Is residual risk acceptable?* | D | | A | | | P A | • Consult with LPA and EA | • Decide whether the residual risk is acceptable | • Advise whether residual flood risk falls within the generally recognised boundaries of acceptability as identified by the scientific community or specified in government guidance<br>• Decide whether to object to the planning application due to the residual risk being higher than the agreed acceptability criteria |
| 3.4 Review options | D | | A | | | | • Based on improved information, review Process 3.1 | | • Same as Process 3.1 |
| 3.5 Re-evaluate options (if required) | D | | | | | | • Based on improved information, review Process 3.2 | | |

**Table 27.5 Summary of roles and responsibilities for FRAs for planning applications continued**

This table should be read in conjunction with the generic approach illustrated on the Activity Chart. If using the digital version of this table, it is possible to click on the relevant process heading to jump to the Activity Chart.
Note: * Box colour on the EA's Standing Advice Matrix (relevant to England only, for Wales only consider 'Red' box)

| | Undertake | Inform | Advise | Check: Red* | Check: Green/ Grey* | Decide | Responsibilities: D - Developer | Responsibilities: P - Local Planning Authority | Responsibilities: A - Environment Agency |
|---|---|---|---|---|---|---|---|---|---|
| 3.6 Select preferred option | D | | | A | P | All | • Consult with LPA and EA<br>• Decide whether to proceed further with the planning application<br>• Select preferred option (taking into consideration likelihood of a successful application, etc.) | • If using Standing Advice, check the following:<br>  • Floor levels are raised to an acceptable level<br>  • Freeboard is sufficiently high<br>  • Safe access and exit routes are provided<br>  • SUDS design is appropriate<br>  • Appropriate flood resistant design and construction techniques are being applied<br>• Decide whether to approve the planning application (fully or with conditions) | • If the FRA has been referred to the EA, check the following:<br>  • Floor levels are raised to an acceptable level<br>  • Freeboard is sufficiently high<br>  • Safe access and exit routes are provided<br>  • SUDS design is appropriate<br>  • Appropriate flood resistant design and construction techniques are being applied<br>• Decide whether to object to the planning application |
| **Process 4 – Monitoring and Review** | | | | | | | | | |
| 4.1 Decide what to monitor | All | | A | | | A | • Review what would be beneficial to meet successfully obligations regarding operation and maintenance associated with the site<br>• Consult with LPA and EA regarding their obligations to the site and their monitoring needs | • Review monitoring needs associated with LA obligations to the site | • Decide whether monitoring is needed<br>• Review monitoring needs associated with EA obligations to the site<br>• Advise on maintenance and operational issues that might effect the residual risk<br>• Advise on uncertainties in the assessment that could be reduced with monitoring<br>• Provide advice regarding available flood warning<br>• Provide advice regarding adaptive management |
| 4.2 Design monitoring programme | All | | A | | | A P | • Negotiate with LPA and EA regarding who does what<br>• Depending on how much responsibility is given to the Developer, plan where, when and how to monitor<br>• Depending on how much responsibility is given to the Developer, obtain agreement from the LPA and/or EA regarding standards for compliance and actions in the event of non-compliance | • Negotiate with Developer and EA regarding who does what<br>• Depending on how much responsibility is given to the LA, plan where, when and how to monitor<br>• Depending on how much responsibility is given to the LA, obtain agreement from the EA regarding standards for compliance and actions in the event of non-compliance | • Negotiate with Developer and LA regarding who does what<br>• Decide who should carry out the monitoring<br>• Depending on how much responsibility falls on the EA, plan where, when and how to monitor<br>• Depending on how much responsibility falls on the EA, agree on standards for compliance and actions in the event of non-compliance<br>• Decide whether the monitoring programme is acceptable for the EA's needs<br>• Provide advise on monitoring techniques |

**Table 27.5 Summary of roles and responsibilities for FRAs for planning applications continued**

This table should be read in conjunction with the generic approach illustrated on the Activity Chart. If using the digital version of this table, it is possible to click on the relevant process heading to jump to the appropriate box.
Note: * Box colour on the EA's Standing Advice Matrix (relevant to England only, for Wales only consider 'Red' box)

| | Undertake | Inform | Advise | Check | | Decide | Responsibilities | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Red* | Green/ Grey* | | D - Developer | P - Local Planning Authority | A - Environment Agency |
| **Process 4 – Monitoring and Review** | | | | | | | | | |
| 4.3 Carry out monitoring | All | | | | | | • If given responsibility, carry out monitoring | | • If the preferred solution resulted in a Developer contribution to an EA flood defence, it is the EA's responsibility to carry out suitable monitoring<br>• If the preferred solution included provision for monitoring for some other purpose than to monitor the development (at the request of the EA), this would also be carried out by the EA<br>• Therefore, if responsible, carry out the monitoring |
| 4.4 Review monitoring results | All | | | | | | • If responsible, review monitoring results and carry out quality control checks of the data | | |
| *Decision: Are results usable?* | | | | | | All | • If responsible for the monitoring, decide if data is usable | | |
| *Decision: Are results acceptable?* | | | | | | All | If given responsibility:<br>• Compare with standards for compliance as decided in Process 4.2<br>• Decide whether the results are acceptable<br>• If the residual risk is not acceptable, consult with LPA and EA regarding the need for further assessment | If given responsibility:<br>• Compare with standards for compliance as decided in Process 4.2<br>• Decide whether the results are acceptable<br>• If the residual risk is not acceptable, consult with EA regarding the need for further assessment | If given responsibility:<br>• Compare with standards for compliance as decided in Process 4.2<br>• Decide whether the results are acceptable<br>• If the residual risk is not acceptable, decide whether there is a need for further assessment |
| 4.5 Report any lessons learnt | All | | | | | | • If responsible, carry out any remedial actions that can be identified without a new assessment, as identified in Process 4.2.<br>• Provide information internally and externally to improve practices in the future. | | |
| 4.6 Review monitoring programme | All | | | | | A P | • Consult with LPA and EA | • Consult with EA<br>• Decide whether the monitoring is effective and modify accordingly | • Consult with responsible bodies<br>• Decide whether the monitoring is effective and modify accordingly |
| *Decision: Is monitoring still needed?* | All | | | | | A P | • Consult with LPA and EA | • Consult with EA<br>• Decide whether monitoring is still needed | • Consult with responsible bodies<br>• Decide whether monitoring is still needed |

# Appendices

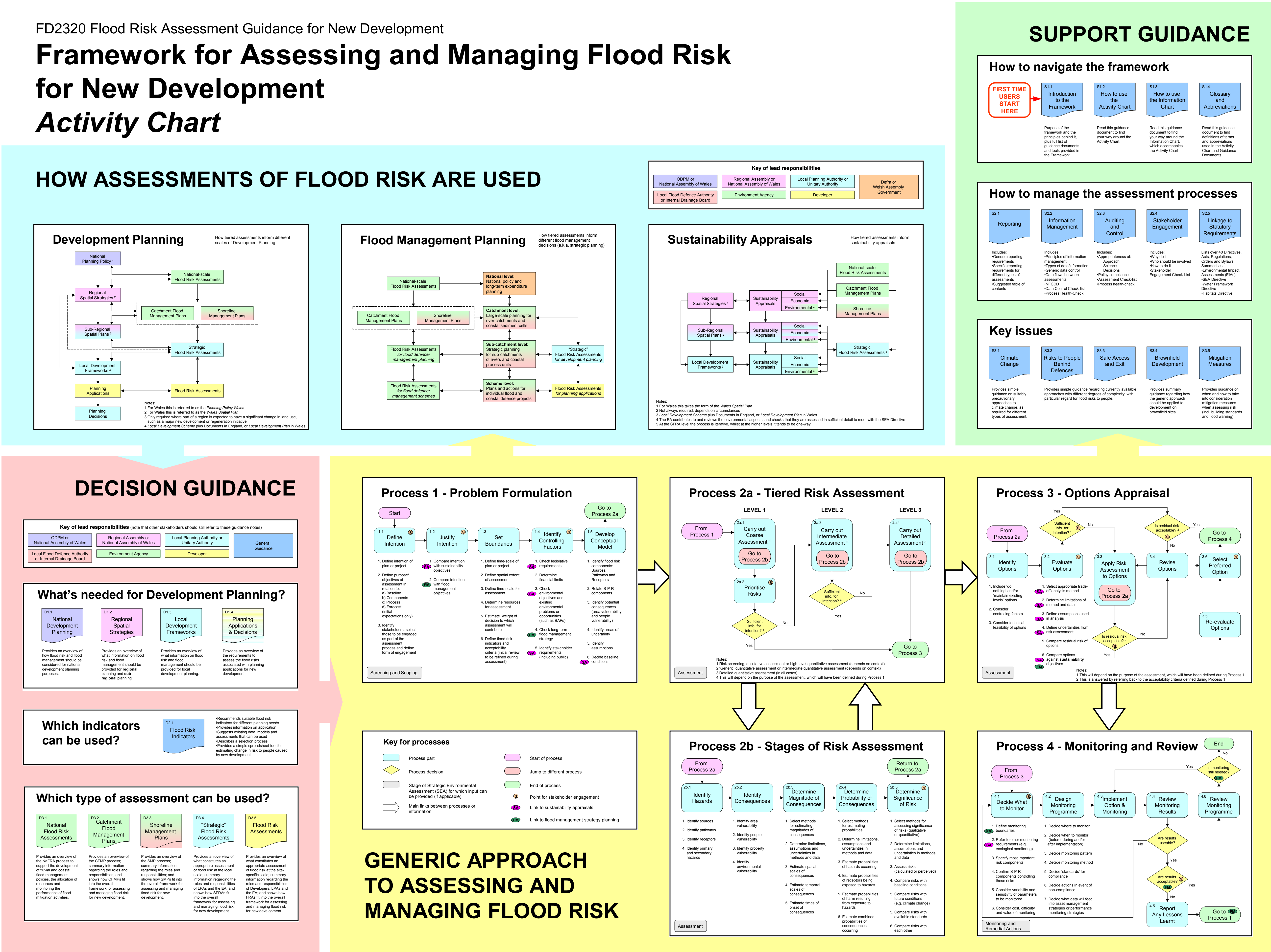
# Appendix A

Activity Chart

FD2320 Flood Risk Assessment Guidance for New Development

# Framework for Assessing and Managing Flood Risk for New Development

## *Activity Chart*



# Appendix B

## Information Chart

Framework Contents
References
Research & Initiatives
Statutes & Regulations
EA Guidance – Only available in digital version of information chart

## Framework Contents

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## Related Research & Initiatives

## Related Statutes and Regulations

| Ref | Title | Date | Comments | Web link to best site found regarding the topic (Note: these are correct as of November 2005) |
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| 1 | Planning and Compulsory Purchase Act | 2004 | | http://www.legislation.hmso.gov.uk/acts/acts2004/20040005.htm |
| 2 | The Water Environment (Water Framework Directive) (Solway Tweed River Basin District) Regulations | 2004 | | http://www.legislation.hmso.gov.uk/si/si2004/20040099.htm |
| 3 | Coastal Protection Regulation | 2004 | | http://www.dlwc.nsw.gov.au/care/coast/pdfs/cpg_eg2004-consultation_draft.pdf |
| 4 | The Environmental Assessment of Plans and Programmes Regulations | 2004 | | http://www.legislation.hmso.gov.uk/si/si2004/20041633.htm |
| 5 | Town and Country Planning (Local Development) (England) Regulations | 2004 | | http://www.legislation.hmso.gov.uk/si/si2004/20042204.htm |
| 6 | Town and Country Planning (Transitional Arrangements) (England) Regulations | 2004 | | http://www.legislation.hmso.gov.uk/si/si2004/20042205.htm |
| 7 | The Water Environment (Water Framework Directive) (England and Wales) Regulations | 2003 | | http://www.legislation.hmso.gov.uk/si/si2003/20033242.htm |
| 8 | The Water Environment (Water Framework Directive) (Northumbria River Basin District) Regulations | 2003 | | http://www.legislation.hmso.gov.uk/si/si2003/20033245.htm |
| 9 | Water Act | 2003 | | http://www.legislation.hmso.gov.uk/acts/acts2003/20030037.htm |
| 10 | Strategic Environmental Assessment Directive (2001/42/EC) | 2001 | Implemented in the UK as The Environmental Assessment of Plans and Programmes Regulations | http://europa.eu.int/comm/environment/eia/sea-legalcontext.htm |
| 11 | Countryside and Rights of Way Act | 2000 | | http://www.hmso.gov.uk/acts/acts2000/20000037.htm |
| 12 | Pollution Prevention and Control Regulations | 2000 | | http://www.defra.gov.uk/environment/ppc/ |
| 13 | Building Regulations | 2000 | | http://www.odpm.gov.uk/index.asp?id=1130474 |
| 14 | Water Framework Directive (2000/60/EC) | 2000 | Implemented in the UK as The Water Environment (Water Framework Directive) (England and Wales) Regulations | http://europa.eu.int/eur-lex/pri/en/oj/dat/2000/l_327/l_32720001222en00010072.pdf |
| 15 | Town and Country Planning (Environmental Impact Assessment) (England and Wales) (Amendment) Regulations | 2000 | | http://www.legislation.hmso.gov.uk/si/si2000/20002867.htm |
| 16 | Local Government Act | 2000 | | http://www.hmso.gov.uk/acts/acts2000/20000022.htm |
| 17 | Management of Health and Safety at Work Regulations | 1999 | | http://www.hmso.gov.uk/si/si1999/19993242.htm |
| 18 | The Control of Major Accident Hazard Regulations | 1999 | Reference should be made to the Good Practice Guide – Flood Risk Assessment for Major Installations in the Flood Plain, final draft June 2003, written by Atkins for the EA | http://www.hse.gov.uk/comah/ |
| 19 | The Environmental Impact Assessment (Land Drainage Improvement Works) Regulations | 1999 | | http://www.legislation.hmso.gov.uk/si/si1999/19991783.htm |
| 20 | Town and Country Planning (Environmental Impact Assessment) (England and Wales) Regulations | 1999 | | http://www.hmso.gov.uk/si/si1999/19990293.htm |
| 21 | Highways (Assessment of Environmental Effects) Regulations | 1999 | | http://www.legislation.hmso.gov.uk/si/si1999/19990369.htm |
| 22 | The Building (Local Authority Charges) Regulations | 1998 | | http://www.odpm.gov.uk/index.asp?id=1131132 |
| 23 | European Commission Directive on 'the assessment of the effects of certain public and private projects on the environment' (85/337/EEC)' as amended by Directive (97/11/EC) | 1985 & 1997 | Implemented in UK under the Town and Country Planning (Environmental Impact Assessment) (England and Wales) Regulations | _ |
| 24 | Town and Country Planning (General Development Procedure) Order | 1996 | | http://www.legislation.hmso.gov.uk/si/si1996/Uksi_19961817_en_1.htm |
| 25 | Environment Act | 1995 | | http://www.legislation.hmso.gov.uk/acts/acts1995/Ukpga_19950025_en_1.htm |
| 26 | Disability Discrimination Act | 1995 | | http://www.hmso.gov.uk/acts/acts1995/1995050.htm |
| 27 | Town and Country Planning (General Permitted Development) Order | 1995 | | http://www.legislation.hmso.gov.uk/si/si1995/Uksi_19950418_en_1.htm |
| 28 | Conservation (Natural Habitats, etc.) Regulations | 1994 | | http://www.opsi.gov.uk/si/si1994/Uksi_19942716_en_1.htm |
| 29 | Habitats Directive (92/43/EEC) | 1992 | Implemented in UK as Conservation (Natural Habitats, etc.) Regulations | _ |
| 30 | Water Resources Act | 1991 | | http://www.hmso.gov.uk/acts/acts1991/Ukpga_19910057_en_1.htm |
| 31 | Land Drainage Act | 1991 | As amended by the Land Drainage Act 1994 | http://www.hmso.gov.uk/acts/acts1991/Ukpga_19910059_en_1.htm |
| 32 | Wildlife and Countryside (Amendment) Act | 1991 | | http://www.hmso.gov.uk/acts/acts1991/Ukpga_19910039_en_1.htm |
| 33 | Planning and Compensation Act | 1991 | | http://www.hmso.gov.uk/acts/acts1991/Ukpga_19910034_en_1.htm |
| 34 | Water Industry Act | 1991 | | http://www.hmso.gov.uk/acts/acts1991/Ukpga_19910056_en_1.htm |

| Ref | Title | Date | Comments | Web link to best site found regarding the topic (Note: these are correct as of November 2005) |
|---|---|---|---|---|
| 35 | Environmental Agency Byelaws | 1991 onwards | Obtainable from appropriate Agency Regional Offices - Reference can also be made to the CIRIA guidance C624, section A1.1.3 Additional consents | _ |
| 36 | Town and Country Planning Act | 1990 | | http://www.hmso.gov.uk/acts/acts1990/Ukpga_19900008_en_1.htm |
| 37 | Environmental Protection Act | 1990 | | http://www.hmso.gov.uk/acts/acts1990/Ukpga_19900043_en_1.htm |
| 38 | Building Act | 1984 | | http://www.odpm.gov.uk/index.asp?id=1130482 |
| 39 | Occupiers Liability Acts | 1957 & 1984 | not available via the internet | |
| 40 | Wildlife and Countryside Act | 1981 | | http://www.jncc.gov.uk/page-1377 |
| 41 | Highways Act | 1980 | not available via the internet | |
| 42 | Conservation of Wild Birds Directive (79/409/EEC) | 1979 | Amended a number of times incl. 2003 | http://www.defra.gov.uk/wildlife-countryside/ewd/rrrpac/wildbirds/ |
| 43 | Health & Safety at Work (Etc) Act | 1974 | | http://www.healthandsafety.co.uk/haswa.htm |
| 44 | Ramsar Convention on Wetlands of International Importance | 1971 | | http://www.ramsar.org/ |
| 45 | Caravan Sites and Control of Development Act | 1960 | not available via the internet | _ |
| 46 | Coast Protection Act | 1949 | not available via the internet | _ |

# Appendix C

R&D Projects and Initiatives

**DETAILS OF RELEVANT INITIATIVES AND RESEARCH PROJECTS**

The following research projects or initiatives have a relevance to FD2320. The following is not exhaustive and should not be considered as such, but it is intended to cover the most prominent work that is currently underway or has been completed relatively recently.

## *ADAPTABLE URBAN DRAINAGE – ADDRESSING CHANGE IN INTENSITY, OCCURRENCE AND UNCERTAINTY OF STORMWATER (AUDACIOUS)*

**Website** http://www.eng.brad.ac.uk/audacious/

*Justification*

There is a need for an improved understanding of the potential impacts of climate change on the performance of existing building drainage and local drainage systems and the downstream interfacial effects to main drainage. This would enable the development of new flexible and adaptable approaches, suitably positioned and integrated, which, within defined uncertainty and allocated risk and cost burdens, may be used to mitigate the effects as part of the overall hierarchy of responses advocated by government.

*Objective*

To develop tools and procedures for the assessment and mitigation of the effects of climate change on urban drainage systems, bringing together hydrologists, building drainage and sewerage engineers, health, social and infrastructural economic specialists. This will include the development of methodologies for management, including assessment of perceptions, costs, failure and risk.

*Deliverables*

Outputs will be toolbox based, with tailored products utilising appropriate models, media and forms for various stakeholder groups.

*Relevance*

This study will consider ways of reducing the flood risk caused by urban runoff in extreme events from the viewpoint of the different responsible bodies (e.g. Water Companies, Highways Authorities, etc.) Currently, there is a recognised gap in FRAs regarding the impact of urban drainage on the overall flood risk of an area and a need for increased co-operation between organisations involved in managing the drainage infrastructure compared to the bodies involved with fluvial or coastal flooding.

## *APPLIED MULTI RISK MAPPING OF NATURAL HAZARDS FOR IMPACT ASSESSMENT (ARMONIA)*

**Website** http://www.territorio.t-6.it/armonia_overview.htm

*Justification*

Natural disasters are a typical example of people living in conflict with the environment. The vulnerability of populated areas to natural disaster is partly a consequence of decades of spatial planning policies that failed to take proper account of hazards and risks in land use zoning and development decisions. Therefore it is critically important to bring together knowledge, technology and actors in the field of risk assessment and land use zoning to achieve more effective natural disaster prevention and mitigation.

*Objective*

The overall aim is to provide the EU with a set of harmonised methodologies for producing integrated risk maps to achieve more effective spatial planning procedures in areas prone to natural disasters in Europe.

Specific objectives are the following:

- Integration and optimisation of methodologies for hazard and risk assessment for different types of potentially disastrous events;
- Harmonisation of different processes of risk mapping in order to standardise data collection, data analysis, monitoring, outputs and terminology for end users (multi-hazard risk assessment);
- Development of a harmonised decision-making tool structure for applying hazard and risk mitigation through spatial planning in risk prone areas and development of a guideline on natural hazard mitigation in the context of the EU Strategic Environmental Assessment Directive (2001/42/EC).

The project covers the following types of natural phenomena:

- Floods
- Earthquakes
- Landslides
- Forest fire
- Volcanic
- Groundwater pollution
- Meteorological extreme events

*Relevance*

This project is useful in relation to providing a means to apply of the SEA directive with the spatial planning procedures across the EU.

### *BUILT ENVIRONMENT: WEATHER SCENARIOS FOR INVESTIGATION OF IMPACT AND EXTREMES (BETWIXT)*

**Website** http://www.cru.uea.ac.uk/cru/projects/betwixt/

*Justification*

Building Knowledge for a Changing Climate (BKCC) is a portfolio of research projects looking at how climate change will effect aspects of the built environment. As part of this research there is a need to have high-resolution weather data appropriate for the built environment.

*Objective*

In order to develop high-resolution climate change scenarios for key locations, this project will utilise computer-based weather generators to produce common source datasets for the other projects in the BKCC initiative. The basis for this additional data will be the UKCIP02 climate change scenarios, which will then be developed for shorter time periods and locations, to meet the particular requirements of the built environment. This project will also address issues of scenario uncertainty relating to key climate elements, and provide further information on potential changes in the "urban heat island" effect.

*Deliverables*

The project will act as a service to the other EPSRC/UKCIP projects in the initiative, and develop best practice in the application of climate change scenarios. At the end of the project, the new data generated will be made more widely available.

*Relevance*

The translation of the UKCIP02 climate change scenarios into shorter time periods and locations, to meet the particular requirements of the built environment will be very valuable for determining the impact of climate change on flooding for new developments and the surrounding urban environment.

## *CATCHMENT FLOOD MANAGEMENT PLANS (CFMP)*

**Website** http://www.environment-agency.gov.uk/yourenv/consultations/747031/

There are two aspects to the work currently carried out regarding CFMPs. The first is the application of the CFMP methodology. The second is looking specifically at the catchment hydraulic modelling element of a CFMP. These have been described separately below.

### Application of CFMPs

*Justification*

A Catchment Flood Management Plan (CFMP) is a high-level strategic planning tool through which the EA will seek to work with other key decision-makers within a river catchment to identify and agree policies to secure the long term sustainable management of flood risk. CFMPs are a new approach in England & Wales. In particular they will improve our understanding of what factors influence floods and flood risks at the catchment scale.

*Objective*

To develop preferred policies for managing flood risk for catchments in England and Wales, and to identify areas to be covered by strategy plans where the policies and associated measures will be developed in more detail for parts of catchments.

*Deliverables*

The Catchment Flood Management Plan.

*Relevance*

CFMPs are to become the key planning approach for river catchments – an area of the planning process that is not currently being addressed adequately. Whilst the Environment Agency (who develops the plans) is not a planning authority, it is intended that CFMPs can be linked with land use plans to ensure that future flood management policies are taken into account in land use planning.

### Catchment Hydraulic Modelling for CFMPs

*Justification*

There are a number of different modelling approaches that could be chosen for analysis of river catchments, each with different degrees of accuracy and cost. There is a need for a consistent approach to the selection of appropriate modelling methods for each catchment and a means of justifying and defending the choice of methods.

*Objective*

To develop an approach to catchment hydraulic modelling, suitable for application to CFMPs, and associated guidance for users.

The approach was developed for different river types based on a range of case studies. These being:

- Upland
- Lowlands with washlands
- Perched, where flood water which overtops the river banks does not return directly to the river
- Heavily engineered urban
- Tidal
- Controlled by control structures at intervals along the river channel

*Deliverables*

A modelling guidance report, which gives guidance on the most appropriate method of modelling for different river types.

Catchment models developed using the guidance will provide water level data for use within the Modelling and Decision Support Framework (MDSF - see below). This in turn will provide information on the economic damages and social impacts of future scenarios and flood management polices.

*Relevance*

The modelling method might be suitable for the proposed approach to modelling for local planning envisaged in Section 6.5 of the report.

*CLIMATE ADAPTION: RISK, UNCERTAINTY AND DECISION-MAKING – UK CLIMATE IMPACTS PROGRAMME (UKCIP)*

**Website** http://www.ukcip.org.uk/

*Justification*

The UK Climate Impacts Programme (UKCIP) helps organisations assess how they might be affected by climate change, so they can prepare for its impact.
UKCIP aims to co-ordinate and integrate an assessment of the impacts of climate change at a regional and national level that is led by stakeholders. UKCIP provides support and guidance throughout the process for both stakeholders and the researchers, so providing a bridge between the researchers and the decision-makers in government organisations and business.

*Objective*

Guidance to help decision-makers handle climate risk and uncertainty, drawing on a wide range of UK expertise in climate change forecasting, risk assessment, policy and project appraisal.

*Deliverables*

The UKCIP report 'Climate adaptation: risk, uncertainty and decision-making' was published on 20 May 2003. It provides a step-by-step decision-making framework designed to help decision-makers (including planners, businesses and government) manage their activities in the face of an uncertain future climate. The guidance helps readers to judge the significance of the climate change risk, compared to the other risks, so that the most appropriate adaptation measures can be determined.

*Relevance*
FD2320 needs to address the issue of climate change. Guidance provided by UKCIP will form an integral part of the framework for FRA.

*CLIMATE CHANGE AND THE HYDRAULIC DESIGN OF SEWERAGE SYSTEMS*

**Website**
http://www.ukwir.org/templates/ukwirsite/ukwir_frame.asp?loadpage=/templates/ukwirsite/ukwir_docmap.asp@

*Objective*
The project was wide ranging, but with a principle focus on the performance of sewerage systems under future (year 2080) rainfall conditions and what changes might be needed in the hydraulic design of sewerage systems to address any problems that climate change might pose. Other issues include a summary of international drainage practice and predicted changes in, sea levels and river flows.

*Deliverables*
There are 13 documents in total, collated in 4 volumes:

- Volume I – Climate Change effects on Rainfall
- Volume II – Rainfall Data Production and Analysis
- Volume III – Sewerage System Modelling
- Volume IV – Associated Topics

*Relevance*
In order to effectively manage the runoff from a new development site, it is essential to design new storm drainage with an appropriate allowance for climate change. These reports provide valuable information regarding what to expect in the way of design changes.

*CLIMATE CHANGE IMPACTS AND ADAPTATION: CROSS REGIONAL RESEARCH PROGRAMME*

**Website** *http://www.defra.gov.uk/environment/climatechange/*

*Justification*
UKCIP02 scenarios indicate that the UK's climate will feature milder, wetter winters and hotter and probably drier summers. Extreme weather conditions, such as heavy rainfall or very high temperatures, are more likely to occur more often, and sea levels will continue to rise. While the UK is taking considerable action to limit carbon and other greenhouse gas emissions through its Climate Change Programme, it is also necessary to prepare for the changes in climate that are already inevitable. Detailed, quantitative research into the impacts of climate change at regional levels in the UK needs to be the basis for this adaptation action.

The decision to set up a more detailed research programme followed earlier scoping work on the impacts of climate change in the UK by regional partnerships and the devolved administrations working with the UK Climate Impacts Programme (UKCIP).

*Objectives*

This is a programme of research into the impacts of climate change on some key UK sectors. Six research projects in total are being undertaken.

Four projects cover specific interests:

- planning, land use and the built environment
- business
- water resources
- countryside and the rural economy

These are investigating the impacts of climate change on particular aspects of these sectors, and also consider potential adaptation responses. This will include using local or regional case studies.

The other two projects are looking at methods for quantifying the costs of climate change impacts and at reviewing adaptation options and strategies.

A pilot project, anticipating this new programme, is investigating the impact of climate change on tourism and recreation in NorthWest England and has been underway for about six months.

*Deliverables*

Unknown.

*Relevance*

These projects will provide a useful source of information for regional decision-makers, such as local authorities, tourist boards, water companies and landowners, of the likely impacts of climate change. They will add to the evidence base that is needed to design effective adaptation responses at a local and regional level.

### *CLIMATE CHANGE IMPACTS ON FLOOD FLOWS IN RIVER CATCHMENTS*

*Justification*

Uncertainties remain regarding the precise nature of future climate change, particularly at a regional level and with regard to extremes, such as short duration high intensity rainfall.

Defra guidance currently suggests certain allowances to test sensitivity to climate change in flood defence scheme appraisals, e.g. a 20% increase in peak flows over the next 50 years.

*Objective*

To assess climate change impacts on river flood flows under the new UKCIP02 scenarios, derived from the Hadley Centre regional climate model. This will include looking at the effect of catchment variability by modelling a wide range of catchment sizes, types and locations.

*Deliverables*

Results from the modelling will be presented to help develop policy and risk assessment and management guidance.

*Relevance*

Results from this project will have a direct bearing on future policy and guidance regarding flood risk and, as such, will be an integral part of the framework for FRA.

## *CLIMATE CHANGE RISK ASSESSMENT: NEW IMPACT AND UNCERTAINTY METHODS (CRANIUM)*

**Website** http://gow.epsrc.ac.uk/ViewGrant.aspx?Mode=Latest&Grant=GR/S18052/02

*Justification*

CRANIUM is part of the EPSRC/UKCIP initiative on Building Knowledge for a Changing Climate.

*Objective*

The aim of the proposed research is to develop new methodologies for analysing uncertainty and making robust risk-based decisions for infrastructure design and management in the face of climate change. It is structured around three tasks:

- Task 1 will analyse uncertainties in key climate variable analysis of built environment, transport and utilities and provide means of communicating uncertainties to modellers and decision-makers.
- Task 2 will develop new methods for assessing system response to uncertain climate forcing.
- Task 3 will address how, in the light of these insights, decision making about operation of, or investment in, the system in question could be managed or modified to reflect potential climate change impacts arc specifically the uncertainties surrounding them.

*Deliverables*

Unknown.

*Relevance*

This project is relevant to the issues highlighted by FD2320 regarding managing and communicating uncertainty, in particular regarding climate change.

## *COMMON STRATEGIES TO REDUCE THE RISK OF STORM FLOODS IN COASTAL LOWLANDS (COMRISK)*

**Website** http://www.comrisk.org/

*Justification*

Many low-lying areas need to be safeguarded from flooding, and it cannot be achieved solely through normal, technical flood control means. A means of transferring and evaluating knowledge, methods and common pilot studies; and a sustainable, harmonious and balanced development of coastal lowlands is seen to be required.

*Objectives*

To provide greater protection from coastal floods through the transfer and evaluation of knowledge, methods and common pilot studies, and to ensure a sustainable, harmonious and balanced development in the coastal lowlands of the North Sea region.

*Deliverables*

- A publication containing principles and recommendations for innovative and integrated risk management strategies in the North Sea Region (a good practice guide)

- A website and policy papers by the relevant coastal authorities on ways to improve coastal risk management on the results of the good practice guide
- An international conference, brochure and press conference

*Relevance*

The tiered approach to flood risk management proposed could be comparable to the integrated risk management approach under investigation by this project.

## *CONDITION MONITORING AND ASSET MANAGEMENT FOR COMPLEX INFRASTRUCTURE SYSTEMS (CMAM)*

**Website** http://www.ceg.ncl.ac.uk/research/projectdetail.aspx?id=214

*Justification*

Flood defences are economically important safety critical infrastructure systems and need ongoing monitoring and maintenance to ensure their integrity. This is no simple task as:

- The scale of the flood defence infrastructure system means there is a large number of system components in need of management;
- Interactions between system components is frequently poorly understood;
- Failure mechanisms of flood defences are complex and site specific due to the natural variability in loading and geotechnical conditions;
- Monitoring information is scarce and can be expensive to obtain;
- Information on system behaviour does not lend itself to being compressed into a single format;
- Uncertainties, which may be significant, are expressed in a format appropriate to the type of evidence and these are not always directly comparable; and
- There may be a large amount of information relating to an investment decision, however it is often only partially relevant, incomplete or conflicting.

Consequently, monitoring and remediation resources can be mis-directed.

An increasing emphasis on strategic planning means decision-makers need to be able to manage and consider large amounts of information describing the behaviour of their system and are, therefore, facing intense information processing demands.

*Objective*

The overall objective of the CMAM project was to develop new decision support techniques to improve the safety and economic performance of complex infrastructure systems.

*Deliverables*

A new methodology for modelling the performance of complex infrastructure systems.

The performance modelling methodology has been implemented in a software tool called Perimeta. Perimeta combines a hierarchical process modelling tool with a database of performance indicators and an inference engine for propagating uncertain information through the hierarchy. A Perimeta model provides a visual overview of system performance and a platform for testing alternative intervention options.

New methods for estimating bounds on the probability of failure of deteriorated flood and coastal defence structures using the concept of fragility.

*Relevance*
This project may enable FD2320 to tie in the concepts of asset performance and risk of failure into the framework for FRA and enable the development of further guidance.

*CREATING NEW FLOODPLAIN LANDSCAPES (Floodscape)*

**Website** http://www.floodscape.net/

*Justification*
The application of 'Creative Flood Management' could lead to more cost-effective and sustainable planning of major investments as a result of:
- more effective and positive interaction with major development proposals, and
- working more closely with local communities and stakeholders who have a clear understanding of flood risk management (as opposed to the traditional approach of flood defence).

*Objectives*
Change public perception from flood prevention to flood risk management.

*Deliverables*
Within the UK, develop a master plan in a Thames Gateway 'zone of change' – potentially buildings designed to allow for flooding, opportunities for controlled inundation of land, public information, emergency evacuation procedures.

Other countries involved are Germany, the Netherlands and Belgium.

*Relevance*
This project could demonstrate the practical application of new and innovative flood risk management techniques.

*DESIGNING FOR EXCEEDANCE IN URBAN DRAINAGE SYSTEMS (CIRIA RP699)*

**Website** http://www.ciria.org.uk/suds/suds_projects.htm

*Justification*
Sewerage is designed for a lower level of performance than considered for flood risk (e.g. 30 or 50-year return periods compared to 100+ years). Therefore, the performance of such systems during these more extreme events can have a significant impact on the overall flood risk of an area, but is not generally taken into consideration.

*Objective*
To provide best practice guidance for the design and management of piped urban sewerage and drainage systems to reduce the impacts that arise when flows occur that exceed their capacity. It will also provide advice on risk assessment procedures and planning to reduce the impacts that exceedance in drainage systems may have on people and property within the surrounding area.

*Deliverables*

Easy to read good practice guidance on designing for exceedance that will be designed to engage a target audience that includes engineers, planners, consultants and developers. The guidance will primarily be aimed at conventional piped drainage although the principles can also be applied to SuDS. Summaries of the consultation and key elements of the document will also be placed on the website.

*Relevance*

This project will be key to the understanding of one of the lesser known/considered elements of flood risk, i.e. urban drainage.

*DEVELOPMENT AND FLOOD RISK: GUIDANCE TO THE CONSTRUCTION INDUSTRY (CIRIA RP675)*

**Website** http://www.ciria.org/acatalog/C624.html

*Justification*

Flooding poses a major threat to people and property and the risk of flooding presents several major challenges to the construction industry. The government has responded to this issue through the provision of Planning Policy Guidance 25, Development and flood risk.

*Objective*

This study will provide advice for the industry on working within PPG25 by providing guidance on the assessment of flood risk from rivers, coasts and groundwater within the land use planning process. It will also provide advice on how the industry can meet flood related planning conditions properly and efficiently.

*Deliverables*

The project outputs will be aimed at the construction industry as a whole and in particular at developers and construction clients. The outputs will also be relevant to planners, regulators, facility managers and members of the public living in at-risk areas.

*Relevance*

This guidance document provides the initial framework for FRA from the perspective of the construction industry and will form one of the main building blocks for FD2320.

*ENVIRONMENTAL CHANGE INDICATORS*

**Website**
http://sciencesearch.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=10204#Description

*Justification*

It is important to monitor and understand changes in environmental loading in order to manage flood risk.

*Objectives*

The objectives of this research are:

- to identify, define and select a wide range of Environmental Change Indicators (ECI) for England and Wales relevant to flood and coastal defence that are likely to be representative of changes in the environment
- to locate data series over sufficiently long periods to make the ECI calculations valid
- to produce five pilot indicators
- to discuss their implications for future use and expansion.

### *Deliverables*

There were 4 project outputs produced:

- An inception report *Can environmental change indicators carry warnings for flood and coastal defence?*
- A report of a workshop
- A paper submitted to the Defra Conference of Flood and Coastal Engineers, July 2002
- A Technical Report *Environmental change indicators (including those related to climate change) relevant to flood management and coastal defence*

### *Relevance*

Understanding the potential environmental change resulting from changes in flood management is an important part of the approach for assessment and management of flood risk. The ability to use ECIs could usefully complement the use of Flood Risk Indicators in the decision-making process.

## *ENVIRONMENTAL CONSEQUENCES OF FLOODING (PHASE 1)*

### *Justification*

Flood risk assessment and management requires understanding the impacts of flooding on a wide range of receptor-types, including buildings, infrastructure, people and the natural environment. Methodologies for assessing flood damage to property and infrastructure are available.[431] The Flood Risks to People R&D project (FD2321) is addressing risks to people. A methodology is needed to assess the positive and negative effects of flooding on the natural environment, to ensure that environmental impacts are given proper consideration in flood risk management decision-making. There is currently no standard approach for evaluating the probability of occurrence and the magnitude of the consequences on the natural environment for use within a flood risk assessment. This means that decision-making is currently not driven by environmental considerations.

### *Objectives*

This project will make recommendations for a focused programme of research that will ensure, in time, that impacts on the natural environment are considered alongside with more traditional socio-economic drivers. This is with the intention that follow on stages will develop an approach to assessing environmental consequences to be used in decision-making and risk communication, within the overall approach to flood risk management.

### *Deliverables*

The main output for this Phase 1 study is a scoping report that will include a literature review, review of R&D and results from consultations and makes appropriate recommendations. These will include tasks that need to be undertaken to develop a methodology. This will also identify potential partners and users (and who else is working on similar issues elsewhere) and indicate opportunities for collaboration and the benefits.

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[431] E.g. the Multi-Coloured Manual, produced by the Flood Hazard Research Centre at Middlesex University in 2003.

*Relevance*
This scoping project is the start of the process to provide the missing element of an effective flood risk/management approach, which is environmental consequences.

*EUROPEAN SPATIAL PLANNING: ADAPTING TO CLIMATE EVENTS (ESPACE)*

**Website** http://www.espace-project.org

*Justification*
Public agencies have a responsibility to minimise the risk posed by climate change, and to develop plans for the future. This requires a better-developed framework than existing to deal with the risk.

*Objectives*
To promote awareness of the importance of adapting to climate change and to recommend that it is incorporated within spatial planning mechanisms at local, regional, national and European levels. It will look at how water resources are managed and how to plan for a future with a changing climate, ensuring that adaptation strategies are incorporated into spatial planning systems. This will include a dynamic transnational approach to climate change that can be implemented by the partners of the project.

*Deliverables*
- Four workshops aimed at developing project outcomes and delivery;
- Four technical conferences focussing on current issues and projects;
- An international conference to provide guidance and input; and
- A final Project Conference to launch the dissemination of project results.

*Relevance*
The issues of spatial planning and the impact of climate change are an integral part of the planning process in the UK as abroad.

*EUROPEAN SPATIAL PLANNING OBSERVATION NETWORK (ESPON)*

**Website** http://www.espon.lu/online/homepage/index.html

*Justification*
Research and studies on spatial development and planning seen from the national, regional and local points of view, is partly already existing and available, although only covering smaller parts of the European territory. There is a need to develop this for the European territory as a whole.

*Objectives*
The projects launched under the ESPON programme are intended to have an integrated approach and a clear territorial dimension. They cover a wide range of issues, stretching from scientific methods and databases via strategic projects to institutional and instrumental questions.

There are the following fields of research:
- Thematic studies on the territorial effects of major spatial developments on the background of typologies of regions, and the situation of cities on the base of broad empirical data.

- Policy impact studies on the spatial impact of Community sector policies, Member States' spatial development policy on types of regions with a focus on the institutional inter-linkages between the governmental levels and instrumental dimension of policies on the base of broad empirical data.
- Horizontal and co-ordinating cross-theme studies as a key component. Evaluation of the results of the other studies towards integrated results such as indicator systems and data, typologies of territories, spatial development scenarios and conclusions for the territorial development.
- Scientific briefing and networking in order to explore the synergies between the national and EU sources for research and research capacities.

*Deliverables*

The anticipated outputs are to have:
- A diagnosis of the principal territorial trends at EU scale as well as the difficulties and potentialities within the European territory as a whole;
- A cartographic picture of the major territorial disparities and of their respective intensity;
- A number of territorial indicators and typologies assisting a setting of European priorities for a balanced and polycentric enlarged European territory;
- Integrated tools and appropriate instruments (databases, indicators, methodologies for territorial impact analysis and systematic spatial analyses) to improve the spatial co-ordination of sector policies.

*Relevance*

This project provides the European context regarding spatial planning.

*EVALUATING A MULTI-CRITERIA ANALYSIS METHODOLOGY FOR FLOOD MANAGEMENT AND COASTAL DEFENCE APPRAISAL*

**Website**

http://sciencesearch.defra.gov.uk/Default.aspx?Menu=Menu&Module=FJPProjectView&Location=None&ProjectID=10734

*Objectives*

- To develop and test multi-criteria analysis techniques suitable for the appraisal of flood and coastal defence projects.
- To provide recommendations for Defra/EA project appraisal guidance on multi-criteria techniques that will improve flood and coastal defence decision-making.

*Relevance*

This project could usefully inform the evaluation of options as part of the generic approach to assessing and managing flood risk presented by FD2320.

*FAILURE ON DEMAND OF FLOOD DEFENCE STRUCTURES/ COMPONENTS*

*Justification*

The project was designed to support the EA's risk framework for flood defence systems and in particular was intended to be compatible with, and support the ongoing development of RASP and NFCDD.

### *Objectives*

To demonstrate whether generic failure rate estimates could be derived for a standard taxonomy of flood defence scheme components. The aim was to use these failure rates, within a risk assessment methodology to predict the future failures of any defined defence schemes made up of these generic components.

A pilot study was carried out in which information on past failures of flood defence scheme components (locks, outfalls, pumping stations, etc.) were gathered via questionnaire and personal interview. In the absence of formal maintenance records, the information was obtained largely from the field experience of EA regional operations staff. The component failure information was incorporated into a database system that provided a means of calculating estimates of component failure rates (or failure-on-demand).

### *Deliverables*

A pilot database system was developed incorporating data on 10 different generic flood defence scheme components, which were further categorised into a number of different variant types.

An envisaged second phase of work did not go ahead, primarily because of the lack of firm records from which to derive failure information, although some recommendations were put forward as to ways failure data could be augmented from subjective judgement and other generic evidence.

### *Relevance*

There remains a recognised gap in the framework for FRA for providing easy to understand and easy to implement guidance/methods for assessing risk of failure of flood defence scheme components.

## *FLOOD MAPPING STRATEGY*

### *Justification*

Flood mapping is fundamental for flood risk management, yet it is extremely complex. It is not a precise science because so many factors affect flooding. Flood mapping is concerned with the estimation of the possible extent of river and coastal flooding, and recording of areas that have flooded in the past. By understanding the areas that are at risk of flooding, the EA can prioritise, justify and target investment to manage and reduce the risk to people, property and the environment.

The EA currently provides the Indicative Floodplain Map (IFM) for England and Wales. It is there to raise awareness of areas in the natural floodplain that could flood in extreme conditions, but does not show degrees of risk or the impact of flood defences. The new mapping will replace the current IFM and will show some flood defence information and more detail on the likelihood of flooding, from rivers and the sea.

### *Objective*

- An assessment of flood risk across England and Wales to an appropriate accuracy depending on current and future land use;
- A quality-assured series of flood outlines marked on maps with an OS background and in an electronic format; and
- An annual revision of the maps to ensure that no map is more than one year old.

*Deliverables*

- Identifies mapping data needs to support management of flood risk and for other purposes (such as supporting planning policy and financial services), and how those needs may be delivered;
- Provides direction and clarity for improving information on flood risk for everyone concerned;
- Prescribes a national policy framework for flood mapping that will deliver EA 'Making it Happen' objectives to reduce flood risk;
- Seeks to further the understanding of the potential impacts of climate change on flood risk across England and Wales; and
- Recommends the way forward for further investment in flood mapping to deliver the vision, aims and objectives agreed by the EA Directors, over the 5 years from 2003 to 2008.

*Relevance*

This will become a fundamental component of the framework for FRA. Its effective implementation is critical for successful planning with respect to flood risk.

*FLOODPLAIN LAND USE OPTIMISING WORKABLE SUSTAINABILITY (FLOWS)*

**Website** http://www.flows.nu/

*Justification*

To individuals and communities across Europe, flooding presents a clear danger. As a result of climate change, urbanisation and land-use changes, floods are becoming more frequent, causing loss and damage to property and life.

*Objective*

To identify and exchange best practice solutions to flooding, bringing together partners from Germany, the Netherlands, Norway, Sweden and the United Kingdom. Local communities will be involved in finding and applying practical solutions.

*Deliverables*

Providing decision makers with more and better information on flood risk to help them:
- Make better decisions about where to site new housing
- Design family houses with a culture of living in and around water
- Provide practical solutions about how to make existing flood-risk housing more resistant
- Provide better warning systems when floods are forecast

*Relevance*

This project is a very useful testing ground for the practical implementation of more sustainable planning decisions and development types.

This project is particularly useful to FD2320 as it involves stakeholders that are not so commonly represented in the other R&D projects or initiatives, i.e. local authorities and the general public.

Particular FLOWS projects of relevance to FD2320 are the following:

- *FLOWS WP1biii project* Guidance on Strategic Flood Risk Assessments for Low-lying Areas
- *FLOWS WP1biii project* Modelling and Mapping of Flood Risk

*FLOOD PLAIN MANAGEMENT MANUAL (PHASE 1)*

**Website**
http://sciencesearch.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=10468

*Justification*

There are intense and conflicting pressures on floodplains. These include conservation, restoration, amenity and development in addition to providing for the passage and storage of floods. Guidance, in a similar form to that already prepared for Australian floodplains, is needed to inform all stakeholders of floodplain management issues and provide a basis for effectively managing flood plains taking into account these conflicting pressures.

*Objective*

To provide preliminary guidance on the effective management of floodplains to river managers, local authorities (planning, amenity and other relevant functions), local communities, conservationists and developers leading to the provision of a Flood Plain manual that forms a common reference for all parties involved in floodplain management.

*Deliverables*

The Stage 1 Report provides preliminary guidance to local authorities and others involved in floodplain management and includes proposals for Stage 2 of the project, it is primarily intended to set the scene for the Stage 2 research. Stage 2 has not taken place.

*Relevance*

The Stage 1 Report provides valuable information regarding on approach and stakeholder involvement.

*FLOOD RISK MANAGEMENT IN ESTUARIES (FRaME)*

**Website** http://www.frameproject.org/

*Justification*

New methods are needed to protect estuaries from the effects of increased flood risk due to climate change, as estuaries are highly productive ecosystems abundant in marine life and a valuable habitat. New initiatives are required whilst still safeguarding the Natura 2000 series.

*Objectives*

To assist in the practical development of sustainable flood risk management strategies in the North Sea estuaries, ensuring that the most favourable strategic options and techniques are adopted. It aims to combine Flood Control Areas with alternative sustainable land use.

*Deliverables*

- An international panel of experts
- A transnational expertise network
- A website
- A best practice manual for the implementation of FCAs along with the demonstration, monitoring and evaluation of three FCAs.

*Relevance*

This has relevance to SMPs and CZMPs within the UK.

## FLOOD RISK MANAGEMENT RESEARCH CONSORTIUM (FRMRC)

**Website** www.floodrisk.org.uk

### *Justification*

The major flooding in the UK in Autumn 2000 and Winter 2000/01 highlighted the damage that flooding can cause. Recent climate change scenarios, produced for the UK Climate Impacts Programme, using computer modelling methods, show that such serious flooding could become a more frequent problem, with heavier winter rainfall, more intense downpours and rising sea levels predicted. To meet these challenges a research consortium has been set up to tackle the problem of flooding in the UK. This is jointly funded by EPSRC and the Defra/EA Joint Flood Management Research programme.

### *Objectives*

Key short-term objectives for the consortium are to:

- Reduce flood risk to people, property and the environment.
- Develop more accurate flood forecasting and warning techniques
- Improve the flood management infrastructure

In the longer-term the consortium will establish a high quality programme of underpinning science to enhance our understanding of flood risk and support the development of improved flood prevention, management and mitigation strategies.

### *Deliverables*

R&D work packages have been developed under the following topics:

- Land Use Management - main aims are to develop scientific understanding of the local scale effects of agricultural land management practices on flooding, modelling tools to represent the impacts and also to provide policy guidance.
- Real-Time Flood Forecasting - main aim is to reduce the risk associated with the operation of the real-time forecasting system.
- Infrastructure - main aims are to develop an improved capability for the prediction of the onset of breach formation and progression and analysis of the geotechnical failure process of fissuring and morphology/structure interactions.
- Whole Systems Modelling - main aim is to deliver the next generation of flood inundation models for coastal and fluvial flooding.
- Urban Flood Management - main aims are to develop methods for predicting flood routes across urban areas and determining consequences and to develop new serviceability indicators to prioritise and optimise remediation measures.
- Stakeholder and Policy – main aim is to identify deficiencies that can be rectified through enhanced stakeholder engagement in developing new multi-functional and spatially explicit policies.
- Morphology and Habitats – main aim is to enhance understanding of the physical processes responsible for driving sediment dynamics and morphological responses to flood management, including investigation of links between morphological adjustments and habitat provision in fluvial and tidal systems.
- Risk and Uncertainty – main aims are to make uncertainty analysis a routine aspect of flood risk modelling activities, to resolve the uncertainty-handling and software issues associated with the construction of composite risk models of flooding systems and to support the implementation of methods of robust, risk-based decision-making for flood management.

*Relevance*

This project has significant relevance to this project. However, a lot of the deliverables will not come on-line until after the completion of this project. Therefore, although the R&D needs to be taken into consideration, it will not be possible to incorporate it directly into our work.

## *FLOOD RISKS TO PEOPLE*

**Website**
http://www2.defra.gov.uk/research/project_data/More.asp?I=FD2317&SCOPE=0&M=PSA&V=PI%3A120
http://www2.defra.gov.uk/research/project_data/More.asp?I=FD2321&SCOPE=1&M=CFO&V=HRWGL

*Justification*

The main factors that contribute to death/injury/harm to people during floods include:

- Flow velocity
- Depth of flooding
- Suddenness of flooding (and the amount of flood warning)
- The degree to which people are exposed to the flood (related to size of floodplain, location of floodplain, type of accommodation, etc.)
- Vulnerability of the population (e.g. old, young, infirm, etc.)

There is a need to understand how these factors combine to cause death or serious harm to people.

*Objective*

To develop methods for assessing and mapping the risk of death or serious harm to people as a direct result of a flood event and to provide guidance on areas where people are most at risk.

*Deliverables*

Algorithms suitable for risk/vulnerability mapping and associated guidance.

*Relevance*

This project is looking at the single most important consideration for a FRA and will provide the fundamental answers regarding risk to people that can then be translated in appropriately precautionary guidance for development planning and flood mitigation.

## *FORESIGHT FLOOD AND COASTAL DEFENCE PROJECT*

**Website** http://www.foresight.gov.uk/

*Justification*

There is a need to produce a long-term vision for the future of flood and coastal defence that takes account of the many uncertainties, is robust, and can be used as a basis to inform policy and its delivery.

*Objectives*

To analyse the drivers of future flood risk (identifying which are most important and which are most uncertain), assess their future impacts and to consider how the UK could respond to the challenges identified. This includes the use of the risk model RASP to quantify risks for England and Wales and looking at urban areas to assess future drivers and risks.

*Deliverables*

Phase 1 produced a first cut assessment in order to:

- identify key factors likely to change flood risk on a 30-100 year timescale (the *Drivers*) in terms of both the physical processes of, and human interventions in, the flooding system;
- provide a framework within which the following phases of the project can quantitatively assess changes in future flood risk; and
- outline a work plan for Phase 2 of the project

Phase 2 deepens the analysis of Phase 1 and quantifies the impacts of future flood risk in the UK for four future scenarios. The Phase 2 report is split into the following topics:

- Deepening the Assessment of Drivers of Future Flood Risk
- National flood risk assessment for England and Wales
- Assessment of intra-urban impacts of future flood risk
- Assessment of environmental impacts of future flood risk

Phase 3 will consider how the UK could respond to the challenges of future flood risk.

*Relevance*

The results from this study will feed into the high-level decision making element of the framework for FRA.

*GUIDANCE ON UNCERTAINTY ASSESSMENT AND COMMUNICATION*

**Websites**

http://www.rivm.nl/en/milieu/milieubalans_verkenning/uncertainties/
http://www.nusap.net/sections.php?op=viewarticle&artid=17

*Justification*

Part of the knowledge and information provided by the Netherlands Environmental Assessment Agency (MNP) is about the quality of the available knowledge and methods used and about the robustness of the policy-relevant conclusions. Policy makers, politicians and other societal actors, in their respective roles, must be able to deal responsibly with the large uncertainties that are sometimes inherent in problems related to the environment, nature and sustainability.

*Objectives*

To provide procedures, guidance and tools to assist those undertaking decision-making activities with associated uncertainties to assess and communication those uncertainties effectively.

*Deliverables*

A series of documents were produced:

- Mini-checklist
- Quickscan Questionnaire
- Quickscan Hints and Actions List
- Detailed Guidance
- Tool Catalogue for Uncertainty Assessment

*Relevance*
The communication style and approach adopted by this project can inform the communication philosophy behind FD2320.

*IMPROVING DATA AND KNOWLEDGE FOR EFFECTIVE INTEGRATED FLOOD AND COASTAL EROSION RISK MANAGEMENT*

*Justification*
The planning, designing, building, operating and maintaining flood and coastal defences, and the establishment of efficient and effective risk management activities such as flood warning, development control, etc. are all dependent on the availability of accurate, relevant and up-to-date data. The understanding of flooding and coastal erosion processes cannot be improved unless we continue to collect data and are able to process them to provide relevant information. It is also important to ensure the information about data sources is widely available.

*Objectives*
To produce tools and best practice guidance for effective data, information and knowledge management related to Flood and Coastal Erosion Risk Management, incorporating the findings of R&D and the activities identified in FD2314 *Position review of data and information issues within flood and coastal defence.*

*Deliverables*
- A report containing details of R&D reviews, consultations, case studies, etc. covering current and future needs
- Tools and techniques to assess data quality, etc.
- A compliant data and meta-data standard register
- Best practice guidance

*Relevance*
The outputs from this project should be incorporated into the live system resulting from FD2320.

*IMPROVING THE FLOOD RESISTANCE OF BUILDINGS THROUGH IMPROVED MATERIALS, METHODS AND DETAILS*

*Justification*
The recent incidences of severe flooding in the UK, together with recent predictions on future flooding from the Fore*sight* project, have given rise to significant interest by Government, the financial institutions, insurers, building industry and the public in the improvement of local flood protection to buildings. This has been driven by the need to protect the health and safety of the individuals living and working in affected properties as well as the need to reduce the economic cost of flooding.

*Objectives*
This project will follow on from existing and ongoing research to investigate two aspects of flooding:
- Resistance to flooding – an evaluation of water exclusion measures for building structures, building systems and their components under controlled laboratory conditions;

- Resilience to flooding – the ability of different constructions and generic products and materials to withstand damage by flooding; the drainage and drying properties of materials; and their ability to be cleaned or replaced.

This will include laboratory tests and field trials.

*Deliverables*

Apart from the R&D project reports, a guidance document will also be produced suitable for public dissemination and delivered by CIRIA.

*Relevance*

This project is just an example of the work currently underway looking at flood resilience of properties, which is one means to mitigate flood risk.

*INTEGRATED FLOOD RISK ANALYSIS AND MANAGEMENT METHODOLOGIES (FLOOD*SITE*)*

**Website** http://www.floodsite.net/

*Justification*

FLOOD*site* is one of the first new-style 'Integrated Projects' funded from the EC 6th Framework Programme. These Integrated Projects cover research in a whole area of science and technology previously commissioned through several smaller projects. Integrated Projects aim to promote co-operation and mobility amongst scientists and to improve access to research infrastructure and training.

*Objectives*

To provide an integrated approach to flood risk analysis and management from operational to strategic planning time horizons, covering river, estuarine and coastal flooding, based on:

- An integrated European methodology for flood risk analysis and management
- A consistent approach to the whole system (natural hazard, ecology, scio-economic and cultural factors)
- A consistent approach towards flooding from rivers, estuaries and the sea
- A framework for integrated flood risk management
- Integration with other EA and national research

*Deliverables*

- Project image, web presence and data procedures
- Report on the language of risk
- Review of dissemination methods and raising public awareness
- Report and software for improved characterisation of flash flood catchments
- Techniques and guidance for estimating coastal and river extremes, accounting for trends and uncertainties
- Hydraulic loading of flood defence structures using new information on extremes
- Report on flood impact evaluation methods used in Europe
- Reports on risk perception and community behaviour in face of flood risks for each country
- Best practice guide outlining defence types, failure modes including 'indicators' and methods of analysis
- Reports on loss of life and modelling damage reduction by flood warning
- Report on MCA method for assessment of pre-flood measures

- Methodology for reliability analysis, including time dependent processes such as deterioration and progressive failure.
- Improved methods for flash flood forecasting in small basins
- Guidance on the emergency repair of dike failures
- Review of measures, policy instruments and strategies for different flooding situations and evaluation of different strategies for flood mitigation with respect of sustainability criteria
- Method to define comprehensive and sustainable for use with future planning scenarios and the FRMA procedure
- Methods to identify in real-time safe evacuation routes
- Report on integrated framework for long-term planning together with a functional design of DSS
- Conceptual integrated framework for propagating of uncertainty through complex models
- Guidelines for the development of a European Flood Hazard Atlas
- FLOOD*lab* web-based tool demonstrator completed
- Educational and Professional Development training material
- Integrated Report on Lessons from the Case Studies
- Final integrated scientific report on the whole project

*Relevance*

The project philosophy is closely aligned to the current flood risk management approach used in the UK and other European countries with risks being assessed through the source-pathway-receptor model and managed and mitigated through pre-flood, flood-event and post-flood activities. This maps well onto the work both of Fore*sight* and the EPSRC Flood Risk Management Research Consortium.

## *INVESTIGATION OF EXTREME FLOOD PROCESSES & UNCERTAINTY (IMPACT)*

**Website** http://www.samui.co.uk/impact-project/

*Justification*

Dams and flood defence structures are essential to modern life in Europe. This project involves 9 participants from 8 countries in a programme of research to investigate extreme flood and failure processes (breaching, sediment movement, urban/rural flood propagation) and the risk and uncertainty associated with each process. These processes contribute the greatest uncertainty to flood prediction.

*Objectives*

Specific objectives of the project are to:

a) Advance scientific knowledge in the areas of breach formation, sediment movement (under extreme floods), flood propagation through urban and rural areas and flood risk management.
b) Develop improved predictive models with which flood risks and uncertainty associated with these processes may be determined within the overall framework of flood risk management
c) Review implications for end user application, and consider how the risk and uncertainty information may be integrated into specific applications

*Deliverables*

Communication of results.

*Relevance*

The known gap in understanding of defence performance and risk is a recognised requirement for improving the FRA process.

*JOINT PROBABILITY – DEPENDENCE MAPPING AND BEST PRACTICE*

**Website**
http://www2.defra.gov.uk/research/project_data/More.asp?I=FD2308&SCOPE=0&M=PSA&V=PI%3A120

*Justification*
This and preceding projects have studied sea level/wave and sea level/fluvial JP problems in some detail, with significant impact on how flood and coastal defences are designed and managed.

The JP approach can be used in urban areas where flooding can be caused by a combination of high direct rainfall and high tide level. The method has not been widely used in this case because of the lack of information on correlation (or statistical linkage) between rain storms and surge heights. There has until now been no detailed analysis of the potential effects of climate change on joint probability of extreme loads. This research is helping to fill these gaps.

*Objective*
To identify and develop best practice guidance for application of joint probability (JP) methods to a range of cases where understanding the risk posed by the combined effect of two or more extreme variables is important.

*Deliverables*
Guidance documentation for the application of JP methods.

*Relevance*
As we move away from only looking at the primary cause of flooding in an area and start to look at the risks associated with all of the influences on an area (e.g. fluvial, pluvial, tidal, etc.), the need to understand JP is fundamental.

*KITEMARK SCHEME*

**Website**
http://www.environment-agency.gov.uk/subjects/flood/826674/830330/877142/484693/?lang=_e

*Justification*
The recent incidences of severe flooding in the UK, together with recent predictions on future flooding from the Fore*sight* project, have given rise to significant interest by Government, the financial institutions, insurers, building industry and the public in the improvement of local flood protection to buildings.

*Objective*
The Environment Agency in England and Wales and has teamed up with HR Wallingford, to develop a certification scheme that is supported by the British Standards Institution.

The devices have been tested in a purpose-built rig at HR Wallingford's laboratories. The rig incorporates a row of terrace house 'fronts' complete with doors, windows, patio doors and airbricks, and a wave machine for realistic testing.

The facility can also test temporary free-standing devices such as barriers and tubes.
The products have also been subjected to a factory test to ensure consistent manufacturing standards.

*Deliverables*

Suitable products are awarded a BSI Kitemark, a well-known quality standard for consumer goods.

*Relevance*

This project is just an example of the work currently underway looking at flood protection for properties, which is one means to mitigate flood risk.

## *MITIGATION OF CLIMATE INDUCED NATURAL HAZARDS (MITCH)*

*Justification*

Past European research has made significant advances in understanding, monitoring and forecasting climate induced natural hazard risks such as floods, droughts and landslides. The MITCH concerted action seeks to translate these advances into practical benefits, by bringing together research institutions and end users (including insurers) with leading involvement in mitigation of natural hazards with meteorological cause.

*Objectives*

- To provide a forum for discussion and debate.
- To assist hazard planning and management by disseminating start-of-the-art research.
- To match end user needs with research community capability.
- To seek implementation pathways for research results.

*Deliverables*

Includes workshops and an active website to aid wide dissemination.

*Relevance*

Although the primary focus is on flood warning, it also considers flood-related hazards, such as land slips, debris flow and climate change impacts. All of which should be considered as part of a FRA.

*MODELLING AND DECISION SUPPORT FRAMEWORK (MDSF)*

**Website** http://www.mdsf.co.uk/

*Justification*

The CFMP process requires large quantities of data and various forms of modelling in order to predict flood levels and their effects under existing conditions and with future scenarios of climate change, land use change and development. In order to make modelling a practical option for multiple catchments, a relatively standardised approach is needed for both data and modelling.

The MDSF aims to:

- Facilitate assembly and management of catchment data;
- Provide guidance on flood water level prediction throughout a catchment;
- Calculate flood extents and depths (in the absence of defences), economic damages and social impacts; and
- Provide a framework for policy evaluation, assessing options and uncertainty estimation.

*Objective*

To provide a tool for use by the EA and consultant staff in the development of CFMPs. This will enable the CFMP programme to go forward in a consistent way, by using common data structures and scenario models and providing value for money by avoiding duplication of effort among consultants.

*Deliverables*

- Procedures providing guidance on the application of MDSF to CFMPs and on specific aspects including modelling;
- Software, including:
  - Customised GIS based on existing ArcView software; and
  - Modelling tools.

Demonstrations of the MDSF software tool are being conducted for development of CFMPs for pilot catchments. It should be noted that the current phase of MDSF is an improvement stage through incorporation of RASP ILM (see below).

*Relevance*

This forms an integral part of RASP and the use of CFMPs.

*NATIONAL FLOOD AND COASTAL DEFENCE DATABASE (NFCDD)*

**Website** http://www.defra.gov.uk/environ/fcd/hltarget/nfcdd.htm

*Justification*

Defra's High Level Target 4A requires the EA, in partnership with other operating authorities, to 'develop a National Flood and Coastal Defence Database and maintain it thereafter.' The specific requirement is to put in place arrangements for systematic collection and storage of data on flood and coastal defences. Given that there are more than 600 operating authorities, multiple data collection and storage systems are in practice.

The need for such a database was reinforced in the autumn 2000 floods, after which government reports called for a clear understanding of the condition and adequacy of defences. The final database should support risk-based approaches to flood defence (i.e. the EA's Flood Risk Management Strategy) and remove the need for operating authorities to develop their own systems, thus releasing EA resources currently used to input operating authority data.

*Objectives*

To provide a single, easily accessible, and definitive store for data on flood and coastal defences, supported by and available to all operating authorities. This database should facilitate the prioritisation of investment, inform management decisions, and aid in measuring achievement of policy aims.

The database will be developed over a number of phases, as the EA's understanding of risk and the best ways to manage it increases (part and parcel of the other R&D projects and initiatives currently underway).

*Deliverables*

- A central 'data warehouse' for storing information on:
  - Location, composition, and conditions of flood and coastal defence assets;
  - Asset inspection histories;
  - Indicative Floodplain Map; and
  - Information on historic or modelled flood events;
- Tools for viewing, analysing, updating, and managing the stored data.

*Relevance*

The NFCDD should be considered as an important element of the overall framework for FRA and also FRM. Not only does it provide the central store for several of important pieces of information required for FRAs (as listed above), but it also provides the audit and control mechanisms for the information.

## *PARRETT CATCHMENT PROJECT*

**Website** http://somerset.gov.uk/enprop/pcp

*Justification*

The catchment receives higher than average rainfall, which with the effects of climate change has lead to an increase in severe flooding events. The catchment harbours numerous residential and industrial areas; along with 47 SSSIs totalling 9,377ha in area. The flooding has had an adverse effect on the local economy and so a catchment strategy is seen to be required.

*Objectives*

- Developing an Integrated Catchment Management plan
- Water farming
- Water management, consisting of moderating runoff, Managing flood events, Improving the rate of flood evacuation, Reducing tidal influence
- Bringing floodwater under a greater degree of control
- Develop a sustainable approach to integrated flood management
- Provide a range of measure for modifying land use
- Develop an integrated approach to rural development

*Deliverables*

A package of measure is to be delivered:

- Changes to agricultural land management
- Creating temporary flood storage areas on farmland

- Controlling runoff from development
- Dredging and maintaining river channels
- Raising riverbanks
- Upgrading pumping stations
- Spreading floodwater across the moors
- Tidal sluice or barrier
- Upgrading of existing channels
- A restriction of new developments on floodplains

*Relevance*

This is a practical example of an integrated catchment strategy.

### *PERFORMANCE AND RELIABILITY OF FLOOD AND COASTAL DEFENCE STRUCTURES*

**Website** http://www.PRFCD.org.uk

*Justification*

It is envisaged that the concept of characterising the reliability of defences through a “fragility curve” will be a critical component in future management decision-making practices – a concept being promoted through RASP and other related research. There is now a clear need to provide practitioners and researchers with an R&D output that provides well argued approaches for developing fragility curves for a range of structures. In particular, explaining the concept of defence fragility and its limitations and opportunities for its use. This research will underpin the uptake of the fragility concept and will clearly highlight gaps in our current understanding of defence performance.

*Objective*

To identify methods and provide guidance on best practice approaches for assessing the reliability of defence structures (linear defences, pumps and gates) and their deterioration in time. The proposed project outputs will directly support the overall joint R&D programme objective of developing improved risk-based management/engineering.

*Deliverables*

Written guidance in the format of an R&D Technical Note on the concept of defence fragility and the methodologies behind the development of fragility curves. A more detailed R&D Project Report outlining the findings of the project and recommendations for future developments.

*Relevance*

The known gap in understanding of defence performance is a recognised requirement for improving the FRA process.

## *PERFORMANCE BASED ASSET MANAGEMENT SYSTEMS (PAMS)*

**Website** http://www.pams-project.net/

### *Justification*

Relative to existing methods associated with the appraisal of new flood defence schemes, current approaches to justifying maintenance needs are crude. In particular, the EA's Flood Defence Management Manual (FDMM) and Management System (FDMS) are no longer consistent with the EA's focus on managing flood risk as opposed to providing flood defence. Both the FDMM and the FDMS provide only limited guidance on which assets offer a critical contribution to flood and coastal erosion risk reduction and how best they should be managed. These shortcomings are widely recognised within the EA.

### *Objective*

To establish a Performance-based Asset Management System that enables flood and coastal defence managers to assess the performance of, and management requirements for, existing flood defence assets. These may involve maintenance, adoption or replacement. In the longer term, the project also seeks to provide a means of identifying the preferred management intervention to achieve a particular performance outcome or expenditure profile.

### *Deliverables*

- A review of possible approaches, highlighting a number of options.
- A detailed methodology (tested with a pilot study).
- A plan for implementation within the EA including training, documentation, software interfaces, etc.
- Implementation of the new approach along with supporting manuals and software.

### *Relevance*

Asset management forms a crucial element of determining future performance of flood defences, which in turn impacts on future flood risk. FRAs should take into consideration the performance of mitigation measures over the lifetime of the development.

## *PLANNING FOR URBAN-RURAL RIVER ENVIRONMENTS (PURE)*

**Website** http://www.purenorthsea.com/

### *Justification*

Water Management systems for Urban-rural fringes are failing to meet the needs of spatial functioning and local stakeholders. Solutions are required to develop and implement sustainable solutions for these problems, including dehydration, poor water quality and lack of spatial quality and identity within the urban-rural fringe zones of medium sized cities.

### *Objectives*

To develop the various spatial fluctuations of water catchment areas in the urban rural fringe, with a focus on public participation, water quality and flood risks through integration of water management policy into spatial planning though the use of water as an organising principle for spatial development. In addition, generation of support for the development of master plans and the implementation of pilot projects along with concrete measures for water systems based on water management and spatial planning policies

*Deliverables*

- Four pilot projects, eighteen master plans, ten workshops, sixteen exchange visits and four sets of guidelines
- PURE check sustainability tool
- Introduction of local authorities to PURE

*Relevance*

The issues of multifunctional land use and assessment methods associated with rural verses urban areas need to be considered as part of this project.

## *POSITION REVIEW OF DATA AND INFORMATION ISSUES WITHIN FLOOD AND COASTAL DEFENCE*

**Website**

http://www2.defra.gov.uk/research/project_data/More.asp?I=FD2314&SCOPE=0&M=CFO&V=WSAST

*Justification*

The use of data is fundamental to many decisions in flood and coastal management, although how that data is collected, managed and archived is neither consistent nor well understood. To encourage a cost-effective approach to future data and information management, a strategic approach to data and information is necessary. This is the whole life cycle of data, being collection, dissemination and use of data for decision-making to support both policy development and operational implementation.

*Objective*

To understand the efficiency of current data and information practices and what opportunities exist to improve the flood and coastal defence process. The project aims to challenge and reflect new thought processes on this top area, to support and promote policy development, implementation processes and operations, taking full account of existing data collection programmes and archives.

*Deliverables*

To report where limitations can be matched with quick fixes and uptake of ongoing research and initiatives.

*Relevance*

Use of data and information management form very important elements of the overall framework of FRAs. This project is the best available source for understanding current information management.

## *PRELIMINARY RAINFALL RUNOFF MANAGEMENT FOR DEVELOPMENTS*

**Website**

http://www.ciria.org/suds/pdf/preliminary_rainfall_runoff_mgt_for_developments.pdf

*Justification*

"Rainfall runoff management for developments - Interim national procedure" produced by the EA is an interim method, which was always expected to be revised as improved tools are developed. It utilises well-recognised existing methods, but revisions were always anticipated to provide a more consistent approach as and when FEH procedures can be extended to catchments at development scale.

*Objective*

To develop a guide based on the requirements of the "Rainfall runoff management for developments - Interim national procedure" produced by the EA.

*Deliverables*

A guide aimed at Regulators, Developers and Local Authorities to advise on the management of stormwater drainage for developments and, in particular, to assist in sizing of storage elements for the control and treatment of stormwater runoff.

*Relevance*

This guide can be used to determine whether a new development is designed to prevent an increase in flood risk either within the development or the hydraulic area of influence – important considerations for the associated FRA.

## *REDUCING THE RISK OF EMBANKMENT FAILURE UNDER EXTREME CONDITIONS*

**Website**

http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=10719#Description

*Justification*

The need for improved guidance on the design and management of embankments across coastal and fluvial areas has been established through Defra and EA Concerted Actions and is supported through experience gained in recent UK flood events. Consistent with the EA Strategy for Flood Risk Management (2003-2008), is the need to take a risk-based and whole life approach to the management of flood defence embankments.

The design and management of flood and coastal defence embankments needs to draw on many civil engineering disciplines including hydraulics, geotechnics, survey inspection techniques, modelling and data analysis, and risk management. During the past decade there have been a range of developments, research projects and initiatives from which the operating authorities can learn and develop improved methods to enhance performance.

*Objective*

To present an overview of embankment performance issues and guidance on good practice for dealing with many aspects of embankment design, operation and management, such that practitioners may identify realistically achievable improvements and move towards ensuring that consistent standards and approach are achieved.

*Deliverables*

Two main deliverables include:

- A good practice guidance document covering a wide range of flood defence embankment issues from embankment function and performance through to introduction of a risk-based approach for sustainable management.
- Identification and prioritisation of key actions and initiatives required to provide immediate and longer term gains in embankment performance so ensuring maximum value from existing and future flood defence embankments.

*Relevance*

Although FRA is concerned with the performance of existing defences, the EA is also involved in providing guidance on design and future operation and maintenance of mitigation measures where developments will be at risk from flooding. The implementation of best practices is an important element of this.

*REDUCING UNCERTAINTY IN ESTIMATION OF FLOOD LEVELS (RIVER CONVEYANCE)*

*Justification*

In the past two decades there has been a managed programme of research on the EPSRC Flood Channel Facility (FCF) at HR Wallingford, on university laboratory flumes and on real rivers. This has resulted in a step advance in the understanding of flow phenomena in complex river and floodplain systems and constitutes the leading international effort in rivers research over the last two decades. This research improved understanding of many of the processes that determine the flood capacity of river and flood plain systems. However, there was a concern that this new knowledge had not been transferred successfully into practice within the UK flood defence community.

*Objective*

To produce a national new tool, the Conveyance Estimation System (CES) which will encompass, categorise and provide access to current knowledge and understanding to facilitate the estimation of conveyance by the various users in the UK.

The project will also provide advice on channel resistance arising from vegetation, substrate and irregularities along with seasonal variation and the influence of maintenance activities.

*Deliverables*

- The Conveyance Estimation System (CES) which will incorporate the conveyance estimator and the roughness advisor, as a stand alone "package" designed to solve simpler types of assessment (e.g. for maintenance operations) in its own right and to support parameter selection in hydraulic models;
- The algorithms of the Conveyance Estimator documented as open source code;
- User documentation, a conveyance manual and training material; and
- In addition, ISIS will be modified to include the CES methods.

The project outputs are directed at meeting the needs of different use groups in the EA and its consultants through the involvement of a consultative group in the development process.

*Relevance*

The use of best modelling practices can only enhance the confidence in the modelling carried out as part of FRAs. To that end, cross-references to this project will be required when developing the framework for FRAs.

*RISK ASSESSMENT FOR FLOOD AND COASTAL DEFENCE FOR STRATEGIC PLANNING (RASP)*

**Website** http://www.rasp-project.net/

*Justification*

To better understand the performance of flood and coastal defences, it is often necessary to consider systems of defences rather than single defences in isolation. At present there is limited guidance on assessing risk to large floodplain areas that depend on numerous, perhaps extensive and diverse, systems of defence such as embankments, walls, and moveable structures. With moves towards more integrated flood management, risk managers must have recourse to sound and practical tools and techniques for assessing the performance of whole systems in order to develop balanced, integrated risk management strategies.

*Objective*

To develop and demonstrate supporting methods for dealing with systems of flood and coastal defences (rather then merely considering single defences in isolation). To enable appropriate levels of analysis to be conducted, as justified by the importance of the decision and its sensitivity to uncertainty, through development of a tiered methodology.

*Deliverables*

RASP will deliver High, Intermediate, and Detailed Level Methodologies to be used for:

- National monitoring of risk from flooding;
- Strategic prioritisation of investment in defence improvements or other flood management options (e.g. increased storage or diversion);
- Targeting flood warning and emergency preparedness;
- Highlighting priorities for monitoring and maintenance and justification of maintenance decisions; and
- Scheme design and optimisation.

Outputs will be compatible with standard GIS to support simple user visualisation. RASP will also involve demonstration studies at pilot sites and production of written guidance to enable widespread application.

RASP will not be delivering new software but will be inputting into current software development projects such as the MDSF and NFCDD. MDSF and RASP are closely related and are being jointly developed.

*Relevance*

RASP with its 3 levels of methodology will form key elements of the framework for assessing flood risk at the national, catchment-wide and scheme scales.

*RISK MANAGEMENT FOR UK RESERVOIRS (CIRIA REPORT C542)*

**Website** http://www.ciria.org.uk/acatalog/C542.html

*Justification*

The storage of large quantities of water in reservoirs is essential for the provision of water supplies, flood storage, production of hydro-electric power, irrigation, canal replenishment, amenity use, etc. Many reservoirs in the UK lie immediately upstream of, or adjacent to, heavily populated areas, and the rapid uncontrolled discharge of water from any such reservoir could have catastrophic consequences on life and property. All reservoirs in the UK holding more than 25,000m$^3$ are subject to regular safety checks in accordance with the Reservoirs Act 1975. Although no lives have been lost as a result of a dam failure since the introduction of reservoir safety legislation in 1930, there have been several "near misses", which may not necessarily have threatened life. There is particular concern about the safety of the many embankment dams constructed more than 100 years ago before the development of soil mechanics. Following the recommendations of the House of Lords Select Committee on Science and Technology in 1982, a study concluded that there were no fundamental reasons why probabilistic risk assessment could not be applied to reservoir safety.

*Objective*

To provide guidance on the application of risk assessment and risk management procedures to UK reservoir practice, primarily for UK reservoir owners, panel engineers, regulators, insurance companies and others concerned with reservoir safety.

*Deliverables*

A guidance document that outlines a risk assessment of reservoirs that fall within the provisions of the Reservoirs Act 1975. Such reservoirs are those designed to hold or be capable of holding more than 25,000m$^3$ of water above the natural level of any part of the land adjoining the reservoir (including the bed of any stream). The principal types of reservoirs covered are: impounding reservoirs; non-impounding reservoirs; and service reservoirs. This legislation covers some 2500 reservoirs, of which about 85% are formed by embankment dams.

*Relevance*

Lessons learnt from this study with regard to risk assessment could be applied to embankment failure associated with flooding.

*RISK, PERFORMANCE AND UNCERTAINTY IN FLOOD AND COASTAL DEFENCE*

**Website**

http://www2.defra.gov.uk/research/project_data/More.asp?I=FD2302&M=KWS&V=FD2302&SUBMIT1=Search&SCOPE=0

*Justification*

Modern flood and erosion risk management aims at managing whole flooding and erosion system, be they catchments or coastlines, in an integrated way that accounts for all of the potential interventions that may alter the flood or erosion risk. Science and technology of risk management have made tremendous progress and process-based models describing key elements of the flooding and erosion systems are now available and continue to develop. The potential now exists for an integrated description of the whole system. In the past in the absence of appropriate decision support tools, risk managers have struggled to handle the complexities inherent in integrated management.

Up to the point of this study, current guidance on risk-based decision-making has been primarily focused on function specific decisions. To achieve best value, these function specific activities need to be conducted within an integrated risk-based framework that covers decisions at different levels and function specific decisions.

Adoption of consistent terminology will play an important role in achieving more integrated risk management. This project outlines key definitions and philosophies.

*Objective*

To review the following:

- Issues surrounding flood and erosion management from a risk and performance perspective
- The principles of risk, performance and uncertainty and the application of these principles in decision-making practice
- The need to move towards a more integrated risk-based decision-making framework
- Risk tools and techniques that may help the flood and coastal defence community to achieve best value and demonstrate areas of success and failure

*Deliverables*

A report covering all of the above.

*Relevance*

This study led the way for the development of RASP and MDSF and provides a comprehensive review of the issues associated with risk, performance and uncertainty in flood and coastal defence.

### *SCIENTIFIC DATA MANAGEMENT BY PROJECT CONSORTIA: BEST PRACTICE GUIDELINES*

**Website** http://www.hrwallingford.co.uk/downloads/projects/estuary_data.pdf

*Justification*

Many estuary management projects require the collation of scientific data and this guide has been produced to assist organisation working on such projects. The need for such guidance was highlighted during the Estuary Research Programme Phase 1 (ERP1) EMPHASYS project completed in 2000. Whilst collating data on the physical processes of British Estuaries, the EMPHASYS project reported the need to develop a standard framework for future projects.

*Objective*

To assist organisations both commissioning projects as well as those actually undertaking the work to have a reference describing what is involved in work of this kind.

*Deliverables*

Best practice guidance document.

*Relevance*

Provides an example of best practice for data management, using the principles of information management proposed for this project.

### *SHORELINE MANAGEMENT PLANS (SMPs)*

**Website** http://www.defra.gov.uk/environ/fcd/policy/smp.htm

*Justification*

A SMP provides a large-scale assessment of the risks associated with coastal processes and presents a long-term policy framework to reduce these risks to people and the developed, historic and natural environment in a sustainable manner. In doing so, a SMP is a high level document that forms an important element of the strategy for flood and coastal defence.

First generation SMPs have been completed around the coastline of England and Wales. Many operating authorities have adopted the recommendations of their Plan as a basis for production of individual strategic plans, monitoring programmes and studies for all or parts of their coastline and, where proven by strategic plans, the implementation of appropriate schemes. Future generations of SMPs should build on the first generation Plans, taking account of information subsequently collected or changing circumstances.

*Deliverables*

Defra published a revised Guide for Coastal Defence Authorities in the summer of 2001 following a review of the strengths and weaknesses of the first generation SMPs and in full consultation with the industry.

This guide concluded that the first generation SMPs were excellent high-level strategic documents, but that further research was needed into how the coast would evolve. As a result of this additional research, Defra has now prepared interim Procedural Guidance for Production of Shoreline Management Plans for consultation (SMP2). This, in due coarse, after further consultation will be superseded.

*Relevance*

SMPs are key for planning at the coastal cell level – an area of the planning process that is not currently being addressed adequately. This is partially due to unclear responsibilities at this level.

### *STRATEGIC FLOOD RISK PLANNING FOR GROWTH AREAS*

*Justification*

The Government's Sustainable Communities Plan sets out a strategy for the development of 200,000 new homes in the South-East by 2016. Many of these homes will be built in flood risk locations. ABI is committed to working with the Government, local authorities, and property developers to ensure that this challenging level of development occurs in a way that is truly sustainable.

*Objectives*

To undertake a study to:

(a) address potential economic and financial costs from flooding due to the additional development set out in the Communities Plan, and
(b) consider the most effective approaches to manage the risk in coming decades.

*Deliverables*

Making Communities Sustainable: Managing Flood Risks in the Government's Growth Areas Summary Report and Full Technical Report have been produced and are available from the ABI website.

*Relevance*

These reports provide a useful example of how assessments of flood risk can be undertaken at the sub-regional planning scale.

## *SUDS – UPDATED GUIDANCE ON TECHNICAL DESIGN AND CONSTRUCTION*

**Website** http://www.ciria.org.uk/suds/suds_projects.htm

### *Justification*

The purpose of this project is to increase industry confidence in the use of Sustainable Urban Drainage Systems (SuDS), particularly with regard to performance and maintenance requirements.

### *Objectives*

- To gather information on the technical performance and environmental benefits of using SuDS, through field monitoring of operational sites;
- Where possible, to try to identify the impact of degradation of SuDS on performance, and the effectiveness of maintenance activities;
- To improve guidance on the selection, design and maintenance of SuDS.

### *Deliverables*

Dissemination of the project findings through CIRIA publications and relevant external publications and journals.

### *Relevance*

There are concerns throughout the industry regarding risks associated with failing to maintain SuDS. There are also recognised problems associated with the adoption of SuDS by Water Companies, which will not be resolved until confidence has been increased regarding performance and maintenance.

## *SUDS WEBSITE – SUSTAINABLE DRAINAGE SYSTEMS: PROMOTING GOOD PRACTICE*

**Website** http://www.ciria.org.uk/suds/

### *Objective*

A CIRIA project to disseminate and promote good practice in the implementation of sustainable drainage in the built environment

### *Deliverables*

Website includes:

- Details of different techniques and how to chose between them
- Legal issues (legislation, planning and approval)
- Details of ongoing research projects
- Case studies
- Details of forthcoming events
- Newsletter
- Publications

### *Relevance*

Provides up to date information regarding best practices.

*SUSTAINABLE FLOOD AND COASTAL MANAGEMENT*

**Website** http://www.sfcm.org.uk/

*Justification*

The UK government strategy "A better quality of life" sets out a number of high level objectives including;

- Social progress which recognises the needs of everyone
- Effective protection of the environment
- Prudent use of natural resources
- Maintenance of high and stable levels of economic growth

Flood and coastal management can contribute to sustainable development in many ways, not least through greater integration with other forms of land and water management. A number of specific sustainability issues have already been identified including;

- Climate change
- The impacts and role of planning guidance
- Opportunities to meet environmental targets
- Stakeholder engagement
- Adaptation of defences
- Materials and recycling
- Development of alternatives to flood defence

*Objectives*

To develop practical guidance and tools for policy makers and practitioners on how flood and coastal management strategies might meet current needs without compromising those of future generations.

*Deliverables*

The project will produce guidance and tools for flood and coastal management policy makers and practitioners. The project will help to integrate sustainability principle into current and future practice.

*Relevance*

This project has a number of common issues with FD2320, these being:

- Climate change
- The role and impacts of planning guidance
- Stakeholder engagement
- Adaptation of defences

Therefore, this project will provide useful insights into these issues

*SUSTAINABLE MANAGEMENT OF URBAN RIVERS AND FLOODPLAINS (SMURF)*

**Website** http://www.smurf-project.info/

*Justification*

The River Tame in the West Midlands (specifically the urban area of the river catchment that includes Birmingham and a large part of the Black Country) is a typical example of an urban river - polluted, heavily modified by culverting, straightening, re-routing and with concrete banks and few natural features.

There is a need to tackle these environmental problems on the Tame by integrating the planning and management of land-use, water quality, ecology and flooding. Subsequently, the methods developed by the SMURF project will be used as a model for work on similar rivers throughout the UK and the European Community.

### *Objective*

To demonstrate how the principles of urban river basin management planning can be applied to highly modified and degraded catchments.

By implementing sustainable land-use planning and water management techniques the SMURF project aims to:

- Improve the amenity, ecology and sustainability of the river catchment
- Involve local communities in the planning of the river basin
- Establish ecological objectives for the river system and a transferable Sustainable Indicators set
- Develop a detailed land-use planning model to help with future redevelopment in the floodplain and protect the community from future impacts of climate change
- Demonstrate how small scale changes can significantly improve a heavily modified river.

### *Deliverables*

One of the major challenges facing agencies involved in the urban planning process is the lack of consistency in the GIS, database and modelling systems used by the respective organisations. In order to facilitate collaboration, an important element of SMURF is the integration of diverse systems into the overall planning environment.

This includes construction of a software system delivering a co-ordinated approach. This combines a GIS user-interface with a database for water quality and ecology, and the automatic running of hydrological models of the catchment.

### *Relevance*

The experience gained from this project in the implementation of urban river basin management planning and development of complementary tools will form a very useful platform for the development of future guidance and tools concerned with the planning process and FRA.

## *SUSTAINABLE WATER MANAGEMENT IN LAND USE PLANNING (CIRIA RP627)*

### *Justification*

Water resources planning is a long-term, strategic activity. Effective liaison between Water Companies and those responsible for strategic land-use planning, particularly at national and regional level, is vital for making decisions that are timely, environmentally acceptable and economically sound. There is a need to raise awareness of the water resources planning process and the timing implications for new infrastructure investment as a result of proposed development. There is also a need to provide clarification regarding how water industry investment fits into land-use planning.

### *Objective*

- To provide good practice guidance on the incorporation of water resource and wastewater treatment issues as part of the planning process for new developments. Particular regard is given to the appropriate use of sustainable approaches to water management, for example, in the aspects of surface and wastewater disposal, the design of water efficient housing and effective use of sources of non-potable water.

- To assess the need for and, if required, identify a framework for a computer based decision support system to assist in the consideration of sustainable water management in the planning process.

*Deliverables*

A good practice guide is designed to meet the needs of planners and developers, with guidance summaries being produced to inform regulators, water utilities and sewerage undertakers in their decision making. The report identifies any further developments required in resolving the potential conflicting needs of new housing and the water environment.

*Relevance*

This guidance report provides substantial information regarding the planning process and the involvement of the relevant stakeholders.

*TEMPORARY AND DEMOUNTABLE FLOOD PROTECTION*

*Justification*

One of the lessons learnt from the Autumn 2000 floods was that the use of local protection, usually sandbags, could significantly reduce the impact of flooding. It was, however, evident that a range of innovative flood protection systems was available, which had the potential to replace the role of sandbags. These had potential for use by either flood defence operating authorities or community groups. Clearly there had to be a better understanding of the capability of these new flood protection systems and how they could be incorporated into flood management plans.

*Objective*

To provide a technical guide and supporting information on the use of temporary and demountable flood protection production systems.

*Deliverables*

- A fact sheet for each system to aid comparison and selection.
- A guidance document that sets out a logical risk-based process for assessing the applicability of temporary or demountable systems to the particular flood protection problem. This guidance is described as ‘interim’ to be reviewed in 2005.

*Relevance*

Temporary and demountable flood protection, although very beneficial for existing development, should not be considered as a primary form of protection for new development. However, they do have a part to play in the overall management of flood risk. Therefore, they are referred to in context in FD2320.

*THAMES ESTUARY 2100*

**Website** http://www.thamesweb.com/page.php?page_id=60&topic_id=9

*Justification*

The effects of climate change, such as sea level rise, increased rainfall and storm frequency, mean that London and the Thames Estuary will be at greater risk from flooding in the future. To compound this, many flood risk areas are undergoing development and regeneration, meaning that more people, buildings and infrastructure are likely to be exposed to the risk of flooding in the future.

Although London's existing tidal defences offer a high level of protection from present day flood risks, they were only designed to provide protection up until 2030. Modifications to these defences could extend their useful life by a few more years, but there is a need for a long-term, strategic look at London's flood defences.

*Objectives*

Thames Estuary 2100 (formerly Planning for Flood Risk Management in the Thames Estuary) is a joint initiative between the Anglian, Southern and Thames regions of the Environment Agency and aims to determine the appropriate level of flood protection needed for London and the Thames Estuary for the next 100 years. In particular:

- Look at tidal defences in the context of the wider Thames Estuary setting;
- Assess the useful life of the existing defences and gain an understanding of the 'drivers' (i.e. climate change, urban development, social pressures and the environment);
- Inform and gain support of political and funding partners and stakeholders; and
- Prepare and manage a programme of studies (linked with consultation) that will eventually lead to a strategy for flood risk management in the Thames Estuary for the next 100 years.

*Deliverables*

At this stage deliverables from the programme of studies are in the process of being identified.

*Relevance*

This project is the biggest/most complex sub-regional/local assessment of flood risk to be undertaken in the UK. Lessons learnt from this will influence the approach adopted by the rest of the UK.

*UK CLIMATE IMPACTS PROGRAMME 2002 CLIMATE CHANGE SCENARIOS: IMPLEMENTATION FOR FLOOD AND COASTAL DEFENCE*

*Justification*

The UKCIP programme released new climate scenarios in April 2002. These provided information at a higher spatial and temporal resolution than had been available in the UKCIP98 report. These scenarios needed to be translated into appropriate and consistent guidance for use within the flood and coastal defence community in England and Wales.

*Objectives*

- To review the precautionary allowances that had been established prior to UKCIP02 for future changes in sea level and river flow.
- To review user requirements.
- To review available information on climate change.

*Deliverables*

- Guidance for users on how to apply UKCIP02 climate change information across a range of flood and coastal defence tasks.
- Following completion of the R&D project, advice was provided to operating authorities on the use of the new scenarios for flood and coastal management.
  http://www.defra.gov.uk/environ/fcd/pubs/pagn/Climatechangeupdate.pdf

*Relevance*

The guidance from this project provides the basis of the climate change recommendations in FD2320.

## *USE OF SUDS IN HIGH DENSITY DEVELOPMENTS*

**Website** http://www.ciria.org.uk/suds/suds_projects.htm

*Justification*

DETR and DTLR Guidance notes for development (PPG25 and PPG3) propose potentially conflicting requirements. PPG3 requires high-density developments while PPG25 emphasises the need to use SuDS. SuDS utilise on-site techniques for retaining rainfall runoff and, therefore, require space to achieve this.

*Objectives*

- Evaluate SuDS features in terms of land uptake and their relative performance in the context of urban housing development
- Consider land use and development layout to maximise the potential for using SuDS units.

*Deliverables*

A guidance document for use by local authorities and developers to assist in defining appropriate use of SuDS for high-density developments and the limitations imposed related to limited land availability.

*Relevance*

There is a recognised problem of conflicting requirements between PPG25 and PPG 3 and there is, therefore, a need in FD2320 to assess these problems and provide guidance where possible. The project illustrates one of the problems and, therefore, the results from this project will be incorporated into any guidance developed.

## *WATER CYCLE MANAGEMENT FOR NEW DEVELOPMENTS (WaND)*

**Website** http://www.wand.uk.net/

*Justification*

There is a need for an improved, nationally recognised method for predicting runoff from development sites. This is a key issue for sizing the capacity (storage and conveyance) of drainage systems and an area in which EA and LA regulation and planning staff have major interests.

*Objective*

To support the delivery of integrated, sustainable water management for new developments by provision of tools and guidelines for project design, implementation and management.

There are three technically based work packages concerning water supply, storm drainage and wastewater. The goal is to identify key performance and design issues and to quantify the key system, infrastructure and environment interactions.

There are two other packages deal with aspects concerned with social acceptability of new 'sustainable' technologies, the decision-making process and the place of water management in it, the role of whole-life costing in this context and the potential for increased health risks.

*Deliverables*

Guidance documents covering all five elements given above and a toolbox that pulls together the strands of the issues and techniques raised in the five work packages.

The model will be used to evaluate alternative development and water management scenarios and to propose more sustainable strategies, demonstrated through a number of case studies.

*Relevance*

Predicting runoff from development sites is key to determining the hydraulic area of influence for a development and the associated flood risk.

# Appendix D

## D2.1 TOOL1 Flood Risk Indicators Tables

Table A Summary Details
Table B Principles of Application

### Table A - Recommended Flood Risk Indicators: Selection Guide

**Key:**

**Type** **1** - STATEMENT: only gives information about the existing flood hazard or risk - the hazard or risk the development is being subjected to.
**2** - CHANGE: can also assess the impact the development has on flood hazard or risk

**Suitability** **A** - Very good, **B** - Good, **C** - Fair

| | | | | | Relevant Country | | Relates to the following consequences | | | General Suitability | | | Suggested application at each level of the tiered risk assessment | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | National | | Regional | | Local | | |
| **FRI Ref** | **Category** | **Indicator** | **Units, etc.** | **Type** | **England** | **Wales** | **Economic** | **Social** | **Environmental** | **National** | **Regional** | **Local** | **Coarse** | **Intermediate** | **Coarse** | **Intermediate** | **Coarse** | **Intermediate** | **Detailed** |
| 1 | **Hazard** | Area AND Proportion of total area in plan that is classified as Flood Zone 3 (England) | ha AND % | 1 | Y | | Y | Y | | A | A | A | Y | Y | Y | Y | Y | Y | Y |
| 2 | | Area AND Proportion of total area in plan that is classified as Flood Zone 2 (England) | ha AND % | 1 | Y | | Y | Y | | A | A | A | Y | Y | Y | Y | Y | Y | Y |
| 3 | | Area AND Proportion of Flood Zone 3 area in plan that is already developed (England) | ha AND % | 1 | Y | | Y | Y | | A | A | A | Y | Y | Y | Y | Y | Y | Y |
| 4 | | Area AND Proportion of Flood Zone 2 area in plan that is already developed (England) | ha AND % | 1 | Y | | Y | Y | | A | A | A | Y | Y | Y | Y | Y | Y | Y |
| 5 | | Total NEW development in Flood Zone 3 (England) | ha | 2 | Y | | Y | Y | | B | B | A | Y | Y | Y | Y | Y | Y | Y |
| 6 | | Total NEW development in Flood Zone 2 (England) | ha | 2 | Y | | Y | Y | | B | B | A | Y | Y | Y | Y | Y | Y | Y |
| 7 | | Area AND Proportion of Flood Zone 3 that is defended (England) | ha AND % | 1 | Y | | Y | Y | | A | A | A | Y | Y | Y | Y | Y | Y | Y |
| 8 | | Area AND Proportion of total area in plan that is classified as Development Advice Zone C1 (Wales) | ha AND % | 1 | | Y | Y | Y | | A | A | A | Y | Y | Y | Y | Y | Y | Y |
| 9 | | Area AND Proportion of total area in plan that is classified as Development Advice Zone C2 (Wales) | ha AND % | 1 | | Y | Y | Y | | A | A | A | Y | Y | Y | Y | Y | Y | Y |
| 10 | | Area AND Proportion of total area in plan that is classified as Development Advice Zone B (Wales) | ha AND % | 1 | | Y | Y | Y | | | A | A | | | Y | Y | Y | Y | Y |
| 11 | | Area AND Proportion of Development Advice Zone C1 area in plan that is already developed (Wales) | ha AND % | 1 | | Y | Y | Y | | A | A | A | Y | Y | Y | Y | Y | Y | Y |
| 12 | | Area AND Proportion of Development Advice Zone C2 area in plan that is already developed (Wales) | ha AND % | 1 | | Y | Y | Y | | A | A | A | Y | Y | Y | Y | Y | Y | Y |
| 13 | | Area AND Proportion of Development Advice Zone B area in plan that is already developed (Wales) | ha AND % | 1 | | Y | Y | Y | | | A | A | | | Y | Y | Y | Y | Y |
| 14 | | Total NEW development in Flood Zone C1 (Wales) | ha | 2 | | Y | Y | Y | | B | B | A | Y | Y | Y | Y | Y | Y | Y |
| 15 | | Total NEW development in Flood Zone C2 (Wales) | ha | 2 | | Y | Y | Y | | B | B | A | Y | Y | Y | Y | Y | Y | Y |
| 16 | | Total NEW development in Flood Zone B (Wales) | ha | 2 | | Y | Y | Y | | | B | A | | | Y | Y | Y | Y | Y |
| 17 | | Expected annual probability of inundation with existing defences (if any) | low to significant or % | 1 | Y | Y | Y | Y | | A | A | A | Y | Y | Y | Y | Y | Y | Y |
| 18 | | Expected annual probability of inundation with proposed improved flood management measures (if any) | low to significant or % | 2 | Y | Y | Y | Y | | B | A | A | | Y | | Y | | Y | Y |
| 19 | | Reduction in area of Functional Floodplain due to new development | ha | 2 | Y | Y | Y | Y | Y | | | A | | | | Y | | Y | Y |
| 20 | | Depth of water in development site for 1% annual probability flood | m | 1 | Y | Y | Y | Y | | | | A | | | | | | Y | Y |
| 21 | | Area AND proportion of total area in plan that is affected by known groundwater flooding problems | ha AND % | 1 | Y | Y | Y | Y | | | C | A | | | Y | Y | Y | Y | Y |
| 22 | | Groundwater levels for existing conditions and with development | m AOD | 2 | Y | Y | Y | Y | Y | | B | B | | | | Y | Y | Y | Y |

## Table A - Recommended Flood Risk Indicators: Selection Guide (continued)

**Key:**

**Type** **1** - STATEMENT: only gives information about the existing flood hazard or risk - the hazard or risk the development is being subjected to.
**2** - CHANGE: can also assess the impact the development has on flood hazard or risk

**Suitability** **A** - Very good, **B** - Good, **C** - Fair

| | | | | | Relevant Country | | Relates to the following consequences | | | General Suitability | | | Suggested application at each level of the tiered risk assessment | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | National | | Regional | | Local | | |
| **FRI Ref** | **Category** | **Indicator** | **Units, etc.** | **Type** | **England** | **Wales** | **Economic** | **Social** | **Environmental** | **National** | **Regional** | **Local** | **Coarse** | **Intermediate** | **Coarse** | **Intermediate** | **Coarse** | **Intermediate** | **Detailed** |
| 23 | | Area AND proportion of total area in plan that is affected by known artificial drainage flooding problems | ha AND % | 1 | Y | Y | Y | Y | Y | | C | A | | | Y | Y | Y | Y | Y |
| 24 | | Standard of flood protection provided by existing artificial drainage systems for existing conditions and with development | % | 2 | Y | Y | Y | Y | | | C | A | | | | Y | Y | Y | Y |
| 25 | | Area AND proportion of total area in plan that is affected by known overland flow problems | ha AND % | 1 | Y | Y | Y | Y | Y | | C | A | | | Y | Y | Y | Y | Y |
| 26 | | Change in downstream conditions (level or flow) | $m^3/s$ | 2 | Y | Y | Y | Y | | | | B | | | | | | | Y |
| 27 | | Change in upstream conditions (level or flow) | m AOD or $m^3/s$ | 2 | Y | Y | Y | Y | | | | B | | | | | | | Y |
| 28 | | Speed of onset of flood | low to rapid or hours | 1 | Y | Y | | Y | Y | | B | A | | | | Y | Y | Y | Y |
| 29 | | Flood Hazard Rating | danger to some, most or all | 1 | Y | Y | | Y | | | | A | | | | | | Y | Y |
| 30 | | Erosion potential at development site | low - high | 1 | Y | Y | | Y | Y | | | A | | | | | | Y | Y |
| 31 | **Area** | Number of properties at risk from fluvial or coastal flooding | No. | 2 | Y | Y | Y | Y | | B | A | A | | Y | | Y | | Y | Y |
| 32 | | Number of properties at risk from main sewer flooding | No. | 2 | Y | Y | Y | Y | Y | | B | A | | | | Y | Y | Y | Y |
| 33 | | Number of properties at risk from flooding caused by overland flow | No. | 2 | Y | Y | Y | Y | | | B | A | | | | Y | | Y | Y |
| 34 | | Number of properties at risk from flooding due to infrastructure failure | No. | 2 | Y | Y | Y | Y | Y | | B | A | | | | Y | | Y | Y |
| 35 | | Expected annual damages - residential and commercial | £ | 2 | Y | Y | Y | | | B | B | A | | Y | | Y | | | Y |
| 36 | | Expected annual damages - agricultural | £ | 2 | Y | Y | Y | | | | B | C | | | | Y | | Y | Y |
| 37 | | Change in economic damages OUTSIDE development area | £ | 2 | Y | Y | Y | Y | | | | C | | | | | | | Y |
| 38 | | Number of buildings with vulnerable or high-risk occupancy in Flood Zones 3 and 2 (England) | No. | 2 | Y | | | Y | Y | | | B | | | | | | Y | Y |
| 39 | | Number of buildings with vulnerable or high-risk occupancy in Flood Zones C1 and C2 (Wales) | No. | 2 | | Y | | Y | Y | | | B | | | | | | Y | Y |
| 40 | | Defence condition where developments are in defended areas | good to bad or Condition Assessment Manual grades | 1,2 | Y | Y | Y | Y | | | B | A | | | | Y | | Y | Y |
| 41 | | Investment in flood defence | £ | 2 | Y | Y | Y | | | | B | A | | | | Y | | Y | Y |
| 42 | | Proportion of properties within Flood Zone 3 that will be provided with an appropriate level of flood warning service (England) | % | 2 | Y | | Y | Y | | | B | A | | | | Y | | Y | Y |
| 43 | | Proportion of properties within Development Advice Zones C1 and C2 that will be provided with an appropriate level of flood warning service (Wales) | % | 2 | | Y | Y | Y | | | B | A | | | | Y | | Y | Y |
| 44 | | Quantity of abstraction from groundwater | Ml/day | 2 | Y | Y | Y | | Y | | C | C | | | | Y | | Y | Y |

## Table A - Recommended Flood Risk Indicators: Selection Guide (continued)

**Key:**

**Type** **1** - STATEMENT: only gives information about the existing flood hazard or risk - the hazard or risk the development is being subjected to.
**2** - CHANGE: can also assess the impact the development has on flood hazard or risk

**Suitability** **A** - Very good, **B** - Good, **C** - Fair

| FRI Ref | Category | Indicator | Units, etc. | Type | Relevant Country | | Relates to the following consequences | | | General Suitability | | | Suggested application at each level of the tiered risk assessment: National | | Regional | | Local | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | England | Wales | Economic | Social | Environmental | National | Regional | Local | Coarse | Intermediate | Coarse | Intermediate | Coarse | Intermediate | Detailed |
| 45 | **People** | Number of people in Flood Zone 3 (England) | No. | 2 | Y | | | Y | | B | A | A | | Y | | Y | | Y | Y |
| 46 | | Number of people in Flood Zone 2 (England) | No. | 2 | Y | | | Y | | B | A | A | | Y | | Y | | Y | Y |
| 47 | | Number of people in Flood Zones 3 and 2 (England) | No. | 2 | Y | | | Y | | | A | A | | | | Y | | Y | Y |
| 48 | | Number of people in Development Advice Zone C1 (Wales) | No. | 2 | | Y | | Y | | B | A | A | | Y | | Y | | Y | Y |
| 49 | | Number of people in Development Advice Zone C2 (Wales) | No. | 2 | | Y | | Y | | B | A | A | | Y | | Y | | Y | Y |
| 50 | | Number of people in Development Advice Zones C1 and C2 (Wales) | No. | 2 | | Y | | Y | | | A | A | | | | Y | | Y | Y |
| 51 | | Number of infirm / disabled people in Flood Zone 3 (England) | No. | 2 | Y | | | Y | | | | B | | | | | | Y | Y |
| 52 | | Number of infirm / disabled people in Development Advice Zone C1 (Wales) | No. | 2 | | Y | | Y | | | | B | | | | | | Y | Y |
| 53 | | Number of infirm / disabled people in Development Advice Zone C2 (Wales) | No. | 2 | | Y | | Y | | | | B | | | | | | Y | Y |
| 54 | | % elderly (over 75yrs) and very young (under 7yrs) in Flood Zone 3 (England) | % | 2 | Y | | | Y | | | | B | | | | | | Y | Y |
| 55 | | % elderly (over 75yrs) and very young (under 7yrs) in Development Advice Zone C1 (Wales) | % | 2 | | Y | | Y | | | | B | | | | | | Y | Y |
| 56 | | % elderly (over 75yrs) and very young (under 7yrs) in Development Advice Zone C2 (Wales) | % | 2 | | Y | | Y | | | | B | | | | | | Y | Y |
| 57 | | Social Flood Vulnerability Index (SFVI) | | 2 | Y | Y | | Y | | | B | B | | | | Y | | Y | Y |

## Table B - Recommended Flood Risk Indicators: Principles of Application

| | | | PART A | | PART B | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **FRI Ref** | **Category** | **Indicator** | **Information Provided** | **Usage for Decision-Making** | **How to Calculate** | **Data and Information Required** | **Roles & Responsibilities** | **Available Tools & Technologies** | **Auditing & Accuracy** |
| 1 | **Hazard** | Area AND Proportion of total area in plan that is classified as Flood Zone 3 (England) | Indicates the extent of the area in the plan that, if developed, would result in the development being considered as "high risk". Only applicable in England. | If the extent is small, development should be avoidable in these Flood Zones. If the area is predominantly in these Flood Zones, the assessment will have to consider flood risk management options. | Overlay planning area on map of Flood Zones. | Flood Zone maps and development area maps. See PPG25 or EA website for definition of the Flood Zones. | EA provides Flood Zone maps. | Flood mapping can be viewed on the EA website. GIS version of the flood mapping is available on request from the EA. GIS can be used to calculate the indicator. | Understand and allow for uncertainties associated with the Flood Zones. If this results in unsustainable flood risk management requirements, consider undertaking hydraulic modelling to provide greater confidence in the flood extents. This would require the use of FRI 17 and possibly FRI 18 if additional mitigation measures are required. |
| 2 | | Area AND Proportion of total area in plan that is classified as Flood Zone 2 (England) | Indicates the extent of the area in the plan that, if developed, would result in the development being considered as "low to medium risk". Only applicable in England. | | | | | | |
| 3 | | Area AND Proportion of Flood Zone 3 area in plan that is already developed (England) | Indicates whether there is already extensive development pressure in this Flood Zone. Only applicable in England. | If there is extensive development in these Flood Zones, it is more likely that further development in these Flood Zones cannot be avoided. Recognising this provides an indication that in all likelihood an increase in investment in flood risk management will be required to prevent an increase in flood risk across the area of the plan. | | | | | |
| 4 | | Area AND Proportion of Flood Zone 2 area in plan that is already developed (England) | | | | | | | |
| 5 | | Total NEW development in Flood Zone 3 (England) | Indicates whether there is an increase in development in this Flood Zone, which in turn would indicate that the flood risk for the area as a whole WOULD be increased without additional flood mitigation measures. Only applicable in England. | This new development may be allowed, if it is an area that is already developed (Zone 3a) depending on the standard of defence. Undeveloped areas (Zone 3b) and functional floodplain (Zone 3c) should not be used for new development except in exceptional circumstances. | | | | | |
| 6 | | Total NEW development in Flood Zone 2 (England) | | The zone is suitable for most development provided that a flood risk assessment is carried out and appropriate flood preparedness and prevention action is taken (ref PPG25) | | | | | |
| 7 | | Area AND Proportion of Flood Zone 3 that is defended (England) | Indicates the proportion of the area in the plan that can be considered as a "reduced risk area". Only applicable to England. See PPG25 for definition of the Flood Zone. See EA's Standing Advice for definition of "reduced risk area". | Following the Sequential Test approach, development in these areas would be preferable to undefended areas. | Overlay planning area on defended areas. | Mapping of defended areas and development areas. | EA provides areas indicated on the Flood Mapping. More detailed information might be held by the Local Authority or local EA office. | Defended areas can be viewed on the EA website. GIS version is available on request from the EA. GIS can be used to calculate the indicator | Not all defences are identified on EA maps. Therefore, this should be checked. The extent of this check depends on the decision scale and level of assessment being undertaken, |
| 8 | | Area AND Proportion of total area in plan that is classified as Development Advice Zone C1 (Wales) | Indicates the extent of the area in the plan that, if developed, would result in the development being considered "at risk" from flooding. It also shows that the area is already developed and served by significant infrastructure, including defences. Only applicable to Wales. | If the extent is small, development should be avoidable in these Development Advice Zones. If the area is predominantly in these Zones, the assessment will have to consider flood risk management options. | Overlay planning area on Development Advice Map. | Development Advice Map (DAM) and development area maps. See TAN15 for definition of the Development Advice Zones. | Welsh Assembly Government provides the Development Advice Map | The DAM can be viewed at local planning offices and libraries. A GIS version of the DAM is available on request. GIS can be used to calculate the indicator. | Understand and allow for uncertainties associated with the Development Advice Zones. If this results in unsustainable flood risk management requirements, consider undertaking hydraulic modelling to provide greater confidence in the flood extents. This would require the use of FRI 17 and possibly FRI 18 if additional mitigation measures are required. |
| 9 | | Area AND Proportion of total area in plan that is classified as Development Advice Zone C2 (Wales) | Indicates the extent of the area in the plan that, if developed, would result in the development being considered "at risk" from flooding. It also shows that the area is without significant defence infrastructure. Only applicable to Wales. | | | | | | |
| 10 | | Area AND Proportion of total area in plan that is classified as Development Advice Zone B (Wales) | Indicates the extent of the area in the plan that, if developed, might result in the development being considered "at risk" from flooding, depending on the site levels. Only applicable to Wales. | | | | | | |

Table B - Recommended Flood Risk Indicators: Principles of Application (continued)

| | | | PART A | | PART B | | | | |
|---|---|---|---|---|---|---|---|---|---|
| FRI Ref | Category | Indicator | Information Provided | Usage for Decision-Making | How to Calculate | Data and Information Required | Roles & Responsibilities | Available Tools & Technologies | Auditing & Accuracy |
| 11 | | Area AND Proportion of Development Advice Zone C1 area in plan that is already developed (Wales) | Indicates whether there is already extensive development pressure in this Development Advice Zone. Only applicable in Wales. | Although by being categorised as Zone C1 there is already an indication that the area is developed, the density of that development will indicate how much further development could take place. Recognising the extent of this provides an indication that in all likelihood an increase in investment in flood risk management will be required to prevent an increase in flood risk across the area of the plan. | Overlay planning area on Development Advice Map. | Development Advice Map (DAM) and development area maps. See TAN15 for definition of the Development Advice Zones. | Welsh Assembly Government provides the Development Advice Map | The DAM can be viewed at local planning offices and libraries. A GIS version of the DAM is available on request. GIS can be used to calculate the indicator. | Understand and allow for uncertainties associated with the Development Advice Zones. If this results in unsustainable flood risk management requirements, consider undertaking hydraulic modelling to provide greater confidence in the flood extents. This would require the use of FRI 17 and possibly FRI 18 if additional mitigation measures are required. |
| 12 | | Area AND Proportion of Development Advice Zone C2 area in plan that is already developed (Wales) | | If there is extensive development in this Development Advice Zone, this would suggest that the area has been mis-categorised and should be Zone C1 and treated as such. | | | | | |
| 13 | | Area AND Proportion of Development Advice Zone B area in plan that is already developed (Wales) | | Further information regarding the area in the plan would result in this Zone or parts of this Zone being reclassified as either Zone A or Zones C1 and C2. In the absence of such information, based on the precautionary principle, this Zone should be treated as Zone C1 or C2, as appropriate. | | | | | |
| 14 | | Total NEW development in Flood Zone C1 (Wales) | Indicates whether there is an increase in development in this Development Advice Zone, which in turn would indicate that the flood risk for the area as whole WOULD increase without additional flood mitigation measures. Only applicable in Wales. | Development can take place subject to application of the "justification test" and the consequences of flooding are acceptable, after due consideration of appropriate mitigation measures. See TAN15 for further details. | | | | | |
| 15 | | Total NEW development in Flood Zone C2 (Wales) | | Only less vulnerable development should be considered subject to application of the "justification test" and the consequences of flooding are acceptable, after due consideration of appropriate mitigation measures. Emergency services and highly vulnerable development should not be considered. | | | | | |
| 16 | | Total NEW development in Flood Zone B (Wales) | Indicates whether there is an increase in development in this Development Advice Zone, which in turn would indicate that the flood risk for the area as whole MIGHT be increase without additional flood mitigation measures. Only applicable in Wales. | Further information regarding the area in the plan would result in this Zone or parts of this Zone being reclassified as either Zone A or Zones C1 and C2. In the absence of such information, based on the precautionary principle, this Zone should be treated as Zone C1 or C2, as appropriate. | | | | | |

## Table B - Recommended Flood Risk Indicators: Principles of Application (continued)

| | | | PART A | | PART B | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **FRI Ref** | **Category** | **Indicator** | **Information Provided** | **Usage for Decision-Making** | **How to Calculate** | **Data and Information Required** | **Roles & Responsibilities** | **Available Tools & Technologies** | **Auditing & Accuracy** |
| 17 | | Expected annual probability of inundation with existing defences (if any) | Indicates more accurately the actual probability of flooding than Flood Zones as it includes the effects of EXISTING flood defences, if these exist, and can be used as a means to define a more accurate flood extent, depending on the data used and the modelling approach undertaken. | Areas should be prioritised for new development in order of least probability of inundation first. New development should also be discouraged from areas where the probability of inundation is greater than the indicative standards recommended by the ODPM or National Assembly for Wales. Otherwise, additional flood risk management measures will be required and FRI 18 should be calculated. | Calculated by modelling. National scale: use National Flood Risk Assessment. Regional scale: use broad-scale modelling as used for CFMPs/SMPs. Local scale: use detailed hydraulic modelling; required model sophistication depends on nature of the area. RASP methodologies can be used at all scales to estimate probability of inundation in defended areas. Alternatives are also available. | Hydrological, hydraulic and topographical survey data. Data on flood defences, including crest levels and condition. | EA can provide existing models and details of defences. Details of defences are also available from other Flood Defence Authorities. | Hydraulic modelling software and GIS software. Defence data is provided in the National Flood and Coastal Defence Database (NFCDD) - although this is currently being populated. | Understand inaccuracies and uncertainties associated with the modelling approach and the data used and allow for these in the decision-making process. Methodologies should be reviewed in light of advances in modelling technology. This indicator should be reviewed as part of the site-specific FRA. |
| 18 | | Expected annual probability of inundation with proposed improved flood management measures (if any) | Indicates the actual probability of flooding taking into account any IMPROVEMENTS to the defences that are proposed. | New development should only be permitted where the probability of inundation is greater than the indicative standards recommended by the ODPM or National Assembly for Wales. Additional flood risk management measures might still be required, due to area or people vulnerability. | | | | | |
| 19 | | Reduction in area of Functional Floodplain due to new development | If there is a reduction in the area of Functional Floodplain (Zone 3c in PPG25), this indicates that the new development is likely to increase in the probability of flooding in the surrounding area. | New development should only be permitted in the Functional Floodplain in exceptional circumstances and appropriate mitigation of the effects of this reduction will be required. | The Functional Floodplain is the unobstructed areas of the floodplain where water regularly flows in times of flood. Undertake hydraulic modelling to determine flow velocities or use expert judgement and local knowledge, depending on level of assessment being undertaken. For detailed assessments, the EA tends to interpret 'regularly' as 10% annual probability (a 1 in 10 year) flood event. | Identification of the Function Floodplain can sometimes be based on expert judgement. However, accurate identification would be based on hydraulic modelling, which requires hydrological, hydraulic and survey data including details of existing flood defences. | Consultants can provide expert judgement and undertake hydraulic modelling. | Hydraulic modelling software. | Understand inaccuracies and uncertainties associated with the modelling approach and the data used and allow for these in the decision-making process. Depending on the proximity of the new development to the Functional Floodplain, it might be necessary to review this indicator as part of the site-specific FRA. |
| 20 | | Depth of water in development site for 1% annual probability flood | Indicates the likely impact of flooding on the development site, as water depth influences property damage and potential risks to people if they are caught in the flood water. | Areas for new development where the depth of water is zero should be chosen in preference to areas with a greater depth of water. The depth might be zero due to being beyond the flood extent, being raised above the flood level or due to the expected annual probability of inundation behind defences being less than 1%. Where this is not possible, a more detailed analysis of the flood risk should be undertaken, with due consideration of safe access and exit requirements. | See Guidance Note S3.3 Safe Access and Exit | | | | Determine accuracy and uncertainty associated with the modelling. (Can be used at all planning scales, but is not as useful or accurate at national and regional scale.) This indicator would need to be reviewed as part of the site-specific FRA. |

## Table B - Recommended Flood Risk Indicators: Principles of Application (continued)

| | | | PART A | | PART B | | | | |
|---|---|---|---|---|---|---|---|---|---|
| FRI Ref | Category | Indicator | Information Provided | Usage for Decision-Making | How to Calculate | Data and Information Required | Roles & Responsibilities | Available Tools & Technologies | Auditing & Accuracy |
| 21 | | Area AND proportion of total area in plan that is affected by known groundwater flooding problems | Indicates areas likely to be affected by groundwater flooding. | New development should avoid these areas if possible. Otherwise, appropriate mitigation measures will be required. The probability of flooding can be reduced by groundwater abstraction (although there might be issues of sustainability in the long-term). A suitable groundwater management strategy should be implemented with any new development. | Overlay planning area on known groundwater flooding areas. | Historic information of groundwater flooding. | EA, Local Authorities and Operating Authorities might be able to provide local information. | GIS can be used to calculate the indicator | This is an imprecise indicator and not generally usable at the national and regional scales (FRI 22 is more useful at the regional scale). Depending on the extent of the groundwater flooding problems, more detailed information might be available at the local scale, but this should still be treated with caution. This indicator should be reviewed as part of the site-specific FRA. |
| 22 | | Groundwater levels for existing conditions and with development | Indicates depth of groundwater flooding. If there is a trend of rising groundwater and/or the groundwater level is currently high, groundwater flooding may potentially be a problem in the future, even if there are no known groundwater flooding problems to date. | | Groundwater level is measured directly at borehole locations. Groundwater spreadsheet calculations or modelling is required to predict change in groundwater level caused by new development. | Groundwater levels from borehole data. Information for modelling includes geological conditions and aquifer data. Useful information can be found in Catchment Abstraction Management Plans (CAMs). | EA hold groundwater borehole data. Consultants undertake trend analysis and modelling. | Spreadsheet software required to store and present data. Groundwater spreadsheet calculations or modelling needed to predict changes. | If development is proposed in an area of potential groundwater flooding, groundwater levels should be sampled regularly to observe impact of the development and compared with model predictions. Frequency of monitoring will depend on aquifer characteristics. Each borehole site must be levelled to correct datum. |
| 23 | | Area AND proportion of total area in plan that is affected by known artificial drainage flooding problems | Indicated areas likely to be affected by flooding from artificial drainage. | New development should avoid these areas if possible. Otherwise, appropriate mitigation measures will be required to protect the new development and the area served by the existing drainage. These would include the use of SUDS and possibly increased investment in the existing drainage system. | Overlay planning area on known drainage flooding areas. | Historic information of drainage flooding. | EA, Local Authorities, Sewerage Undertakers and Internal Drainage Boards can provide local information. | GIS can be used to calculate the indicator. Hydraulic modelling software. | This is an imprecise indicator and not generally usable at the national and regional scales. More detailed information will be available at the local scale. However, this will tend to be address point data of reported flooding and will need interpreting/approximating into areas at risk. This indicator should be reviewed as part of the site-specific FRA. |
| 24 | | Standard of flood protection provided by existing artificial drainage systems for existing conditions and with development | Indicates annual probability of flooding from the existing drainage system (whether surface water or combined drainage) and the capacity of the existing foul or combined drainage system. Can also indicate the change in annual probability of flooding and reduction in capacity, if details of the proposed development are known or can be estimated (generally only appropriate at the local scale). | This indicator is most relevant with existing urban areas, in particular where connection to the existing drainage system might be the most sustainable solution. New development should avoid areas where stormwater flooding from the surface water or combined drainage system is below acceptable standards. Otherwise appropriate mitigation measures will be required to protect the new development from existing flooding and prevent the exasperation of the flooding for the surrounding area. This would include SUDS and possibly increased investment in the existing drainage system. New development should be avoided in areas where the foul or combined drainage system does not have sufficient capacity to convey the additional foul flows, if possible. Otherwise, increased investment in the existing foul/combined drainage system will also be required to reduce the probability of foul flooding within the development site or the surrounding area. | Hydraulic modelling of the existing drainage system and for the proposed development, if required. | Details of existing drainage systems. If the assessment is at the local scale, details of proposed development and its drainage requirements and subsequently, if undertaking modelling, information required includes existing sewer network data, connected population, connected impermeable and permeable areas, soil characteristics, suitable rainfall data, etc. Alternatively, information might be available from Drainage Area Plans. | Sewerage Undertakers hold information regarding their drainage system, including Drainage Area Plans and associated models. Consultants undertake additional modelling work related to the new development, if required. | Hydraulic modelling software. | Hydraulic models of the existing drainage systems should be verified against flow survey data. Assumptions or uncertainties regarding the characteristics of the new development and the design of its drainage should be tested for sensitivity and then subsequently allowed for in design safety factors. |

Table B - Recommended Flood Risk Indicators: Principles of Application (continued)

| FRI Ref | Category | Indicator | Information Provided | Usage for Decision-Making | How to Calculate | Data and Information Required | Roles & Responsibilities | Available Tools & Technologies | Auditing & Accuracy |
|---|---|---|---|---|---|---|---|---|---|
| | | | PART A | | PART B | | | | |
| 25 | | Area AND proportion of total area in plan that is affected by known overland flow problems | Indicates areas likely to be affected by flooding from overland flows (considering flood routes/paths and storage). | New development should avoid, if possible, local low spots where overland flows drain to during extreme events. Otherwise, appropriate mitigation measures will be required. New development should also avoid known routes of overland flow. Otherwise additional measures to manage these flows (usually by redirection) will be required. | Overlay planning area on areas of known overland flow problems. Alternatively, undertake modelling to provide more detailed mapping of the overland flow routes and temporary storage locations. | Depending on the decision-making scale and the scale of the risk, this may consist of local knowledge or include hydraulic modelling. If undertaking modelling, catchment topography, soil characteristics and suitable rainfall data, etc. is required. | EA, Local Authorities, Sewerage Undertakers and Internal Drainage Boards can provide local information. Consultants undertake modelling work. | GIS can be used to calculate the indicator. Hydraulic modelling software. | This indicator is generally too imprecise at the regional scale, but useful at the local scale. If relying on local knowledge, however, this tends to only identify particularly high risk areas and should be reviewed as part of the site-specific FRA. Hydraulic models should ideally be verified against observed data, however, depending on the frequency of occurrence, this is rarely practicable. Therefore, assumptions and uncertainties should be allowed for in any subsequent decision-making. |
| 26 | | Change in downstream conditions | Indicates the change in flood probability for areas downstream of the new development. | New development should not worsen flood risk elsewhere. Where worsening of flood risk is identified, mitigation measures should be implemented. | Hydraulic modelling of the development area and the surrounding areas before and after development. Flow is the easiest parameter to calculate. However, levels can subsequently be estimated, if sufficient information is provided. | Modelling requires hydrological, hydraulic and survey data at different scales, including details of existing flood defences | Consultants undertake hydraulic modelling work. | Hydraulic modelling software. | Understand and allow for inaccuracies and uncertainties associated with modelling and allow for this in the decision-making process. This indicator should be reviewed as part of the site-specific FRA. Subsequent to the development being built, checks could be undertaken by monitoring downstream. |
| 27 | | Change in upstream conditions | Indicates the change in flood probability for areas upstream of the new development. | | Hydraulic modelling of the development area and the surrounding areas before and after development. This primarily requires a means to estimate change in level. | | | | |
| 28 | | Speed of onset of flood | Indicates potential danger to people. In flash flooding and defence breaching or overtopping, the speed of onset is fast and the risk to people is high. In floods on rivers with a slower response, groundwater flooding and sewer flooding, the speed of onset is slow so the risk to people is lower. | New development should avoid areas with a rapid speed of onset, if possible. Flood warning, flood preparedness and emergency response that are appropriate to the type of flooding should be developed. Speed of onset in different areas would help to prioritise response actions including evacuation. | Basic risk identification (in the form of 'low' to 'rapid' onset) is carried out with knowledge about the catchment and drainage characteristics (e.g. steep catchments, quick responding watercourses, inadequate storm water drainage, etc.), defence locations and previous flood incidents. In-depth assessment (actual hours) is carried out by modelling the flooding to estimate speed of onset and rate of water rise and water spreading. | Basic assessment requires existing Flood Warning Plans, catchment topography and hydrology, defence type and location, and records of historic flooding. Information for modelling includes hydrology, soils data, hydraulics, topography, defence information, sewer network details, groundwater data, tidal water levels and wave heights. Selection of information depends on type of modelling. Existing model study results should be used where possible. | EA has information of catchments in England and Wales where heavy rainfall is likely to give rise to very rapidly rising river levels and depth and velocity of flooding could cause extreme risk to life. EA has Flood Warning Plans. Sewerage Undertakers hold data (generally for urban areas). Consultants undertake hydraulic modelling and calculate the indicator. | Hydraulic modelling software. The National Flood and Coastal Defence Database (NFCDD) holds information on defence locations, standard and condition. | Understand and allow for uncertainties and inaccuracies associated with the hydraulic modelling. This indicator should be reviewed as part of the site-specific FRA. This indicator should be reviewed regularly after the development is carried out to identify any changes in speed of onset, leading to increased risk. |
| 29 | | Flood Hazard Rating | Indicates flood risk to people, based on depths and velocities of flooding. | New development should avoid areas with a high flood hazard rating. Indicator can be used to undertake development zoning, based on the Sequential Test approach of developing in areas of lowest flood hazard first. It can also used to develop appropriate flood warning, flood preparedness and emergency response strategies. | See Guidance Note D2.1 ADD2 Flood Risks to People Calculator | See Guidance Note D2.1 ADD2 Flood Risks to People Calculator | See Guidance Note D2.1 ADD2 Flood Risks to People Calculator | See Guidance Note D2.1 ADD2 Flood Risks to People Calculator | Understand and allow for inaccuracies and uncertainties associated with modelling and allow for this in the decision-making process. This indicator is most useful at local scale where depths and velocities will be more accurate but could be used at the regional scale. |

## Table B - Recommended Flood Risk Indicators: Principles of Application (continued)

| | | | PART A | | PART B | | | | |
|---|---|---|---|---|---|---|---|---|---|
| FRI Ref | Category | Indicator | Information Provided | Usage for Decision-Making | How to Calculate | Data and Information Required | Roles & Responsibilities | Available Tools & Technologies | Auditing & Accuracy |
| 30 | | Erosion potential | Indicates locations where river banks or coasts are eroding or are vulnerable to future erosion. Erosion of beaches may also undermine sea defences and cause a breach. Erosion of river banks may also undermine fluvial defence embankments and increase the amount of debris in a flood. | Avoid new development in areas of erosion potential, if possible. Otherwise mitigation measures will be required. It may be possible to prevent erosion by engineering works or changing catchment or coastal cell management. Defence location should be reviewed if there is potential for breaching resulting from erosion. | Coastal: Trend analysis of historic and current profiles to identify erosion potential. Possible wave modelling to assess future morphological changes. Fluvial: Review historic maps to identify changes. Assess channel erosion potential by fluvial geomorphological assessment. | Historic maps of coastlines and rivers. Refer to SMPs and Coastal Strategy Plans for information on coastal erosion. Wave model inputs include wave data, coastal topography and bathymetry, and information on soils and geology. Information for fluvial geomorphological assessment includes hydrology, topography, morphology and sediment data. | EA and Local Authorities are responsible for river and coastal erosion. Consultants undertake assessments and calculate the indicator. | GIS can be used to overlay historic maps. Modelling software is used for wave analysis. | This indicator should be reviewed as part of the site-specific FRA. Allowing for uncertainty in the assessment, where erosion is likely to be a problem, part of the risk management might include field monitoring to identify actual change. |
| 31 | **Area** | Number of properties at risk from fluvial or coastal flooding | Indicates potential social and economic consequences of fluvial and coastal flooding based on Flood Zones or Development Advice Zones. Numbers of new properties at risk are required to indicate the relative change in magnitude of these consequences. This indicator does not give the actual probability of the flooding in defended areas. | Aim to minimise the increase in number of properties at risk. Where unavoidable, use in conjunction with information on probability of flooding to consider flood risk management requirements. | Overlay address point data on Flood Zones 2 and 3 (England) or Development Advice Zones C1 and C2 (Wales) and count properties within these Zones to determine existing number of properties. Overlay development plans with estimates of property numbers and recount | England: Flood Zone maps and development area maps. See PPG25 or EA website for definition of the Flood Zones. Wales: Development Advice Map (DAM) and development area maps. See TAN15 for definition of the Development Advice Zones. | EA provides Flood Zone maps. Welsh Assembly Government provides the Development Advice Map. | England: Flood mapping can be viewed on the EA website. GIS version of the flood mapping is available on request from the EA. Wales: The DAM can be viewed at local planning offices and libraries. A GIS version of the DAM is available on request. GIS can be used to calculate the indicator. | Understand and allow for uncertainties associated with the Flood Zones and Development Advice Zones. If this results in unsustainable flood risk management requirements, consider undertaking hydraulic modelling to provide greater confidence in the flood extents. This would require the use of FRI 17 and possibly FRI 18 if additional mitigation measures are required. |
| 32 | | Number of properties at risk from main sewer flooding | Indicates potential social and economic consequences of main sewer flooding. If based on OFWAT figures, this indicates the number of properties with an annual probability of flooding of greater than or equal to 10%. | New development should avoid areas with existing properties at risk, if possible. Otherwise, appropriate mitigation measures will be required to protect the new development and the area served by the existing sewerage. These would include the use of SUDS and possibly increased investment in the existing sewerage system. | Overlay data for existing properties at risk on development plan. Count the number of properties within the area of the plan. Local figures can be extrapolated to give figures for new development, but this can only be considered an initial estimate as other factors will play a part in actual future performance. | "DG5" registered properties for urban flooding (preferably with mapping) and mapping of development plan. | OFWAT collects and collates data for existing properties from Sewerage Undertakers. | GIS can be used to calculate the indicator. | Spot survey of properties on register can verify data. |
| 33 | | Number of properties at risk from flooding caused by overland flow | Indicates potential social and economic consequences of flooding caused by overland flow. Numbers of new properties at risk are needed to indicate the relative change in magnitude of these consequences. | New development should avoid areas with existing properties at risk, if possible, as new development is also likely to be at risk unless appropriate mitigation measures are provided. | If available, overlay data of known properties with overland flow problems onto a map of the plan area. Alternatively, undertake modelling to provide more detailed mapping of the overland flow routes and temporary storage locations and count the properties in these areas. Overlay development plans with estimates of property numbers and recount. | Depending on the decision-making scale and the scale of the risk, this may consist of local knowledge or include hydraulic modelling. If undertaking modelling, catchment topography, soil characteristics and suitable rainfall data, etc. is required. | EA, Local Authorities, Sewerage Undertakers and Internal Drainage Boards can provide local information. Consultants undertake modelling work. | GIS can be used to calculate the indicator. Hydraulic modelling software. | This indicator is generally too imprecise at the regional scale, but useful at the local scale. If relying on local knowledge, however, this tends to only identify particularly high risk areas and should be reviewed as part of the site-specific FRA. Hydraulic models should ideally be verified against observed data, however, depending on the frequency of occurrence, this is rarely practicable. Therefore, assumptions and uncertainties should be allowed for in any subsequent decision-making. |

## Table B - Recommended Flood Risk Indicators: Principles of Application (continued)

| | | | PART A | | PART B | | | | |
|---|---|---|---|---|---|---|---|---|---|
| FRI Ref | Category | Indicator | Information Provided | Usage for Decision-Making | How to Calculate | Data and Information Required | Roles & Responsibilities | Available Tools & Technologies | Auditing & Accuracy |
| 34 | | Number of properties at risk from flooding due to infrastructure failure | Indicates potential social and economic consequences of flooding caused by infrastructure failure. Numbers of new properties at risk are needed to indicate the relative change in magnitude of these consequences. | New development should avoid areas with existing properties at risk, if possible, as new development is also likely to be at risk unless appropriate mitigation measures are provided. | If available, overlay data of known properties at risk onto a map of the plan area. Alternatively, use plans of infrastructure, information on performance of this infrastructure and expert judgement to estimate areas at risk and then count the properties in these areas. Overlay development plans with estimates of property numbers and recount. | Any available data of known properties at risk. Plans of infrastructure, such as canals, reservoirs, pumping stations, gates, sewerage assets, etc. Performance information for infrastructure. | Information on infrastructure and its performance is available from British Waterways, Water Companies and other Sewerage Undertakers, etc. | GIS can be used to calculate the indicator, if areas at risk are known. | This indicator is generally too imprecise at the regional scale, but useful at the local scale. If relying on local knowledge, however, this tends to only identify particularly high risk areas and should be reviewed as part of the site-specific FRA. |
| 35 | | Expected annual damages - residential and commercial | Indicates economic consequences of flooding. Details of the new development are needed to estimate the change in damages as a result of the new development and any associated flood risk management measures. | Aim to prevent an increase in the total EAD for the area of the plan. Use in conjunction with FRI 36 to obtain overall damages. The indicator can be used to plan mitigation measures to reduce flood risk to the development and the surrounding area, for example improved defences or raising of property thresholds. | This is the integral of the damage against flood frequency equation. This is calculated for all existing and new properties including those that benefit from flood defences. Flood water levels are required for a range of return periods, which are obtained from hydraulic modelling. The Multi-Coloured Manual (MCM) method is used for damage calculation. | Hydraulic modelling requires hydrological, hydraulic and survey data, including details of existing flood defences. Data on building types, areas and threshold levels are needed for economic calculation. Information on existing properties can be obtained from the National Property Database (NPD). | Consultants undertake hydraulic modelling work and calculate indicator. | Hydraulic modelling software. The Modelling and Decision Support Framework (MDSF) can be used to calculate property damages at regional and local scales. RASP methodology can be applied at national, regional and local scales. | Understand and allow for inaccuracies and uncertainties associated with modelling and allow for this in the decision-making process. This indicator is most useful at local scale where flood levels will be more accurate. |
| 36 | | Expected annual damages - agricultural | Indicates economic consequences of flooding. Details of the new development are needed to indicate the relative change in magnitude of these consequences. | Aim to prevent an increase in the total EAD for the area of the plan. Use in conjunction with FRI 35 to obtain overall damages. The indicator can be used to plan mitigation measures to reduce flood risk. | Indicator can be calculated using the Agricultural Land Classification (ALC) and the calculation method in the Modelling and Decision Support Framework (MDSF). | Agricultural Land Classifications and flood risk areas are needed. Flood risk areas can take the form of the Flood Zone maps (England) or Development Advice Map (Wales) or more accurately defined flood extents, if available. | EA provides Flood Zone maps and ALC maps. Welsh Assembly Government provides the Development Advice Map. Consultants undertake hydraulic modelling work and calculate indicator. | The Modelling and Decision Support Framework (MDSF) | Method is crude but should be sufficiently accurate for most developments. |
| 37 | | Change in economic damages OUTSIDE development area | Indicates the change in economic consequences of the new development on the surrounding area. | New development should not worsen flood risk elsewhere. Where worsening of flood risk is identified, mitigation measures should be implemented. | Hydraulic modelling of the development area and the surrounding areas before and after development. Use of model results to calculate economic damages. Catchment modelling can provide an indication of impacts. More detailed modelling is needed for more accurate estimates. | Hydraulic modelling requires hydrological, hydraulic and survey data, including details of existing flood defences. Economic calculations require property data. Depth damage curves can be obtained from the Multi-Coloured Manual (Flood Hazard Research Centre, 2004). | Consultants undertake hydraulic modelling work and calculate indicator. | Hydraulic modelling software. MDSF to calculate economic damages. | Understand and allow for uncertainties and inaccuracies associated with the hydraulic modelling, property data and damage calculations. |

Table B - Recommended Flood Risk Indicators: Principles of Application (continued)

| | | | PART A | | PART B | | | | |
|---|---|---|---|---|---|---|---|---|---|
| FRI Ref | Category | Indicator | Information Provided | Usage for Decision-Making | How to Calculate | Data and Information Required | Roles & Responsibilities | Available Tools & Technologies | Auditing & Accuracy |
| 38 | | Number of buildings with vulnerable or high-risk occupancy in Flood Zone 3 (England) | Indicates social consequences of flooding. Buildings with high-risk occupancy include hospitals, homes for the elderly, schools, fire stations, police stations and any other facilities that provide emergency services during floods. Some industries also constitute high-risk such as power stations, chemical plants, incinerators and waste disposal sites. Therefore, this can also indicate environmental consequences of flooding. | New buildings with vulnerable or high-risk occupancy in this Flood Zone should be avoided, if possible, and not be permitted if undefended. Overall flood risk for the area contained within the plan, might be reduced if existing buildings of this type can be relocated out of this Flood Zone. | Overlay plan on Flood Zone maps and identify (existing and proposed) buildings with vulnerable or high-risk occupancy within Flood Zone 3. | Flood Zone maps. Locations of existing and proposed buildings with vulnerable or high-risk occupancy. | EA provides Flood Zone maps. Details of existing buildings should be available from the Local Authority. | Flood mapping can be viewed on the EA website. GIS version of the flood mapping is available on request from the EA. GIS can be used to calculate the indicator. | Understand and allow for uncertainties associated with the Flood Zones and Development Advice Zones. If this results in unsustainable flood risk management requirements, consider undertaking hydraulic modelling to provide greater confidence in the flood extents. This would require the use of FRI 17 and possibly FRI 18 if additional mitigation measures are required. |
| 39 | | Number of buildings with vulnerable or high-risk occupancy in Flood Zones C1 and C2 (Wales) | | New buildings with vulnerable or high-risk occupancy in Zone C1 should be avoided, if possible, and not be permitted if in Zone C2. Overall flood risk for the area contained within the plan, might be reduced if existing buildings of this type are relocated out of Zones C1 and C2. | Overlay plan on Development Advice Map and identify buildings with vulnerable or high-risk occupancy within Zones C1 and C2. | Development Advice Map. Locations of existing and proposed buildings with vulnerable or high-risk occupancy. | Welsh Assembly Government provides the Development Advice Map. Details of existing buildings should be available from the Local Authority. | The DAM can be viewed at local planning offices and libraries. A GIS version of the DAM is available on request. GIS can be used to calculate the indicator. | |
| 40 | | Defence condition where developments are in defended areas | Indicates likelihood of defence failure by breaching, which in turn can indicate a higher probability of flooding than assumed based on the Standard of Protection of the defence (i.e. the annual probability of flooding it was designed to protect against). This might be used instead of FRI 17, which requires modelling or suitably reliable results from an existing assessment. | New development should avoid areas protected by defences in poor condition, if possible. Otherwise additional investment in these defences will probably be required. It is advisable to make planning decisions and prioritise investment in flood defence based on actual probability of inundation, which takes into consideration the Standard of Protection of the defence and the defence condition, which would result in the use of FRI 17 and FRI 18 (if required). Also...<br><br>See Guidance Note S3.2 Risk to People behind Defences. | Overlay defence condition ratings on plans of the defences and the corresponding defended areas. | Surveys of defence condition give a rating on a scale of 1 to 5, where 5 is good and 1 is bad. (See the Condition Assessment Manual) If undertaking an assessment at the local scale, more detailed information regarding the type of defence and the reason for the rating will also help to prioritise investment. | EA holds defence condition data for EA defences. Other Flood Defence Authorities, e.g. LAs and IDBs, provide local knowledge and any additional data for other defences. | Defence condition is provided in the National Flood and Coastal Defence Database (NFCDD) - although this is currently being populated. GIS can be used to map the indicator. | Care needs to be taken if using the data in the NFCDD, as this currently contains data or varying degrees of accuracy. At the local scale, this should be verified based on local knowledge held by the EA and the other Flood Defence Authorities. |
| 41 | | Investment in flood defence | Indicates proposed investment in new and existing defences and, therefore, indicates whether or not the new development will be defended now and in the future. | New development, where possible, should avoid areas where investment in flood defence is low compared to the defences required, as this means significant additional investment will be required from the Developers. If this additional investment is too large, then the proposed development location might not be viable. Such developments and defences are also unlikely to conform to the strategic plans, which identify future investment needs and are produced by the EA and other Flood Defence Authorities as part of the their flood risk management planning responsibilities. | These should be whole-life costs. If an estimation of the investment in flood defence required with the new development can be compared with the currently planned investment, any increase will indicate the additional investment that will have to be borne by the Developers. This estimation would be based on either an extrapolation of current planned investment (for coarse or intermediate level assessments) or standard engineering approaches for flood defence design (for detailed assessments). These results can be overlaid on plans of the defences and the corresponding defence areas, if required for spatial planning. | Identification of flood defences (new and existing) affected by new development. Figures for existing defence investment. Figures for additional defence investment required as a result of the new developments, which will be based on defence design. | EA and other Flood Defence Authorities, e.g. LAs and IDBs, have information/data on existing defence investment. | GIS can be used to map the indicator. Hydraulic modelling software might be required for detailed defence design. | If extrapolating costs, an allowance for uncertainty should be included. Any defence design should be checked independently. |

## Table B - Recommended Flood Risk Indicators: Principles of Application (continued)

| | | | PART A | | PART B | | | | |
|---|---|---|---|---|---|---|---|---|---|
| FRI Ref | Category | Indicator | Information Provided | Usage for Decision-Making | How to Calculate | Data and Information Required | Roles & Responsibilities | Available Tools & Technologies | Auditing & Accuracy |
| 42 | | Proportion of properties within Flood Zones 2 and 3 that will be provided with an appropriate level of flood warning service (England) | Indicates the proportion of properties where there is enough time for people to act and emergency procedures to be implemented should a flood be forecast. | All new development in these Zones should have an appropriate standard of flood warning service that has been agreed with the Emergency Services and the EA. Approaches to flood warning may differ between Zones and between properties with different probabilities of flooding. | Overlay extent of existing and proposed flood warning and emergency planning on map showing Zones. | Flood Zones maps. Flood Warning Plans and Emergency Plans. | EA provides Flood Zones maps and Flood Warning Plans. LAs provide Emergency Plans. | Flood mapping can be viewed on the EA website. GIS version of the flood mapping is available on request from the EA. GIS can be used to calculate the indicator. | This indicator should be checked once developments have been built and thereafter at appropriate intervals, such as when Flood Warning Plans or Emergency Plans are updated. |
| 43 | | Proportion of properties within Development Advice Zones C1 and C2 that will be provided with an appropriate level of flood warning service (Wales) | | | | Development Advice Map. Flood Warning Plans and Emergency Plans. | Welsh Assembly Government provides the Development Advice Map. EA provides Flood Warning Plans. LAs provide Emergency Plans. | The DAM can be viewed at local planning offices and libraries. A GIS version of the DAM is available on request. GIS can be used to calculate the indicator. | |
| 44 | | Quantity of abstraction from groundwater | By indicating change in abstraction rates, indicates likely change in groundwater levels and, therefore, change in risk of groundwater flooding. | If significant reductions in abstraction are likely, an assessment must be made of the subsequent increase in risk of groundwater flooding. New development should avoid these areas, if possible. Otherwise, appropriate mitigation measures will be required. A suitable groundwater management strategy should be implemented with any new development. | The type of analysis undertaken should depend on the scale of the risk, and may include use of existing data on abstraction rates, analysis of data of recorded groundwater levels or groundwater modelling. | Data on licensed abstraction rates is held in the National Abstraction Licence Database (NALD). Data on actual abstraction, although this is not always available. Proposed abstraction figures for the new development. | EA and in some cases Water Supply Companies can provide groundwater abstraction information. | GIS can be used to map the indicator on spatial plans. Groundwater modelling software can be used for detailed assessments. | If there is a risk for the development and/or the surrounding area, monitor groundwater levels before and after development. |
| 45 | **People** | Number of people in Flood Zone 3 (England) | Indicates the number of people in the relevant Zone or Zones and, therefore, exposed to a flood hazard. This indicator does not give the actual probability of the flooding in defended areas. | New development should aim to avoid an increase in this indicator. Otherwise there will be a need for additional flood risk management measures. The spatial distribution of this indicator can be useful for planning flood warning and emergency response. | Overlay development plan on map showing Zones. Estimate the number of people based on the number and type of properties in the relevant Zones. Alternatively use census data for existing development. Appropriate assumptions will need to be made for new development. This indicator also can be used to consider temporal change, e.g. work patterns and tourism. | Flood Zone maps. Census data or mapping and address point data. | EA provides Flood Zone maps. Office of National Statistics and the EA hold census data. | Flood mapping can be viewed on the EA website. GIS version of the flood mapping is available on request from the EA. GIS can be used to calculate the indicator. | If warning and emergency planning is required, this indicator should be checked once developments have been built and thereafter at appropriate intervals. This indicator will also need checking at appropriate intervals for determining future investment levels for flood defence and other flood risk management measures. |
| 46 | | Number of people in Flood Zone 2 (England) | | | | | | | |
| 47 | | Number of people in Flood Zones 3 and 2 (England) | | If there are uncertainties regarding the extent of Flood Zone 3 and Flood Zone 2, this lumped indicator can be used instead. | | | | | |
| 48 | | Number of people in Development Advice Zone C1 (Wales) | | New development should aim to avoid an increase in this indicator. Otherwise there will be a need for additional flood risk management measures. The spatial distribution of this indicator can be useful for planning flood warning and emergency response. | | Development Advice Map. Census data or mapping and address point data. | Welsh Assembly Government provides the Development Advice Map. Office of National Statistics and the EA hold census data. | The DAM can be viewed at local planning offices and libraries. A GIS version of the DAM is available on request. GIS can be used to calculate the indicator. | |
| 49 | | Number of people in Development Advice Zone C2 (Wales) | | | | | | | |
| 50 | | Number of people in Development Advice Zones C1 and C2 (Wales) | | If there are uncertainties regarding the extent of Flood Zone 3 and Flood Zone 2, this lumped indicator can be used instead. | | | | | |

## Table B - Recommended Flood Risk Indicators: Principles of Application (continued)

| | | | PART A | | PART B | | | | |
|---|---|---|---|---|---|---|---|---|---|
| FRI Ref | Category | Indicator | Information Provided | Usage for Decision-Making | How to Calculate | Data and Information Required | Roles & Responsibilities | Available Tools & Technologies | Auditing & Accuracy |
| 51 | | Number of infirm / disabled people in Flood Zone 3 (England) | Indicates the number of people unlikely to be able to move to safety during floods, which may result in serious injury and loss of life. | New development should aim to avoid an increase in this indicator. Otherwise there may be a need for special measures to assist the infirm and disabled people during a flood, in ADDITION to standard flood risk management measures. The spatial distribution of this indicator can be useful for planning flood warning and emergency response. | Overlay development plan on map showing Zones. Estimate the number of infirm and disabled people based on the number and type of properties in the relevant Zones. Alternatively use census data for existing development. Appropriate assumptions will need to be made for new development. | Flood Zone maps. Census data or mapping and address point data. | EA provides Flood Zone maps. Office of National Statistics and the EA hold census data. | Flood mapping can be viewed on the EA website. GIS version of the flood mapping is available on request from the EA. GIS can be used to calculate the indicator. | If warning and emergency planning is required, this indicator should be checked once developments have been built and thereafter at appropriate intervals. |
| 52 | | Number of infirm / disabled people in Development Advice Zone C1 (Wales) | | New development should not be permitted to increase this indicator in this Zone, as this does not constitute "less vulnerable" development. | | Development Advice Map. Census data or mapping and address point data. | Welsh Assembly Government provides the Development Advice Map. Office of National Statistics and the EA hold census data. | The DAM can be viewed at local planning offices and libraries. A GIS version of the DAM is available on request. GIS can be used to calculate the indicator. | |
| 53 | | Number of infirm / disabled people in Development Advice Zone C2 (Wales) | | | | | | | |
| 54 | | % elderly (over 75yrs) and very young (under 7yrs) in Flood Zone 3 (England) | Indicates the number of people likely to have difficulties with evacuation and more likely to experience health impacts during or after the flood. | New development should aim to avoid an increase in this indicator. Otherwise there may be a need for special measures to assist the elderly and, in some cases, the very young during floods, in ADDITION to standard flood risk management measures. The spatial distribution of this indicator can be useful for planning flood warning and emergency response. | Overlay development plan on map showing Zones. Estimate the number of elderly and very young people based on the number and type of properties in the relevant Zones. Alternatively use census data for existing development. Appropriate assumptions will need to be made for new development. | Flood Zone maps. Census data or mapping and address point data. | EA provides Flood Zone maps. Office of National Statistics and the EA hold census data. | Flood mapping can be viewed on the EA website. GIS version of the flood mapping is available on request from the EA. GIS can be used to calculate the indicator. | |
| 55 | | % elderly (over 75yrs) and very young (under 7yrs) in Development Advice Zone C1 (Wales) | | New development should not be permitted to increase this indicator in this Zone, as this does not constitute "less vulnerable" development. | | Development Advice Map. Census data or mapping and address point data. | Welsh Assembly Government provides the Development Advice Map. Office of National Statistics and the EA hold census data. | The DAM can be viewed at local planning offices and libraries. A GIS version of the DAM is available on request. GIS can be used to calculate the indicator. | |
| 56 | | % elderly (over 75yrs) and very young (under 7yrs) in Development Advice Zone C2 (Wales) | | | | | | | |
| 57 | | Social Flood Vulnerability Index (SFVI) | Indicates the social consequences of flooding in overview in terms of both economic and physical well-being. | Areas for new development should be prioritised based on this indicator, i.e. new developments with lower potential vulnerability should be developed first. Within the proposed new developments, this indicator can also be used in planning flood warning and emergency response. | The SFVI has been developed by the Flood Hazard Research Centre (FHRC). The Modelling and Decision Support Framework (MDSF) can be used to calculate the SFVI for existing development from census data. For new development, the SFVI should be calculated manually. | Information on population for existing and proposed development including % elderly (over 75yrs), % lone parents, % long term sick, % unemployed, % overcrowding (households with more than 1 person per room), % non-car ownership and % non-home ownership. | Office of National Statistics and the EA hold census data. | Modelling and Decision Support Framework (MDSF). GIS can be used to map the indicator. | |

# Appendix E

D2.1 TOOL2 Flood Risk to People Calculator – Example A

FD2320 Flood Risk Assessment Guidance For New Development
Version 3.0
## Flood Risk to People Calculator

FINAL

| Key | |
|---|---|
| | Required input |
| | Calculation |
| | Results |
| | Additional comments |

Guidance Note

Check for missing data

Transfer Data to Record

Clear Record

Clear Entered Values

### 1. Calculation Summary

| | |
|---|---|
| Development (sub area) | Example A |
| Reference | A |
| Design event - probability 1 in x years | 1000 |
| Risk pathway (no defence, overtopping or breach) | no defence |
| Calculation completed by | SDW |
| Date | 21st March 2006 |
| Approved by | HUD |
| Date | 28th March 2006 |

**Outcome**

| | |
|---|---|
| Proposed development is | Unacceptable |
| Proposed development with mitigation is | Acceptable |

Comments

Individual risk criterion (death < 1 in 10,000 AND no increase in individual risk)

### 2. Information about current flood hazards & vulnerability

| | Development | Comments/Source of Information |
|---|---|---|
| Depth (D) (m) | 1.5 | [illegible] |
| Velocity (v) (m/s) | 1 | [illegible] |
| Debris Factor (DF) | 0 | [illegible] |
| Flood Warning Score | 2.15 | [illegible] |
| Speed of Onset | 2 | [illegible] |
| Nature of Area | 2 | [illegible] |
| Area of Zone (ha) | 1000 | |
| Population (N) | 3000 | |
| The very old (75 years or over) (%) | 10 | |
| Infirm/disabled/sick (%) | 9 | |

### 3. Information about the proposed development

| | Development | Comments/Source of Info | Mitigation | Comments/Source of Info |
|---|---|---|---|---|
| Proposed Development | Newtown | | | |
| Number of Domestic Properties | 1000 | [illegible] | 1000 | [illegible] |
| Nature of Area | 2 | [illegible] | 1 | [illegible] |
| Occupancy Rate | 2.2 | [illegible] | 2.2 | [illegible] |
| Household populations | 2200 | | 2200 | |
| Includes Elderly? | Yes | [illegible] | No | [illegible] |
| Includes Infirm? | Yes | [illegible] | No | [illegible] |
| Number of Industrial Units | 10 | [illegible] | 10 | [illegible] |
| Number of Workers | 500 | [illegible] | 500 | [illegible] |
| Working Population | 125 | [illegible] | 125 | |
| Total Population | 2225 | | 2325 | |

### 4. Impact of development on flood risk

| | Development | | Mitigation | |
|---|---|---|---|---|
| Development will increase flood levels by (%) | 10% | [illegible] | 0% | [illegible] |
| Development will increase velocity by (%) | 10% | [illegible] | 0% | [illegible] |
| Improve flood warning & emergency planning | | | 3 | [illegible] |

### 5. Risks to People calculation

Flood characteristics

| | Existing Situation | Post development | Mitigation | Comments |
|---|---|---|---|---|
| Depth (D) (m) | 1.5 | [illegible] | 1.5 | |
| Velocity (v) (m/s) | [illegible] | 1 | [illegible] | |
| Debris Factor (DF) | [illegible] | [illegible] | [illegible] | |
| Flood Hazard Rating (HR) | [illegible] | [illegible] | [illegible] | [illegible] |

Area Vulnerability

| | Existing Situation | Post development | Mitigation | Comments |
|---|---|---|---|---|
| Flood Warning Score | [illegible] | 2.15 | [illegible] | |
| Speed of Onset | [illegible] | [illegible] | 2 | |
| Nature of Area | [illegible] | 2 | [illegible] | |
| Area Vulnerability Score | [illegible] | [illegible] | [illegible] | [illegible] |

People at Risk

| | Existing Situation | Post development | Mitigation | Comments |
|---|---|---|---|---|
| [illegible] | [illegible] | [illegible] | [illegible] | |
| [illegible] | 14% | 16% | 12% | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | |

People Vulnerability

| | Existing Situation | Post development | Mitigation | Comments |
|---|---|---|---|---|
| The very old (75 years or over) (%) | 10 | [illegible] | [illegible] | |
| Infirm/disabled/sick (%) | [illegible] | 14 | [illegible] | |
| People Vulnerability (%) | [illegible] | [illegible] | [illegible] | [illegible] |

Injuries and deaths

| | Existing Situation | Post development | Mitigation | Comments |
|---|---|---|---|---|
| Number of injuries | [illegible] | 497 | 288 | [illegible] |
| Fatality Rate | [illegible] | 5% | 5% | |
| Number of deaths | 7 | 25 | 12 | [illegible] |

Probabilities during event (NOT individual risk)

| | Existing Situation | Post development | Mitigation | Comments |
|---|---|---|---|---|
| Probability of injury | [illegible] | [illegible] | [illegible] | |
| Probability of death | [illegible] | [illegible] | [illegible] | |
| Probability of event 1 in | 1000 | 1000 | 1000 | |
| Individual Risk of Death 1 in | 423616 | 207055 | 444694 | |
| Risk factor (>1 = increase) | | 2.0 | 1.0 | |
| Societal risk | [illegible] | [illegible] | [illegible] | [illegible] |
| Risk factor (>1 = increase) | | [illegible] | 1.7 | |

Tolerable risk based on table in R2P Phase 1 with arbitrary thresholds

| | 1 in | | Comments | |
|---|---|---|---|---|
| [illegible] | [illegible] | | [illegible] | |
| [illegible] | 1000 | | Development | With Mitigation |
| [illegible] | 10000 | | Unacceptable | Acceptable |
| [illegible] | 100000 | | | |
| [illegible] | 1000000 | | | |
| [illegible] | 10000000 | | | |

# Appendix F

S2.3 TOOL Assessment Check-List

# S2.3 TOOL - Assessment Check-List

## Introduction

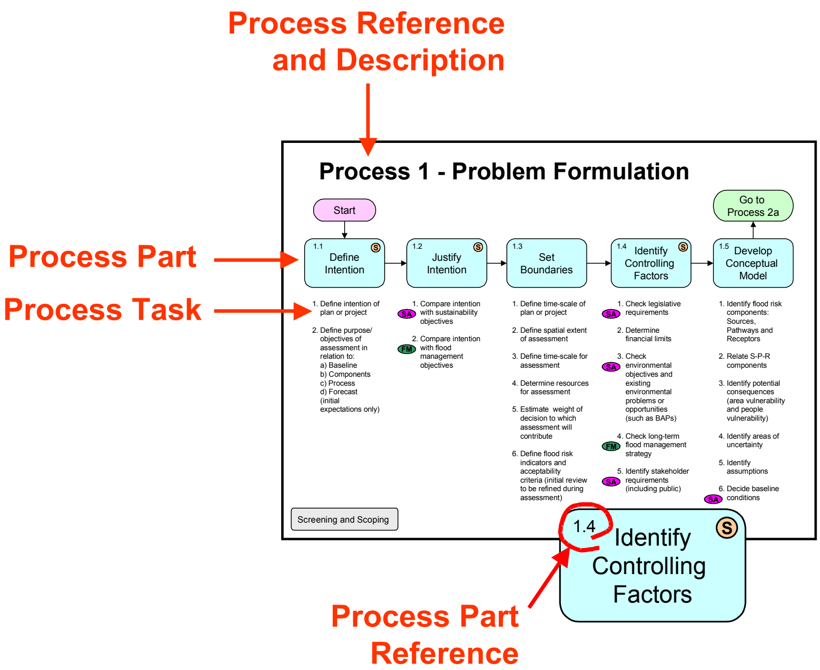
There are 4 check-lists, corresponding with the 4 milestone points in the Compliance Model for Assessing and Managing Flood Risk for New Development[432]:

- Process 1 Check-List 4 pages
- Process 2 Check-List 8 pages
- Process 3 Check-List 6 pages
- Process 4 Check-List 2 pages

It is recommended that these check-lists should be completed in turn and remedial actions should be carried out prior to proceeding to the next check-list.

The processes in the generic approach are categorised into 3 levels of activities, as shown below:

Level 1 Process (1, 2a, 2b, 3 and 4)
Level 2 Process Part (e.g. 1.1)
Level 3 Process Task (e.g. 1.1.1)




Each question should be given a score out of 5 (unless stated otherwise) based on the following statements:
0 Not at all
2 In principle
3 Clearly documented
4 With supporting evidence (in the form of authenticated data sources)
5 Evidence checked and science verified

Space is provided for brief comments to justify the score given. A Check-List Score Sheet has been provided (see over) to provide a summary of the scores. An example of a completed score sheet and a suggested verdict have been provided.

[432] See Figure 2 in Guidance Note S2.3 Auditing and Control

**Score Sheet**

| Process | Total Score | Maximum Score | Percentage Score |
|---|---|---|---|
| **Process 1 – Problem Formulation** | | 85 | |
| **Process 2 – Tiered Risk Assessment** | | See below | |
| High Level Assessment | | 50 | |
| Intermediate Level Assessment (if applicable) | | 110 | |
| Detailed Level Assessment (if applicable) | | 90 | |
| **Process 3 – Options Appraisal** | | See below | |
| If a risk assessment of options **is not** required | | 45 | |
| If a risk assessment of options **is** required | | 175 | |
| **Process 4 – Monitoring and Review** | | 60 | |
| **TOTAL** | | | |

**Example score sheet and verdict**

| Process | Total Score | Maximum Score | Percentage Score |
|---|---|---|---|
| **Process 1 – Problem Formulation** | **60** | 85 | **71** |
| **Process 2 – Tiered Risk Assessment** | | See below | |
| Coarse Assessment | **42** | 50 | **84** |
| Intermediate Assessment (if applicable) | **66** | 110 | **60** |
| Detailed Assessment (if applicable) | **40** | 90 | **44** |
| **Process 3 – Options Appraisal** | | See below | |
| If a risk assessment of options **is not** required | | 45 | |
| If a risk assessment of options **is** required | **97** | 175 | **55** |
| **Process 4 – Monitoring and Review** | **0** | 60 | **0** |
| **TOTAL** | **301** | **570** | **54** |

**Verdict**

The assessment process has been followed except that Process 4 was not considered at all. However, there is a lack of documentation and supporting evidence. There is a particularly low score for the detailed level assessment (in particular due to insufficient consideration of the significance of the risk). Therefore, the assessment is not appropriate, as it does not provide sufficient information for decisions to be made with confidence and the following remedial actions should be taken:

1. Documentation should be improved
2. Greater supporting evidence should be provided for the intermediate level assessment
3. The detailed level assessment should be reviewed in full and include an assessment of the significance of the risk
4. Process 4 should be carried out

**Process 1 Check-List (page 1 of 4)**

| 0 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Not at all | In principle | Clearly Documented | With supporting evidence | Evidence checked and science verified |

**1.1 Define Intention**

1.1.1 Has the intention of the plan or project been defined? (max score 3) ☐

1.1.2 Has the purpose/objectives of the assessment been defined? (max score 3) ☐

1.1.3 Have all stakeholders been identified, appropriate stakeholders selected for engagement and the type of engagement defined? ☐

**1.2 Justify Intention**

1.2.1 Has the intention been compared with sustainability objectives? (max score 3) ☐

1.2.2 Has the intention been compared with flood management objectives? (max score 3) ☐

**1.3 Set Boundaries**

1.3.1 Has the time-scale of the plan or project been defined? (max score 3) ☐

## Process 1 Check-List (page 2 of 4)

| 0 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Not at all | In principle | Clearly Documented | With supporting evidence | Evidence checked and science verified |

1.3.2 Has the spatial extent of the assessment been defined? ☐

1.3.3 Has the time-scale of the plan or project been defined? (max score 3) ☐

1.3.4 Have the resources for the assessment been determined? (max score 3) ☐

1.3.5 Is the weight of the decision to which the assessment contributes specified? (max score 3) ☐

**1.4 Identify Controlling Factors**

1.4.1 Have the legislative requirements been checked? (max score 3) ☐

1.4.2 Have the financial limits been determined? (max score 3) ☐

1.4.3 Have the environmental objectives and existing problems and opportunities been checked? ☐

## Process 1 Check-List (page 3 of 4)

| 0 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Not at all | In principle | Clearly Documented | With supporting evidence | Evidence checked and science verified |

1.4.4 Has the long-term flood management strategy been checked? ☐

1.4.5 Have all the stakeholder requirements been identified? ☐

**1.5 Develop Conceptual Model**

1.5.1 Have the hypothetical flood risk components (S-P-R) been identified? ☐

1.5.2 Have the risk components (S-P-R) been related? ☐

1.5.3 Have all potential consequences been identified? ☐

1.5.4 Have all areas of uncertainty been identified? ☐

1.5.5 Have all assumptions been identified? ☐

## Process 1 Check-List (page 4 of 4)

| 0 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Not at all | In principle | Clearly Documented | With supporting evidence | Evidence checked and science verified |

1.5.6 Have baseline conditions been decided?

**Go to the Process 2 Check-List.**

## Process 2 Check-List (page 1 of 8)

| 0 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Not at all | In principle | Clearly Documented | With supporting evidence | Evidence checked and science verified |

**2a.1 Carry out Coarse Assessment**

***2b.1 Identify Hazards***

2b.1.1 Have the potential sources of flooding been identified? ☐

2b.1.2 Have the potential pathways been identified? ☐

2b.1.3 Have the potential receptors been identified? ☐

2b.1.4 Have the primary and secondary hazards been identified? ☐

***2b.2 Identify Consequences***

2b.2.1 Has the area vulnerability been identified? ☐

2b.2.2 Has the people vulnerability been identified? ☐

## Process 2 Check-List (page 2 of 8)

| 0 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Not at all | In principle | Clearly Documented | With supporting evidence | Evidence checked and science verified |

2b.2.3 Has the property vulnerability been identified?

2b.2.4 Has the environmental vulnerability been identified?

**2a.2 Prioritise Risks**

2a.2.1 Have the risks been prioritised?

2a.2.2 Is there sufficient information for intention? YES/NO

**If yes, go to the Process 3 Check-List. If no, proceed to 2a.3 of this check-list.**

**2a.3 Carry out Intermediate Assessment**

***2b.1 Identify Hazards***

2b.1.1 Have the potential sources of flooding, identified during the high level assessment, been reviewed and confirmed?

2b.1.2 Have the potential pathways, identified during the high level assessment, been reviewed and confirmed?

# Process 2 Check-List (page 3 of 8)

| 0 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Not at all | In principle | Clearly Documented | With supporting evidence | Evidence checked and science verified |

2b.1.3 Have the potential receptors, identified during the high level assessment, been reviewed and confirmed? ☐

2b.1.4 Have the primary and secondary hazards, identified during the high level assessment, been reviewed and confirmed? ☐

*2b.2 Identify Consequences*

2b.2.1 Has the area vulnerability, identified during the high level assessment, been reviewed and confirmed? ☐

2b.2.2 Has the people vulnerability, identified during the high level assessment, been reviewed and confirmed? ☐

2b.2.3 Has the property vulnerability, identified during the high level assessment, been reviewed and confirmed? ☐

2b.2.4 Has the environmental vulnerability, identified during the high level assessment, been reviewed and confirmed? ☐

## Process 2 Check-List (page 4 of 8)

| 0 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Not at all | In principle | Clearly Documented | With supporting evidence | Evidence checked and science verified |

### *2b.3 Determine Magnitude of Consequences*

2b.3.1 Have appropriate methods for estimating magnitudes of consequences been selected? ☐

2b.3.2 Have the limitations, assumptions and uncertainties of methods and data been determined? ☐

2b.3.3 Have the spatial scales of all consequences been estimated? ☐

2b.3.4 Have the temporal scales of all consequences been estimated? ☐

2b.3.5 Have the times of onset for all consequences been estimated? ☐

### *2b.4 Determine Probability of Consequences*

2b.4.1 Have appropriate methods for estimating probabilities been selected? ☐

| 0 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Not at all | In principle | Clearly Documented | With supporting evidence | Evidence checked and science verified |

2b.4.2 Have the limitations, assumptions and uncertainties of methods and data been determined? ☐

2b.4.3 Have the probabilities of all hazards been estimated? ☐

2b.4.4 Have the probabilities of receptors being exposed to hazards been estimated? ☐

2b.4.5 Has the probability of harm from exposure to hazards been estimated? ☐

2b.4.6 Have combined probabilities of consequences been estimated? ☐

2a.3.1 Is there sufficient information for intention? YES/NO ☐

**If yes, go to the Process 3 Check-List. If no, proceed to 2a.4 of this check-list.**



Total Score: _______ Out of: _______ %: ____

## Process 2 Check-List (page 6 of 8)

| 0 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Not at all | In principle | Clearly Documented | With supporting evidence | Evidence checked and science verified |

**2a.4 Carry out Detailed Assessment**

***2b.3 Determine Magnitude of Consequences***

2b.3.1 Have appropriate methods for estimating magnitudes of consequences been selected? ☐

______________________________________________

______________________________________________

______________________________________________

2b.3.2 Have the limitations, assumptions and uncertainties of methods and data been determined? ☐

______________________________________________

______________________________________________

______________________________________________

2b.3.3 Have the spatial scales of all consequences been determined? ☐

______________________________________________

______________________________________________

______________________________________________

2b.3.4 Have the temporal scales of all consequences been determined? ☐

______________________________________________

______________________________________________

______________________________________________

2b.3.5 Have the times of onset for all consequences been determined? ☐

______________________________________________

______________________________________________

______________________________________________

***2b.4 Determine Probability of Consequences***

2b.4.1 Have appropriate methods for estimating probabilities been selected? ☐

______________________________________________

______________________________________________

______________________________________________

| 0 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Not at all | In principle | Clearly Documented | With supporting evidence | Evidence checked and science verified |

2b.4.2 Have the limitations, assumptions and uncertainties of methods and data been determined? ☐

2b.4.3 Have the probabilities of all hazards been determined? ☐

2b.4.4 Have the probabilities of receptors being exposed to hazards been determined? ☐

2b.4.5 Has the probability of harm from exposure to hazards been determined? ☐

2b.4.6 Have combined probabilities of consequences been determined? ☐

***2b.5 Determine Significance of Risk***

2b.5.1 Have appropriate methods for assessing the significance of risks been selected? ☐



Total Score: _______ Out of: _______ %: ☐

## Process 2 Check-List (page 8 of 8)

| 0 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Not at all | In principle | Clearly Documented | With supporting evidence | Evidence checked and science verified |

2b.5.2 Have the limitations, assumptions and uncertainties of methods and data been determined? ☐

______________________________

______________________________

______________________________

2b.5.3 Have all risks (relative or absolute) been assessed? ☐

______________________________

______________________________

______________________________

2b.5.4 Have all risks been compared with baseline conditions? ☐

______________________________

______________________________

______________________________

2b.5.5 Have all risks been compared with available standards? ☐

______________________________

______________________________

______________________________

2b.5.6 Have all risks been compared with each other? ☐

______________________________

______________________________

______________________________

**Go to the Process 3 Check-List.**



Total Score: _______ Out of: _______ %: ☐

**Process 3 Check-List (page 1 of 6)**

| 0 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Not at all | In principle | Clearly Documented | With supporting evidence | Evidence checked and science verified |

**3.1 Identify Options**

3.1.1 Have 'do nothing' and 'maintain existing level' options been included? (max score 3)

3.1.2 Have the controlling factors (identified in process 1.4) been considered? (max score 3)

3.1.3 Has the technical feasibility of all options been considered?

**3.2 Evaluate Options**

3.2.1 Has an appropriate trade-off analysis method been selected? (max score 4)

3.2.2 Have the limitations of the method and data been determined?

3.2.3 Have the assumptions used in the analysis been defined?

## Process 3 Check-List (page 2 of 6)

| 0 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Not at all | In principle | Clearly Documented | With supporting evidence | Evidence checked and science verified |

3.2.4 Have the uncertainties from the risk assessment been defined?

3.2.5 Have residual risks for each option been compared?

3.2.6 Have the options been compared against social, economic and environmental factors?

3.2.7 Is there sufficient information for intention? YES/NO

**If yes, go to question 3.3.1. If no, proceed to 3.3 of this check-list.**

**3.3 Apply Risk Assessment to Options**

***2b.1 Identify Hazards***

2b.1.1 Have the potential sources of flooding, identified during Process 2, been reviewed in light of the options proposed?

2b.1.2 Have the potential pathways, identified during Process 2, been reviewed and confirmed in light of the options proposed?

## Process 3 Check-List (page 3 of 6)

| 0 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Not at all | In principle | Clearly Documented | With supporting evidence | Evidence checked and science verified |

2b.1.3 Have the potential receptors, identified during Process 2, been reviewed and confirmed in light of the options proposed? ☐

2b.1.4 Have the primary and secondary hazards, identified during Process 2, been reviewed and confirmed in light of the options proposed? ☐

*2b.2 Identify Consequences*

2b.2.1 Has the area vulnerability, identified during Process 2, been reviewed and confirmed in light of the options proposed? ☐

2b.2.2 Has the people vulnerability, identified during Process 2, been reviewed and confirmed in light of the options proposed? ☐

2b.2.3 Has the property vulnerability, identified during Process 2, been reviewed and confirmed in light of the options proposed? ☐

2b.2.4 Has the environmental vulnerability, identified during Process 2, been reviewed and confirmed in light of the options proposed? ☐

## Process 3 Check-List (page 4 of 6)

| 0 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Not at all | In principle | Clearly Documented | With supporting evidence | Evidence checked and science verified |

### *2b.3 Determine Magnitude of Consequences*

2b.3.1 Have appropriate methods for estimating magnitudes of consequences been selected? ☐

2b.3.2 Have the limitations, assumptions and uncertainties of methods and data been determined? ☐

2b.3.3 Have the spatial scales of all consequences been determined? ☐

2b.3.4 Have the temporal scales of all consequences been determined? ☐

2b.3.5 Have the times of onset for all consequences been determined? ☐

### *2b.4 Determine Probability of Consequences*

2b.4.1 Have appropriate methods for estimating probabilities been selected? ☐

**Process 3 Check-List (page 5 of 6)**

| 0 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Not at all | In principle | Clearly Documented | With supporting evidence | Evidence checked and science verified |

2b.4.2 Have the limitations, assumptions and uncertainties of methods and data been determined?

2b.4.3 Have the probabilities of all hazards been determined?

2b.4.4 Have the probabilities of receptors being exposed to hazards been determined?

2b.4.5 Has the probability of harm from exposure to hazards been determined?

2b.4.6 Have combined probabilities of consequences been determined?

***2b.5 Determine Significance of Risk***

2b.5.1 Have appropriate methods for assessing the significance of risks been selected?



Total Score: ______ Out of: ______ %: ______

## Process 3 Check-List (page 6 of 6)

| 0 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Not at all | In principle | Clearly Documented | With supporting evidence | Evidence checked and science verified |

2b.5.2 Have the limitations, assumptions and uncertainties of methods and data been determined? ☐

2b.5.3 Have all risks (relative or absolute) been assessed? ☐

2b.5.4 Have all risks been compared with baseline conditions? ☐

2b.5.5 Have all risks been compared with available standards? ☐

2b.5.6 Have all risks been compared with each other? ☐

3.3.1 Has evidence been presented as to why the residual risk acceptable? ☐

YES/NO

**If yes, go to the Process 4 Check-List.**

**If no, this evidence should be presented before any subsequent decisions can be considered appropriate.**



Total Score: _______ Out of: _______ %: ☐

## Process 4 Check-List (page 1 of 2)

| 0 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Not at all | In principle | Clearly Documented | With supporting evidence | Evidence checked and science verified |

### 4.1 Decide What to Monitor

4.1.1 Have the monitoring boundaries been defined? (max score 4)

4.1.2 Have other monitoring requirements been taken into consideration? (max score 3)

4.1.3 Have the most important risk components been identified?

4.1.4 Have the S-P-R components controlling these risks been identified?

4.1.5 Has the variability and sensitivity of monitored parameters been considered?

4.1.6 Have the costs, difficulty and value of the monitoring been considered? (max score 3)



Total Score: _______ Out of: _______ %: ____

## Process 4 Check-List (page 2 of 2)

| 0 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Not at all | In principle | Clearly Documented | With supporting evidence | Evidence checked and science verified |

### 4.2 Design Monitoring Programme

4.2.1 Have appropriate monitoring locations been selected? (max score 4)

4.2.2 Has it been decided when to monitor? (max score 3)

4.2.3 Has a monitoring pattern been determined? (max score 3)

4.2.4 Has an appropriate monitoring method been selected? (max score 4)

4.2.5 Have appropriate ‘standards’ for compliance been decided? (max score 4)

4.2.6 Have appropriate actions in event of non-compliance been decided? (max score 4)

4.2.7 Has it been decided what data will feed into asset management strategies and/or performance monitoring strategies? (max score 3)

# Appendix G

Quick Reference Card

## Where to get further information

## Decision Guidance

**What's needed for development planning?**

D1.1 National Planning Policy
D1.2 Regional Spatial Strategies
D1.3 Local Development Frameworks
D1.4 Planning Applications

**Which indicators can be used?**

D2.1 Flood Risk Indicators

**Which type of assessment can be used?**

D3.1 National-scale Flood Risk Assessments
D3.2 Catchment Flood Management Plans
D3.3 Shoreline Management Plans
D3.4 Strategic Flood Risk Assessments
D3.5 Flood Risk Assessments

## Support Guidance

**How to navigate the framework**

S1.1 Introduction to the Framework
S1.2 How to use the Activity Chart
S1.3 How to use the Information Chart
S1.4 Glossary and Abbreviations

**How to manage the assessment processes**

S2.1 Reporting
S2.2 Information Management
S2.3 Auditing and Control
S2.4 Stakeholder Engagement
S2.5 Linkage to Statutory Requirements

**Key issues**

S3.1 Climate Change
S3.2 Risk to People behind Defences
S3.3 Safe Access and Exit
S3.4 Brownfield Development
S3.5 Mitigation Measures

Further information can be found in the Defra/EA R&D Project FD2320 Technical Reports 1 & 2, March 2005, by HR Wallingford Ltd.

## Check List

**Process 1 - Problem Formulation**

1.1 Has the purpose of the plan or project and associated assessment been defined?
1.2 Can the plan or project be justified with respect to sustainability and flood management objectives?
1.3 Have the spatial and temporal boundaries of the assessment been defined?
1.4 Have the controlling factors (e.g. legislative, financial, environmental, flood management, stakeholder requirements) been identified?
1.5 Has a conceptual model been developed and baseline conditions identified?

**Process 2a - Tiered Risk Assessment**

2a.1 Have risks been screened?
2a.2 Have risks been prioritised?
2a.3 Has an intermediate assessment been carried out (if required)?
2a.4 Has a detailed assessment been carried out (if required)?

**Process 2b - Stages of Risk Assessment**

2b.1 Have the hazards been identified?
2b.2 Have the consequences been identified?
2b.3 Have the magnitudes of consequences been determined?
2b.4 Have the probabilities of the consequences been determined?
2b.5 Has the significance of the risk been determined?

**Process 3 - Options Appraisal**

3.1 Have options been identified (including 'do nothing' and 'maintain existing levels')?
3.2 Have the options been evaluated (considering social, environmental and economic objectives and technical feasibility)?
3.3 Has an assessment of flood risk been carried out for the options (if required)?
3.4 Have options been revised (if required)?
3.5 Have options been re-evaluated (if required)?
3.6 Has the preferred option been selected?

**Process 4 - Monitoring and Review**

4.1 Has it been decided whether monitoring is needed and what needs to be monitored?
4.2 Has a monitoring programme been designed (if required)?
4.3 Has monitoring been carried out (if required)?
4.4 Have monitoring results been reviewed (if required)?
4.5 Have any lessons learnt been reported?
4.6 Has the monitoring programme been reviewed (if required)?

# Framework for Assessing and Managing Flood Risk for New Development

## QUICK REFERENCE CARD

### *Efficiency*

Enables users to carry out activities in a timely manner reducing duplication of work, by using outputs from existing assessments (where possible) and by including timely links to flood defence and environmental strategies.

### *Effectiveness*

Enables users to communicate the assessment and decision-making processes to stakeholders in a transparent and unambiguous manner, through both reporting and auditing mechanisms.

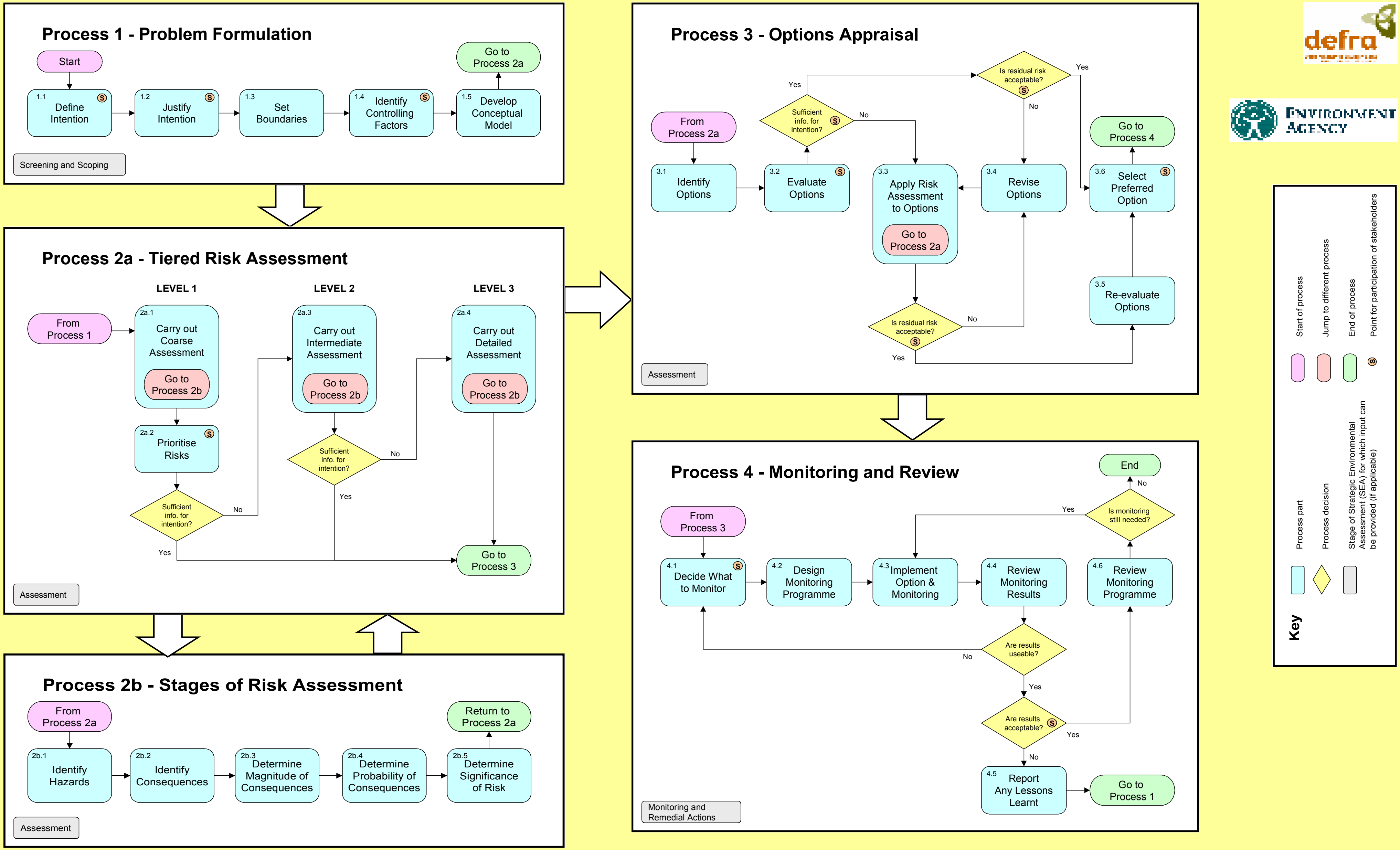
### *Evolution*

Enables monitoring and review of processes, decisions and flood risk to improve practices and implementation of the framework in the future.
Designed as an evolving tool for users to incorporate lessons learnt, new research and development and new legislation as and when it comes on-line.

defra

Environment Agency

# Generic Approach to Assessing and Managing Flood Risk for New Development



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