

The aims of planning policy on development and flood risk are to ensure that flood risk is taken into account at all stages of the planning process to avoid inappropriate development in areas at risk of flooding, and to direct development away from areas at highest risk.



LOCAL DEVELOPMENT FRAMEWORK

Strategic Flood Risk Assessment for
Herefordshire
TECHNICAL REPORT
DRAWINGS & APPENDICES
3rd Edition

REPORT QUALITY CONTROL

Report 1110-TR1-C – Herefordshire Strategic Flood Risk Assessment

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DATA UPDATES

Users of this SFRA should be aware that many of the floodplain maps presented in this study date from the release of April 2007, and consequently have been superseded by periodic updates. The Environment Agency periodically issues further updates on a quarterly basis, and the latest floodplain maps can be checked on their web-site.

Similarly, Herefordshire Council will also occasionally update its own material, flood reports and development sites database.

Subsequent users of this SFRA and its associated GIS layers and databases should always confirm with Herefordshire Council and/or the EA that they are using the latest available information.

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EXECUTIVE SUMMARY

Chapter 1 - The Regulatory Framework

This Report delivers the Strategic Flood Risk Assessment for Herefordshire. It is innovative in many respects in the new techniques used and extent of the issues which it addresses. All forms of flooding and their impact on the natural and built environment are material planning considerations. Flooding threatens life and causes substantial damage to property, as the recent events of 1998, 2000, 2004 and 2007 in Herefordshire have shown. Although flooding cannot be wholly prevented, its impacts can be avoided or reduced through good planning and management. To this end the Government's objectives for development and flood risk are set out in *Planning Policy Statement 25 (PPS25): Development and Flood Risk*, including the needs and scope of SFRA's.

This chapter describes comprehensively the regulatory framework surrounding Strategic Flood Risk Assessments, including reference to the Water Framework Directive, Regional Flood Risk Assessment, and the ongoing EA Catchment Flood Management Plan. The SFRA pre-empt's the likely recommendations of the Pitt Report (due summer 2008) in which there are likely to be many far-reaching recommendations with regard to Local Planning Authority engagement in flood resilience and flood management issues which should be addressed in a forward thinking Strategic Flood Risk Assessment.

The SFRA is heavily orientated towards a Geographic Systems Approach (GIS). Although there is substantial information, evidence, tools and guidance contained within the text, this represents a small proportion of the insight delivered via the databases and GIS layers developed. Some 40 separate databases and or information layers have been produced, some of them very substantial in their content. The 'Evidence Maps' provided throughout the document are merely an insight as to what is available within the GIS framework.

Chapter 2 - Flood Hydrology and Flood History

Many CFMPs and SFRA's ignore the fundamental principle that floods do not originate from rivers. Rivers represent only a pathway for flooding. Flooding arises from excessive runoff within catchments, the runoff speed, quantity and peak being determined from catchment characteristics. Hence, a true understanding of flood risk assessment must consider catchments as the fundamental 'management unit', not rivers. This SFRA, whilst obviously addressing fluvial risk, breaks new ground by focusing also on catchment dynamics as they influence general flood risk, and the importance of catchment hydrology generally in an appreciation of flood risk management. The SFRA has analysed in detail the hydrology and runoff dynamics for 47 separate sub-catchments within the study area, most notably in terms of rainfall, wetness condition, percentage runoff and time to peak. These parameters are widely used in the development of Flood Risk indexes for use in the Sequential Test of PPS 25, and in the consideration of possible drainage strategies for future integrated flood management.

A short history of flooding within Herefordshire is presented, with reference to some notable floods.

Chapter 3 – Current Development and Flood Risk

This Chapter summarises the best available knowledge with regard to general current sources of flooding and flood risk within the SFRA study area. Flooding can arise from a variety of sources, not just fluvial floodplains. The widespread flooding of July 2007 confirmed that as much as 40% of flooding within Herefordshire arises from sources other than the major fluvial floodplains. One of the central undertakings of the SFRA has been to create a [HSFRA Flood Reports Database](#) and GIS layer that incorporates all of these 2007 reports, but also includes as far as could be readily determined, other historical and anecdotal flood reports throughout the County from a wide range of sources. It is undoubtedly the most complete reference for historical flood reports available, and is one of the foundation evidence bases of the Strategic Flood Risk Assessment. It includes to date some 552 separate records, incorporating approximately 920 individual flood reports, but it is at a best estimate only 70% complete.

A significant number of hydraulic and hydrological studies have been carried out within Herefordshire in the last 20 years, and these are all summarised.

The sub-catchment with the greatest current fluvial flood risk (hazard x consequence) is the Lower Wye sub-catchment (including Hereford), extending along the River Wye between Belmont and Monmouth. 1253 properties are at risk in a 1% AEP flood event. The catchment with greatest proportional flood risk (properties as % of total) is actually the Upper Lugg, where 17% of properties are at risk. This is closely followed by the Pinsley Brook at 16% of total.

Smaller settlements with a significant history of flood disruption include Bosbury, Eardisland, Ewyas Harold, Hampton Bishop, Hereford, Kington, Leintwardine, Leominster and Ross-on-Wye. Emergency planning and future development proposals should take particular account of these settlements with regard to avoidance of increased flood risk.

Chapter 4 - Flood Hazard and Flood Risk Indicators

Possibly unique amongst UK SFRA, this study has attempted to develop a set of generalised but quantifiable catchment flood hazard and risk Indexes, based on the essential hydrological components of 47 policy specific identified sub-catchments. It was concluded that one of the most useful measures that a LPA could have at its disposal when sequentially testing land and development type allocations within the Local Development Framework would be a set of systematically derived indices that would compare sub-catchments on a like for like basis. Such a measure would greatly simplify:

- Where alternatives are available, the allocation of a development area to a lower category of flood risk, in compliance with the Sequential Test approach of PPS 25.
- Identification of future increased flood risk by comparison of development pressures in relation to the existing flood potential index.
- Identification of catchments most vulnerable to flash flooding
- Identification of the highest risk catchments where improved flood warning, or critical infrastructure resilience may be required

Based on ranked catchment hydrological parameters, a single composite index known as the [Catchment Flood Hazard Index](#) has been derived for each sub-catchment. This Index is useful in identifying which catchments may be subject to higher than average surface water flooding, flash flooding and climate change. A second key index, useful for current flood risk and use in the Sequential Test is the [Fluvial Flood Risk Index](#). This summarises the number of properties known to be at risk of flooding within a particular sub-catchment in the 1% AEP event. A further index has used the catchment hydrograph time to peak (Tp(t)) rankings to derive a [Flood Timing & Evacuation Index](#). The higher the rank of the index, the shorter is likely to be the flood peak timing of the catchment; hence there is greater possibility of flash flooding, reduced flood warning time, and/or capacity of emergency services to respond to emergencies.

Chapter 5 - Future Development and the Sequential Test

A sequential risk-based approach to determining the suitability of land for development in flood risk areas is central to government policy, and should be applied at all levels of the planning process. Local Planning Authorities allocating land in Local Development Documents should always apply the Sequential Test to demonstrate that there are no reasonably available sites in other areas with a lower probability of flooding. This Chapter addresses one of the core requirements of the SFRA, namely to apply a sequential risk approach to the allocation of potential development land identified by the LPA. Evidence and guidance in this Chapter will be of use both to the Local Planning Authority in preparing Local Development Documents (LDDs).

Herefordshire Council has prepared throughout 2007 a major database of potential development sites. The availability of this database also in GIS format greatly enhances the capacity of the Sequential Test to be demonstrated in an open and transparent way, an essential requirement of PPS 25. Assessment of the sites in the database in accordance with the hierarchy of flood management measures is one of the core outputs of the Strategic Flood Risk Assessment. It can be stated that all of the Evidence Maps and supplementary tools of the SFRA are intended to support the transparent application of this hierarchy, including the Sequential Test.

The key to a successful implementation of the Sequential Test is to attain transparency and objectivity in the evaluation of alternative sites. A significant failure of the Sequential Test some other Local Development Frameworks (LDFs), and hence continuing objections from the EA has been the lack of these two criteria with respect to site allocations.

To assist in a systematic evaluation of sites, a standardised methodology is proposed that compares alternative sites within a check-list of 16 possible issues. For many sites, some of the issues will not be relevant, or there will be no information on this issue. **SEQUITIR** (Sequential Test Indicative Report) is an innovative and useful methodology to interact with the Herefordshire Council sites databases and GIS layers, uniquely developed for the Herefordshire SFRA. It is a systematic method to identify, compare and sequentially test sites on the basis of the key flood risk issues. Its primary purpose is to assist Herefordshire Council planners to allocate sites for development with appropriate levels of flood risk, in compliance with PPS 25. Furthermore SEQUITIR is explicit and transparent in the way it operates. Hence it can be used as part of the evidence base in supporting why specific sites have been selected or allocated for a particular use in Local Development Documents (LDDs), especially to satisfy potential EA transparency concerns.

Assuming a County wide average of 30 dwellings/ha, and assuming a full take up of 16,600 dwellings under the Regional Spatial Plan, 553 ha. of residential land is required to meet growth targets. This represents 10.5% of potentially available housing land. Not all of this land will be reasonably available, and many sites will be inappropriate for development. Nevertheless, this small proportion suggests that there is significant scope to allocate housing land outside Flood Zone 3 and Flood Zone 2 land in compliance with the Sequential Test.

A key section brings together the identified development pressures, the flood management hierarchy and various essential Evidence Maps and support tools to assist the LPA in its allocations and policies for Local Development Documents. A systematic review of the principal sites identified under the **HSFRA Development Sites** database and GIS layer is conducted, which has used the SEQUITIR approach.

The greatest development pressures fall within the Hereford and Leominster environs. The strategic flood management issues in Hereford are complex. Development in the Yazor Brook generally will greatly increase the loading on the Yazor Brook. This has a confined channel through Hereford city, and frequently generates flooding in the Widemarsh area. On the south side of the Wye feasible development sites in and around Bullingham will also greatly increase loadings on local watercourses, most particularly the Withy and Red Brooks. These watercourses encounter significant flooding at present, largely due to high tailwater levels arising from the River Wye itself. In Leominster there is significant potential development on the south side which may also require river channel capacity reinforcement.

It is recommended that in accordance with Government thinking, the integrated drainage issues are investigated with a model-based **Surface Water Management Plan**. This is strongly recommended for the Hereford area, which should identify with some accuracy the timings of the various flood peaks arriving at Hereford, especially the Lugg, the Yazor Brook, Withy Brook and the Red Brook, and assess the extent to which attenuation is or is not feasible in the area. This study should identify feasible sites and routes for strategic attenuation reservoirs or new diversionary channels, and confirm in outline terms the extent to which site runoff discharges (whether attenuated or not) will exacerbate or reduce downstream flood risks. A similar but less extensive study would be beneficial at Leominster.

[Chapter 6 - Flood Warning Systems](#)

Adequate flood warning systems are an integral part of cohesive and effective flood risk management. The purpose of flood warning is to provide advice which permits those people vulnerable to impending flooding to take actions which lessen the consequences of inundation, should it be experienced. Whilst the EA predominantly focuses on flood warnings to protect life and property, there is also an increasing need for LPAs and emergency services to utilise timely flood-warnings to protect critical infrastructure. This Chapter examines the status of the current flood warning system, and identifies where future improvements may be needed to lessen residual flood risk for both existing and future development and critical infrastructure.

The hydrological evidence based prepared for the SFRA can be used to critically identify weaknesses and needed improvements to the flood warning system. As with all resources and investments, these should be targeted at areas of greatest risk. Downstream of impermeable catchments or during summer type flash flooding, very little warning may be given. It follows that this places an additional requirement on emergency services and the LPA generally to be as thoroughly prepared for short-notice flooding as possible. Critical infrastructure generally was not adequately prepared during the 2007 floods, and preparedness through timely flood warnings and good contingency planning is a key future issue for the LPA.

The most rapidly responding catchments in the SFRA area are the Wriggle Brook, Back Brook, Honddu, Lower Monnow and the Upper Leaddon. Any development proposed adjacent to the floodplain in these catchments will have to take special account of flood risk imminence. The settlements most at risk from sudden flood peaks and which are most likely

to be affected by inadequate warning are Ewyas Harold (Dulas Brook not modelled), Bosbury, Ledbury, Bromyard and Kington.

Chapter 7 - Sustainable Sites and Buildings

The Government's future vision for surface water is to develop:

- More adaptable drainage systems delivering reduced flood risk, improved water quality, and decreasing burdens on the sewer system
- Better management of surface water drainage, allowing for the increased capture and reuse of water; slow absorption through the ground and more above-ground storage and routing of surface water separate from the foul sewer system
- Better public appreciation of the causes and consequences of surface water run-off and the actions we can all take to minimise the risks

The Local Development Framework must promote policies that recognise that:

- existing property and infrastructure may be subjected to increased frequency and/or depth of flooding in the future
- future development should lessen the hydraulic loading on underground and above ground surface water systems to minimise downstream risks
- future development should incorporate improved resilience to flood inundation where it is not feasible to locate it outside the floodplain

This Chapter summarises the current supportive best practices in sustainable drainage systems (SUDS) that could be applied in varying degrees within the provisional drainage strategies outlined in Chapter 9, and as a measure of last resort where buildings are inevitably placed in the fluvial floodplain, designs that can be implemented to improve either the flood resistance or flood resilience of new buildings. Where avoidance or alteration to the development type is not feasible or appropriate, then measures of site resilience and building resilience must feature as part of the formal process of the sequential reduction in flood risk.

Allocating new development sites to areas of least fluvial risk is only 50% of the sustainability test. New developments well outside the floodplain and not therefore themselves at risk of flooding may place significantly increased loading on receiving sewers and watercourses, sometimes many kilometres downstream of their location. Flood risk to downstream third-parties is thereby increased.

Arrangements for managing surface water drainage are currently split between the Environment Agency, local authorities, water companies, and other agencies, with no one organisation having overarching responsibility. As a result, decisions about new drainage or development investments are often taken without a complete understanding of surface water risks and the most effective solutions, or optimum solutions are not implemented because the controlling Agency refuses to adopt the proposed structures.

The Government's view is that the key to the consistent and successful implementation of SUDS for all development sites is inclusion of a sustainable drainage policy within regional and local development documents. This should be implemented with the collaboration of the Environment Agency and the sewerage undertaker (Welsh Water). In areas of intense development or locally complex drainage issues, it may be necessary to formulate a [Surface Water Management Plan](#) that has multi-agency engagement and support

The lack of policy or legislation supporting the long term ownership and maintenance responsibility for SUDS hinders the implementation of SUDS. DEFRA as part of the process to implement the WFD is currently looking at options to allocate the maintenance liability of SUDS and it is possible that supporting legislation will be available in advance of 2015.

In all flood risk areas, a basic level of flood resistance and resilience will be achieved by following good building practice and complying with the requirements of the Building Regulations 2000. A substantial amount of building resilience guidance is available from the Environment Agency, DCLG and BRE and some key examples have been illustrated. The guidance is not comprehensive with respect to design or cost. However the key references can provide good sources to where further information can be obtained.

With regard to site runoff attenuation rates where it is not clearly established what the downstream risks may be, the safest and most appropriate general option is to maintain the same runoff from the developed site as that for the green-field site for the same event. For example, in a 2% Annual Equivalent Probability storm (1 in 50 year equivalent), the site should be able to discharge at an equivalent of the 1 in 50 green-field runoff rate.

[Chapter 8 – Emergency Response and Civil Contingency Planning](#)

Under the Civil Contingencies Act 2004, Local Resilience Forums should ensure that risks from flooding are fully considered, especially including the resilience of infrastructure that will have to operate during floods. This knowledge should form the basis for preparing appropriate flood risk management and emergency response measures. This Chapter summarises the emergency response framework and an inventory of critical infrastructure within Herefordshire, and provides guidance to the LPA in respect of additional measures that may be required to enhance contingency planning in association with emergency services and infrastructure providers.

Anticipating the recommendations of the Pitt Report 2008, the SFRA has conducted a desk-based outline appraisal to evaluate the number of key infrastructure assets throughout Herefordshire that may be at risk of inundation during a major flood event. Reference is also made to infrastructure where the highway to/from an asset may also be flooded, thereby compromising access to or effectiveness of the asset. The section is focused on the key Market Towns in order of population where infrastructure is likely to be most critical.

It is strongly recommended that the Emergency Planning Unit of Herefordshire Council make use of the Critical Infrastructure GIS layers provided as part of the SFRA, with a view to identifying where such infrastructure is vulnerable. Utilities identified as having critical assets in the floodplain should be systematically contacted by Herefordshire Council and queried as to their level of preparedness, contingency plans, and alternative facilities.

[Chapter 9 – Strategy Options for Drainage and Flood Management](#)

In line with various Government sourced reports and likely policy guidance, LPAs will need to take an increasingly proactive role in identifying and managing flood risk. This requires a coordinated long-term overview of the likely infrastructure that will be needed, and coordinated and integrated policies that deliver effective sustainable flood management. This is a challenging task for any LPA, but this must be addressed soon. This section brings together various previous evidence bases, and identifies the key strategic infrastructure and associated policy issues that will have to be promoted in the near to medium future. Some of these issues may be considered in other strategic plans; especially the Environment Agency based [Catchment Flood Management Plan](#) and the [Severn Trent River Basin Management Plan](#).

This Chapter of the SFRA begins to address these likely policy options associated with Surface Water Management Plans, which nevertheless will have to be continued post-SFRA via stakeholder discussions between the LPA, Welsh Water and the Environment Agency.

As part of the new strategy for flood risk management Making Space for Water the UK Government is exploring how the different organisations in urban drainage can work in partnership to promote a more strategic and integrated approach to surface water management. It sees [local authorities in a central leadership role](#), with the Environment Agency advising on and potentially quality-assuring the plans. In particular LPAs and water companies should work together in preparing such plans and using them to guide investment decisions on solving local drainage, including options for above-ground storage and routing.

In critical drainage areas, where the risk from surface water drainage is significant, the local authority should prepare a [Surface Water Management Plan](#). This would be an action plan, agreed by all local stakeholders with drainage responsibilities, to clarify responsibilities and manage these risks. Given the potential risks posed by surface water

flooding around the country, the Government is now consulting separately on how to give Surface Water Management Plans a stronger role in coordinating development and investment planning.

The historically piece-meal approach to site drainage and flood mitigation (each site for itself) is not sustainable in the long term. Truly integrated strategies require that at the micro-scale (the site) each site contributes in a consistent way to the wider policy objectives, BUT the policy objectives must coincide with what is practicably feasible at the site scale AND is appropriate at the local catchment scale. It is the contention of this SFRA that in preparing for effective drainage and flood management, policies arising from current flood risk and future development impact should be catchment and sub-catchment based.

Runoff impacts are fundamentally different in their scale and timing within different catchments. Effective long-term flood risk management MUST therefore be based on catchments, not arbitrary policy units such as those considered in the EA CFMPs. Furthermore, the catchment hydrodynamics (volume of runoff, speed of runoff, drainage capacity, and timing of peak) must be very well understood before blindly embarking on drainage and flood mitigation policies that may prove to be counter-productive in the long-term.

Site attenuation does indeed reduce local runoff to a safe (less than bankfull) amount, but the knock-on effect is that the delayed outflow continues for a longer period than when it is unattenuated, and this tends to increase peak flow on the main river peak downstream. Hence flood-risk is actually increased in the downstream location. These subtle but crucial alterations to local drainage patterns have not been well understood previously, and consequently ignored by regulatory authorities. If there is a committed move to more strategic, integrated drainage management as required by UK Government, then these subtleties must be appreciated and incorporated into drainage policies and Surface Water Management Plans generally.

This SFRA is founded on catchments, and has presented a wealth of evidence and data to support emerging appropriate drainage policies for integrated flood management. The process is ongoing, but a provisional list of appropriate drainage strategies (based on catchment hydrodynamic principles and what is at risk) is drafted in Table 9-2. A cascading type check-list has been formulated to assist in identifying the most likely appropriate policy.

Nine different catchment based drainage strategies have been formulated that provide an integrated approach that lessens overall flood risk at the regional scale whilst also protecting local property and/or critical infrastructure. Some strategies should actively promote rapid runoff to maximise effective use of channel capacities and rapid timings of watercourses, others will maintain the status quo in terms of matching green-field runoff rates, and at the other end of the scale, significant attenuation may be desirable (by storage of flood water either on-site or in strategically placed reservoirs).

Herefordshire Council must greatly increase its awareness and field-intelligence of the sources and mechanisms of flooding in its administrative area. This is essential to effective planning, investment and emergency response in flood management. There should be a systematic method of efficiently collating flood and accessing information, whether from fluvial flooding or from surface water.

Chapter 10 – Future Flood Management Issues

It is likely that in the coming decade Herefordshire Council will play an increasingly proactive role in the strategic and contingency aspects of ever increasing flood risk within its own region. This Chapter summarises latest industry and Government guidance and evolving issues that are likely to directly affect Herefordshire Council and which may provide further material for the evidence base.

The DEFRA strategy '[Making Space for Water](#)' has identified the need for a holistic, joined-up, and integrated approach to manage flood risk. An improved response is especially needed in urban areas where there is a complex interaction of drainage systems and fractured institutional arrangements. Published in March 2008, the [Future Water](#) strategy document is a far-reaching set of objectives and visions across the entire water cycle. Amongst other objectives, the Government signals its intention to use Surface Water Management Plans as a tool to improve the coordination of drainage stakeholders. It also wants to promote sustainable drainage by clarifying responsibilities and improving incentives for property owners and developers.

A key driver future driver in integrated flood risk management is likely to be the insurance industry, who may withdraw cover from flood risk properties, and who may seek compensation from LPAs who are deemed to be negligent in providing or maintaining satisfactory drainage and flood management infrastructure.

1. THE REGULATORY FRAMEWORK

1.1 Planning Policy Statement 25 – Development and Flood Risk

All forms of flooding and their impact on the natural and built environment are material planning considerations. Flooding threatens life and causes substantial damage to property, as the recent events of 1998, 2000, 2004 and 2007 in Herefordshire have shown.

Although flooding cannot be wholly prevented, its impacts can be avoided or reduced through good planning and management.

To this end the Government's objectives for development and flood risk are set out in [Planning Policy Statement 25 \(PPS25\): Development and Flood Risk](#) (Department for Communities and Local Government, December 2006)¹. The key aims are to:

- Ensure that flood risk is taken into account at all stages of planning
- Avoid inappropriate development in areas of flooding
- Direct development away from high risk areas
- Ensure that new development takes climate change into account and does not increase flood risk elsewhere

1.2 West Midlands Regional Flood Risk Appraisal

With regard to regional and local planning strategies, PPS25 directs Regional Planning Bodies (RPBs) to ensure that their Regional Spatial Strategy (RSSs) include a broad consideration of flood risk from all sources and set out a strategy for managing it. This process is primarily informed by the production of a Regional Flood Risk Appraisal (RFRA).

The [West Midlands Regional Flood Risk Appraisal](#)² was submitted by Consultants Faber Maunsell in October 2007.

Under 4.4.3, the RFRA concludes that *“the Wye and its tributaries do not present a major source of flood risk within the region”*. This is a somewhat surprising statement, as numerous towns and villages in the County, including Hereford, Leominster, Ross-on-Wye, Bromyard, Ledbury and Kington have all encountered serious flooding in recent years.

Accepting the relative nature of RFRA's i.e. flood risk (defined as **probability x consequence**) in Herefordshire may be of a lesser magnitude than in Worcestershire or Gloucestershire for example, at the local scale it is apparent

that flooding in Herefordshire is relatively frequent and potentially damaging, albeit tending to affect relatively small communities.

The exception to this is the city of Hereford itself, parts of which are shown by the Environment Agency Flood Zone Map to have significant risk of major flooding. Since 1998, the Lower Bullingham, Rotherwas and Hampton Bishop residential areas have encountered flooding to the extent that evacuations were necessary. Widespread non-fluvial flooding occurred throughout Herefordshire in summer 2007,

Figure 1-1 – Environment Agency 1% and 0.1% Flood Map for Hereford



1.3 Local Development Framework

Herefordshire Council is in the process of developing its new Local Development Framework (LDF), derived from the Herefordshire Unitary Development Plan (UDP). Adoption of the Local Development Framework is expected in the autumn of 2008. LDF policies and proposals have been developed to be consistent with those of the West Midlands Regional Spatial Strategy, RSS11. Throughout, there is a strong emphasis on the delivery of sustainable development.

Flood risk within the County has been identified by the Council as a significant issue potentially affecting future housing development and employment opportunity. It is a requirement of Planning Policy Statement (PPS) 25 that Local Planning Authorities (LPAs) should undertake Strategic Flood Risk Assessments (SFRAs) to inform sound planning policies at all levels of planning, including Regional Spatial Strategies and Local Development Documents.

This document is part of the essential 'evidence base' that will be used to generate policy and strategy for Local Development Frameworks (LDFs) and Local Development Documents (LDDs).

1.4 The Water Framework Directive

1.4.1 Process and Objectives

Directive 2000/60/EC³ of the European Parliament establishes a framework for community action in the field of water policy (known as The Water Framework Directive or WFD). The new approach emphasises the strong need for integrated approaches to the protection, improvement and sustainable use of water resources.

The Water Framework Directive applies to all surface freshwater bodies (including lakes, streams and rivers), groundwaters, groundwater dependant ecosystems, estuaries and coastal waters out to one mile from low-water. It came into force in December 2000, and transposed into UK law by December 2003.

Its overall objective is consistent, sustainable water management across Europe in order to:

- Reduce pollution, prevent deterioration and improve the condition of aquatic ecosystems including wetlands
- Promote sustainable use of water
- Help reduce the effects of floods and droughts

The primary mechanism for implementing the WFD is by means of River Basin Management Plans (RBMPs). There are 11 major river basin 'districts' defined within England and Wales, and as the 'competent authority' for implementation of the WFD objectives in England and Wales, the Environment Agency is responsible for submitting proposals to the Secretary of State for:

- Environmental objectives for each body of water within a River Basin
- The Programme of Measures defined to deliver these objectives
- A River Basin Management Plan for each River Basin District

The WFD introduces six-year cycles of planning, intended to be consultative with major regional stakeholders, and iterative in its process.

The significance of the WFD to the role of Herefordshire Council is that Herefordshire forms a significant proportion of the River Wye catchment area, which is itself a significant part of the Severn Trent River Basin District.

Hence, through the well defined consultation process, Herefordshire has the opportunity to influence the content and implementation of the River Basin Management Plan through its own local policies and plans, most notably the

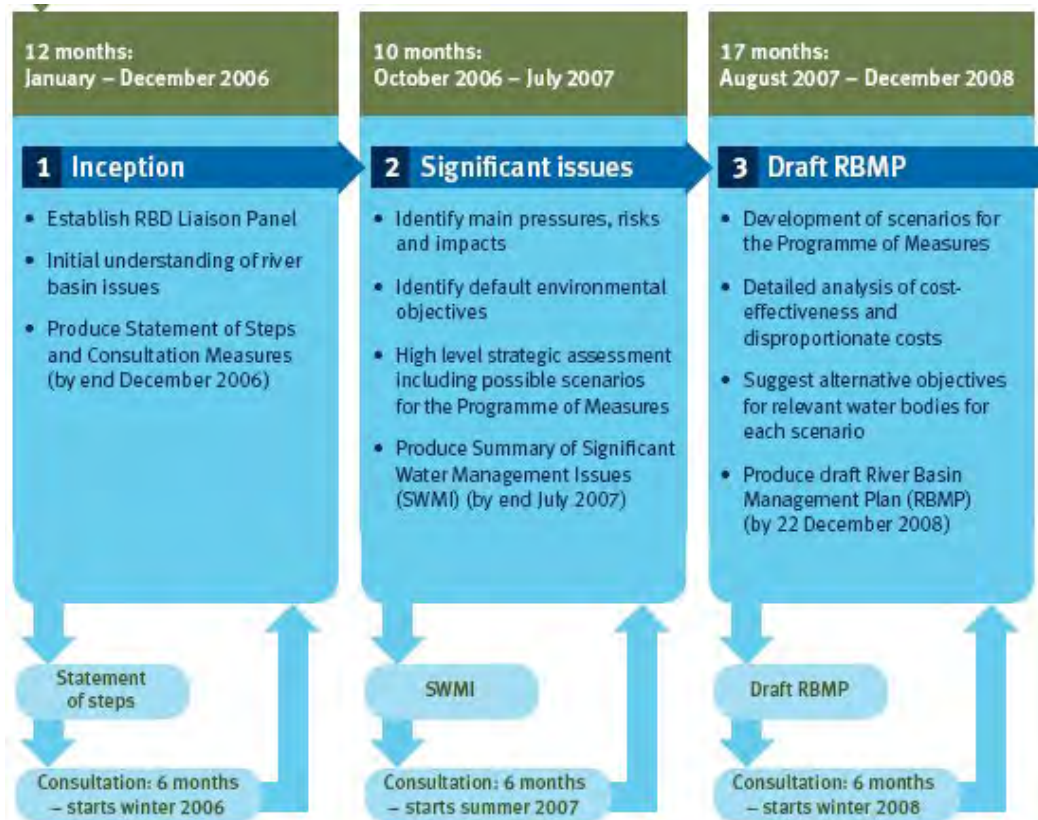
Water Cycle Strategy, this Strategic Flood Risk Assessment, and its Local Development Framework generally.

Conversely, if Herefordshire Council does NOT input to the consultation process, other stakeholder views may predominate, and the Council's long-term targets and aspirations may be more difficult to achieve if these are seen as contrary to the regionally set environmental objectives.

1.4.2 The Severn Trent River Basin Management Plan

In common with all RBDs, the River Basin Management Plan process is regulated by a strict time-table of consultations. A RBD Liaison Panel representing major regional stakeholders was formed in 2006 to overview the consultation process. Figure 1-2 summarises the milestone stages to 2008.

Figure 1-2 – Overview timescales of RBMP Process to December 2008

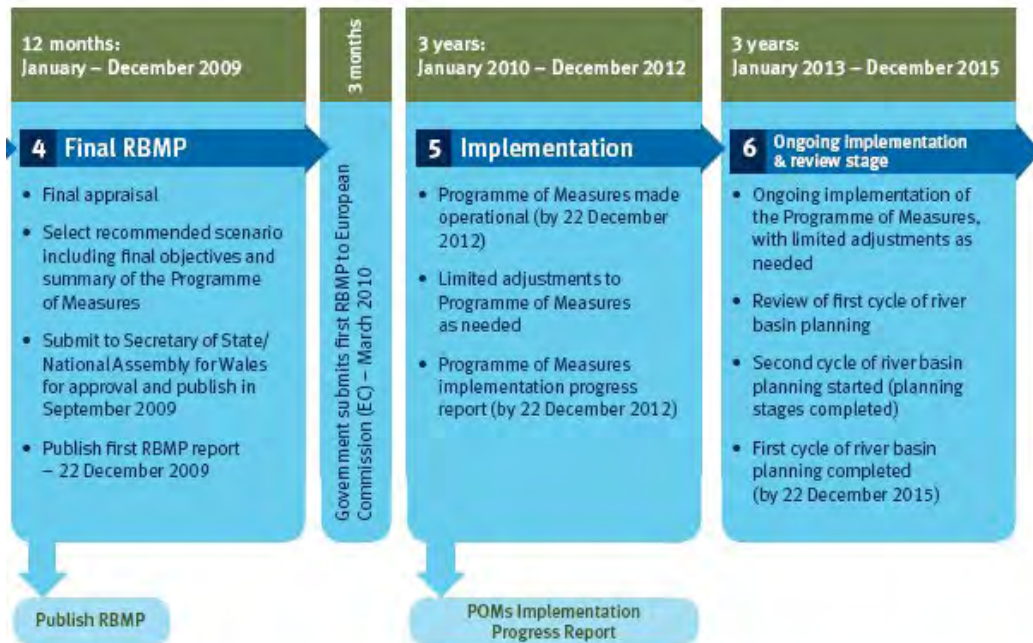


Source: A Framework for River Basin Planning – A Summary (Environment Agency February 2006)

A key interim document is the **Summary of Significant Water Management Issues** ⁴, which was distributed for consultation until 24 January 2008. Following this the next major milestone will be the publication of the Draft RBMP in December 2008. From January – August 2009 a final appraisal stage will lead to an approval by the Secretary of State in September 2009 and implementation of the plan for a six year period between 22 December 2009 – 22 December 2015.

Hence it is vital that Herefordshire Council represents its interests throughout the consultation phases and in particular during the final commenting phase on the Draft River Basin Management Plan in 2008.

Figure 1-3 - Overview timescales of RBMP Process to December 2015



Source: A Framework for River Basin Planning – A Summary (Environment Agency, February 2006)

1.5 Catchment Flood Management Plans

Catchment Flood Management Plans (CFMPs) are being developed by the Environment Agency throughout England and Wales for all principal river catchments. CFMPs are a planning tool through which the Agency 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. CFMPs are a learning process to support an integrated approach to land use planning and management.

Hence one of the key roles of a CFMP is to support the higher level objectives of the River Basin Management Plans under the Water Framework Directive.

CFMPs aim to better understand the complex causes of flooding and promote co-ordinated action on every front in partnership with others to reduce flood risk by:

- Understanding current and future flood risk
- Planning for the likely impacts of climate change
- Preventing inappropriate development in flood risk areas
- Delivering more sustainable measures to reduce flood risk

- Exploring the wider opportunities to reduce the sources of flood risk, including changes in land use and land management practices and the use of sustainable drainage systems.

It will be evident that there is a high degree of overlap between CFMPs and SFRA. Whilst the CFMP is at a higher strategic level than an SFRA, and may influence flood management policies downwards to the local level, equally, a CFMP should recognise the aspirations and Local Development Frameworks generated by the Local Planning Authority (LPA), as many local and strategic flood management options can only be implemented through the planning framework.

To this end the SFRA Consultants instigated close cooperation with the EA CFMP team in January 2008, to ensure a coordinated and consistent approach to flood management issues generally across the two documents. To emphasise the importance of coordination, the SFRA makes specific cross reference to the CFMP where appropriate throughout this document.

1.5.1 Policy Framework of CFMPs

CFMPs are high level policy documents and do not necessarily determine specific flood risk reduction measures or management approach for flooding issues in a catchment. Whilst it is not possible to understand in detail what will occur in 50 to 100 years time, general trends can be projected to test the sustainability of plans. The CFMP will be reviewed as appropriate to reflect changes in the catchment, although this is unlikely to be within 5 years of the CFMP being produced.

CFMP policies will be driven by the extent, nature and scale of current and future flood risk across the whole catchment, with the overall aim of reducing flood risk by meeting specific CFMP objectives.

The CFMP will show the broad areas where these decisions should be applied. These areas are known as 'policy units' and it is here that the Environment Agency will set policies to manage the level of flood risk. During policy appraisal there is an assessment of catchment objectives and possible future changes to address the level of flood risk. CFMPs utilise a standardised set of policy options, as shown in Figure 1-4.

Figure 1-4 – Standardised Policy Options for CFMPs

Table 1.1: Definition of policy options	
CFMP Policy Option	Risk management approach
1. No active intervention (including flood warning and maintenance). Continue to monitor and advise.	Accept existing and future risks and allow natural processes to evolve
2. Reduce existing flood risk management actions (accepting that flood risk will increase over time).	Accept existing and future increases in risk
3. Continue with existing or alternative actions to manage flood risk at the current level (accepting that flood risk is likely to increase over time from this baseline due to climate change).	Accept existing risk. Increasing risk in the future will be acceptable
4. Take further action to sustain current scale of flood risk into the future (responding to the potential increases in flood risk from urban development, land use change and climate change).	Reduce risks in the longer term as they increase from current level. Eliminate new risk
5. Take further action to reduce flood risk (now and/or in the future).	Reduce the risk now and in the longer term. Eliminate new risk.
6. Take action to increase the frequency of flooding to deliver benefits locally or elsewhere (which may constitute an overall flood risk reduction, e.g. for habitat inundation).	Transfer the risk.

1.5.2 The Wye and Usk Catchment Flood Management Plan

The Wye and Usk CFMP is being currently developed by EA Wales, as this region has primary responsibility for the majority of rivers within Herefordshire. The **Wye and Usk Catchment Flood Management Plan (Scoping Report)**⁵ was published in September 2007, for a 3 month consultation period. The CFMP will identify broad policies for sustainable flood risk management that make sense in the context of the whole catchment and for the long term (50 to 100 years).

The Wye and Usk CFMP area contains two major river systems, the Wye and the Usk, and their main tributaries; the Lugg, Frome, Trothy, Monnow, Lwyd, Ithon, Irfon and Arrow. There are also a number of smaller coastal rivers that drain into the Severn Estuary. The Wye and Usk catchment covers a large part of south east Wales and includes most of Herefordshire and parts of Gloucestershire.

The draft CFMP will be prepared during January to April 2008, followed by an important consultation period from April to July 2008. During this period it is essential that key issues identified in the SFRA are cross-referenced to the CFMP.

The future development proposals of Herefordshire Council, supported by appropriate policies with regard to sustainable drainage systems and strategic

flood management issues, should be consistent with and contribute to the overall policies suggested in the CFMP.

1.5.3 The Severn Catchment Flood Management Plan

The Severn Catchment Flood Management Plan (CFMP) consultation document was issued for consultation on Monday 26 May 2008. It gives an overview of the existing flood risk across the catchment and sets out how the Environment Agency would like to manage this risk over the next 50 to 100 years.

The Severn CFMP covers an area of approximately 11000 km². Major tributaries include the Rivers Vyrnwy, Roden, Tern, Teme, Leadon, Warwickshire Avon and Stour. The main urban areas of the catchment include Shrewsbury, Telford and the Black Country, Kidderminster, Worcester and Gloucester, all of which lie outside Herefordshire.

Major areas are at risk from river flooding, as seen from the widespread floods of Easter 1998, Autumn 2000, and Summer 2007. They include Shrewsbury, Worcester, Tewkesbury and Gloucester, as well as towns on tributary rivers such as Leamington Spa, Evesham and Kidderminster. In addition there are significant areas of agricultural land located in floodplain that are subject to flooding. The CFMP identifies the locations currently at risk and predicts how this might change in the future with scenarios such as climate change, urban development and changes in land use.

Some small areas of Herefordshire fall within the Severn River Basin to the north and east of the County. The principal river of this system within Herefordshire is the River Teme, and the main tributary of the River Leadon past Ledbury. Principal villages where there are reported flooding issues include Orleton and Brimfield on the Gosford Brook, and Bosbury on the River Leadon.

Flood management strategy in these areas will need to refer to this CFMP for guidance.

1.6 Role of Strategic Flood Risk Assessments

The primary aim of a Strategic Flood Risk Assessment is to determine whether planning policies or development land allocations will increase the risk of flooding, both within the development and the surrounding area, and to identify and promote measures that will minimise flood-risk and/or enhance flood resilience at all levels, particularly with regard to future development and existing critical infrastructure.

1.6.1 Local Development Documents

Local development documents (LDDs) provide a key planning tool for ensuring that flood risk is factored into the allocation of land types in accordance with regional policy but also taking account of local issues and concerns.

The Core Strategy LDD should include clear, strategic and robust policies for the management of flood risk, taking climate change into account.

LDDs should demonstrate that the land allocations meet the Sequential Test as set out in **Annex D: Planning Policy Guidance 25 – Development and Flood Risk**.

The SFRA should therefore provide the evidence base, maps, methodologies and tools to enable these objectives.

1.6.2 Future Development ‘Deliverables’ of an SFRA

Major delays and/or Refusal at Appeal for development sites often occur due to inappropriate development in flood risk zones. Sustainable and effective planning policy under PPS25 suggests that wherever possible development is steered away from flood risk areas, but where this is not possible, that development is appropriate and the consequences minimised.

Pre-emptive recognition of such situations within the Local Development Framework is likely to greatly reduce the level of objection from the Environment Agency and speed the planning process.

The Environment Agency will usually object to planning applications on the following grounds:

- (i) the proposed development is not consistent with Government Planning Policy
- (ii) lack of evidence that the sequential test and (where needed) the exception test have been applied correctly
- (iii) a planning application is not supported by a flood risk assessment
- (iv) the flood risk assessment does not demonstrate that the development and its occupants/users will be safe for the lifetime of the development, does not increase flood risk elsewhere and does not seek to reduce risk overall
- (v) The LPA is the final decision-maker, but if it grants permission for a major development against the EA it has to notify the Secretary of State. This 'Call-in' direction should encourage LPA's to follow Agency advice.

The essential aim of the SFRA is to determine whether development policies and land allocations are likely to increase the risk of flooding. Consequently, a satisfactory SFRA (both from the standpoint of the LPA and the EA) should provide sufficient data and sequential test information for all proposed development sites to enable the LPA to make informed and substantiated decisions about appropriate allocation of land that are in accordance with Government Planning Policy, meeting the criteria of PPS 25 in particular, and to be able to demonstrate these in a transparent way to the Environment Agency.

1.6.3 Flood Resilience ‘Deliverables’ of an SFRA

Resilience, (the ability to resist and recover from damage) at its broadest scope might be taken to include flood management measures at every scale, from the catchment scale incorporating widespread policies affecting catchment drainage and runoff, down to the micro-level of how individual properties should be wired and flood proofed.

A particularly crucial aspect of dealing with and recovering from major floods is that of anticipating what impacts floods may have. Knowing what to expect means that impacts can be planned for and mitigated against. Resilience can be promoted at three levels:

- The regional scale, especially with regard to critical infrastructure protection (electricity supplies, telecoms, water supply)
- The local scale, where sites incorporate good drainage and flood protection design (elevated floor levels, flood pathways)
- The building scale, where individual buildings adopt best practice in terms of flood resilience (flood barriers, waterproof materials, elevated wiring)

Level 1 and Level 2 SFRAs as defined in the [Practice Guide Companion to PPS25](#)⁶ do not explicitly cite the need for investigations into critical infrastructure or building scale resilience.

The consultants are of the view that a thorough SFRA at any level should take account of wider strategic issues of critical infrastructure, flood warning, drainage policy and building resilience. It will never be possible to locate every new development out of the floodplain, nor is this economically viable in many cases. Hence, other measures in addition to the ‘avoidance’ principle are of relevance in the overall armoury of strategic flood protection measures.

Some earlier SFRAs that we have reviewed have done little more than reproduce the Environment Agency Flood Zone Maps with little further insight into how existing property might be protected by strategic measures, or how future development might contribute to enhanced flood management practices.

Consequently, the Herefordshire SFRA is wider in scope and more detailed in application than many other sub-regional SFRAs. In particular, we consider that incorporating truly strategic issues into the sequential test for individual developments is likely to lead to a more coherent, robust and integrated overall strategy.

Overall, flood resilience at a particular site will be a varying combination of:

- Avoidance, where possible (location outside the floodplain)
- Regional critical infrastructure planning and contingency arrangements
- Sub-catchment scale runoff and flood minimisation policy
- Strategic solutions to flood risk (reservoirs, storage and flood defences)
- Adequate flood warning and rapid evacuation measures
- On site flood & drainage management

- Individual building resilience

1.7 The Pitt Review – December 2007

Our more integrative approach was borne out by the interim conclusions of the **Pitt Review – Learning Lessons from the 2007 Floods**⁷. Although the Final Report is not due until summer 2008, there are many far-reaching interim conclusions with regard to Local Planning Authority engagement in flood resilience and flood management issues which should be addressed in a forward thinking Strategic Flood Risk Assessment.

The Report sets out proposals for ensuring that advice and warnings from various agencies are better coordinated, that councils play their full part in reassuring the public and that people are made fully aware of any flood risk when they buy or rent property. It also makes clear that individuals and communities must share responsibility for actions to deal with flooding.

The Review recommends that the Environment Agency should take strategic direction of managing inland flood risks, **while local authorities should adopt a new leadership and scrutiny role overseeing flood risk management within their local area.**

The Review makes recommendations on sharing information, building greater standards of protection and the closer involvement in preparedness planning of essential service providers, such as the water and power companies.

Amongst many other interim conclusions, the Pitt Review identified that:

“there is a clear need to extend the models for river and coastal flooding, drawing on data from the summer’s floods, to analyse different extreme scenarios (including multiple flooding events occurring simultaneously or within overlapping time periods) and to capture the impact of saturated ground on flooding risk”.

“The scale of the surface water flooding problem faced in summer 2007 and the growing likelihood of similar flooding in the future means there is a clear need for action”.

“Rapid progress must be made over the next few years to ensure that flood risk planning and management, including public warnings and emergency response, is underpinned by an improved understanding of when and where flooding will occur”.

Figure 1-5 – Pitt Review on National News

▶ LIVE BBC News 24

Your news when you want it 

Last Updated: Monday, 17 December 2007, 10:47 GMT

[✉ E-mail this to a friend](#) [🖨️ Printable version](#)

'Urgent action' needed on floods

Planning for flooding should have the same priority as terrorism or flu prevention, the independent reviewer into the summer floods says.

Sir Michael Pitt also said the public should have been better prepared for the severe floods which damaged thousands of homes in England.

The interim report urged local government and emergency services to improve their knowledge and practices.

The government has said it agrees with the report's 15 key recommendations.

A further 72 recommendations Sir Michael made are being studied in detail by the Department for Environment, Food and Rural Affairs.

Sir Michael called on the government to take a "broad, strategic role" in ensuring the review's recommendations were introduced, but also to address how it plans for flooding - which is "now such a major issue".

"We're trying to raise the priority of flooding, putting it on a level that is somewhat similar to terrorism or pandemic flu."

VIDEO AND AUDIO NEWS

How victims of the floods are still living in caravans

▶ Watch

SUMMER FLOODS

LATEST NEWS

- ▶ UK 'ill-prepared' against floods
- ▶ 'Urgent action' needed on floods
- ▶ Flood funding 'too inconsistent'
- ▶ UK set to receive EU flood money
- ▶ Concern over early warnings

FEATURES

- ▶ Keeping their heads above water
- ▶ Devastating legacy of floods
- ▶ Victims worry about insurance

IN PICTURES

- ▶ Your pictures: Summer floods
- ▶ London's drowning
- ▶ Floods one week on

BACKGROUND AND ANALYSIS

- ▶ Q&A: Review into summer floods
- ▶ The 'bereavement' of the floods
- ▶ Soggy summer in stats
- ▶ Q&A: Your insurance questions
- ▶ Where has all the water gone?

HAVE YOUR SAY

- ▶ Are better warnings needed?



Parts of the country were left under water in the floods

▶ Watch [Report author](#)

Source: BBC News, 17 December 2007

1.8 Environment Agency Review of 2007 Summer Floods

The Environment Agency conducted its own review into key lessons from the 2007 flooding ([Review of 2007 Summer Floods](#)⁸). It produced a wide ranging set of conclusions and recommendations including the need for enhanced and more effective flood warning procedures.

Of particular relevance to the Herefordshire SFRA, the Agency concluded that

“the extreme flooding in the summer showed just how poorly protected much of our vital public infrastructure, such as roads and railways, utilities, police and fire service premises, health care facilities and others is. It was clear that water and electricity supplies were particularly vulnerable”.

“This questions just how effective the Civil Contingencies Act is in getting Category 2 responders (such as the utilities) to plan for and respond to flood incidents. Mandatory minimum standards to provide a base level of flood protection for critical infrastructure might need to be considered alongside regulatory incentives for critical infrastructure operators”.

“The resilience of public infrastructure (electricity, water and sewerage), including the location of control centres and telephone exchanges, should be reviewed and, where practicable, made more resistant to flooding. The summer floods have highlighted that more needs to be done about this issue”.

“Floodplain development was one of the main concerns people raised at our flood surgeries. The Government’s planning policy on development in flood risk areas, PPS25, was updated in January 2007. It is essential that policy on development in the floodplain, PPS25 in England and TAN15 in Wales, is firmly applied. Where development does go ahead in areas of flood risk the developers must be responsible for achieving adequate flood risk management”

“The Government should put measures in place to make sure that key utilities and public services take responsibility for protecting their assets and facilities appropriately. We propose that all public authorities and all private sector utilities that provide essential public services should have a duty under the forthcoming Climate Change Bill, in line with those for Category 1 and 2 responders under the Civil Contingencies Act, to take account of future climate change impacts when providing their services”.

“People need to be more aware of the risks of flooding and better prepared to protect themselves and their properties. We should promote more people signing up to our flood warning service, protecting their properties more by using door guards and air brick covers and other measures to protect them from the effects of flooding, and increasing the number of homes being built or restored to withstand flooding”

“Under PPS25 (and TAN15 in Wales), Strategic Flood Risk Assessments (SFRAs) are required for all areas. They are currently variable in quality, often not providing a good assessment of the risk from surface water and other forms of flooding. This is principally due to use of inappropriate methodology and lack of suitable data and information on some forms of flooding – either because it does not exist or it has not been provided by others, such as water utility companies”.

1.9 The Structure and Use of this SFRA

1.9.1 The Study Area

This SFRA covers the County of Herefordshire. River basins and catchments however do not follow administrative boundaries, and the Herefordshire SFRA must take account of the hydrological and flood influences and impacts that lie outside its authority boundary. The Herefordshire situation is somewhat complex because the hydrological boundaries of the required study area extend across the Welsh border to the west and the Gloucestershire and Worcestershire borders to the east and north. Two Environment Agency Regions (Wales and Midlands West Area) have regulatory powers within the County boundary, essentially defined by the boundary of the Wye and Teme river basins.

Whilst the headwaters of the River Wye catchment in mid-Wales have been accounted for in the basic hydrological analysis, detailed analysis for the Herefordshire Wye SFRA has been confined to those sub-catchments that lie downstream of Gauging Station 55007 (Wye @ Erwood). The River Wye and the tributaries of the Monnow, Lugg, Arrow and Frome form the core study area. Parts of the River Teme and upper Leadon in the adjacent River Severn River Basin are also included in the Strategic Flood Risk Assessment.

Evidence Map 1-1 illustrates the extent of the actively studied area, in conjunction with various other administrative boundaries.

1.9.2 The Geographic Information System Evidence Base

A very substantial part of the work effort of the SFRA has been to develop ongoing databases and GIS layers for use by Herefordshire Council planners and its agents. These databases are ‘behind the scenes’, but form the principal part of the evidence base. The SFRA Technical Report (this document) essentially describes how and why these data layers have been prepared, and summarises the key policy and strategic issues that arise from their interpretation.

Greatest value is obtained from the GIS evidence base by using it primarily on the appropriate platform (in this case the Council’s MapInfo™ GIS software). A number of key GIS data layers have been formally developed and submitted to the Council as part of the evidence base. These will be summarised in the relevant sections.

It is anticipated that wherever appropriate, the relevant GIS layers and/or databases can be released to third parties, in particular the Environment Agency, Consultants and Developers to facilitate Detailed Flood Risk Assessments within the strategic guidance of the Strategic Flood Risk Assessment.

For illustrative purposes only, A3 sized versions of relevant 'Evidence Maps' are provided at the end of each section to aid understanding of the written text. An identical but larger, smaller scale map is provided at A2 size in the Technical Appendices which provide more clarity and detail of the output.

For third party privacy and security reasons, site specific details such as address, postcode or other identification are generally not labelled on these maps, although such data IS contained within the electronic databases or GIS layers for access by authorised personnel.

1.9.3 The Supportive Text Evidence Base

The SFRA Technical Report is structured into 10 key sections. Each section, whilst contributing to the overall objectives, acts as a stand-alone input to support future Local Development Documents.

Each section of the SFRA Technical Report document addresses a key issue with regard to flood risk and management. The existing **data or evidence base** is presented and reviewed first (often this has had to be compiled from extensive collection of raw data), and this is followed by a **strategic appraisal** of the main issues pertinent to that section. Any interactions with the **Catchment Flood Management Plan** are addressed in the next stage. A series of factually based **Evidence Based Statements** summarise the key issues that should be taken account of in the Local Development Framework. Where specific aspects of policy or guidance need further refinement or investigation, these are highlighted in the **Evidence Based Recommendations**. Finally, the references cited or **directly relevant additional resources** used are summarised. These resources are invariably available over the internet, and hence where possible [http://](#) links have been provided, which thus become directly linked to this document.

1.10 Interactions with EA Catchment Flood Management Plan

The detailed outputs and policy implications of the SFRA should extensive consideration by the EA before it finalises its CFMP, so as to avoid future policy conflicts or inconsistencies.

The EA proposes to issue the Draft Wye Usk CFMP in April 2008 for a 3 month consultation period. The Severn River Basin Management Plan will be issued for consultation in December 2008. It is strongly recommended that the EA take full account of the detailed evidence base, issues raised, strategy proposals and recommendations raised in this document, as this assessment is

an altogether more detailed and comprehensive insight into flood risk management within Herefordshire. The SFRA study has examined detailed hydrology and flood risk for a study area of some 2585 km², this representing 75% of the entire River Wye basin. Hence, strategic flood risk management proposals of this SFRA will be a significant component of any future Catchment Flood Management Plan.

1.11 Evidence Based Statements

- 1) Flood risk within the County has been identified by the Council as a significant issue potentially affecting future housing development and employment opportunity. It is a requirement of Planning Policy Statement (PPS) 25 that Local Planning Authorities (LPAs) should undertake Strategic Flood Risk Assessments (SFRAs) to inform sound planning policies at all levels of planning.
- 2) The Regional FRA concludes that *“the Wye and its tributaries do not present a major source of flood risk within the region”*. This SFRA however concludes, based on comprehensive surveys of historical flooding, that flood probabilities within Herefordshire are in fact relatively high, due to undulating topography and reduced impermeability soils. Flood consequences are perhaps relatively lower than in some other areas of the West Midlands, but the towns of Hereford, Ross-on-Wye, Leominster and Ledbury have all encountered serious flooding on a local scale within the last 10 years.
- 3) The Severn Trent River Basin Management Plan and the Wye Usk Catchment Flood Management are highly relevant concurrent strategic planning frameworks. The Herefordshire SFRA should both take account of these frameworks, and contribute to their development. The Severn Trent RBMP will be published in draft from in December 2008, and will have a 6 month consultation period. The Wye Usk CFMP will be published in draft form in April 2008 for a 6 month consultation period.
- 4) The primary aim of this Strategic Flood Risk Assessment is to determine whether planning policies or land allocations will increase the risk of flooding, both within the development and the surrounding area, and to identify and promote measures that enhance flood resilience at all levels, particularly with regard to future development and existing critical infrastructure.
- 5) The Pitt Review (Interim Report) sets out proposals for ensuring that advice and warnings from various agencies are better coordinated, that councils play their full part in reassuring the public and that people are made fully aware of any flood risk when they buy or rent property. It also makes clear that individuals and communities must share responsibility for actions to deal with flooding. The Review recommends that the Environment Agency should take strategic direction of managing inland flood risks, while local authorities should adopt a new leadership and scrutiny role overseeing flood

risk management within their local area.

- 6) The Pitt Review (Interim Report) concludes that the scale of the surface water flooding problem faced in summer 2007 and the growing likelihood of similar flooding in the future means there is a clear need for action. Rapid progress must be made over the next few years to ensure that flood risk planning and management, including public warnings and emergency response, is underpinned by an improved understanding of when and where flooding will occur.
- 7) The Environment Agency Review of the 2007 Summer Floods concludes that people need to be more aware of the risks of flooding and better prepared to protect themselves and their properties. More people should be actively encouraged to sign up to the flood warning service, protecting their properties more by using door guards and air brick covers and other measures to protect them from the effects of flooding, and increasing the number of homes being built or restored to withstand flooding.
- 8) The Environment Agency Review of the 2007 Summer Floods concludes that the Government should put measures in place to make sure that key utilities and public services take responsibility for protecting their assets and facilities appropriately. All public authorities and all private sector utilities that provide essential public services should have a duty under the forthcoming Climate Change Bill, in line with those for Category 1 and 2 responders under the Civil Contingencies Act, to take account of future climate change impacts when providing their services.

1.12 Evidence Based Recommendations

- 1) The provisional conclusions and recommendations raised in the Pitt Review should be scrutinised by Herefordshire Council with respect to improving the robustness of its own planning decisions, particularly with regard to future development in the floodplain, drainage control, and resilience of critical infrastructure.
- 2) The provisional conclusions and recommendations raised in the Environment Agency 2007 Summer Floods Review should be scrutinised by Herefordshire Council with respect to improving the robustness of its own planning decisions, particularly with regard to future development in the floodplain, drainage control, and resilience of critical infrastructure.
- 3) Herefordshire Council should engage more proactively in the consultation procedures for the Severn RBMP and the Wye Usk CFMP. To date very little response by Herefordshire Council has been reported by the catchment plan managers for these various projects.
- 4) The SFRA should take account of wider issues beyond a simple appraisal of future development impacts within the flood zones. In addition to providing evidence to support the Sequential Test of PPS25, evidence and analysis should be provided that support policies intended to strengthen

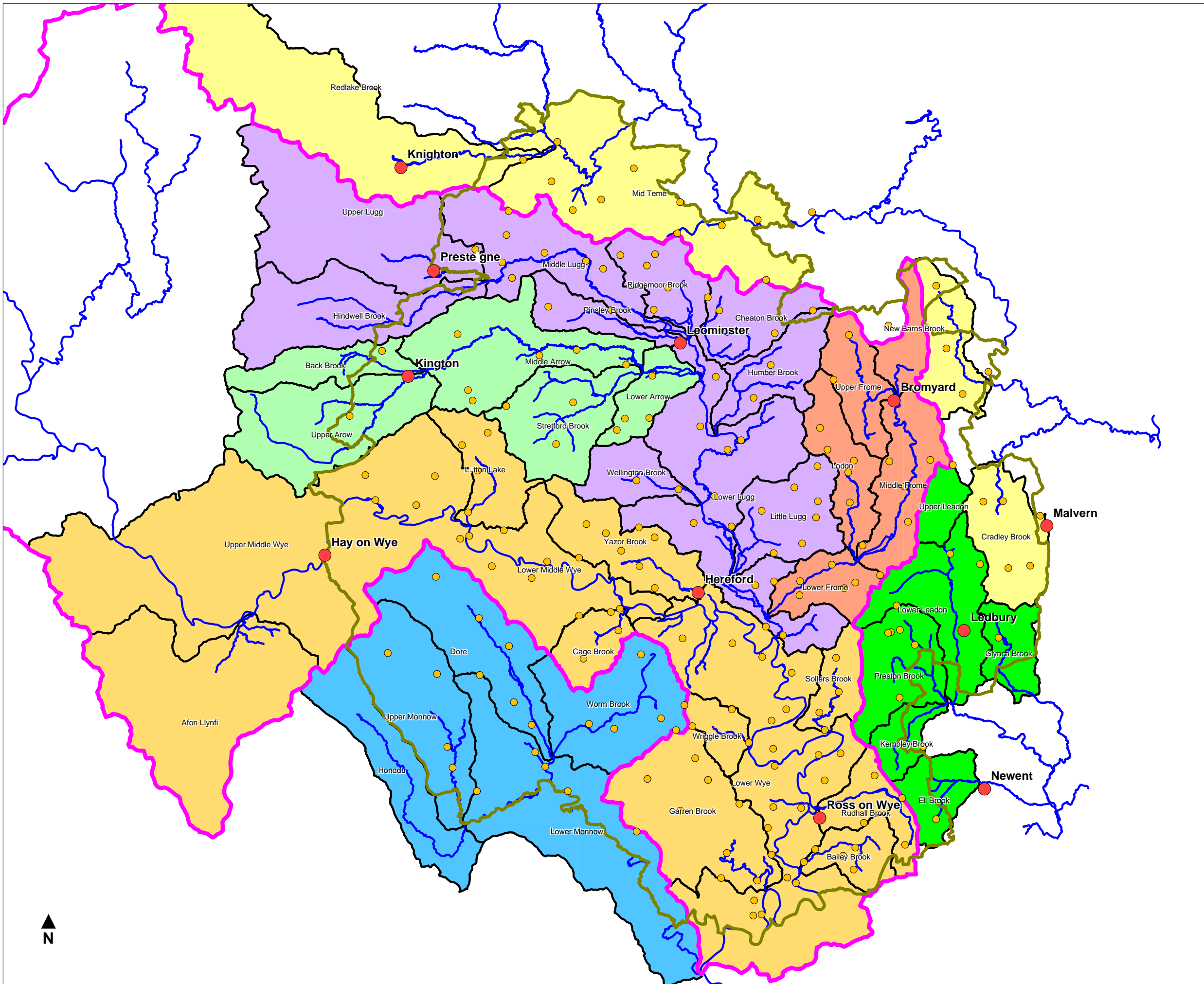
flood resilience at all scales, from sub-catchment strategic level, through site drainage practice down to individual building resilience.

1.13 References and Additional Resources

The following published or web-based documentation has been referred to in this section, and may provide useful further reference material for the Local Development Framework.

1. **Planning Policy Statement 25 (PPS25): Development and Flood Risk** (DCLG, December 2006)
<http://www.communities.gov.uk/publications/planningandbuilding/pps25floodrisk>
2. **West Midlands Regional Flood Risk Appraisal – Final Report**, (West Midlands Regional Assembly, October 2007).
3. **Water Framework Directive, 2000/60/EC**
<http://www.environment-agency.gov.uk/wfd>
4. **River Basin Planning: summary of significant water management issues, Severn River Basin District** (Environment Agency, July 2007)
5. **Wye and Usk Catchment Flood Management Plan (Scoping Report)** (Environment Agency, September 2007).
6. **Development and Flood Risk: A Practice Guide Companion to PPS25 'Living Draft' - A Consultation Paper**, (DCLG, February 2007)
<http://www.communities.gov.uk/publications/planningandbuilding/developmentflood>
7. **The Pitt Review – Learning Lessons from the 2007 Floods – Interim Report** (Cabinet Office, December 2007).
http://www.cabinetoffice.gov.uk/upload/assets/www.cabinetoffice.gov.uk/flooding_review/flood_report_web.pdf
8. **Review of 2007 Summer Floods** (Environment Agency, December 2007)
<http://www.environment-agency.gov.uk/subjects/flood/1867303/>

Evidence Map 1-1 – River Wye Catchment and Extent of SFRA Study Area



Key

	Herefordshire
	Wye River Basin
	Principal Rivers
	Main Town
	Wye River Catchment
	Lugg River Catchment
	Arrow River Catchment
	Frome River Catchment
	Leadon River Catchment
	Monnow River Catchment
	Teme River Catchment

Client
Herefordshire Council

Scheme
Strategic Flood Risk Assessment

Drawing

Title SFRA Study Area

Subset Catchment Colour Code

No. EB/1-1/a

Date 24-1-2008

Approved:BF

Revisions

Scale : 1:NTS

Evidence Map 1-1



2. FLOOD HYDROLOGY AND FLOOD HISTORY

2.1 Essentials of Flood Hydrology

2.1.1 Sub-catchments

Many CFMPs and SFRAs ignore the fundamental principle that floods do not originate from rivers. Rivers represent only a pathway in the conventional Source – Pathway – Receptor approach to risk analysis. Flooding arises from excessive runoff within catchments, the runoff speed, quantity and peak being determined from basic catchment characteristics. Hence, a true understanding of flood risk assessment must consider catchments as the fundamental ‘management unit’, not rivers. The more detailed the catchment and sub-catchment breakdown, the more refined and flexible will be the eventual overall strategic assessment.

This kind of approach is a new and innovative one amongst SFRAs, but is likely to result in a better long-term approach to true strategic management of flooding.

This SFRA has identified 47 separate sub-catchments within the study area, and the catchment characteristics or ‘descriptors’ as defined by FEH are presented in Technical Appendix A. Hydrological appraisal of these 47 separate catchments with regard to flood risk potential has been one of the core areas of the Strategic Flood Risk Assessment.

The database and GIS layer **HSFRA All Catchments** is one of the primary evidence bases of the SFRA. As well as delineating the boundaries, this layer incorporates important data fields such as the Fluvial Current Flood Risk Index, Catchment Flood Hazard Potential Index, and the Flood Timing Index, which form essential components of the Sequential Test. All are described under Chapter 3.

See [Evidence Map 2-1 Topography and Catchments](#)

2.1.2 General Topography

The source of the Wye is in the Cambrian Mountains where the river channels are characterised by steep gradients, which cause rainfall to run rapidly over land. The middle reaches of the Wye are characterised by a large lowland floodplain. Surface run-off is slower than in the upper reaches. A feature of the middle Wye between Builth Wells and Hereford is the Letton Lakes topographic depression, which acts as a natural, unmanaged area of flood storage. In the lower reaches towards Ross-on-Wye, the river flows through the wide steep sided Wye Valley before flowing from Chepstow out to the Severn Estuary.

The principal tributaries of the Wye are the Monnow, Lugg, Arrow and Frome. The Herefordshire administrative boundary also extends north and east to cover sub-catchments and tributaries of the River Teme and River Leadon which are both tributaries of the River Severn, and the River Monnow. The Lugg and Arrow rise in steeper upland areas, before passing to the broader shallow floodplain of the Lugg between Leominster and Hampton Bishop.

The SFRA study area (from Builth Wells to Ross-on-Wye) is 2585 km². Of this the County of Herefordshire comprises 2173 km² or 84%.

See [Evidence Map 2-1 Topography and Catchments](#)

2.1.3 Geology, Soils and Precipitation

Precipitation, topography and soil type (derived from underlying geology) are the three predominant influences on flood hydrology. An understanding of the interactions of these basic physical drivers of flooding is essential in managing flood risk from 'first principles'. Many SFRA and CFMPs neglect to analyse the simple principal mechanisms of runoff generation. An appreciation of elementary catchment 'hydrodynamics' can provide many robust strategic level solutions to flood risk.

The Old Red Sandstone geology which predominates over most of Herefordshire has low permeability, allowing limited drainage. However, there are significant local variations influenced by a range of soil types. The gravel aquifers around Hereford may provide a sub-surface route for flood waters. Moving southwards along the Wye from Hereford, the soils become increasingly permeable due to the influence of sandstone or limestone geology. The limestone geology in particular allows water to drain through the rocks, reducing surface run-off and the catchment's response to rainfall.

Soils in the Middle and Lower Wye are dominated by deep, well-drained and fertile Brown Soils, with scatterings of Surface Water Gleys and Groundwater Gleys. Brown soils occur in different forms from slowly permeable soils to less permeable loams and clayey soils. The sub-surface layers are highly valued for agricultural purposes. However the low permeability of the underlying geology means that in times of heavy rainfall the soil will become saturated quickly. The reduced capacity of the soil will lead to increased surface run-off and a reduction in catchment response to rainfall. Pockets of shallow free draining soils are concentrated in the east of the catchment overlying the Limestone geology of the Forest of Dean.

Higher precipitation naturally tends to produce higher quantities of runoff. Equally important, high precipitation catchments tend to have wetter antecedent conditions, which means they tend to have less available storage and runoff responds more rapidly and more frequently. Across the Herefordshire SFRA area precipitation is highest in the north-western and south-western areas (Red Brook above Knighton, 996 mm/a), (Honddu above Monmouth, 1206 mm/a). There is a rapid decline in rainfall gradients across Herefordshire moving west to east, such that in the Upper Frome above Bromyard, annual precipitation is 727 mm/a, and in the Leadon above Ledbury, it is only 694 mm/a.

Steeper or less permeable catchments will tend to have proportionately higher peaks and more rapid response than shallower well drained catchments. Steep catchments that are also less permeable are particularly flood prone, and have the added disadvantage that the time of the flood peak will be relatively rapid.

These characteristics influence the timing and magnitude of fluvial flooding, but also play a significant part in general surface flooding.

2.1.4 Percentage Runoff

Standard Percentage Runoff (SPR) is one of the critical catchment parameters in flood generation. SPR has been used by UK hydrologists since the Flood Studies Report inception of 1975. The Flood Studies Report (FSR, NERC 1975) was accepted as the national standard for flood risk estimation until it was superseded in 1999 by the Flood Estimation Handbook (FEH), which developed further many of the ideas and principles in the FSR (NERC, 1999).

Catchments with low SPR values will as a general rule generate low response to rainfall. This is because they are more permeable, and a significant proportion of precipitation tends to infiltrate to deeper ground, until these zones reach field saturation point.

Hence an appreciation of the distribution of SPR within an SFRA area is vital in the development control process for two reasons:

- Volumes of flood runoff are directly related to the SPR value of an individual catchment (less the antecedent soil storage value). This may be of significance when allowing for climate change effects or planning catchment scale flood storage or attenuation works, or simply within the Sequential Test whereby new development would by preference be sited in lower SPR areas, subject to groundwater issues.
- SPR is a useful general indicator of where source control techniques (such as permeable landscaping, soakaways and swales) may be appropriate. Source control is regarded as a key principle in supporting concepts of sustainable management and integrated pollution control for diffuse non-point stormwater runoff, with infiltration procedures being a prime component of such source-control systems. The potential conflicts between the benefits of groundwater recharge and the risks to long-term groundwater quality are an issue however.

Evidence Map 2-2 (Standard Percentage Runoff by Sub-catchment) summarises the Flood Estimation Handbook (FEH) generated values of SPR for the 47 different sub-catchments. These range from 13% in the Bailey Brook south of Ross-on-Wye, to 40% in the Lodon and Middle Frome catchments.

For this SFRA we have evolved the following 5 classes of SPR with regard to how on-site drainage might be managed:

- SPR 10 – 20% - Potentially highly suitable for infiltration source control
- SPR 20 – 25% - Potentially moderately suitable for infiltration source control
- SPR 25 – 30% - Potentially neutral for infiltration source control (site specific)

SPR 30 – 35% - Potentially moderately unsuitable for infiltration source control
 SPR 35 – 40% - Potentially highly unsuitable for infiltration source control

Table 2-1 summarises the proportion of the 47 sub-catchments falling within each class.

Table 2-1 – Classification of Sub-catchments by SPR

SPR Class	Named Sub-catchments	Total area Km ²	%
35 – 40%	Upper Arrow, Middle Wye, Letton Lake, Stretford Brook, Wellington Brook, Yazor Brook, Cheaton Brook, Humber Brook, Sapley Brook, Bromyard Brook, Upper Frome, Middle Frome, Lodon, Little Lugg, Upper Leadon, Lower Leadon, Preston Brook, Kempley Brook, Cage Brook, Worm Brook, Lower Monnow	1417	44.7
30 – 35%	Lynfi, Upper Monnow, Redlake Brook, Upper Lugg, Hindwell Brook, Back Brook, Middle Arrow, Ridgemoor Brook, Pinsley Brook, Lower Arrow, Lower Lugg, Lower Frome, Cradley Brook, Glynch Brook, Ell Brook	1057	33.4
25 – 30%	Sollers Brook	22.5	0.7
20 – 25%	Honddu, Lower Wye, Middle Lugg, Teme	509.7	16.1
10 – 20%	Garren Brook, Bailey Brook, Rudhall Brook, Wriggle Brook	162.1	5.1

Therefore 78% of the SFRA area has a soil type potentially highly or moderately unsuitable for source control techniques. Obviously there will be site specific exceptions in every case, but with regard to overall strategy, the suitability of infiltration source control measures as opposed to surface water storage for new development is a key policy issue.

Evidence Map 2-2 should be taken account of in Local Development Documents when considering the appropriate forms of on-site and local drainage control strategy. Site specific investigations will be needed to confirm site suitability for source control techniques. These issues are dealt with more fully in Chapter 7 – Sustainable Sites and Buildings.

See [Evidence Map 2-2 – Standard Percentage Runoff by Sub-catchment](#)

2.1.5 Unit Hydrograph Time to Peak (Tp)

The second key characteristic in flood generation is the Unit Hydrograph Time to Peak parameter. Widely used and understood in international hydrology, the Unit Hydrograph is a hypothetical unit response of the watershed to a unit input of rainfall, commonly 10mm.

A unit hydrograph is used to more easily represent the effect rainfall has on a particular basin. This allows easy calculation of the response to any arbitrary precipitation input, by simply performing a convolution (successive multiplication) between successive time-blocks of rainfall and the cumulative unit hydrograph output.

The actual (observed) hydrograph of a flood event will vary in duration and magnitude depending on the rainfall event that caused it. However, the underlying Unit Hydrograph that contributes to the total hydrograph has fixed attributes, in particular the Time to Peak (Tp) and the time base D. These are a function of the physical characteristics of the catchment, and therefore do not readily change in the short term.

Tp is critically important in Strategic Flood Risk Assessments because this parameter more than any other determines how quickly the catchment responds to a rainfall event. Because Tp can be calculated for any sub-catchment and compared to others within the river basin on a 'like for like' basis, useful strategic decisions can be made about where to place attenuation facilities for example, or promote increased positive drainage rates, depending on the relative spatial arrangement of Tp's across a river basin.

Catchments with short UH Tp's will tend to have rapid response times AND disproportionately higher flood peaks than a catchment of the same area and percentage runoff but a longer Tp value. Short Tp catchments obviously are more problematic in terms of flood warning, which is a highly relevant issue for new development and critical infrastructure.

Short Tp catchments are more susceptible to flash-flooding. At the extreme, small urbanised catchments will have a Tp value measured in minutes, as opposed to 36 hours for the River Wye at Hereford for example.

A detailed hydrological appraisal of the 47 sub-catchments (as summarised in Technical Appendix A-1) has generated Evidence Map 2-3, which categorises each sub-catchment into one of the following classes:

UH Tp < 5 hours	= Very rapid response catchment
UH Tp 6 – 7 hours	= Moderately rapid response catchment
UH Tp 7 – 9 hours	= Average response time
UH Tp 9 – 11 hours	= Moderately slow response catchment
UH Tp > 11 hours	= Very slow response catchment

See [Evidence Map 2-3 – Sub-catchments and comparative Flood Response Time](#)

Table 2-2 – Classification of sub-catchments by UH Tp

UH Tp Class	Named Sub-catchments	Total area Km ²	%
< 5 hours Very rapid	Back Brook, Upper Monnow, Honddu, Wriggle Brook	191.5	6.7%
5 – 7 hours Moderately rapid	Redlake Brook, Upper Lugg, Hindwell Brook, Upper Arrow, Sapley Brook, Llynfi, Letton Lake, Little Lugg, Wellington Brook, Upper Leadon, Dore, Cradley Brook, Glynch Brook, Sollers Brook, Kempley Brook, Ell Brook, Rudhall Brook, Bailey Brook	1035	36%
7 – 9 hours (Average)	Ridgemoor Brook, Cheaton Brook, Humber Brook, Upper Frome, Bromyard Brook, Lodon, Yazor Brook, Preston Brook, Cage Brook, Worm Brook	241.9	8.4%
9 – 11 hours Moderately Slow	Middle Lugg, Middle Arrow, Pinsley Brook, Stretford Brook, Lower Arrow, Middle Frome, Lower Leadon, Garren Brook	470.5	16.4
> 11 hours Very slow	Middle Wye, Lower Lugg, Lower Frome, Lower Monnow	927.6	32%

2.2 Notable Documented Floods

2.2.1 Notable Floods on the River Wye

Flood effects of the River Wye are most obviously noted at Hereford and Ross-on-Wye. Flood records derive from two key gauges on the Wye, namely the Environment Agency Gauging Station at Belmont, Hereford (55002), and the Environment Agency Gauging Station at Redbrook, Ross-on-Wye (55023).

Table 2-3 – Ranked Notable Floods on the River Wye at Hereford

River	Date	Peak Flow m ³ /s	Assigned Probability	Comments
Wye at Hereford	04-Dec-1960	958	0.25% (1 in 400)	
	xx-Feb-1795	900	0.40% (1 in 250)	
	28-Oct-1998	706	2.50% (1 in 40)	
	28-Dec-1979	663	4.00% (1 in 25)	
	31-Oct-2000	661	4.35% (1 in 23)	
	02-Feb-2002	661	4.35% (1 in 23)	
	07-Mar-1998	625	5.55% (1 in 18)	
	05-Feb-2004	623	6.66% (1 in 15)	

To date the 4th December 1960 flood remains the largest on record. It should be noted that statistical analysis of this flood based on the Flood Estimation Handbook procedures suggests that this flood approached a 0.25% Annual Equivalent Probability (AEP). In practice, there being two such events from 213 years of record suggests a return period (RP) perhaps closer to 1 in 200.

The 1998 event, which caused widespread damage and disruption in Hereford, is noted to have an AEP of only 2.50%, or 1 in 40 RP. In statistical terms it was not a particularly extreme flood.

2.2.2 Notable Floods on Wye Tributaries

For completeness, significant floods that caused notable damage and disruption on the principal tributaries of the Wye or the River Teme are listed in Table 2-4.

Table 2-4 – Notable Floods on Wye Tributaries

River	Date	Peak Flow m ³ /s	Assigned Probability	Comments
Temе at Tenbury	03-Dec-1960	240	5% (1 in 20)	Regional flooding
Lugg at Byton	28-Oct-1998	87	<1% (>1/100)	
Lugg at Leominster	21-Jul-2007	77	5% (1 in 20)	Leominster flooded
Arrow at Titley Mill	10-Jan-1986	58	3% (1 in 30)	Eardisland flooded
Temе at Knightsford	28-Dec-1979	247	10% (1 in 10)	Orleton, Eardisley
Wye, Ross-on-Wye	08-Dec-2000	?		Ross-on-Wye flooded

2.3 Catchment Flood Frequency Analysis

2.3.1 Environment Agency River Monitoring Stations

The Environment Agency operates a number of River Monitoring Stations (RMSs) on the River Temе and Wye systems. Stations that are used to evaluate river discharge are listed in Table 2-5, and are also shown in [Evidence Map 5-2](#).

The RMSs have two key functions:

- Monitoring of water level to calculate discharge
- Monitoring of water level to provide flood warning

For completeness, and use by subsequent Agencies and Consultants, an approximate assessment has been carried out of the Flood Growth Curve (FGC) for each Station. This analysis uses the recommended standard method of the Statistical Method based on Pooling Groups. For comparison, the estimate of peak discharge derived from the method of Catchment Descriptors is also shown, and Table 2-5 shows that Stations require an adjustment of between 1.4 and 2.0 x Descriptor Estimate in order to obtain a calibrated match with the observed flow estimates.

Table 2-5 – FEH Estimated Flood Frequency Curves

River	Station	NRFA Ref	FEH Status	Peak Flow	Date	50% QMED	20% 1 in 5	10% 1 in 10	5% 1 in 20	2% 1 in 50	1.3% 1 in 75	1% 1 in 100	Chrstcs QMED	Scale Factor
Teme	Tenbury	54008	QMED Yes Pooling Yes	240	03-Dec-60	139.1	180	208	236	275	294	307	97.9	1.42
Teme	Knightsford Bridge	54029	QMED Yes Pooling Yes	247	28-Dec-79	168.5	217	249	281	325	346	361	118.9	1.42
Lugg	Byton	55014	QMED Yes Pooling Yes	87	28-Oct-98	27	37	45	53	66	72	77	32.8	0.82
Lugg	Butts Bridge	55021	QMED Yes Pooling Yes	77	21-Jul-07	43.7	57	67	76	89	95	100	42.3	1.03
Arrow	Titley Mill	55013	QMED Yes Pooling Yes	58	10-Jan-86	27.1	38	49	55	69	76	82	24.2	1.12
Lugg	Lugwardine	55003	QMED Yes Pooling No	61	04-Feb-02	76.8	99	114	128	148	158	165	76.8	1.00
Frome	Yarkhill	55018	QMED No Pooling No	-	09-Apr-98	21.3	30	35	41	48	52	55	14.4	1.48
Wye	Erwood	55007	QMED Yes Pooling Yes	1229	02-Dec-60	541.2	713	833	952	1114	1188	1242	357.1	1.52
Llynfi	Three Cocks	55025	QMED Yes Pooling No	198	27-Dec-79	47.6	66	79	94	117	129	138	22.6	2.11
Wye	Belmont	55002	QMED Yes Pooling Yes	958	04-Dec-60	387	494	566	635	725	764	792	358.8	1.08
Leadon	Wedderburn	54017	QMED No Pooling No	-	11-Jul-69	49.6	66	76	87	100	106	111	22.4	2.21
Honddu	Tafalog	55015	QMED No Pooling No	-	24-Oct-60	16.7	22	26	31	37	39	42	9.7	1.72
Monnow	Grosmont	55029	QMED Yes Pooling Yes	222	09-Apr-98	150.8	203	240	280	339	368	389	49.4	3.05
Wye	Redbrook	55023	QMED Yes Pooling No	944	03-Feb-02	542.9	678	768	859	986	1046	1089	393.8	1.379

2.4 Evidence Based Statements

- 1) Rivers represent only a pathway in the conventional Source – Pathway – Receptor approach to risk analysis. Flooding arises from excessive runoff within catchments, the runoff speed, quantity and peak being determined from basic catchment characteristics. Hence, a true understanding of flood risk assessment must consider catchments as the fundamental ‘management unit’, not rivers.
- 2) This SFRA has identified 47 separate sub-catchments within the study area. Detailed hydrological appraisal of these 47 separate catchments with regard to flood risk potential has been one of the core areas of the Strategic Flood Risk Assessment.
- 3) Precipitation, topography and soil type (derived from underlying geology) are the three predominant influences on flood hydrology. An understanding of the interactions of these basic physical drivers of flooding is essential in managing flood risk from ‘first principles’. Many SFRA and CFMPs neglect to analyse the simple principal mechanisms of runoff generation. An appreciation of elementary catchment ‘hydrodynamics’ can provide many robust strategic level solutions to flood risk.
- 4) Across the Herefordshire SFRA area precipitation is highest in the north-western and south-western areas (Red Brook above Knighton, 996 mm/a), (Honddu above Monmouth, 1206 mm/a). There is a rapid decline in rainfall gradients across Herefordshire moving west to east, such that in the Upper Frome above Bromyard, annual precipitation is 727 mm/a, and in the Leadon above Ledbury, it is only 694 mm/a.
- 5) Steeper or less permeable catchments will tend to have proportionately higher flood peaks and more rapid response than shallower well drained catchments. Steep catchments that are also less permeable are particularly flood prone, and have the added disadvantage that the time of the flood peak will be relatively rapid. These characteristics influence the timing and magnitude of fluvial flooding, but also play a significant part in general surface flooding.
- 6) Standard Percentage Runoff (SPR) is one of the critical catchment parameters in flood generation. Catchments with low SPR values will as a general rule generate low response to rainfall. This is because they are more permeable, and a significant proportion of precipitation tends to infiltrate to deeper ground, until these zones reach field saturation point. Hence an appreciation of the distribution of SPR within an SFRA area is vital for strategic flood control and drainage planning.
- 7) 78% of the SFRA area has a soil type potentially highly or moderately unsuitable for source control techniques. Obviously there will be site specific exceptions in every case, but with regard to overall strategy, the suitability of infiltration source control measures as opposed to surface water storage for new development is a key policy issue.

- 8) All 47 sub-catchments have been mapped in terms of their suitability for infiltration and source control measures. The catchments that are most likely to be suitable for infiltration type source control of runoff are the Honddu, Lower Wye, Middle Lugg, Teme Garren Brook, Bailey Brook, Rudhall Brook and the Wriggle Brook.
- 9) The second key characteristic in flood generation is the Unit Hydrograph Time to Peak parameter. T_p is critically important in Strategic Flood Risk Assessments because this parameter more than any other determines how quickly the catchment responds to a rainfall event. Because T_p can be calculated for any sub-catchment and compared to others within the river basin on a 'like for like' basis, useful strategic decisions can be made about where to place attenuation facilities for example, or promote increased positive drainage rates, depending on the relative spatial arrangement of T_p 's across a river basin.
- 10) All 47 sub-catchments have been analysed and mapped in terms of their speed of response. The catchments with the shortest times to peak, and hence relatively high levels of flood hazard are the Back Brook, Upper Monnow, Honddu and Wriggle Brook.
- 11) Herefordshire has encountered significant flood hazard in recent years. Of the 10 most major floods since 1795, five of these have occurred within the last 20 years (1990, 1998, 2000, 2004 and 2007). Hence, flood hazard is a very real and possibly increasing phenomenon. Flood damage cost may not be relatively as high as other conurbations in the West Midlands, due to a lesser degree of vulnerability (property at risk) but critical infrastructure within the County in particular seems to be disproportionately vulnerable.

2.5 Evidence Based Recommendations

- 1) Current flood risk management within Herefordshire by both Herefordshire Council and the Environment Agency should recognise the value of assessing flood risk by sub-catchment as opposed to rivers. Generalised flood risk (i.e. flooding from all sources) is better understood and managed by assessing flood hazard and flood vulnerability at the catchment scale. This is an innovative approach that is perhaps new to Local Planning Authorities and the EA.
- 2) The databases and hydrological base maps prepared for the SFRA should be made widely available to other Agencies, Consultants and Developers to promote a co-ordinated understanding and application of the 'catchment approach'.
- 3) Both the Environment Agency and Herefordshire Council should mutually engage in ensuring that the technical outputs of the SFRA and the policy implications thereof are taken account of in the higher level CFMP.

2.6 References and Additional Resources

The following published or web-based documentation has been referred to in the following sections, and may provide useful further reference material for the Local Development Framework.

- 1) **Risk Performance and Uncertainty in Flood and Coastal Defence – A Review** (HR Wallingford, 2002, SR587)
- 2) **Guide to the Management of Floodplains to Reduce Flood Risks – Stage 1** (HR Wallingford, 2003, SR599).

Evidence Map 2-1 – Sub-catchments, floodplains and topography



- Key**
- County Boundary
 - Wye River Basin
 - Principal Rivers
 - Main Town
 - Ground < 100 mAOD
 - Ground 100 - 150 mAOD
 - Ground > 150 mAOD
 - EA Flood Zone 3 (Extreme or < 0.1%).

Client
Herefordshire Council

Scheme
Strategic Flood Risk Assessment

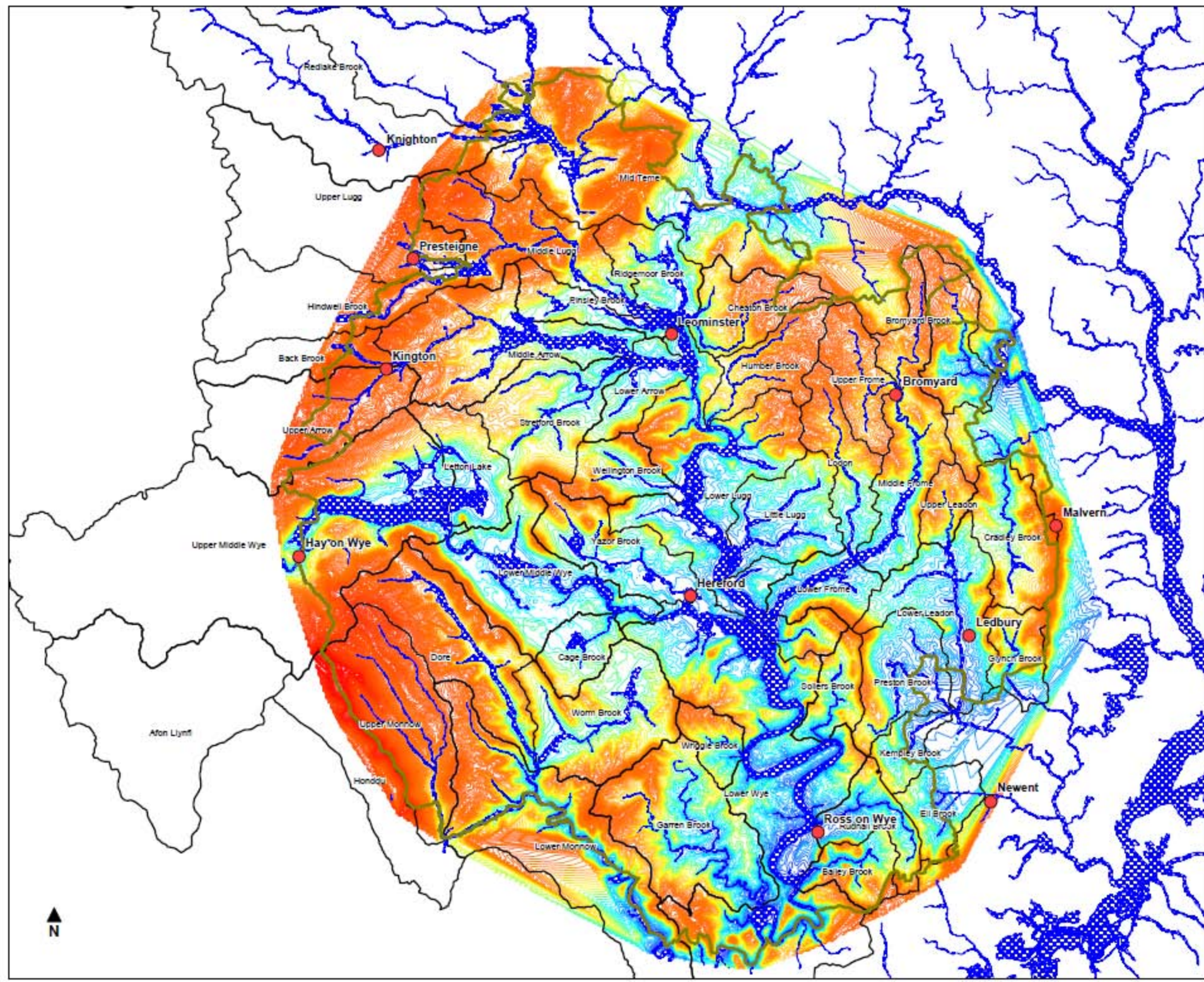
Drawing

Title	Topography & Floodplains
Subset	Contours & catchments
No.	1110/EB/2-1/a
Date	24-1-2008
Check:	BF

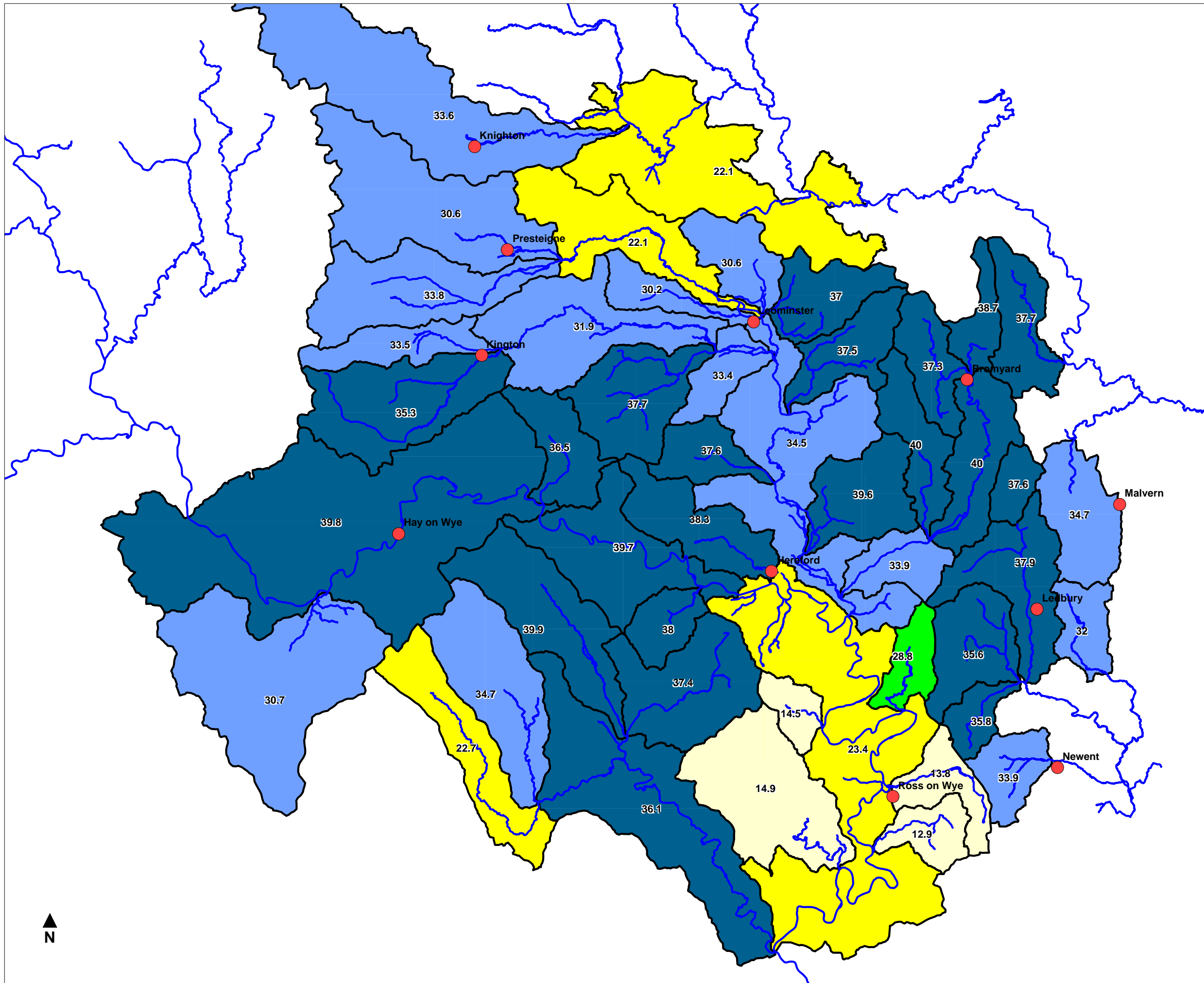
Revisions

Scale : 1:NTS

Evidence Map 2-1



Evidence Map 2-2 – Standard Percentage Runoff by Sub-catchment



Key	
	Herefordshire
	Wye River Basin
	Principal Rivers
	Sub-catchment boundary
	Main Town
	SPR 35 - 40%
	SPR 30 - 35%
	SPR 25 - 30%
	SPR 20 - 25%
	SPR 10 - 20%

Client	Herefordshire Council
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Scheme	Strategic Flood Risk Assessment
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Drawing	
Title	Standard Percentage Runoff
Subset	Source Control Suitability
No.	EB/2-2/a
Date	24-1-2008
Check:	BF

Revisions	
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Scale :	1:NTS
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Evidence Map	2-2
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Evidence Map 2-3 – Comparative UH Time to Peak by Sub-catchment

Key	
	Herefordshire
	Wye River Basin
	Principal Rivers
	Sub-catchment boundary
	Main Town
	Tp < 5 hours (rapid)
	Tp 6 - 7 hours (moderate)
	Tp 7 - 9 hours (average)
	Tp 9 - 11 (slower)
	Tp > 11 hours (slow)

Client
Herefordshire Council

Scheme
Strategic Flood Risk Assessment

Drawing
Title Unit Hydrograph Tp
Subset Peak response time (hours)
No. EB/2-3/a
Date 24-1-2008
Check: BF

Revisions

Scale : 1:NTS

Evidence Map 2-3

