Institutional Management of Surface Water in England and Wales

by

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Abstract

Drainage has been managed in England and Wales for centuries, but only in the past 20 years has the focus moved away from land drainage and engineered flood defence, to a more holistic catchment management. This shift reflects more general concerns with urban flooding, environmental sustainability, and climate change trends.

Flooding events mean that water is increasingly treated as a responsibility as well as an asset, and recent legislation attempts to build a hierarchy within the relevant institutions, to manage surface water and flood risk. This document examines historical influences in the light of recent statutory changes, and analyses current roles and responsibilities for surface water.

A visual approach is used on a case study area, to track rainfall on its path to the sea. The interaction of differing liabilities and powers is illustrated and analysed according to ownership, responsibility and water type.

The conclusions highlight a lack of holistic management, noting discrepancies between ownership and responsibility, between types of responsibility, and between flood risk and drainage. There are specific issues in urban areas, including frequent handovers between drainage bodies, weakening of planning control, and domination by the Environment Agency.

Key recommendations include effective catchment management by tightening planning regulations, and enhancing stakeholder participation, state involvement and strong environmental leadership. Finally, fragmented water legislation needs integrating in order to promote proactive management of this vital commodity, accepting it as both an asset and liability.

Executive Summary

Introduction

Many recent changes have been implemented in legislation regarding flooding in England and Wales, in an attempt to enhance institutional accountability and efficiency. In order to explore any current complexities of institutional surface water management, these responsibilities are to be investigated, analysed and mapped in a clear diagrammatic form.

The aims and objectives of this research are defined as follows:

Aim: To present a visual mapping of the institutional responsibilities for surface water within the case study areas: illustrating the management of water as it moves from rainfall towards the sea.

Objectives:

1. To establish the roles, responsibilities and interactions of all surface water stakeholders
2. To track specific theoretical flows of water across a catchment, considering the implications of runoff and infiltration, as well as constructed drainage, sewers and all watercourses
3. To illustrate the changes in institutional management as a visual mapping
4. To summarise pertinent background information to facilitate these objectives

To accomplish these objectives, mixed data is drawn from a literature review, policy investigation, map analysis, field samples, interviews and tracking a planning request.

Literature Review

Hydrology demonstrates links between surface and groundwater flooding, between drainage and flooding, and between pluvial (surface water) and fluvial (river) flooding. However, pluvial flood management is a relatively new concept in the UK and Local Authorities are still building knowledge in this area in order to manage flood risk effectively.

Over the centuries, flood management in England and Wales was limited to agricultural drainage. However in the past 50 years, flood management has changed from field drainage to a focus on engineered defence – recently shifting to more considered management of catchments as a whole. Floods, it is now understood, cannot be controlled; rather they require intelligent adjustments on the part of the population affected by rivers. Rivers should be given space to flood, and floodplains returned to this purpose rather than developed for housing. However, evidence indicates that this is still not always the case. Sustainable drainage supports a holistic approach by creating ‘soft drainage’ to encourage infiltration or storage of water, rather than rapidly gravitating it towards rivers, and this concept is now implemented for new buildings.

In order to cope with flood events, resilience techniques such as ‘wet’ or ‘dry’ flood proofing are used, either to resist the flood itself or to resist the damage caused by water. Post-flood support can include insurance compensation, which has recently been renegotiated in England. A longstanding ‘gentlemen’s agreement’ has just been modified to permit a limited increase in high risk premiums, along with a cross subsidy from low-risk households. Scotland leads the way in participatory work with insurers, communities, legislators and planners, successfully linking all aspects of flood management and improving accountability.

Increased urbanisation, land use and agriculture changes will continue to combine with likely climate changes, to make the management of surface water a key issue for the future.

Methodology

This research uses the pluralistic methodology observed from the literature reviewed; including interviews, policy reviews, and direct observation. The core of the research is a case study; tracking surface water in several carefully selected locations in the Severn catchment. Criteria to select urban locations are tabulated and assessed to avoid researcher bias, and culminate in the selection of Worcester and Shrewsbury as case study locations. Rural locations are included for completeness, and include the source of the Severn as well as a border area, to compare Welsh and English influences, Multiple transect route options are then plotted and examined using online mapping, to choose the widest variety of terrains and institutional diversity from the four selected locations, leading to analysis in the final diagrams.

Sources of data include a full policy investigation of legislative and strategy data, literature review, exploring institutional contacts and documents, tracking a development request on a planning portal, analysing interactive maps, performing physical and theoretical (mapped) transect walks and conducting interviews with stakeholders. This diverse data should permit a rich selection of data for presentation and analysis. Drawing tools and online interactive maps are then used to present findings in mapped illustrations of terrain, transect route, water flow and a visual analysis of associated institutional responsibilities.

Policy data

Policy regarding drainage, water resource and flooding has changed significantly in the past 25 years; notably with privatisation of water supply and sewerage in the 1989 Water Act, and allocation of local drainage responsibilities between Internal Drainage Boards (IDBs) and Local Authorities in the 1991 Land Drainage Act. The Environment Act of 1995 then established the independent Environment Agency whose remit included river management.

An increase in urban flood events, coupled with environmental considerations and appreciation of catchment management, led to European water directives, which were encapsulated in the Flood and Water Management Act in 2010. This allocated further responsibility to Local Authorities, who were directed to manage all local surface water risk, while the Environment Agency was to supervise all national drainage and flood risk, as well as

managing main rivers. A series of flood strategy documents were mandated from both bodies and all stakeholders were directed to coordinate and share information. This change was intended to prevent the confusion of recent flood events where accountability for water assets had been unclear. It should be noted that the Environment Agency retained only permissive powers, meaning they are permitted, but not obliged to intervene in flood and drainage supervision.

Sewage is managed by water companies in England and Wales, directing often combined flows of sewage and stormwater to treatment plants and outflows. The resultant contaminated flooding has generated upgrades to sewage systems, even though water companies are not strictly liable for sewage flooding caused by excess rainfall.

Water falling on local roads is the responsibility of local Highways Authorities, with trunk roads managed by the Highways Agency. Water drained from any road will then pass into storm sewers, combined sewers, soakaways, or a nearby watercourse.

Planning offers a key opportunity for improving flood management; by regulating development on floodplains and now including the Environment Agency as statutory consultee. Planning Policy Statement 25 offers guidance to planners, with the sequential test and exception rules defining risk based judgements in conjunction with flood zone maps, ostensibly to keep development away from floodplains. Newer regulations issued in 2012 as the National Planning Policy Framework, carry a presumption in favour of sustainable development and appear to define floodplains more subjectively. Sustainable or soft drainage is favoured to mitigate flood risk, and these infiltration and flood storage techniques are now mandated in national standards for construction.

Other stakeholders include farmers and private landowners, who enjoy riparian rights for water passing over their land. These ancient rights regard water as an asset rather than a responsibility, but landowners may be obliged by a drainage body to effect repairs in the event of a surface water problem. Peripheral stakeholders include British Waterways, who own and manage 2600km of canals crossing river basins; and Ofwat, who oversees Water Companies.

Results

Data is then gathered in to the results section, with sources including preliminary observations in sample locations, and interviews with representatives from Worcestershire County Council, the Environment Agency, Lower Severn Internal Drainage Board, and an agricultural riparian landowner. Further data is also gathered from tracking a large planning application near a flood zone. Moving to the case study, theoretical flows are tracked across mapped contours, followed by physical transect walks following these flows to main rivers. These results are all detailed and referenced on maps and photographs taken during field work, to make the routes easier to follow.

Analysis

The collated results from fieldwork, mapped routes, policy investigation and interviews are now interpreted and illustrated in colour coded diagrams and pie charts for each location. The diagrams demonstrate institutional influences for drainage, flood risk, and supervision responsibilities, as well as category of ownership and water channel type. These aspects are all presented against a scaled foundation, detailing all influences for the first 10km of each route selected. Pie charts are used to demonstrate the breakdown of drainage by responsible institution, for one entire route for each location.

These diagrams demonstrate a number of points regarding the changing influences along flow routes. These include noticeable changes as sampling shifts from rural to increasingly urban settings: institutional influences are different; management type changes more frequently; the Environment Agency increasingly manages more of the flow; more water is piped underground; and unchannelled surface water reduces significantly. Other key issues are visible over all terrains, these include: the continuous split between ownership and responsibility; multiple drainage handovers between institutions; and the imposition of flood-risk management on a body which does not fully control drainage.

Conclusion and Recommendations

A number of observations suggest a lack of holistic management:

- There is a clear distinction between land ownership and the various levels of responsibility;
- Responsibility is split between three layers of liability: drainage, flood risk, and supervision;
- Local Authorities control flood risk, yet hold only partial control for urban drainage;
- Drainage legislation has been updated by flood statutes, without real any attempt to integrate, or understand the link between the two concepts.

Other issues have been noted specifically in urban areas:

- Water Companies and Highways Authorities act as primary drainage bodies in towns
- Urban drainage is normally implemented almost entirely underground
- Frequent handovers between drainage stakeholders are still common
- The Environment Agency plays an increasingly dominant role, leading to a loss of local knowledge
- Loopholes are often exploited by developers, to gain planning permission near floodplains

Key recommendations include the tightening of planning regulations in order to support effective catchment management; incorporating lessons learned from Scotland around stakeholder participation, restoring state involvement and encouraging strong environmental leadership.

Finally, fragmented water legislation needs integrating in order to promote proactive management of this vital commodity, accepting it as both an asset and liability.

Glossary

Abbreviations

ABI	Association of British Insurers
ADA	Association of Drainage Authorities
ALT	Agricultural Land Tribunal
AOD	Above Ordnance Datum (In UK normally = Above Sea Level)
ASL	Above Sea Level
CFMP	Catchment Flood Management Plan
COW	Critical Ordinary Watercourse
DCLG	Department of Communities and Local Government
Defra	Department for Environment, Food and Rural Affairs
DETR	Department of Environment, Transport and the Regions
DRR	Disaster Risk Reduction
EFRA	Environment, Food and Rural Affairs
EA	Environment Agency (for England)
EAW	Environment Agency in Wales
EIA	Environmental Impact Assessment
EU	Council of the European Union
FRA	Flood Risk Assessment
FRM	Flood Risk Management
FRR	Flood Risk Regulations 2009
FWMA	Flood and Water Management Act 2010
GCC	Gloucester County Council
IDB	Internal Drainage Board
LA	Local Authority
LFDC	Local Flood Defence Committee
LLFA	Lead Local Flood Authority
LPA	Local Planning Authority
MAFF	Ministry of Agriculture Fisheries and Food
NFU	National Farmers Union
NPPF	National Planning Policy Framework
NRA	National Rivers Authority
NRW	Natural Resources Wales
NWC	National Water Council
OS	Ordnance Survey
PFRA	Preliminary Flood Risk Assessment
PPG25	Planning Policy Guidance note 25
PPS25	Planning Policy Statement 25 Development and Flood Risk

RFDC	Regional Flood Defence Committee
RFRA	Regional Flood Risk Appraisal
RLDC	Regional Land Drainage Committees
RMA	Risk Management Authority
RWA	Regional Water Authority
SAB	SUDS approving body
SC	Shropshire Council
SFRA	Strategic Flood Risk Assessment
SuDS	Sustainable Drainage System
SWMP	Surface Water Management Plan
TBC	Tewkesbury Borough Council
UK	United Kingdom of Great Britain and Northern Ireland
WCC	Worcester County Council

Definitions

The following table (Environment Agency, 2012c) defines relevant legislative terms:

Term	Definition	Source
watercourse	Includes all rivers and streams and all ditches, drains, cuts, culverts, dikes, sluices, sewers (other than public sewers within the meaning of the Water Industry Act 1991) and passages, through which water flows.	Land Drainage Act 1991 [section 72(1)]
ordinary watercourse	"Watercourse" that does not form part of a "main river"	Flood and Water Management Act 2010
main river	Watercourse shown as such on a main river map. Main river maps are held by Defra and Welsh Government	Water Resources Act 1991 [section 113]
public sewer	Sewer for the time being vested in a sewerage undertaker etc	Water Industry Act 1991
culvert	Covered channel or pipe designed to prevent the obstruction of a watercourse or drainage path by an artificial construction. There is no definition in current legislation. This definition will be added to Section 72 of the Land Drainage Act	Flood and Water Management Act 2010 Paragraph 39

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1. Introduction

"Floods are 'acts of God', but flood losses are largely acts of man." White, 1945

"The institutional and policy frameworks ... represent the rocks on which ... wise floodplain management founders." Smith, 2000

This report is structured into six main sections: setting the context in chapter one, then conducting a literature review to explain background information and establish previous research findings. The methodology is then explained along with tools and data sources, before starting on initial data collection with the policy investigation. Field data and maps are presented in the results chapter, followed by analysis and diagrams, finishing with conclusions and recommendations in the final chapter.

1.1. The context

1.1.1. Background

This topic was inspired by two reports into the 2007 floods in Britain, especially Hull, where it was observed that responsibilities were unclear for smaller watercourses contributing to flooding, Coulthard et al. (2007) and Coulthard and Frostick (2010) provided information for the Pitt Review (Pitt, 2008), exposing the complexity of multiple agencies managing different areas of the drainage system. During the devastating 2007 floods in Hull, diverse institutions, all played separate but significant roles in the floods, while not necessarily coordinating well, especially at times of crisis. It was subsequently suggested that a mapping of surface water according to responsible institutions could be instructive. It appears from literature reviews and other inquiries, that no such mapping has yet been devised.

1.1.2. Project definition

The aim of this project is therefore to explore the institutional management of surface water across an urban and rural catchment, to better understand the implications for flood risk reduction in England and Wales.

Ownership and responsibility for surface water in England and Wales is complex, and has recently undergone several changes, with the Environment Agency (EA) now playing a leading role in flood prevention. At the same time both climate trends and land use are changing; urbanisation and pressure for new houses are encouraging building on flood plains. The pace of change means that flood prevention is often specific and reactive rather than holistic and preventative; focusing on river barrier defences rather than integrated catchment management and overall risk reduction (Goodson, 2011).

Flooding is the culmination of a cumulative series of events, and managing the river alone is often too little and too late. Main watercourses are managed for flood risk by the EA; however, water flows into rivers from a variety of sources, including roads, (managed by highways authority/agency), agricultural drains (landowners) minor watercourses and culverts (multiple drainage bodies) and sewers (water company). It has been observed that during a flood incident, confusion between responsibilities for different watercourses can create conflicts and delays in response. More significantly, early and sustainable management of smaller watercourses could ultimately reduce flood conditions in the main river.

1.1.3. Justification

Several of the recommendations in the Pitt review were implemented in to 2010 Floods Act, including augmenting the role of the EA into a coordinating flood agency.

> *"The responsibilities for certain drainage assets remain unclear ... This lack of transparency in ownership and the complexity involved could be reduced by having a single national organisation with an overarching responsibility for all types of flooding."*
>
> Pitt, 2008

However, the role of the EA remains permissive, and responsibilities for surface water remain diverse. This research therefore provides a useful exercise in tracking complexities of institutional responsibilities, and their likely impact on flood risk management. It also offers the opportunity to review the effect of recent legislative changes in surface water management.

The House of Commons EFRA Select Committee (2008) concluded that institutional factors played a large part in the landmark 2007 UK floods. They quote written evidence received from MPs and members of the public on the cause of flooding, including:

- Poor maintenance of drains;
- Poor watercourse maintenance and lack of dredging;
- Landowners unaware of their responsibilities;
- Development on the flood plain;
- Confusion over responsibility for certain drainage assets;

Finally, disaster risk reduction (DRR) must consider the mitigation of the cumulative aspects of risk, (Bosher et al., 2009). If water is not regarded as a risk until it reaches the river, this effectively creates a disincentive for management of smaller water sources. In order to effectively implement pre-disaster mitigation, flood risk management should be carried out across the entire catchment, and not simply at the river. The implication of these cumulative effects on surface water is a key point for investigation.

1.2. Problem statement

The intention here is to clearly state the problem in order to remain focused during investigation into a diverse and wide ranging subject. The problem statement is therefore defined here as follows:

Which institutions in England and Wales are responsible for different types of surface water and can their interaction be clearly illustrated?

1.3. Aims and objectives

1.3.1. Aim

The primary aim is: To present a visual mapping of the institutional responsibilities for surface water within the case study areas: illustrating movement of a raindrop across the areas of institutional ownership.

1.3.2. Objectives

5. To establish the roles, responsibilities and interactions of all surface water stakeholders
6. To track specific theoretical flows of water across a catchment, considering the implications of runoff and infiltration, as well as constructed drainage, sewers and all watercourses
7. To illustrate the changes in institutional management as a visual mapping
8. To summarise pertinent background information to facilitate these objectives

1.4. Research questions

The following research questions have been identified for this project:

- What role does each agency play in managing surface water?
- How do key stakeholders (such as local authorities, farmers, utilities, highways authorities or private landowners) manage small watercourses under their control?
- How do the respective institutions interact, especially at the boundaries between each section of drainage or watercourse?
- Do planning laws ensure that developers take responsibility for the effect that development has on urban drainage and consequent flood risk?
- Who are the incidental stakeholders and what is their role?
- Is surface water managed using short term reactive event management or long term proactive catchment management?

These have been developed into further detailed research questions, then classified by concept and summarised in Table 1.1:

Concept	Questions	Data source
Water mgt	Who manages each form of water?	Policy review
	Is surface water treated as an economic good or a liability and cost?	Policy review & lit review
Institutional interaction	How well do the different institutions work together?	Policy review, lit review, interviews
	Are the boundaries between institutions clear and mappable?	Policy review & transect walks
	Is water simply passed by gravity as quickly as possible to the next institution downstream?	Transect walks
Public/ private sector	Who gives permission to build in flood plains and with what caveats? Investigate 106 rulings.	Policy review, lit review, interviews
	Who pays for the Impact of development on water management? Taxpayers? Developers? Owners?	Policy review, lit review, interviews
National/local interaction	Who manages the overall flood risk, is this EA for the whole country?	Policy review, lit review, interviews
Public sector / householder interaction	Where do the house holders' responsibilities start and end?	Policy review
	Should there be state subsidies for insurance ?	All

Table 1.1 Concepts mapped to research questions

1.5. Expected findings

Initial research suggests that flood risk management still lacks a holistic approach and is still localised and reactive. It appears that the approach to planning permission can be flawed in implementation, and that developers are rarely directed to contribute to improved drainage. It is therefore hoped to highlight any discrepancies within the planning process, overall catchment management, and interaction between the different stakeholders and institutions.

It is expected that the cumulative effect of different sources of surface water is not sufficiently anticipated, and that surface water is not proactively managed. If drainage is regarded simply as an opportunity to pass water downhill to the next institution, it is likely that flood risk is managed mainly at the river level.

1.6. Unit of analysis

The core of the project is the case study; including theoretical and physical transect walks, leading to mapping of institutional responsibility for various streams of surface water. Unit of analysis will generally be the watercourse under examination, along with the institutional owner concerned with its control. Overall geographical limits will be set by the catchment boundary of the river Severn.

1.7. Research beneficiaries

It would appear that the complexities in water legislation in England and Wales are contributing to the growing flood risk in the country. A clear illustration of excessive institutional complexity and lack of cooperation could highlight opportunities for improvement in this area.

This research could therefore play a part in highlighting anomalies in the management of surface water in England and Wales, which could have value for organisations involved in flood risk management and DRR strategies in this area.

1.8. Scope of research

The intention of this study is to explore the link between surface water management and institutional ownership. As such, an initial investigation is conducted into legislation, regulatory guidelines and institutional roles. This policy review is limited to recent legislation, mostly since the 1930s, which has a direct bearing on current water management policies. The resource and environmental management of water is noted, but not investigated as closely as drainage and flooding.

All responsibilities for main rivers are clearly allocated to the EA, and while implications of this are discussed, main rivers are not investigated in as much detail as drainage and smaller watercourses, which have more complex management.

The catchment under investigation is limited to the Severn basin in England and Wales, and while other catchments may be mentioned, they are not examined here. Technical details such as flood estimation techniques, flood response protocols, or specific engineered solutions are not within scope.

1.9. Research Methodology

Theoretical analysis and information gathering is the primary aspect of the first phase, and takes the initial form of a literature review. This is followed by the policy investigation, reviewing statutes, directives, regulations and strategy documents, in order to understand the relative roles and responsibilities of stakeholder institutions. This policy review forms the preliminary section of the data collection, and is pivotal to inform subsequent analysis in the light of institutional responsibilities. Further desk research involves catchment analysis using Ordnance Survey (OS) maps, where the transect walks in the Severn catchment are planned and undertaken in a theoretical approach.

Representatives of several stakeholder organisations are interviewed in order to triangulate data and assess real world application of roles. Physical data gathering implements the planned transect walks in the field, after which findings are collated and plotted into charts. Finally, results are presented in a graphical format, along with further analysis of these mixed data sources to present the different influences on the watercourses identified.

Progress is managed and measured according to tasks, using the workplan shown in Appendix V: Work Plan and Schedule', updated and adjusted dynamically as worked progresses.

Figure 1.1 Shropshire road flooding. Source: SC (2010a)

2. Literature Review

The purpose of this review is to summarise the current state of knowledge in the topic, to establish any gaps in knowledge, and to build the researcher's knowledge of the subject. This has been achieved by analysing strategy papers and books in order to consider a wide background to the subject of surface water management and institutional factors.

Policy papers have been included here where they inform the debate. However, institutional information provides primary data to this project, and has been analysed in the separate policy review in chapter 4.

2.1. Hydrology of Land Drainage

In order to understand the behaviour of surface water, it is necessary to note some relevant hydrological background. Jones (2000) explains that flash floods, or sudden onset floods, are usually generated by rain falling on saturated ground and are known as pluvial floods. This form of infiltration excess, or surface run off, occurs when rainfall intensity exceeds infiltration. Slow onset, or riverine floods, are known as fluvial floods and are caused by swollen rivers overtopping their banks. Clearly the two are linked: as the faster pluvial flooding moves down towards the river, the slower fluvial flood develops; watercourses fill the main river, which eventually overtops its banks. Given the importance of surface water management to this project, and the clear allocation of responsibility for all main rivers to the Environment Agency (EA), this research mainly examines the preliminary interaction of rain and surface water runoff with existing watercourses.

Rowe et al. (1997) describes the proportion of surface water run-off as a function of the storage characteristics of the soil, the underlying bedrock, and the density of vegetation cover. Jones (2000) adds that rainfall characteristics combined with the shape of the basin, hillside properties and channel networks, will define the characteristics of surface water. The speed of run-off will therefore affect both the likelihood and type of a pluvial flood.

Ibbitt et al. (1997) observe that the direction of rain bearing clouds across a catchment can have a great effect on peak flows passing downriver. Storms passing along, rather than across the catchment will create greater stream flows; while rain moving down (rather than up) the catchment produces a 'plug' flow, as the peak flow runs with the current. This is reinforced by Jones (2000) who adds that the speed of the storm also affects the size of the peak flow. This is particularly relevant for the River Severn, which suffers from sudden peak flows in Wales/Shropshire borders, where the current runs in the same direction as the prevailing wind, and increased hill rainfall travels east from Wales, along with the river (Biggs, 2009), creating classic flood conditions.

.

Ibbitt et al. (1997) detail the infiltration of rainfall as it moves downwards through the soil, until it reaches an impervious surface, whereupon it will run downhill as a sub-surface flow. As a result, the ground surface becomes saturated near water channels, and subsurface storm flow will eventually enter the stream channel. Hence groundwater can also contribute to surface water, and vice versa. .

There also is an intricate interaction between surface water drainage and river levels, which can link pluvial and fluvial flooding. Shaw et al. (2011) describe it thus:

> *"High river levels can reduce the discharge capacity of surface drains because of reduced hydraulic gradient ... or even back up into drains... Conversely, a surface water system that conveys water very efficiently may discharge storm water into rivers, contributing to food risk downstream".*

Observing a direct causal effect from surface water to floods in 2007, Marsh and Hannaford (2007) explain that:

"An unusual, and very significant, feature of the summer flooding was the high proportion of damage not attributable to fluvial flooding. Around two-thirds of the properties affected (>8,000 in Hull alone) were inundated, as drains and sewers were overwhelmed following the summer storms.

Both the Pitt Review (Pitt 2008) and the Environment, Food and Rural Affairs (EFRA) Select Committee inquiry on 'Flooding' (House of Commons EFRA, 2008) stress the need for amended institutional and legislative arrangements in order to achieve effective surface water management. An attempt has been made to address this, by making local authorities responsible for local flood risk and land drainage in England and Wales (Great Britain. *Flood and Water Management Act 2010*). Unfortunately, the concept of pluvial flooding is a relatively new one in the UK, and few local authorities are in a position to even map the pluvial flood risks. Shropshire Council (2010) admits that:

> *Surface water mapping is in its infancy in comparison to fluvial flood risk mapping. As such, surface water flood maps of Shropshire do not currently exist. Whilst the Level 1 SFRAs for the Districts and Boroughs of Shropshire identified recorded incidents of surface water flooding within Shropshire, no detailed mapping was undertaken.*

Finally, EA (2009) acknowledges a lack of knowledge in pluvial flooding with the words: "*Work continues to improve the understanding and mapping of surface water flood risk*". OFWAT (2010) likewise explains how OFWAT strives to:

> *"improve available evidence on the costs and benefits of different solutions for managing surface water flooding", and will "promote new methods for incentivising, regulating, engineering and charging for drainage and surface water flooding risk management".*

Shaw et al. (2011, p414) hypothesise that land drainage is so closely related to flood risk management, that legal responsibility for drainage may in fact be a part of flood management. In consequence, complex institutional arrangements for drainage can have a detrimental effect on the planning and responses for flood risk. The link between land drainage and flood risk management is now well established, therefore needs to be considered in context here.

2.2. Flood Risk Management

Johnson and Priest (2008) see the history of flood management as progressing through three clear phases of: 'agricultural focused land drainage', moving to flood defence with an 'engineered approach' soon followed by 'flood risk management'. Myers and Passerini (2000, pp244-248) describe these phases as: modifying the floods (the structural response), modifying community susceptibility to flooding (using zoning or warnings), or modifying the impact of flooding (with insurance or tax breaks). Smith (2000) extends this by dividing floodplain management into: initial ignorance; interim 'taming' (structural) solutions; and finally learning to live with flooding. All agree that there have recently been two very different approaches: engineering and holistic catchment management.

2.2.1. Engineering approach

Fleming and Frost (2002) describe the prevalence of flood protection engineering in the 1960s, as well as the enhancement of flood estimation methods, with the advent of the rational method to make run off calculations. These techniques used the source-pathway-receptor model shown in Figure 2.1, where it was originally felt best to manage the pathway by controlling the river. At the time, this approach was favoured by engineering companies, who often had the greatest influence on strategic decision-making. Not until much later were strides taken toward management of the receptor, by refraining from building on flood plains.

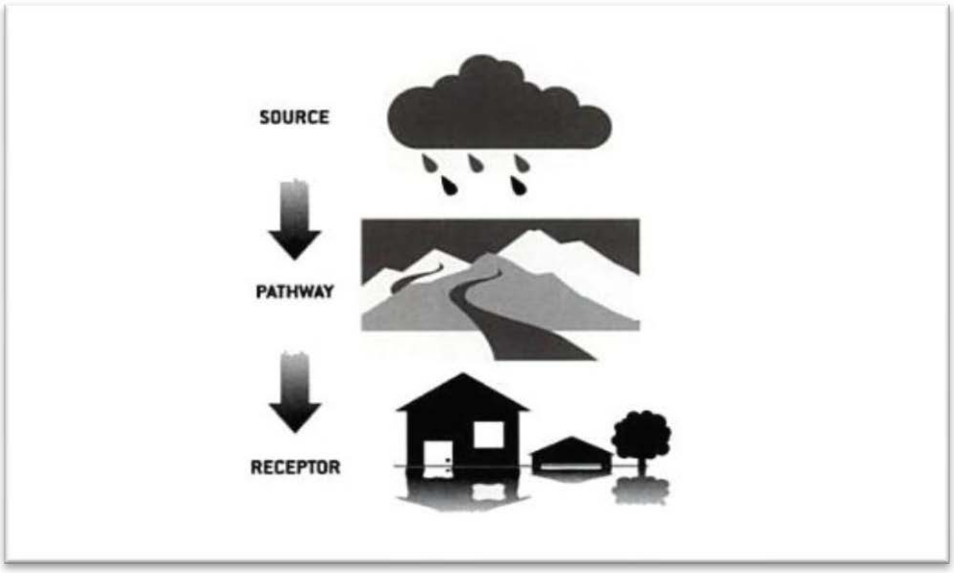

Figure 2.1 Source-pathway-receptor model for floods: the greatest control is with the receptor. Source: Huntingdon and MacDougall (2002)

A wealth of papers in the 90s seek to discourage this practice: Ibbitt et al. (1997) note that once structural defences fail they generally make the situation worse, by creating a sudden influx of water which has no easy path of retreat. They can even make the overall situation worse before they fail, by constricting the river flow to the point where levels upstream increase.

Parker (1995) described this as the 'escalator effect', where

> *"Progressively higher levels of structural flood defence have been provided to protect against rising flood loss potential associated with floodplain development. Within the current institutional context, the process is a circular one until the floodplain becomes completely developed." (Parker, 1995, p360)*

He adds that the downstream flooding is rarely paid for by the organisation causing the problem. Tobin (1995) sums up the practice of building flood barriers as counterproductive, by engendering a false sense of security which encourages vulnerable development onto the flood plain (Figure 2.2), and raising the river levels to create further problems downstream.

Figure 2.2 'Defended' flood plain development: New Orleans after Hurricane Katrina, 2005. Source: Wordpress (2009).

Parker (1995) also noted the arrival during the early 1990s of a growing debate about 'managed retreat', or the deliberate process of avoiding the construction of flood defences and instead permitting the inundation of floodplains.

Myers and Passerini (2000) consider the facts that flood are a hazard only after humans construct a built environment on flood-prone lands. Smith (2000) considers that the true costs of developing the floodplain is rarely considered, and that education rather than regulation is the way to break out of the cycle of protect-develop-crisis-concern-protect. He suggests that it is not the flood plains which need managing, but the people.

Debates such as these made it increasingly clear that the engineered response was uneconomic and unsustainable, and as stated in Huntingdon and MacDougall (2002), the natural way to discharge excess river water was to leave space for floodwaters.

> *"We cannot prevent flooding, we can only strive to prevent its adverse impacts."* Huntingdon and MacDougall, 2002, (p39).

This paper further suggests that the best way to manage flood risk is to remove critical buildings and to widen the river corridor to increase flow capacity (p45). This was reflected in the UK with Defra (2008b) and Defra (2005) in the expressively titled "Making space for water", which heralded a new strategic approach to flood risk management in England. At this point, the 'conveyance option' or flood defence philosophy moved towards catchment management and flood storage.

2.2.2. Holistic catchment management

By the early 2000s, Frost and Knight (2002) claim near universal agreement for a holistic approach to river basin management, and point out that:

> *"individual flood alleviation schemes cannot be considered in isolation and that what happens in one part of the catchment will have effects on other areas some distance away."* Frost and Knight (2002). See Figure 2.3*:*

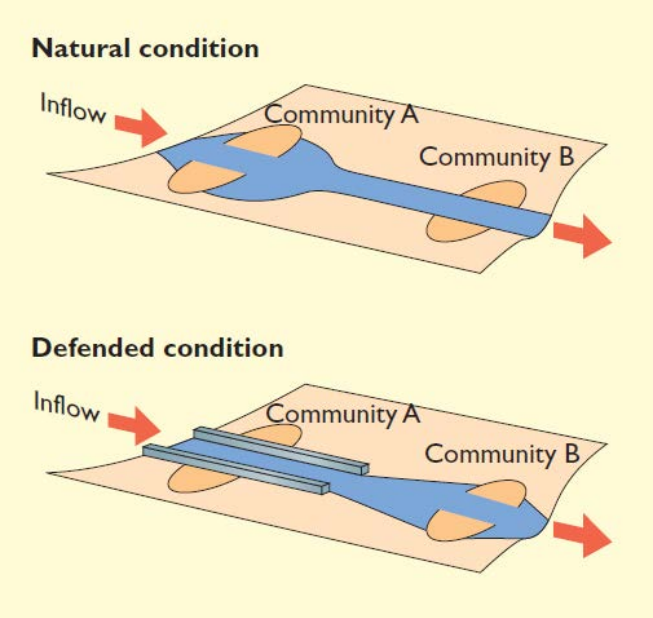

Figure 2.3 Flood defences should not be considered in isolation. Source: Fleming (2002b, p18)

This movement involves integrated planning for built development, land use patterns, nature conservation and emergency planning. This change in approach was noted as far back as 1993, in the Ministry for Agriculture, Fisheries and Food's "Strategy for Flood and Coastal Defence" (MAFF, 1993), but not generally incorporated into national strategy until early 2000s, with the Water Framework Directive and Flood and Water Management Act of 2010.

Crichton (2005) demonstrates that non-structural measures, such as planning controls and sustainable drainage prove a more efficient method for tackling the problem rather than relieving the symptoms. Frost and Knight (2002) advocate the use of undeveloped land for flood storage to reduce peak flows downstream. Along with Fleming (2002a) and Rickard (2002b) they feel this should be regarded as legitimate land use, either within development or subsidised as agricultural set aside land. Alternatively, English Nature (2001) proposes:

> *" encouraging washlands to be considered as a viable flood defence option, together with investigating the appropriate compensatory payments (such as a washland agri-environment scheme) that may be paid to land owners"*

This is exemplified by the River Quaggy restoration project, (EA [n.d.]), which released the previously underground river from culverts by converting a local under-utilised park into a strategic wetland. At high flow, flood waters are allowed to rise back over the park, which can hold 85,000m^2 of water, successfully protecting local houses from flooding (Figure 2.4).

Figure 2.4 River Quaggy: Wetlands in Sutcliffe Park, Lewisham. Source: Landscape Institute (2013).

Rickard (2002b) gives supporting examples of Leigh Barrier on the River Medway, or Lincoln washlands, which use sluices to fill flood storage. This approach recognises that flood storage will reduce the overall flow whereas a flood defence will simply pass the peak flow downstream.

An integrated approach is extolled in ICE (2012), who urge regulatory support for this:

"ICE would like to see the advancement of catchment-based approaches for managing water resources, including best practice in land management. Effective catchment management planning is a substantial institutional, social and political challenge"

Ellis and Revitt (2010) are encouraged by the number of recent institutional documents demonstrating the current value placed on catchment management and land-use control. However, the challenges in this approach are recognised by Potter (2008), who lists a series of institutional barriers to land use change, such as: complex funding arrangements, fragmented administrative structures, the demand for multi-agent partnerships, and dismissive attitudes to an 'environmental' approach.

2.3. Floodplain Development

Fleming (2002b) looks back at the growth of development on urban flood plains, as cities increased in size and the demand for building land increased beyond possible supply. The possibility of occasional flooding seemed at the time to be outweighed by the value of the development in social and economic terms (Figure 2.5).

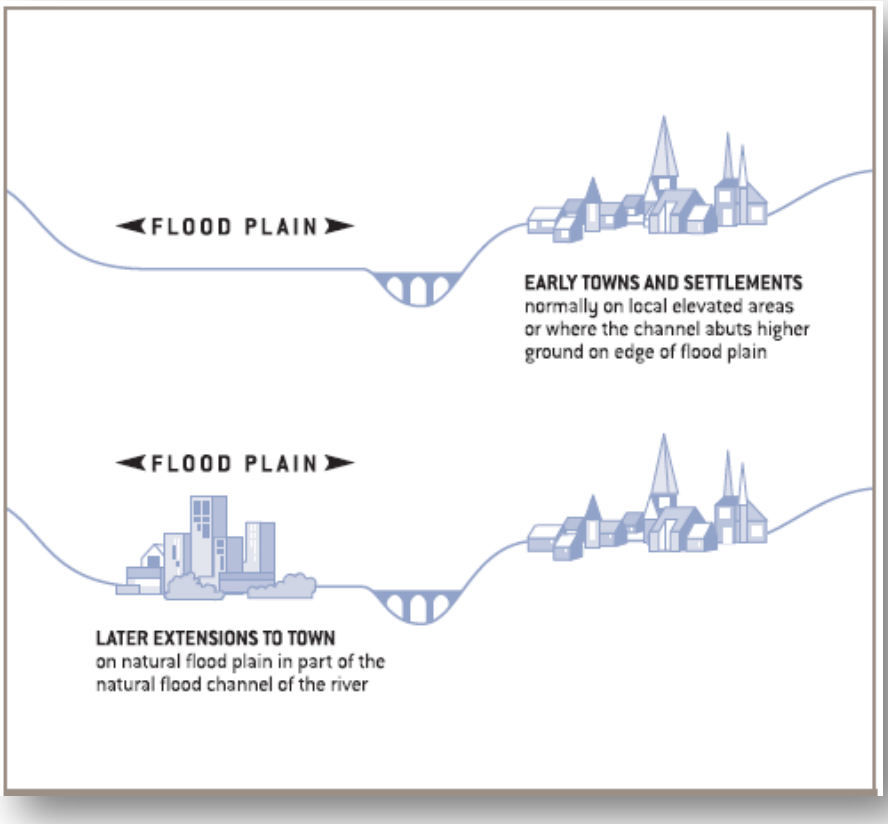

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Figure 2.5 Riverside settlements encroaching on the flood plain. Source: Fleming (2002b, p16)

Since 1995 the EA is statutory consultee to the planning process, in order to include the wider issues of flood and environmental risk into development. However the economic drivers of

floodplain development in England still appear to be paramount. Bosher (2013) assesses Department for Communities and Local Government Land Use statistics between 1989 and 2010, finding that over those two decades nearly 1 in 10 new dwellings in England is built in flood prone areas – over 10,000 dwellings in real terms. These figures lead him to the conclusion that planning regulations have a negligible effect on controlling development on flood plains. According to Crichton (2005), who quotes similar statistics, Local Planning Authorities (LPAs) still fail to heed the advice of the EA, and continue to permit development in flood hazard areas. Porter and Demeritt (2012) attribute this lack of cooperation to the differing priorities of the EA as compared to LPAs. The EA, with responsibility for flood-risk management has a significantly narrower focus than LPAs, whose elected officials are accountable to local voters and are responsible for aspects such as local economic development, housing provision, and sustainable communities.

The unsound enforcement of planning laws is considered by Parker (2000a, p16), where it appears that full legislative powers are not always used. This debate is furthered by Monbiot (2000) who notes that Local Authorities are increasingly playing an enabling rather than controlling role for developers. He gives many examples where councils are acting in partnership with developers, and refers to a concept known as 'offsite planning gain' where inducements may legally be offered to councils, to facilitate planning permission. The Adaptation Sub-Committee of the Committee on Climate Change (2012) feels that the planning approval process is not sufficiently transparent or accountable. They state that "*the Environment Agency only knew whether or not their advice had been followed in 65% of planning applications where they had objected*." It is suggested that all too often Local Authorities did not sufficiently investigate alternatives to building on flood plains, or assess likely future costs of protection.

As stated within Standard Note 4100, Planning and Flooding, (House of Commons Library, 2012): "*the Environment Agency cannot veto planning applications, so guidance for planning authorities is particularly important".* This document also refers to the current "build and protect" policy for flood plains. This phrase is reiterated by Adaptation Sub-Committee of the Committee on Climate Change (2012), along with a warning that the current focus on community protection and flood proofing buildings will generate higher protection costs as risks increase in future. They feel that by 2035 the combination of climate change and land use trends could virtually double the number of properties at risk of flooding. Significantly, the committee asserts that:

> *"Development in the floodplain grew at a faster rate than elsewhere in England over the past ten years."*

Finally, Rickard, (2002a) makes the point that development on low lying ground not only builds over the flood plain, but also creates conditions too low for effective sewerage. This raises the

risk of contaminated sewage floods, as well as increasing the likelihood of higher groundwater levels.

2.4. Sustainable Drainage Systems (SuDS)

In 1994, Andoh, (1994) linked the integrated management philosophy with a new concept in water drainage:

> *"Urban drainage practice and control philosophy until recently has, as result, been based on solving localised problems either by transferring excessive flows in drainage systems downstream by upgrading sewer pipes ... Problems of downstream flooding and pollution and the realisation of the interdependence and interaction of the effects of the localised control measures, has focused attention, in more recent times, on the need for an integrated systems approach which looks at urban drainage networks as part of integrated catchment systems."*

White and Howe, (2002) make the point that:

> *As development coverage and land use change increases, the natural storage capacity of the basin may decrease. Furthermore, an intensification in the amount of mainly impermeable surfaces, results in a higher velocity of runoff from rainfall. Water that would have previously recharged the water table is now transported quickly into the nearest watercourse.*

Similarly, Reed et al. (1999) state that incremental development increases runoff volumes incrementally and will aggravate flood risk lower down the river system. They point out that urbanisation reduces the "*beneficial buffering effect of seasonal moisture deficits*" and increases the proportion of the year when floods can take place. The Adaptation Sub-Committee of the Committee on Climate Change (2012) further suggest that an increase in surface water flooding due to the prevalence of hard paving in urban areas may grow with more intense rainfall due to climate change.

White and Howe, (2002) proposed the enhancement of planning controls along with sustainable drainage systems, or SuDS, These have since been encapsulated in planning regulations and enforced under the Water Framework Directive 2000, completing the 10 year evolution of a conceptual, novel idea to a standard design in mainstream urban development, (Goodson, 2011).

SuDS is defined as a portfolio of surface water mechanisms, which seek to detain water from gravity channels by means of attenuation, infiltration or temporal storage. These can improve water quality by infiltration, replenish groundwater storage, or simply delay the downward flow of runoff water to reduce peak flow levels (Goodson, 2011). Shropshire Council (2010) list

SuDS methods to include: green roofs, soakaways, infiltration techniques, wetlands and rainwater harvesting. These are detailed in Table 2.1:

Type	Description
Balancing Pond	A pond designed to attenuate flows by storing runoff during the peak flow and releasing it at a controlled rate during and after the peak flow has passed. The pond always contains water. Also known as wet detention pond.
Detention Basin	A vegetated depression, normally dry except after storm events constructed to store water temporarily to attenuate flows. May allow infiltration of water to the ground
Filter Strip	A vegetated area of gently sloping ground designed to drain water evenly off impermeable areas and filter out silt and other particulates.
Green Roof	A roof with plants growing on its surface, which contributes to local biodiversity. The vegetated surface provides a degree of retention, attenuation and treatment of rainwater, and promotes evapotranspiration.
Infiltration Basin	A dry basin designed to promote infiltration of surface water to the ground.
Road Side Rain Gardens	Reversing historical trends in developing impermeable front gardens back to green open areas to help attenuate flows at a property level and improve and link habitats.
Permeable Surface	A surface formed of material that is itself impervious to water but, by virtue of voids formed through the surface, allows infiltration of water to the sub-base through the pattern of voids, e.g. concrete block paving.
Rainwater Harvesting	A system that collects rainwater, for use in the property, from where it falls rather than allowing it to drain away. It includes water that is collected within the boundaries of a property, from roofs and surrounding surfaces.
Swale	A shallow vegetated channel designed to conduct and retain water, but may also permit infiltration; the vegetation filters particulate matter

Table 2.1 Options for SuDS techniques. Source: Shropshire Council (2012)

Similar techniques on a larger scale are proposed by the EA (2012e) for more rural applications, in 'Rural Sustainable Drainage Systems'.

2.5. Resilience

Resilience can be defined as *"the capacity of human and physical systems to cope with and respond to extreme events" Bosher et al. (2009) and in the case of flooding can* take many forms, from building protection using wet or dry flood proofing, to householder support services, or flood insurance.

2.5.1. Flood-proofing

Flood resistant buildings are considered by Rickard (2002b), who proposes raised living areas, concrete rather than wood floors, higher level power sockets and wiring, and non-wood kitchen materials. This uses the technique of 'wet' flood proofing – permitting flood water to flow through the lower levels of the house, and using appropriate design and materials to resist the effects of water rather than vainly resisting the water itself. The traditional technique

of ‘dry’ flood proofing relies on external barriers to resist the intrusion of floodwater into the house, which can only have limited success, and even when successful can cause structural damage by the pressure of external water.

2.5.2. Flood Insurance

Insurance can offer the benefit of spreading the cost of flooding over time and space, but as Arnell (2000) points out, this arguably allocates a disproportionate cost for those who choose to live in low risk areas. He also raises concerns that comprehensive flood insurance, while protecting householders from loss, can also encourage occupation of flood plains by emphasising protective measures after construction, rather than wise land use. He considers the merits of schemes in such countries as the US, where a national flood insurance programme (NFIP) provides financial protection for communities in existing buildings whilst restricting cover for newer constructions in high risk areas. By linking the penalties to the decision maker, flood risk management can directly affect land use control. In France and Australia there exist similarly linked scheme with insurance which pays householders only if local land use rulings have been observed. Few countries, however, link land use to insurance payouts in this way.

Shaw et al. (2011) point out that historically, communities have expected the state to solve their problems; to reduce the likelihood or consequences of a flood, and to subsidise insurance. This philosophy now appears to be shifting, a change which exposes tensions between individual and collective responsibilities, as can be observed in a recent renegotiation of flood insurance in Britain. Recently the Association of British Insurers (ABI) has been lobbying the government to share the financial risk of underwriting of cover for householders in flood prone areas. This fundamentally changes an arrangement that remained in place for more than 50 years.

Huber (2004) describes the 1961 arrangement as a ‘gentlemen’s agreement’, between Government and the insurance industry. This agreement divided the responsibility between the state provided flood defences, and the private companies insuring householders for flood. The insurers guaranteed that residential properties could insure again flood risk at an additional premium not exceeding 0.5% on the sum insured, no matter what the risk. However, increasing flood risk due to climate change trends and land use changes, and several serious flood years (1998 and 2000), combined with a perceived lack of state investment in flood protection, led to alarm on the part of the insurance industry, who initiated renegotiations between with the government.

As a result, a finite term ‘agreement of principles’ was settled in 2002, to include a commitment from the government to increase flood defence spending and further regulate land use controls. The insurance industry agreed to insure ‘as many as possible’ residential properties at a competitive rate but reflecting actual flood risk. This agreement expired in June

2013, by which time further flood events had occurred in 2004, 2007 and 2012, so three working groups were established to continue negotiations with the Association of British Insurers (ABI), (House of Commons Library, 2013a).

Johnson and Priest' (2008, p522) consider that the progressive emphasis on non-protective measures greatly affects this agreement, leading to the conclusion that the insurance industry is:

> *".. likely to remain committed to lobbying for continued investment in structural defences since these are the factors that will allow them to reduce claims and maximize profit."*

This requirement for flood defences put the insurance sector out of step with current trends in flood risk management.

Defra Network (2013) announced a new agreement in July 2013:

> *"The new agreement will cap flood insurance premiums [according to council tax bands]... To fund this, a new industry-backed levy will enable insurance companies to cover those at most risk of flooding. All UK household insurers will have to pay into this pool, creating a fund that can be used to pay claims for people in high-risk homes."*

The Association of British Insurers (ABI, 2013) describes the agreement as:

> *"..an agreement in principle between UK insurers and the Government to develop a not-for-profit flood fund – known as Flood Re – to ensure that flood insurance remains affordable and available to homeowners at high flood risk."*

This renegotiation could be seen as following a gradual trend from state support to individual responsibility, while walking a fine line to balance political and commercial demands.

2.6. Institutional Management

The past 25 years have seen repeated updates in British legislation for drainage and water supply, now showing a new interest in flooding. These statutes consolidate centuries of change, from agricultural drainage to the tenets of environmental protection and flood risk management. In order to drive these principles onward, new hierarchies and layers of control have been established, in an attempt to rationalise management of surface water (Johnson and Priest, 2008). The Policy Investigation in chapter 4 further examines how the paradigm changes discussed above in section 2.2, have culminated in strategic changes in direction for key institutions.

A number of ethical dilemmas are presented by flooding, as considered by Parker (2000b), especially the responsibility for protection, warning and safety of the public. Policy decisions set the framework for this moral responsibility held by landowners, developers, planners, architects, engineers, government and householders.

2.7. Lessons from other countries

Crichton (2012) points out that Scotland sets an example to England in efforts to reduce flood risk and build resilience. Despite the fact that 2011 recorded the highest rainfall in Scotland since 1910, no major flood losses were recorded. This is attributed to a combination of legislation, liaison work, and negotiation with insurers.

Flood Liaison and Advice Groups (FLAGs) were established in 19 areas between 2000 and 2003, informally resolving flooding and planning issues by participatory work with councils, insurers, planners, developers and all key stakeholders, to solve flooding problems together. Supporting this, legislation known as SPP7 prohibits residential development where the flood risk exceeds the 1 in 200, meaning that development in flood hazard areas is now negligible in Scotland:

> *"This firm approach has meant that developers have by now sold almost all their land banks in high-risk areas and accept that they will never get permission to build there."* Crichton (2012)

In addition, Scottish councils have a statutory duty to maintain watercourses, initiate flood defence projects, and report every two years on flooding problems and preventative action. Such legislation enhances the councils' motivation for preventing floods and could even establish a legal liability for flood compensation from the council. Finally, resilient reinstatement is encouraged after a flood or storm, so that repairs are carried out to enhance the buildings' future resilience to inundation (Crichton, 2013).

Smith (2000) considers the dichotomy in the United States where higher tiers of government subsidise risk by providing state insurance, financing disaster aid, and building state flood defences. This reduces the incentive for local institutions to improve flood plain management, as they are not the main risk-bearers. He uses, Australia to exemplify a move from coercion to co-operation, where New South Wales requires a 1:100 flood exclusion zone to be imposed by local government for all new development. As the local authority is held liable for any losses to new development from flooding, this creates a stronger incentive to comply with correct flood zoning. He advocates this as a way to "*get the state out of the business of subsidising risk*"

In contrast, Thompson and Sultana (2000) discuss deficiencies in the flood management strategy of Bangladesh, a country where a regular flood regime has historically been used for economic benefit. With no agency specifically responsible for flood management, increased flooding is regarded as nobody's problem. In addition, conflicts of interest generated by wealthy landowners means that there is no real support for reforming legislation. Thus a weakened state can abandon poorer communities to the risks endemic in a changing flood regime.

2.8. Future Risk

Pressures caused by increased urbanisation, land use changes and changing patterns in agriculture have been creating new demands on land use. These are now combined with changes in climate patterns to stress the river and drainage beyond previous expectations:

> *"The two main factors affecting floods, the meteorology and the physical conditions in the river basin, have both varied significantly in the recent past", (Fleming and Frost, 2002, p6)*

Converging evidence on climate change supports the estimation that peak flows over a given return period could increase 20% in 50 years (NCE, 2001).

According to the Adaptation Sub-Committee of the Committee on Climate Change (2012):

> *"Current evidence suggests that increases in rainfall intensity and the frequency of high river flows are likely under a changing climate, leading to an increased risk of surface water and river flooding in the UK".*

This report makes it clear that flood has been identified by the Government as one of Britain's largest current risks. In addition, the Climate Change Risk Assessment (2012) identifies that flood risk is projected to rise significantly in Britain, from £1.3 billion, to £2.1 - £12 billion by the 2080s.

2.9. Summary

The material reviewed considers factors as various as hydrology, flood risk management, land use changes, climate change and issues from other countries. These give a good basis for further exploration into the research questions and objectives. The lack of directly relevant material is noted, and considered indicative of lack of research in this area. Every opportunity has been taken to explore a diverse range of background knowledge in order to inform this investigation with the relevant philosophies and technologies in this area.

3. Methodology

This chapter describes the methodology used within this project, expands on the sources of data to be used, and compares this approach with those employed by previous researchers in this field.

3.1. Approach

According to Guba and Lincoln (1994) a paradigm is the researcher's world view, defining a basic set of beliefs about the nature of the world and establishing the researcher's place in that world. Each researcher's belief set defines their inquiry paradigm, in this case the methodological question, determining how to investigate the inquiry in hand. This paradigm may be positivist, denoting a traditionally scientific approach to data, or constructivist, indicating a more dialectical approach; however it may not encompass both. Given the policy review aspect of this research, there is a clear positivist approach to the paradigm behind this project, indicating a mainly quantitative methodology. Maps, legislation, and boundaries of responsibility are irrefutable evidence and objective data, playing a major part in determining responsibilities for water management.

Regarding the methodology behind the research, this may be quantitative or qualitative or even mixed (Guba and Lincoln, 1994), and in this case the methodology is mainly quantitative. Transect walks, both physical and theoretical, are used to map boundaries of responsibilities: these are of a quantitative nature, and may be complex in interaction, but still feasible to illustrate on a map. Interviews are more qualitative in nature and may add richness to the data, but still contain quantitative data and are used to reinforce findings and triangulate information.

Triangulation will be used to validate data collected by each method, for instance regulations will be reviewed directly, then an attempt made by interviews or observation to assess the implementation of regulations in practice. Transect walks will then validate the data gleaned from previous sources.

An inductive reasoning approach will be taken here, working from the bottom up to gather information, then to develop generalisations and theories. There is no preconceived theory to prove, rather an interest in the effect created by multiple institutions managing surface water in a flood prone area.

3.2. Approach observed from literature review

The literature assessed used a variety of data sources, including interviews with key stakeholders, physical observation, literature reviews, and policy reviews. Key background material such as Caponera (1992), Sewell and Barr (1977) and Parker and Sewell (1988) developed policy reviews mainly by consulting legislative and policy documentation.

Input to policy decisions includes reviews such as the Pitt Review (Pitt, 2008), which examines over 1000 written submissions, as well as consulting widely, reviewing other countries and visiting flood-affected communities. Other source reviews include the "Flooding" report by the House of Commons EFRA Select Committee (2008), which solicited data from members of the public and MPs; held a formal inquiry hearing MPs, flood-affectees, and expert witnesses; as well as visiting flood-washed towns.

Among the more analytical material, Coulthard and Frostick (2010) specify that they draw on studies and independent reviews (Coulthard et al., 2007), which draw information from primary stakeholder discussions, reports from the public, statutes and incident reports. Others, such as Bosher et al. (2009), use mixed sources; interviewing professionals from construction, planning, insurance, emergency management and local/national government agencies, as well as assessing questionnaire responses.

The methodology adopted by Watson, et al. (2009) consists of analysing a mix of data sources: content analysis of policy documents, grey literature and academic publications, plus observations at planning meetings, and interviews with senior stakeholders. This is supported by similar methodology used by Porter and Demeritt (2012) who triangulate information from formal policy documents with semi structured interviews with Environment Agency (EA) staff, followed by deeper unstructured interviews with local planners.

In general, a pluralistic approach can be observed, combining data from policy reviews, interviews, written submissions and site visits, and this approach is to be emulated as far as possible within this project. The transect walk approach appears not to have been used in any of the literature examined.

3.3. Case study

The core of this project is the case study, offering the opportunity to sample data from five locations within the catchment. This permits examination of many paths of water from different terrains, logically tracked from precipitation into a river and thence the sea. This track is mapped onto the responsible bodies, to directly denote institutional management of that water. The intention of this mapping is to examine the complexity of current management responsibilities.

3.3.1. Reason for case study approach

The case study approach enables a number of runoff paths across the catchment to be mapped, linking water flows and sources to their respective responsible owners. The challenge then is to find an explicit method for presenting this relationship mapping. This is addressed in section 3.8 below.

The River Severn has been chosen partly due to its length; at 290 kilometres it is considered the longest river in Britain, draining an area of 2,065 km^2, and as a consequence its diversity.

Changes in flow and demeanour are evident as it flows down from the Welsh hills, into Shropshire then across the lowlands of Worcestershire and Gloucestershire (Biggs, 2009). It ultimately evolves into the Severn estuary where it is bridged by the 990m span Severn Bridge, before flowing into the Bristol Channel and Irish Sea (Encyclopaedia Britannica, [n.d.]).

The river rises at over 800m above sea level, in an area where average rainfall exceeds 2000mm. It has several mountain tributaries before reaching the Montfort gauging station near Shrewsbury. The drainage area for Montfort is 4325km^2, with 50,000Ml of storage developed in 1968, at Clywedog reservoir (known locally as Llyn Clywedog, see Figure 3.1). However this reservoir is near the river's source, where it can provide minimal flood storage, and has a drainage area of only 49 km^2 (Shaw, 1989). These factors all contribute to the diversity and longstanding flood history of the River Severn, making the catchment an interesting area for study.

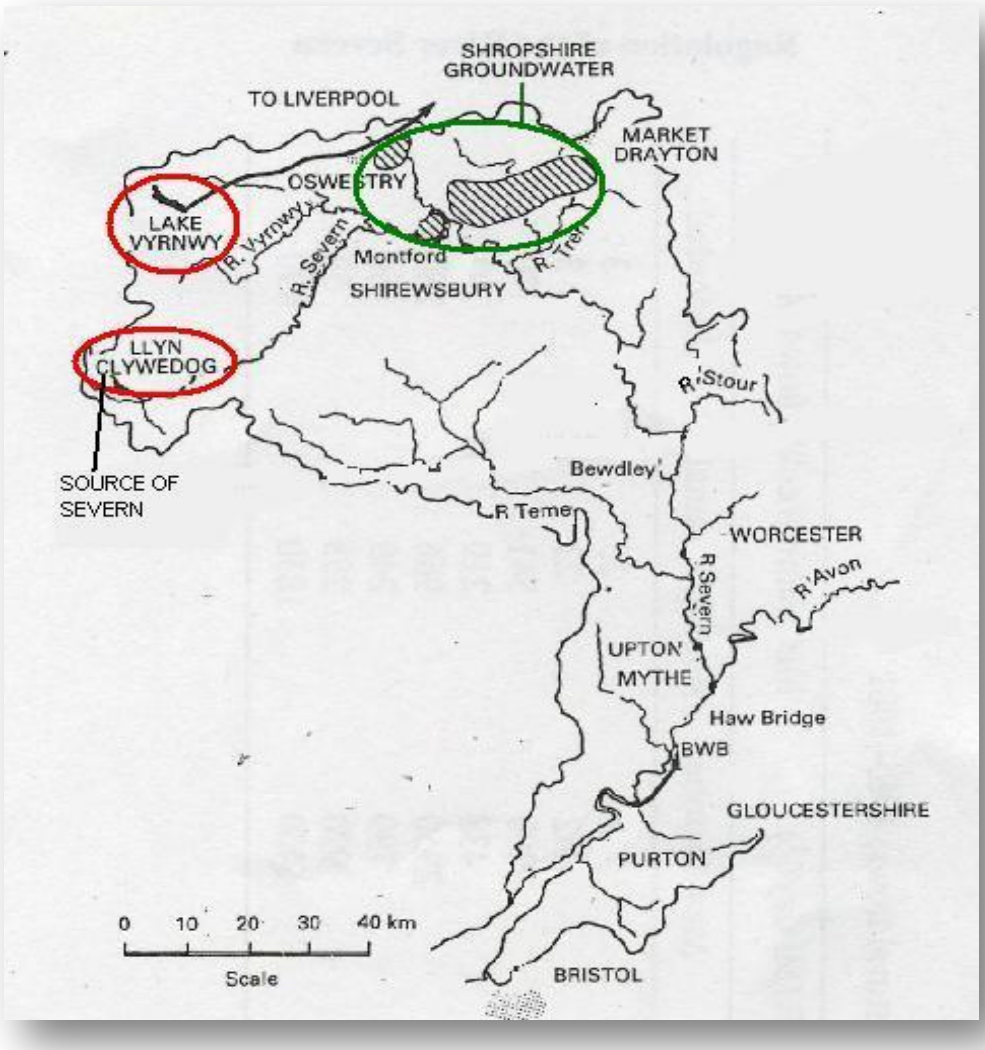


Figure 3.1 Upper Severn catchment, showing water storage. Source: Shaw (1989), annotated by author.

At least one town on the Severn is sought for a specific case study area. Preferred aspects of this location include: regular new development, both industrial and residential; a recent history of flood events, a wide range of managing entities and diversity of topographical features.

3.3.2. Selection criteria for case study area

In order for the final relationship mapping to be meaningful, it is important to select the case study area carefully. A methodical selection is necessary to avoid the effect of researcher bias, so a series of selection criteria has been developed and tabulated for comparison.

It has been decided to select an area with a history of flooding, where management of surface water is taken seriously, in order to explore the institutional link with disaster risk reduction. For this reason several of the criteria are linked to flooding. The flood history of the area is included, especially the number of years designated as major flood events. Consideration is given to current flood protection, and any other factors such as local resilience to flood events.

Topography is related not only to flooding but also to behaviour of watercourses and the effect of local institutions such as internal drainage boards (which are mainly in the lowlands). Topography is therefore included as one of the criteria tabulated here.

The response of the local authority to the Flood Risk Regulations of 2009 is considered, both as indicating a serious approach to surface water management, and denoting a likely flood risk. The Flood Risk Regulations of 2009 stipulated that the EA and Local Authorities had to prepare Preliminary Flood Risk Assessments (PFRAs) by December 2011. (see section 4.3.3). The PFRA, is therefore one of the key documents to be expected on a comprehensive local authority website. Surface Water Management Plans and flood risk maps need only be produced if flood risk areas are identified in the PFRA. The availability of these additional documents on a council website is taken as indication both that information is available and that flood risk is established in this area.

Availability of other information such as maps, contacts, and guidance documents is included to support these criteria. As evidence of planning regulations is to be one of the threads of investigation, usability of the local planning portal is considered and added as a selection factor. Evidence of a local plan is included for the same reason.

Finally, consideration of local partners is observed from PFRA documents, and included to indicate a variety of stakeholders and potential richness in results.

All these criteria are tabulated for review in Table 3.1 below:

	WORCESTER	SHREWSBURY	TELFORD	TEWKESBURY
LOCAL AUTHORITY	Worc county council	SHROPSHIRE County Council	Telford and Wrekin Council	Gloucestershire County Council
FLOOD HISTORY	1990, 2000, 2004, 2007, 2012, 2013	1998, 2000, 2002, 2004, 2007, 2012	2004, 2007	1990, 2004, 2007
LA WEB INFO	GOOD	OK	OK	GOOD
WEB DOCS	Many, clearly referenced	Many, but only with careful searching	Very few on website	Many on GCC website
CONTACTS	None listed	flood@shropshire.gov.uk 0345 678 9006	Flooding team : Tel: 01952 384876	Not listed
LOCAL MAPS	None on website	Good interactive map	None on website	Link to offsite map
LOCAL PLAN	Full details on website	Framework and core strategy	Core strategy, local plan and action plan	Local plan 2011, Core strategy
PLANNING INFO	search by week, full docs, slow loading	search by week, full docs, efficient	search by week, full docs, efficient	search by week, full docs, efficient
TOPO-GRAPHY	Very flat terrain, historic floodplain	Melverley floodzone. River loops in city	Flat terrain at Telford. Main risk at Ironbridge, in gorge	Flat terrain, confluence of Severn and Avon, floodplain
HEIGHT above sea level	20m above sea level (ASL)	60m in city; 330m above Melverley	140m at Telford, 40m at river in Ironbridge	10m ASL
OTHER LOCAL COUNCILS	Six district councils	Shrewsbury town council		Tewkesbury Borough Council
OTHER FACTORS	Canal through town	Melverley is EA flood point	National Growth point	historic community resilience to floods
LOCAL PARTNERS	Severn Trent. Lower Severn IDB.	Severn Trent Water. Dwr Cymru.	Severn Trent; Strine IDB	LSIDB; Severn Trent, 6 District councils
DOCUMENTS ON WEBSITE	Preliminary Flood Risk Assessmemt (PFRA) only	Surface water mgt, Strategic flood risk assessment, PFRA	PFRA only	Strategic flood risk assessment, PFRA
FLOOD DEFENCES	Permanent flood barriers and walls	Temp flood barriers deployed as needed	Temp flood barriers deployed as needed	Water plant only, £205k budget 2013

Table 3.1 Criteria for selection of case study area. Sources: Data is collated from council websites, EDINA [n.d.], EA [n.d.]a, with flood history data from Black and Law (2004).

3.3.3. Finalising the case study area

Tabulating all the local data available at this stage makes it possible to see the key differences between areas at a glance. It then becomes clear that Worcester and Tewkesbury are similar in terms of stakeholders and terrain, both working with an internal drainage board and Severn Trent Water, and based in low lying areas with broad flood plains (see Figure 3.2). However, information is more readily available from Worcester, with a good quality website and comprehensive document archives and it is judged likely that the size of the city will make it easier to access data, and that the institutional variety will provide more diverse insights.

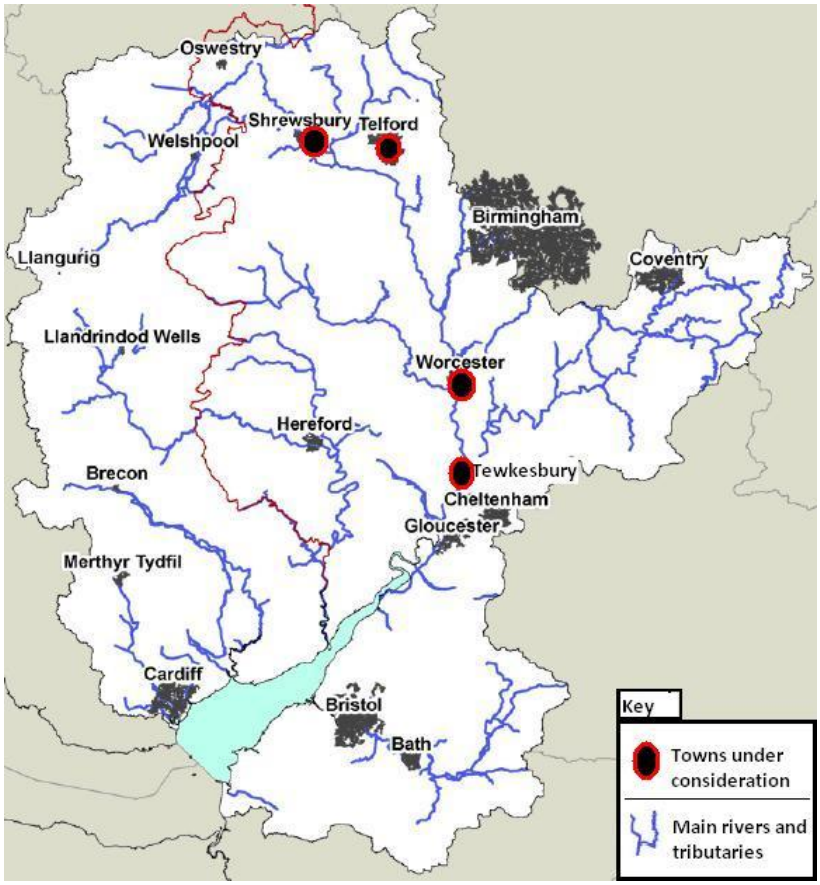


Figure 3.2 Map of potential case study areas in Severn Basin. Source: From EA (2009a, p8), annotated by author.

Shrewsbury is similarly diverse and well sized, with interactive flood maps and many available strategic documents. The terrain is extremely varied with hills and major tributaries close to the west, and the use of demountable flood barriers and necessary protection of historic features offer further interest. The two larger cities both offer diversity of stakeholders and ongoing development, while having contrasting terrain and different local authorities. In contrast Telford, being located in between Shrewsbury and Worcester, offers little additional interest other than a differing IDB (Strine) and a designation as a national growth point. Given that river actually passes through Ironbridge, rather than Telford, it is concluded that Telford has even less to offer than Tewkesbury.

It is therefore judged best to focus data gathering on the two larger towns of Shrewsbury and Worcester, to demonstrate any difference between counties, terrain, and upper/lower reaches of the river. In addition, two smaller rural investigations will also be conducted, to provide balance and reflect the full range of terrain cross the catchment. One location is the source of the Severn, for completeness and mountain terrain, and the other examines the border hills area between England and Wales, to demonstrate administrative diversity.

3.3.4. Selecting the transect walk routes

According to Population Communication Services (PCS) [n.d.], a transect walk is conducted by following a pre-mapped path through all zones of project interest, in order to observe local conditions and obtain detailed information. The intention in this project is to observe conditions along the likely path of travel for surface water. In a typical transect walk this includes social conditions, but here the main issues are ownership and responsibility boundaries, along with physical channel conditions.

Ibbitt et al. (1997) and Jones (2000) all note that antecedent storage conditions will affect runoff, including the shape and slope of catchment, permeability of ground, channel slope and roughness, and land use. The locations for the transect walks are therefore selected with the aim of traversing many of these aspects, in order to present a representative sample. Multiple routes are plotted for each location, in order to provide sufficient samples for a variety of final diagrams.

3.4. Sources of data

The following are proposed as sources of data:

3.4.1. Literature review

A literature review is undertaken in order to establish the extent of previous work in this area, to establish any gaps in information and to structure background data. It is necessary to understand current thinking on issues such as flood risk management, hydrology, sustainable drainage, international approaches, flood insurance and development on flood plains. This will facilitate informed decisions regarding methodology, especially data collection via transect walks and interview questions. See Box 3-1 for details on search methodology.

3.4.2. Policy review

Legislation and policy are a key source of institutional data, therefore an exploration of such data is undertaken in the form of a policy investigation. This includes recent statutes relating to water resources, flood management, surface water control and drainage, as well as older legislation with a bearing on the subject. In addition, regulation and policy documents regarding planning, highways and waterways are investigated where they have a bearing on roles and responsibilities towards surface water. A detailed understanding of relevant

regulations and recent legislation is necessary in order to appreciate the distinctions between different institutions and their responsibilities for different aspects of surface water.

3.4.3. Information issued by institutions

Information issued directly by institutions, such as flood maps, surface water management reports, statutes and regulatory documents are an essential source of data for the policy review and are used to direct data collection.

Information is maintained at a current level by registering for email updates on government websites, planning portals, and professional bodies. Data from these sources needed careful reading and triangulation to establish detailed facts, but are often the only source for hard background information.

3.4.4. Information from contacts

Contacts have been established as per Table 3.2 and useful information has been forthcoming immediately from some contacts. Lower Severn IDB has given full information and references, Shropshire Flood Manager has shared local documents, and Wychavon District Council (who deal with drainage on behalf of Worcester Council) has shared useful background information now that the right person has been located. The EA has responded with an offer for interview but Severn Trent has failed to reply other than to repeatedly acknowledge receipt and promise a response within 10 days.

ORGANISATION	INITIAL EMAIL	INITIAL NUMBER	DATE OF REQUEST	RESPONSE	TITLE	LAST ACTION
Shropshire Council	flood@shropshire.gov.uk		30/05/13	yes	Flood and Water Manager,	reply 6/6
Worcester Council (Wychavon DC)	customerservicecentre@worcester.gov.uk		07/06/13	yes	Senior Asst Engineer, South Worcester Land drainage partnership	reply 24/6
Environment Agency	enquiries:environment-agency.gov.uk	01709 389 201 (Mon-Fri, 8am - 6pm)	08/06/13	yes	Flood & Coastal Risk Management Advisor - - Partnership & Strategic Overview Team	reply 27/6
Severn Trent Water	customercare@severntrent.co.uk	08456 016 616	08/06/13	receipt only	None	chased 19/6
Lower Severn IDB	admin@lowersevernidb.org.uk	01454 413340	08/06/13	yes	Civil Engineer, Lower Severn Internal Drainage Board	Interview 11/07/13
Agricultural / landowner?	N/A		08/06/13	yes	Farm Manager, Powys.	

Table 3.2 Contact details for stakeholder interviews. All data from organisational websites and enquiries.

The ensuing interviews should provide enlightening insights from professionals involved in the sector at an operational level.

3.4.5. Theoretical ‘transect walks’ across case study areas

Before the physical transect walks could take place it is necessary to perform the same route as a desk ‘walk’. This fulfils the purpose of investigating the terrain and any likely findings in a short time, enabling the most institutionally varied router to be selected. This work is carried out using paper maps, local authority interactive maps, and the academic mapping tool Digimap, which permits examination of contours and watercourses in detail.

3.4.6. Tracking planning request - including flood risk advice

In order to establish the relationship between the EA and Local Authorities with regards to local planning permission, an example has been sought of a planning application for housing development in a flood risk area. This would normally require submission of a Flood Risk Assessment (FRA) and would serve to highlight the advisory role of the EA in such cases. As part of this investigation, local strategic plans for surface water management are reviewed alongside the planning application.

3.4.7. Interviews with stakeholder representatives

A number of different institutions have been approached in order to understand how these responsibilities are implemented in practice in the case study area. Subsequently, contacts within local authorities, the environment agencies and other stakeholders have been developed in order to interview representatives of each institution directly. This includes organisations such as Internal Drainage Boards, local land owners or users, the EA and relevant Local Authorities, in order to assess the responsibilities accepted by different stakeholders in this issue.

These contacts are interviewed in a semi-structured format, with prepared questions but following interesting aspects as they arose. The intention is to highlight exactly how the different responsibilities are implemented in practice in the case study area.

This approach enables the triangulation of data, whilst obtaining new perspectives and insights into real world problems and common solutions.

3.4.8. Transect walks across case study areas

Transect walks provide the final ‘boots on the ground’ approach to the investigation, tracking the route taken by surface water as it passes through the case study area, ultimately identifying ‘ownership’ along the route. A variety of walks are selected, seeking to cross as many differing zones of institutional management as possible, to explore the interaction between various entities. These are selected from the theoretical ‘transect walks’, benefiting from the previous investigation in order to select the richest potential runoff route.

Literature Search Techniques

Snowballing

Three papers acted as a trigger for this research project (Coulthard et al., 2007, Coulthard and Frostick, 2010 and Porter and Demeritt, 2012). All have proved useful in terms of content and further references, as well as leading to newer publications which cite them. This technique of snowballing from relevant papers is one effective search technique, but requires discipline to track links effectively. It also risks repeating the same influences and sources.

Initial library catalogue and shelf searches for background on water institutions lead to institutional websites and further links which generate more documents. More academic papers are then sought for a more critical analysis of these institutions..

Database searches

Searching library databases and Google scholar for fresh material requires inventive use of search strings. Checking keywords for relevant documents already identified, suggests:

governance; drainage; urban drainage; SuDS; flood; risk; regulation; bureaucracy; institutional arrangements; institution; statute; legislation; governance; government; England; Wales; Britain; UK; Europe; risk governance; bureaucratic...

These are searched in combination and refined to produce manageable results. Searching geo/eco/water databases in this way yields excellent results, including direct links to relevant journals. The search strings are refined as the issues are explored, a better understanding of the topic is developed and the evaluation of source and content becomes faster.

Multiple options for England/Britain/UK necessitate repeated searches with small changes to the search strings. This is time consuming, and multiple keywords denoting ‘institutional’ or ‘governance’ compound the effect. .

Rapid evaluation

Scanning long results lists by eye becomes the most effective technique for refining results. This requires rapid judgement based only on title details; however, several factors soon became clear evaluation criteria. Firstly, the most useful publications are post 2007 floods and the consequent regulatory adjustments. Secondly, much of the institutional data is superficial and publicity orientated. Papers are therefore judged by date, author and publisher, as well as recommendations from academics or contacts.

Abstracts are then skimmed in order to establish relevance, and interesting content can be scanned for pertinent topics and interesting insights. In this way, large numbers of relevant documents can be identified.

Box 3-1: Literature Search Techniques

3.5. Stakeholder analysis

Stakeholders in this case are likely to include:

- Defra
- The Environment Agency
- Local Authority (as Lead Local Flood Authority).
- District Councils. (who may implement surface water management in practice)
- Internal Drainage Boards (such as Rea IDB, Lower Severn IDB)
- Local Planning Authority
- Highways Authority
- Highways Agency
- Severn Trent Water
- British Waterways (where canals exist, such as Worcester)
- Private landowners
- Business and agricultural land owners
- Organisational landowners such as Shropshire Wildlife Trust.
- OFWAT

The analysis chapter assesses the various stakeholder responsibilities for the watercourses identified from the mixed data sources. A combination of source data is synthesised, using policy documents, interviews with key stakeholders, map data and physical observations.

Graphical diagrams present the influence of all relevant agencies, exploring the complexity of institutional management in flood risk areas, and any mitigation by recent legislation.

3.6. Tools used

Large scale ordnance survey maps are a key tool for theoretical catchment analysis. This includes both paper and interactive maps, with particular use of Digimap to establish key points in the catchment and assess many of the selection criteria in the case study area. Digimap is also used to develop theoretical 'transect walks', as well as permitting annotation in order to illustrate findings in the final presentation. These annotated maps are then printed for use as reference while performing physical transect walks. Digimap also offers the facility for historic maps from the 1890s onwards, permitting the identification of culverted city watercourses which previously flowed overland.

Graphical diagrams are to be developed using readily available PC tools such as Paintbrush, MSOffice Picture Manager and Visio, which are also used to adjust and annotate photographs and maps. Document search and evaluation tools are detailed in Box 3-1: Literature Search Techniques.

3.7. Limitations of Methodology

This approach gives the benefit of multiple sources, enabling data to be triangulated, verified and enriched. The policy investigation provides direct information on institutional roles and responsibilities, the theoretical 'transect walk' permits the optimal route to be selected, and the physical transect walk offers direct observation, possible adjustment and deeper investigations. Interviews are then used to corroborate this data and develop new insights. Such a rich range of data should permit a broad understanding of the issues revealed.

However one limitation of this approach is anticipated as difficulty in persuading stakeholders into interviews, or limitations in frankness of interviewees. Planned mitigation includes attempting to establish contacts with multiple organisations from an early stage in the research. Further problems could be in accessing internal data, such as sewerage or drainage maps, or reasons for planning decisions. Where such information is not available, a logical assumption is made and the reasoning behind it explained in the assumptions section.

In many cases surface water runs across private land and access may not be possible (Figure 3.3). It may be necessary to surmise some surface water routes from contours and OS maps.

Figure 3.3 Padlocked access to Rad Brook, Shrewsbury. Photograph taken by author, July 2013

3.8. Presentation of findings

Data established by these means is presented initially by a mapped route in graphical format, using annotated Digimap output to demonstrate changes in terrain and route. These maps are then analysed, data extracted, and further expressed using colour coding to illustrate all changes in institutional responsibility.

Finding a meaningful illustration which works in a paper format presents some challenges, as few precedents are found for such work. The initial preference is for a colour coded line to represent institutions along a transect route; however this presents limitations in terms of representing the terrain as well as ownership and responsibility. The main aspects to be illustrated are: the physical form of water, type of channel ownership, the terrain, and drainage responsibility. In this manner it is hoped to present useful analytical data for further exploration.

4. Policy Investigation

The paradigm shifts observed in section 2.2 have naturally been reflected in incremental changes in policy and legislation in Europe and the UK. This policy framework forms an essential aspect of the research data, underpinning the water sector and defining how stakeholders interact. The purpose of this chapter is to examine the current state of water management policy, with particular regard to recent legislation for management of surface water

Policy information was often gleaned directly from government legislation, with strategy papers, official reports and analysis literature illuminating further details. This critical policy review then provides the contextual framework for the subsequent data analysis undertaken in chapter 6.

4.1. Scope of Review

The legislative division of water management into separate functions of resources, drainage and floodwaters has led to a raft of complex legislation and multiple institutional management entities. This has not only created the tangled environment leading to this research, but also makes the study quite extensive. As a result some boundaries have been placed on researching the legislative acts, limiting these to the most relevant legislation of the past 100 years, focusing on analysing those of the past 25 years.

4.2. Legislation

4.2.1. Land Drainage Statutes

Fleming and Frost (2002) discuss how historically, towns have long been settled on flood plains, due to the trading advantages, fertile land, and high strategic defensive values. The original agricultural drainage ditches evolved over time and are often now buried under centuries of urban development. As a consequence, the ownership of ancient drainage ditches is often unclear, and based on permissive powers rather than statutory duties.

The **Land Drainage Regulations of 1932** attempted to consolidate a confusing mass of previous regulations and in doing so replaced the Statute of Sewers of 1531 and many ancient local regulations. This Act created catchment boards and Internal Drainage Boards, to manage drainage on a regional level, which was especially important in low lying areas such as the Fens, (*Land Drainage Regulations 1932*). Further legislation followed nearly 30 years later with the **Land Drainage Act of 1961**. This instigated and regulated charging for drainage, while defining the relative functions of the various institutions. The River Board was to cover boundary works, the Local Authorities were responsible for flood management, Internal Drainage Boards (IDBs) retained drainage responsibility, and the Agricultural Land Tribunal still had powers over agricultural ditches (Great Britain, *Land Drainage Act 1961*). A

further Land Drainage Act in 1976 was subsequently superseded in 1991 (Great Britain, *Land Drainage Act 1976*).

The **1991 Land Drainage Act** consolidated the enactments specifying the functions of Internal Drainage Boards (IDBs) and drainage related activities of Local Authorities. It specified the duties, constitution, funding and powers vested in IDBs, and detailed the relative land drainage responsibilities of Local Authorities and Agricultural Land Tribunals (ALTs). ALTs were empowered to manage the interaction between different agricultural land owners, where an order is issued in order to improve drainage across a neighbour's land. The 1991 Land Drainage Act also covered the revised designation of IDBs, the provision of land drainage, and financial obligations related to both (Great Britain, *Land Drainage Act 1991*).

The 1991 Act was itself subsequently updated in 1994 to repeal certain environmental and conservation aspects of the work of IDBs, as well as ensuring access to such areas by the public (Great Britain, *Land Drainage Act 1994*). However 1991 remains the key statute for drainage liabilities and rights (ICE, 2010).

4.2.2. Water Resources Statutes

Growing water scarcity and poor water quality in urban centres led to a review of the water industry in the 1950s. Bold recommendations were made, highlighting centuries of fragmentation into thousands of units, and lack of coordination between agencies, leading to reform of the sector in the early 60s. The **1963 Water Resources Act** (Great Britain, *Water Resources Act 1963*) established 29 River Authorities to replace the 34 River Boards, which had been in place since 1950, in turn replacing Catchment Boards established in the 30s. The River Authorities had similar catchment boundaries to River Boards (Figure 4.1) and took on most of their responsibilities – with some new duties, such as innovations in water management, charging and planning (Sewell and Barr, 1977).

Figure 4.1 1963 River Authority boundaries. Source: Sewell and Barr (1977, p398)

According to Sewell and Barr (1977), water drainage responsibilities were

now shared between River Authorities, Internal Drainage Boards, and Ministry of Agriculture Fisheries and Food (MAFF). This Act was the first to establish water as an economic good; introducing charges and restrictions for water withdrawal for the first time.

It quickly became apparent that this legislation had a number of weaknesses which were sought to be mitigated by the **1973 Water Act**. This further consolidated water agencies and established 10 Regional Water Authorities (RWA) to replace over 1500 water management units, including the 29 River Authorities (Thomas and Ford, 2005).

The **Public Health Act of 1936** had defined most sewers, culverts and watercourses as the responsibility of Local Authorities (Rickard, 2002a); however the 1973 Water Act now shifted responsibility for sewerage, sewage disposal and water supply from Local Authorities to the RWAs, while leaving drainage shared between MAFF and newly created Regional Land Drainage Committees (Great Britain, *Water Act 1973*). This legislation came into force at the same time as the 1974 reorganisation of local government, reinforcing a number of local changes in administration roles, (Ofwat, 2011).

RWAs were now multipurpose bodies, covering water supply, sewerage, and river management, in an effort to consolidate all aspects of water management under one umbrella. A corporate management approach was adopted, emphasising control of costs, and charging water separately from household rates. The National Water Council emerged as a coordination body for RWAs, heralding a distinct move towards nationalisation of the water industry in Britain (Sewell and Barr, 1977).

Nationalisation of the water sector was never fully realised. Changing political ideologies led to the radical **Water Act of 1989,** privatising the ten RWA's and their water supply and sewerage functions. This required the establishment of a regulatory body – Ofwat – to monitor the new regional monopolies. At that point, management of the river functions was transferred to a newly created National Rivers Authority (Shaw, 1998) which was later to be subsumed within the Environment Agency (EA), as part of the Environment Act 1995 (Great Britain, *Environment Act 1995*).

Since 1989, water law in England and Wales has been consolidated and to some extent updated by **The Water Industry Act 1991** and **The Water Resources Act 1991**, then amended by **The Water Industry Act 1999** and **The Water Act 2003**. However the basic principles of the 1989 legislation remain intact (Great Britain, *Water Act 1989*).

More recent proposals include the **Water Bill 2013** now in legislative progress; with its stated intention to reform the water market, protect abstraction sources, enable businesses to select non-local water suppliers, and encourage water companies to trade water amongst themselves.

The current division of responsibilities for water resources can still be summarised as Figure 4.2:

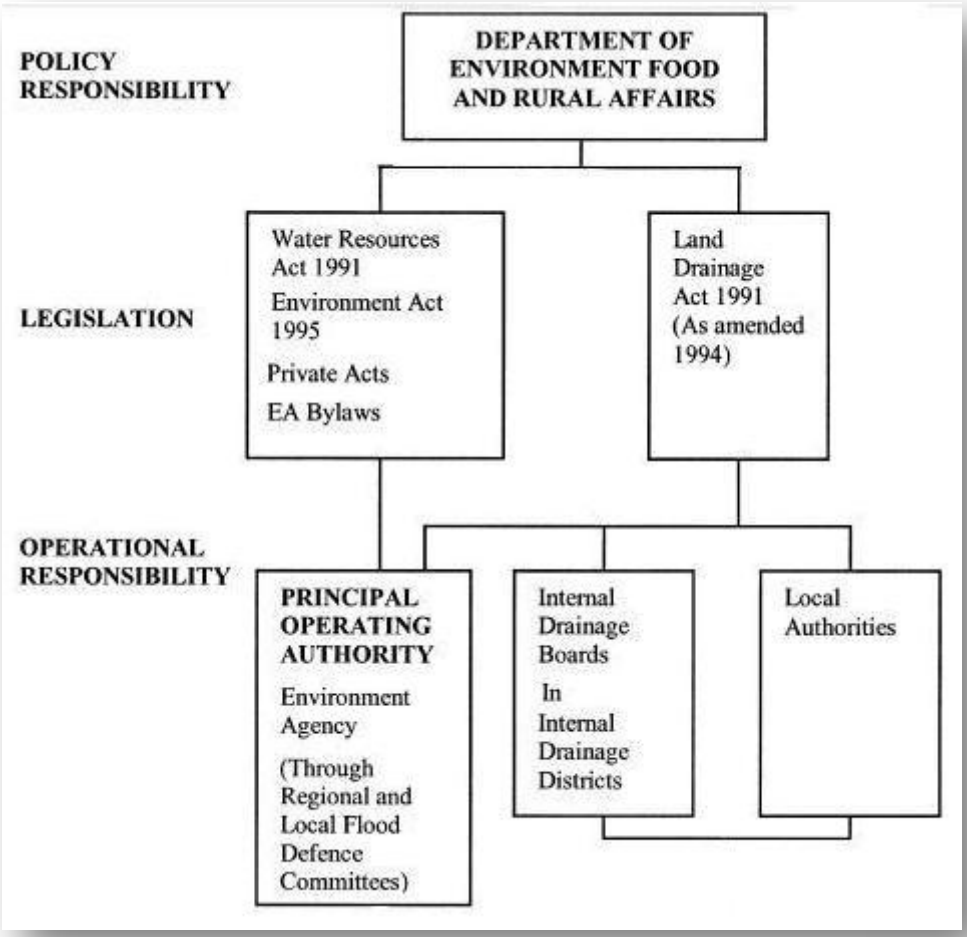


Figure 4.2 Division of responsibility for water management. Source: Brown (2002)

4.2.3. Flood Management Statutes

Until the late 1990s, flooding was not considered a major issue in the UK, so initial legislation in this area emanated from the Council of the European Union. The **European Water Framework Directive 2000** promoted sustainable development for water resources and encouraged the consideration of flood risk, in the context of environmental management, (Goodson, 2011). This directive was focused on cleaning up polluted waters, using a river basin management approach, across multiple countries if necessary. Attention was also given to groundwater depletion and habitat conservation (Council of the European Union, 2000). The EA (2012a) accepted the responsibility for developing River Basin Management Plans (RBMPs) while Local Authorities were required to provide information and assistance to the EA, and subsequently obliged to reflect RBMP data in their planning decisions.

The later sister directive, **European Floods Directive 2007** followed some years of disastrous floods in Europe, including the UK. This Directive required flood risk assessments of all water courses and coast lines, full mapping of the flood risk in these areas and the implementation of coordinated measures to control this risk. This included the imperative to provide the public with access to this information and to include them in the planning process. Both the 2000 and 2007 Directives used the river basin management model as the key to integrated water management. (Council of the European Union, 2007)

Following serious UK flooding in 2007, the **Pitt Review 2008** presented a comprehensive review of events, making a number of legislative recommendations to the government (Pitt, 2008). The hydrological events of 2007 were clearly extraordinary by historical standards. According to Marsh and Hannaford (2007), in the lower Severn basin alone, peak river flows exceeded previous recorded maxima by wide margins. Apparently changing trends in rainfall patterns and clear institutional issues, combined with European Union (EU) directives, all led to the subsequent flood statutes.

The European Floods Directive was implemented under English and Welsh law within the **Flood Risk Regulations of 2009** in order to bring together key partners to manage flood risk from all sources (Great Britain, *Flood Risk Regulations 2009)*. These regulations introduced the designation of Lead Local Flood Authority (LLFA) – corresponding to upper tier or unitary Local Authorities – which were now made responsible for local flood risk from surface runoff, groundwater, and ordinary watercourses. LLFAs were obliged to prepare local surface water management plans and strategic flood risk assessments for their region (Defra, 2011). Where an IDB is in place these retain their existing powers over watercourses and drains, but the flood risk is still managed by the LLFA (EA, 2012c).

The EA had its authority extended to include flood risk from the sea, main rivers, and reservoirs, while retaining drainage supervisory powers. Flood Risk Management Plans and flood hazard maps had to be produced by both Local Authorities and EA for their respective areas of jurisdiction, with a duty to cooperate with each other incumbent upon both parties (Great Britain, *Flood Risk Regulations 2009*).

The Flood and Water Management Act (FWMA) 2010 is normally considered in conjunction with the Flood Risk Regulations of 2009. This legislation reinforced the growing trend towards managing water sustainably and at the catchment level. This was one of the key tenets within 'Making Space for Water' (Defra, 2005), and "Towards a new national flood emergency framework" (Defra, 2008a); strategies which were reinforced by the summer 2007 floods and the Pitt Review (Pitt, 2008).

The key points of this Act reiterated the respective roles of the EA and the LLFAs:

> *"A lead local flood authority for an area in England must develop, maintain, apply and monitor a strategy for local flood risk management in its area",*
>
> (Great Britain, *Flood and Water Management Act 2010*)

As recommended by several of the post 2007 flood reports (Coulthard and Frostick, 2010; House of Commons EFRA Select Committee, 2008; Pitt, 2008) the Environmental Agency had now acquired overarching responsibility for all types of flooding: coastal, fluvial and pluvial, in an effort to integrate response and mitigation works.

> *"To give the Environment Agency an overview of all flood and coastal erosion risk management, and [to give] unitary and county councils the lead in managing the risk of all local floods".* OFWAT (2010)

It could be argued that although the FWMA tasked the EA with the management of river flood risk, it still had no real control of those aspects of drainage which cumulatively contribute to flooding.

4.3. Key Institutions

Coulthard et al. (2007) had expressed concerns that no single agency accepted responsibility for any elements outside their own terms of reference nor had they historically allowed others to influence their own obligations. This was emphasised as a recurring theme - one of inadequate consultation, poor co-operation and lack of unity between the agencies. It was recommended that in future the EA, Local Authority and Water Companies need to co-operate closely on operation, investment and design.

Subsequently, as part of the 2010 FWMA, the EA, LLFAs, IDBs, Highways Authorities and Water Companies were designated as Risk Management Authorities (RMAs). RMAs were obliged by the FWMA to collaborate and share data, in order to contribute to wise land use planning (Great Britain, *Flood and Water Management Act 2010*).

The hierarchy of RMAs and flood risk responsibilities can now be expressed as in Figure 4.3:

The various RMAs and peripheral institutions are examined in detail in this section, along with their changing roles and interactions.

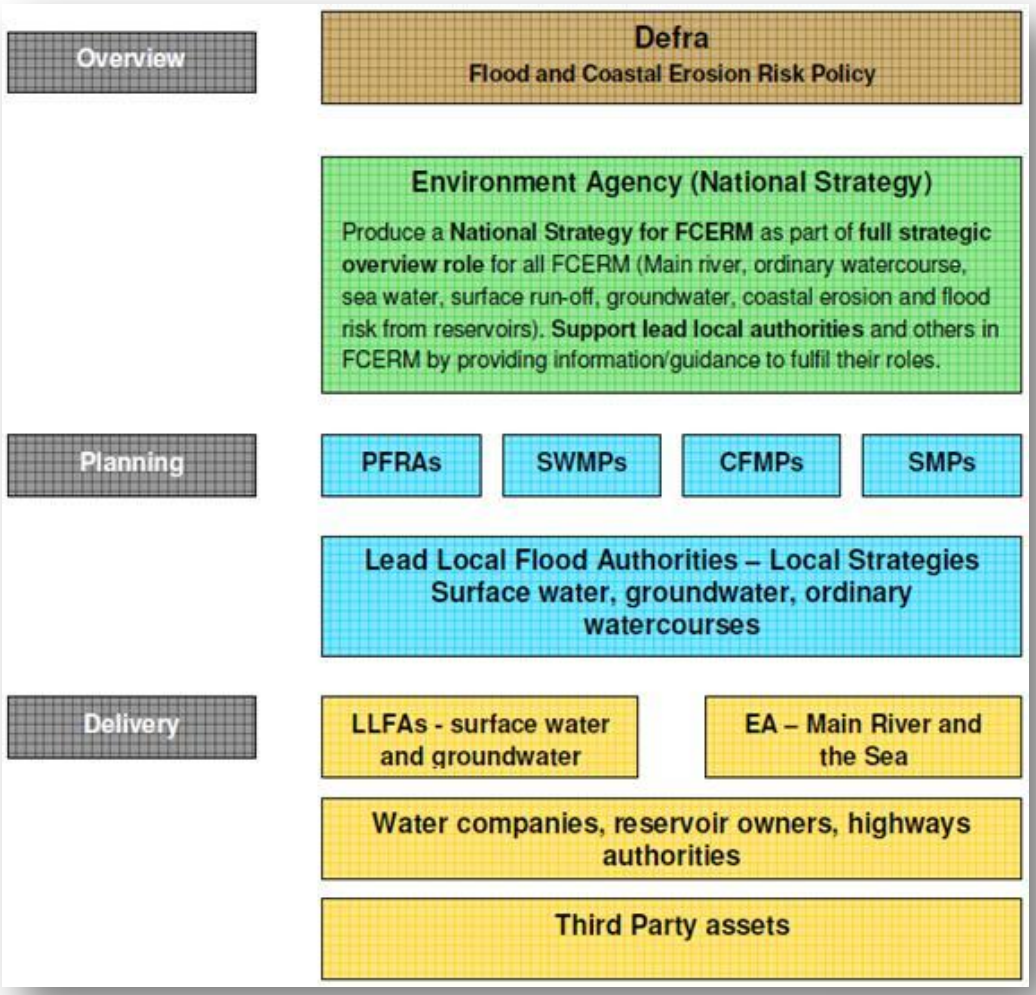


Figure 4.3 Responsibilities for Flood Risk. Source: Shropshire Council (2012)

4.3.1. Department for Environment, Food and Rural Affairs (Defra)

Formed in 2001, when the Ministry of Agriculture, Fisheries and Food (MAFF) was merged with the 'greener' parts of the Department of Environment, Transport and the Regions (DETR), the Department for Environment, Food and Rural Affairs (known as Defra) combined agriculture and rural issues with the newer environmental concerns. Defra is the government department in charge of setting policy and regulations on environmental, food and rural issues, and with its stated aims of *"reducing risks to people from environmental impacts such as disease, climate change, floods",* clearly includes water management under its remit.

In terms of operational and risk management, Defra has delegated the responsibility for main rivers to the EA while the IDBs (where applicable) or LLFAs maintain ordinary watercourses Rickard, (2002a). Landowners, of course, continue to maintain watercourses within their own riparian responsibilities.

4.3.2. The Environment Agency (EA)

The Environment Agency was established as a non-departmental public body by the **1995 Environment Act**; in order to manage rivers and coastal defence, and also to regulate water resources and permit discharges to receiving waters (Ofwat, 2011). At that point they also assumed the functions of the National Rivers Authority (ICE, 2010), based on the catchment divisions depicted in Figure 4.1.

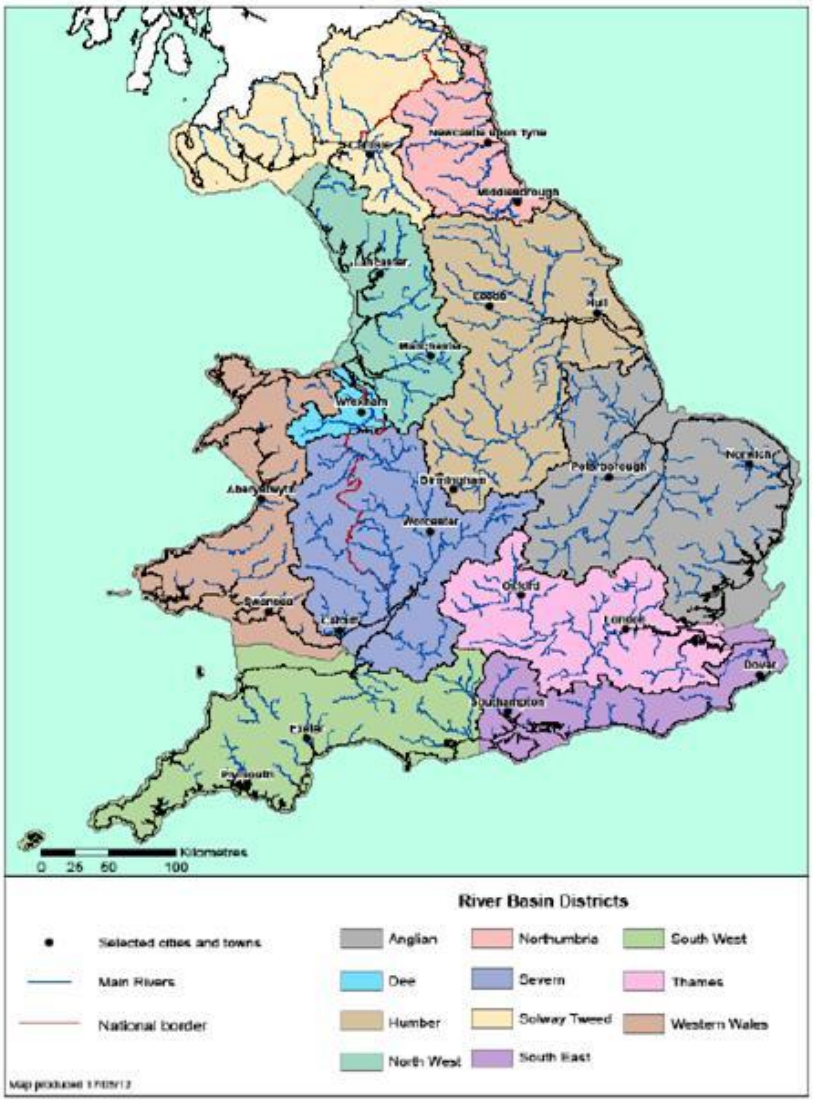


Figure 4.4 River Catchments 2012. Source: EA, (2012b)

They were empowered under the Water Resources Act 1991 to manage flood risk from main rivers and the sea, as well as providing flood warning and forecasting services (Great Britain, *Water Resources Act 1991*). Operational land drainage work is provided through the mechanism of Regional Flood Defence Committees (RFDCs), who may in turn delegate to Local Flood Defence Committees (LFDCs) (Shaw et al. 2011). It should be noted that the EA (2009) powers are permissive, which they define as follows:

This means that we may choose to intervene in the public interest, where we believe works would be beneficial and / or economically viable, but we have no legal duty to do so. This recognises that we have finite resources and must prioritise how we use them.

'Making Space for Water' (Defra, 2005) was a key strategy document for the EA, outlining a 20 year plan for a coordinated approach to land use, planning policy and urban design, integrated with catchment-based water management.

Coulthard and Frostick (2010) point out that there was no system of warning from surface water flooding in the United Kingdom, despite there being an extensive warning system for coastal and fluvial flooding. This was clearly an oversight that led to householder distress during the floods of 2007. This was remedied once overall flooding responsibility was passed to the EA.

The EA (2009a) refers in the Severn Catchment Flood Management Plan to the middle Severn Corridor (Shrewsbury to Worcester), where although "*the risk is currently managed appropriately, it is expected to rise significantly in the long term*". Further protection from flooding will be achieved by reducing dependence on raised flood defences, instead managing development in order to restore river storage on undeveloped floodplains.

Natural Resources Wales (NRW) is a new body accountable to the Welsh Government, taking over the work of the EA in Wales. Working closely with the EA in border areas, they provide the same functions and statutory duties for Wales as the EA does for England.

4.3.3. Local Lead Flood Authorities (LLFA)

Under the enhanced role of a Local Lead Flood Authority as defined by FWMA 2010, Local Authorities are expected to coordinate the roles of other RMAs within their districts, and to respond to advice by the EA, both as a Local Planning Authority (LPA) and as an LLFA. In areas where there are no Internal Drainage Boards, the Local Authority also has a role as drainage authority for all ordinary watercourses in the district (EA, 2006).

LLFAs have a duty under FWMA 2010 to develop a series of flood management documents over 6 years, covering all forms or local flooding (see Figure 4.5). Firstly, the Preliminary Flood Risk Assessment (PFRA) identifies locations of significant flooding, referred to as 'blue squares', based on past and future flooding data. 'Blue squares' are defined as a $1km^2$ square where more than 200 people, 20 businesses, or 2 items of critical infrastructure are at risk of flooding. Once 'blue squares' are identified within the PFRA, related Flood Hazard and Flood Risk Maps must be produced. Flood Risk Management Plans are then required for any locations highlighted in the Flood Risk Maps (Shropshire Council, 2011).

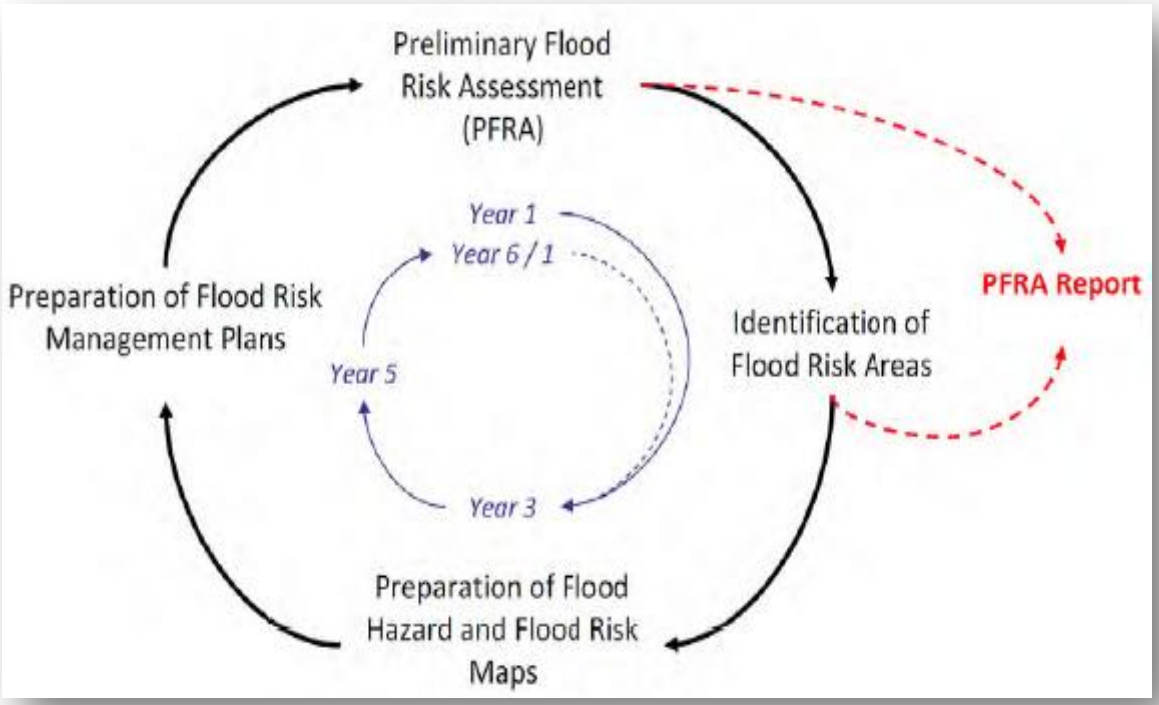


Figure 4.5 Schedule of required flood risk management activity for LLFAs. Source: Warwickshire County Council (2011)

This expansion of role generated an unexpected need for specialist skills to fulfil such an enhanced role. For example, Wychavon District Council (2012) explains that work on ordinary watercourses, previously carried out by the EA or District Councils has now passed to LLFAs. The LLFA in this case delegates all these functions back to the South Worcestershire Districts under an existing partnership arrangement, due to a lack of skills held by the LLFA. This partnership combines the land drainage functions of three District Councils: Malvern Hills, Wychavon and Worcester, enabling them to work more efficiently.

4.3.4. Internal Drainage Boards (IDB)

According to Ofwat, (2011) Internal Drainage Boards (IDBs) were originally formed to control groundwater and local watercourse levels. These were focused in areas that relied on artificial drainage, especially land reclaimed from marshes and the sea, and 170 IDBs still exist, managing 1.2 million hectares of drainage (ICE, 2010). The relevant IDBs for this project are the Lower Severn IDB (LSIDB) covering Worcestershire and Gloucestershire, and three IDBs to the west of Shrewsbury: named Melverley, Rea and Powysland.

IDB powers are summarised by the Association of Drainage Authorities, [n.d.]:

"Under the Land Drainage Act 1991, each IDB exercises a general power of supervision over all matters relating to water level management within its district. In pursuance of this role they can prohibit the obstruction of watercourses within their district.

Thus, anyone constructing or altering a weir, bridge, embankment, culvert or similar obstruction must first seek the consent of the IDB before undertaking works. IDBs also have a series of bylaws relating to the management of watercourses and can designate features and structures within their district which relate to managing flood risk."

These permissive powers are used to clear weed from several hundred kilometres of watercourse, as well as de-silting and re-profiling around 60km of watercourse each year (email from Civil Engineer at LSIDB, 10th June 2013). As stated in LSIDB (2003), IDBs' powers now include a policy on flood prevention and environmental measures.

IDBs' powers may appear to overlap with those of Local Authorities, but they focus only on drainage. Where an IDB exists, it acts as the primary drainage body for that area (ICE, 2010), handing control to the Local Authority at their boundary, or to the EA at the main river. Since 1991 the EA has supervised the work of IDBs, as well as Local Authorities, both being deemed 'drainage bodies' under the Land Drainage Act 1991. This continued with FWMA 2010, which placed duties on Risk Management Authorities (RMAs) to co-operate, share data and have regard to local and national strategies (email from Civil Engineer at LSIDB, 10th June 2013). IDBs are now expected to play a role in helping LLFAs to develop and implement their local flood risk strategies (Association of Drainage Authorities and EA, [n.d.]).

4.3.5. Water Companies

ICE (2010) explains in detail the distinction between watercourses and sewers, as the two are subject to very different legislation and rulings. A sewer is vested in a sewerage undertaker, and the public has the right to discharge into them under the Water Industry Act of 1991, derived from principles within the Public Health Act 1936. Primary responsibility for sewerage and sewage disposal is currently held by the water companies.

Water supply and sewerage management is structured and regulated differently across different parts of the UK, which affects the relationships between the primary entities in each region. England's water and sewerage services are provided by regional private companies which are overseen by regulators Ofwat. In Wales, Glas Cymru is regulated by Ofwat Wales, but has no shareholders as it is run solely for the benefit of customers, while Scotland and Northern Ireland have retained the pre-1989 publicly owned model (ICE, 2012).

The distinction between householders and water companies is clearly defined by Severn Trent ([n.d.], p1). The householder is responsible for waste water pipes that are located within their land boundary (purple lines on Figure 4.6). The water company holds responsibility for the

underground pipes outside the boundary, including those shared between neighbours (in yellow), and connecting to the public sewerage network (in red).

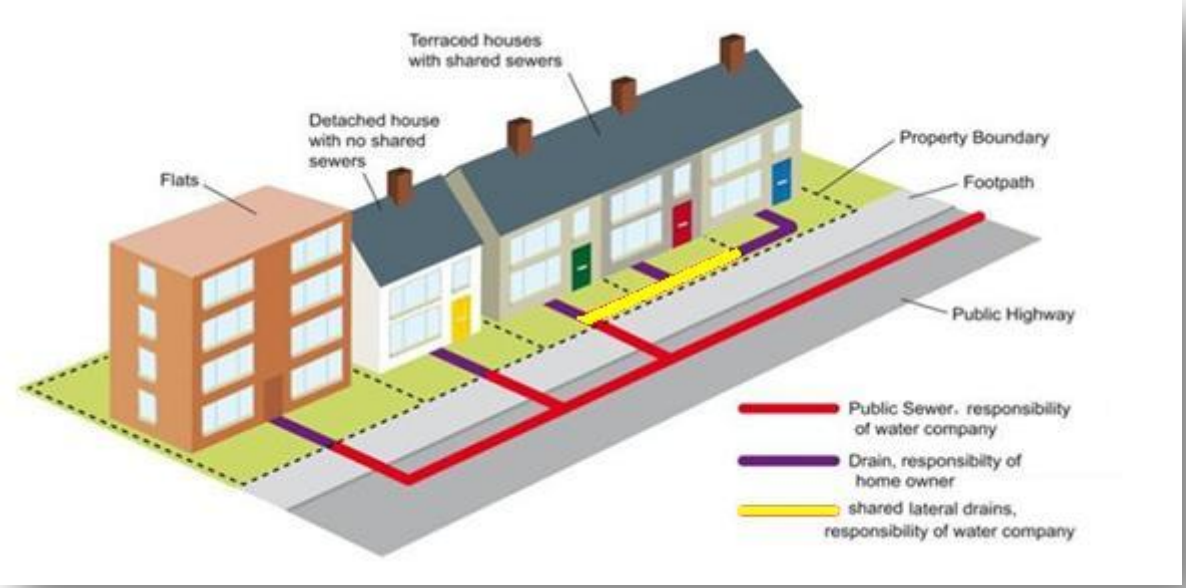


Figure 4.6 Sewerage responsibilities defined. Source: Adapted from Severn Trent Water [n.d].

Many older sewerage systems in Britain have combined flows from different sources; this has a direct impact on surface water management. Combined systems collect both rainfall runoff and foul water, so in times of very heavy rainfall sewers can become inundated and contribute to contaminated flooding. To avoid this, the combined system should include a combined sewer overflow to permit discharging of excess storm water to a watercourse. Fleming (2002b) observed over 10 years ago that while combined sewers had been the norm in the UK for many years, the pressure on such drainage was growing with increased levels of urbanisation and impermeable surfaces, combined with trends of more intense rainstorms. With the advent of sustainable drainage systems (SuDS) (see section 2.4) new housing developments are now assumed to contribute only foul water into sewers, with infiltration systems implemented for surface water (Shropshire Council, 2010).

The House Of Commons EFRA Select Committee (2008) notes that the existing charging structure used by water companies does not encourage reduction of surface water runoff. The result is that much surface water is routed into public sewers, while water companies are still not statutory consultees in the planning process, and rely on the EA's intervention. Conversely, they do have an obligation under human rights to protect householders from undue flooding, following a legal precedent set in 2001 (Rickard, 2002a). Flood risk from sewers (and water mains) is excluded from LLFA risk liability under FWMA 2010, unless caused by rainwater (Great Britain, 2010). However, many utilities are now upgrading

pipework or installing pumping stations, to avoid the public distaste and negative publicity resulting from contaminated floodwaters (Figure 4.7).

Figure 4.7 Headline sewer upgrades from SevernTrent website. Source: Severn Trent Water, 2013

4.3.6. Highways Authorities

Severn Trent [n.d.] states that the local Highway Authority, usually the county council, has responsibility for effectual drainage of roads on the local road network, in so far as ensuring that road drains, including gullies, are properly maintained. ICE (2010) further explains that the situation is complicated where the land under the highway is dedicated to, rather than owned by the authority. In the case of a dedicated highway, the authority does not own the land or ditches either side of the road, and may be obliged use sub-highway drainage pipes instead of roadside ditches.

ICE (2010) explains that culverts may be used during road construction to pass a watercourse under a road, and the highways authority is then responsible for maintenance of that culvert. However there is no obligation for the authority to increase the size of the culvert, in the event of any increase in flows from upstream. It is worth noting that culverting is now rarely approved by the EA for new development other than highways, due to floods caused by poor maintenance of debris across trash screens.

The central Highways Agency is responsible for managing road drainage from the trunk road network in England, including the slip roads to and from trunk roads (Shropshire Council, [n.d]). This surface water is likely to discharge to a watercourse, but increasingly is passed to

SuDS influenced reed beds and soakaways, as detailed in the Memorandum of Understanding between the Highways Agency and EA (2009).

A lack of clarity had been observed regarding any event of surface water flooding a road, (ICE, 2010); however, responsibility has now been passed to LLFAs to manage surface water issues under the 2010 FWMA (Great Britain, *Flood and Water Management Act 2010*). The highways authority does hold an established right under the Highways Act of 1980, to drain roads into existing drains and sewers, and in towns this is generally how road drainage is managed (ICE, 2010). However Rickard (2002a) notes that under-designed highway drainage can lead to sewer floods, by passing excess storm water into combined sewers.

4.3.7. Local Planning Authorities (LPAs)

Parker (2000a) notes that institutional constraints in England and Wales had historically led to a lack of integration between planning and flood defence. The Flood Regulations of 2009/2010 sought to address these issues as part of the shift from engineering to environmental responses. The 'National flood and coastal erosion risk management strategy for England' document (Defra and EA, 2011) was produced as a requirement of the 2010 FWMA; this strategy document listed five strategic methods to tackle flood risk, shown in Figure 4.8.

Figure 4.8 Managing flood and coastal erosion risks. Source: Adapted from Defra and EA (2011)

One key point in this strategy, 'prevent inappropriate development', emphasises that:

"The Environment Agency will work with local authorities and developers to avoid inappropriate building or redevelopment in areas of high flood or coastal erosion risk. Key to this is ensuring that risks are effectively identified in local strategies ... and being careful to manage land elsewhere to avoid increasing risks",

thereby placing planning regulation high on the flood agenda. This adds another stakeholder in the form of the Department of Communities and Local Government (DCLG), responsible for spatial planning policy and operation (ICE, 2010). The Local Planning Authority (LPA) is the day to day decision maker on planning.

As stated by the EA (2006), the EA is now a statutory planning consultee on matters relating to:

- most development in Flood Zones 2 and 3;
- major development in Flood Zone 1;
- development within 20 metres of main rivers; and
- proposals involving culverting any river or stream

The EA's role as advisors on technical aspects of flood risk includes the provision of appropriate data, commenting on methods and conclusions, and advising on local flood risk management proposals. ICE (2010) acknowledges that the LPA may choose to approve a planning request to which the EA objects on flood grounds. In these cases the application must be referred to the Secretary of State to consider whether it should be sent for determination. This indicates that with regard to planning regulations, the advice of the EA must be sought but not necessarily heeded. The EA itself has stated that it takes a "yes, if" approach to planning permission (EA, 2012d), presenting itself as a positive facilitator rather than a moderator of development. This leaves effective flood plan management with very few advocates at a senior level.

4.3.7.1. Planning Regulation

Given the commercial demands on valuable land for development, the main control for reduction of flood plain building needs to be via the imposition of planning regulation. **Planning Policy Guidance note 25** (PPG25), was issued in 2001 by the DTLR, as guidance to LPAs to reduce the risk of flood presented by new developments. PPG25 was replaced by **Planning Policy Statement 25** (PPS25) in the Communities and Local Governments Act 2006, which clarified the respective responsibilities of all stakeholders (Department for Communities and Local Government, 2009 and 2009a). In parallel, the Town and Country Planning Order 1995 obliged LPAs to take advice from the EA with regard to development in flood risk areas (Goodson, 2001).

The primary aim of PPS25 was to ensure that new development should not increase flood risk overall. The local Strategic Water Management Plan produced by LLFAs is intended to support this aim by sharing information both about flood risk zones and their future planning to mitigate that risk (Defra, 2010). To this end, the sequential test and exception tests are explained in 'Standard Note 4100, Planning and Flooding', (House of Commons Library, 2012) as a risk based approach, using flood risk zoning maps to direct the decision making process towards the zone of lowest risk. The exception test applies to brownfield sites and only if "*there are wider sustainability benefits that outweigh flood risk*" (ICE, 2010).

The Construction Industry Research and Information Association (CIRIA, 2004) further explain the recommended precautionary principle as the approach used in cases of lack of certainty, using the best available data but in a cautious manner. Flood Risk Assessments (FRAs) are required for areas of high flood risk probability, to assess whether the proposed development is at risk directly, or whether it increases the risk elsewhere. FRA results are intended to be used to direct the construction to an area of lower risk, but as FRAs are frequently conducted by the requesting developers, this would appear to generate a conflict of interests. The obligation on developers to accept flood surveys by the EA is known as a Section 105, referring to the relevant section of the 1991 Water Resources Act. (CIRIA, 2004), where this is "*for the purpose of carrying out its flood defence functions",* (Great Britain, *Water Resources Act 1991*). However, it appears from Shropshire Council planning portal, (n.d.), that Section 105s are considerably less prevalent than FRAs.

ICE (2010) describes the case where a proposed development will increase the surface water runoff into a watercourse prone to flooding. This can lead to *'a planning obligation'* under Section106 of the **Town and Country Planning Act 1990**, where the developer undertakes to pay for drainage improvements downstream before planning permission is granted: The EA may seek a drainage impact assessment and consequent flood mitigation contribution from developers, but Rickard (2002a) raises the concern this is rarely enforced.

The EA described PPS25 as:

> *"a 'significant tightening and improvement of the legislation', and said it had improved things in a number of ways ... the Agency had powers to "call in" the Secretary of State for Communities and Local Government if a local authority ignored its advice."*
>
> House of Commons EFRA Select Committee (2008).

However, Bosher (2013) observes that while the sequential approach should be used for the identification of non flood prone development land, it can be abused by developers. He demonstrates that the sequential test argument has been used successfully by developers arguing that there are no low risk areas available, while seeking permission to build in flood prone areas. Similarly, Monbiot (2000) highlights government proposals to "*speed up the*

planning process in response to business need"; avoiding wasting time at public inquiries reviewing issues which have already been settled, by limiting input from the public. He concludes that these measures would *"further tilt the balance of decision-making towards to development and away from local people".*

The subsequent **National Planning Policy Framework** (DCLG, 2012) is described as 'streamlining planning regulation', apparently in favour of developers, by introducing a "*presumption in favour of sustainable development*" (p3 then repeated on pages 4, 13, 28, 39 and 52). It clearly states that "*development which is sustainable can be approved without delay"* (p4). This framework directs local government to ensure that risks can be managed through suitable adaptation measures, such as green infrastructure, or SuDS, as well as by directing development away from flood plains. This policy came into force in March 2013 and replaces many planning policy statements including PPS25, in wide ranging changes to planning policy in England.

The sequential and exception tests are still in force, in order that "*local plans should apply a sequential, risk-based approach to the location of developmen*t", but the emphasis appears to have shifted to prioritise 'sustainable' adaptation, rather than locating away from flood plains. The precautionary principle advised in the PPS25 Practice Guide (DCLG, 2009) is not mentioned in the National Planning Policy Framework (NPPF) Technical Guidance (Department for Communities and Local Government, 2012a), by which it is superseded.

Zoning as defined by PPS25 (DCLG, 2009a) has remained much the same in NPPF, but zone 3B - the functional floodplain - is no longer clearly defined by a 5% flood probability in one year, but now equivocates: "*The identification of functional floodplain should take account of local circumstances and not be defined solely on rigid probability parameters". It adds that 5% "should provide a starting point for consideration and discussions to identify the functional floodplain",* thereby leaving the definition of this highest risk zone much more subjective, arguably to the benefit of developers.

4.3.7.2. Sustainable Drainage Systems (SuDS)

Driven by the sustainability goals of the EU Water Framework Directive 2000, the Flood and Water Management Act 2010 created an obligation to incorporate sustainable drainage systems (SuDS) into new housing developments (British Property Federation, 2010). Since then, soft drainage techniques have become the norm for flood risk management, with LLFAs expected to establish their own SuDS Approving Body to ensure future compliance with national standards (Defra, 2011).

Defra (2001) stipulates in the "National Standards for SuDS", that runoff destinations should be considered only in the following order,

1. Discharge into the ground
2. Discharge to a surface water body
3. Discharge to a surface water sewer
4. Discharge to a combined sewer

SuDS are now routinely added to developments, and their contribution towards reducing the overall site runoff, often facilitates planning permission, even close to flood zones. However it could be argued that enhancing infiltration in flood plains merely raises the water table which also contributes to flooding.

Some issues have been noted around the reluctance of Local Authorities or Water companies to accept responsibility for maintenance of wetlands, (Rickard, 2002a), as these are currently less well defined than channel drainage. Further regulation may be needed in this area to allocate responsibilities and ensure that SuDS remain sustainable.

4.4. Other Stakeholders

4.4.1. Landowners and Riparian Rights

Legal rights and obligations in Britain extend beyond statute, and include case law (court decisions), or common law (common customs). Riparian rights are enjoyed by landowners bordering or under a watercourse of natural origin, and are defined mainly by common law. There is no obligation on riparian owners to maintain or de-silt a watercourse, but they may be obliged to do so by a drainage authority under the Land Drainage Act of 1991(ICE, 2010).

> *"we have powers of enforcement by serving a notice under Section 28 of the Land Drainage Act. If this is ignored, we may carry out the necessary work ourselves and then recharge the person responsible for the full cost incurred."* Durham County Council (2012)

In general, landowners are responsible for their own land drainage and for accepting and managing inbound flows on to their land. These flows must then be passed on undiminished without obstruction, pollution or diversion. They do have a natural right to collect and discharge surface water onto lower land, even if this increases the onward flow due to improved land drainage. These enhanced flows must then be accepted by the lower land owner. However, they may not cause or perpetuate a nuisance, for instance by a blockage to a culvert (ICE, 2010).

Under the EU Water Framework Directive of 2007, a riparian owner who causes environmental damage to their watercourse may be required to carry out remedial works. The FWMA 2010 has updated powers held by drainage bodies under the Land Drainage Act of 1991, empowering them to carry out flood risk works on private land, or to serve notice on

riparian owners increasing flood risk from their watercourse (EA, 2012f). However, in general riparian rights are simply that – rights rather than responsibilities.

4.4.2. Agricultural Influence

Agricultural responsibilities for drainage are identical to those of any landowner. However historically, agriculture was the most significant influence on drainage until the 1980s, with MAFF grant-aiding field drainage and fewer incidents of city flooding. The emphasis on engineered barriers followed by an environmental awareness, can be seen as mirroring social changes from rural to urban to city living, followed by a desire for 'environmental harmony'. (Parker. 2000a)

MAFF grants for field drainage ended in the 80s, due to changes in agricultural strategy, and Frost and Knight, (2002) warn that this has caused continued deterioration of agricultural drainage. Combined with a loss of skills across generations, more intense farming techniques and larger fields, this could lead to increased soil displacement in intense rainfall, contributing to erosion and silt blocking of downhill water courses (Interview with Wychavon District Council, July 2013).

Shropshire Council (2010) note in their Water Cycle Study that low lying agricultural land at the confluence of the Severn and the Vyrnwy floods regularly and low earth embankments have been constructed to provide some protection. Known locally as argaes, these bunds provide significant protection to downstream communities, such as Shrewsbury, by storing substantial volumes of floodwater until after the surge.

4.4.3. British Waterways

ICE (2010) mention that other bodies may also hold common law obligations for drainage, such as British Waterways, navigation authorities and licensed coal operators. The latter is due to the potential effect of subsidence on drainage and is enshrined in mining codes and the Coal Mining Subsidence Act 1991.

Crichton (2005) raises a concern that British Waterways owns and manages 2600km of canals which link into UK river basins, sometimes transferring flows from one catchment to another. Most of the canals were constructed over 200 years ago, and generally operate with only 300mm of freeboard, which can lead to overtopping of embankments during flood events.

British Waterways is very aware of the risk and has a system of sluices, weirs, pumps, and floodgates to control the flow into canals, however no government yet appears to have fully recognised the challenges presented by an aging canal network (Crichton, 2005).

4.4.4. Ofwat

Ofwat was established in 1989, to act as the industry regulator for the regional monopolies formed by the privatisation of water utilities in England and Wales.

> *"Ofwat is responsible for regulating the sectors, acting independently of the industry, government and other stakeholders, while working within the government policy framework" Ofwat / EA, 2007*

This monitoring role is primarily achieved through performance objectives set for each water company. These are benchmarked across all regions, with the expectation of continued efficiencies and financial penalties for unmet targets. This generates a focus on results at the end of the five year review period. (Ofwat, 2011)

The current strategy for Ofwat includes planning for sustainable water and water depletion, and focuses on four principles: ensuring a fair deal for customers; making monopolies improve; harnessing market forces; and keeping water companies accountable (Ofwat, 2010).

4.4.5. Agricultural Land Tribunals

According to Defra, [n.d], Agricultural Land Tribunals (ALTs) were established under the Agriculture Act 1947; they are relevant here in that they mediate drainage disputes between neighbours.

There are eight ALTs within England and Wales, acting as independent statutory bodies with jurisdiction only within a specific geographic area. These generally issue directions regarding access required onto neighbouring land to maintain ditches, or orders to improve agricultural drainage causing problems downstream (Defra, [n.d]).

4.5. Division of Responsibilities

The roles of the various institutions have changed several times over the past five decades, with significant changes in flood legislation in the past five years. Since 1991, land drainage management has operated as a tiered system, updated from FWMA 2010 in Table 4.1:

Institution or person	Responsibilities
Environment Agency	• Oversight of flood risk management in England and Wales • Costs and practicalities of providing river flood defences • Catchment Flood Management Plans • River Basin Management Plans • Reporting flooding incidents • Operation and maintenance regimes for main rivers
Local Authority	• Land-use planning and urban development • Highway drainage (Highways Agency for major routes) • Sustainable drainage systems in their control • Ordinary watercourses in their control • Strategic Flood Risk Assessments • Surface Water Management Plans • Reporting flooding incidents • Re-engineering costs for flow routes or storage • Operation and maintenance for ordinary watercourses
Internal Drainage Boards	• Land drainage and water level management in their area • Sustainable drainage systems in their control • Operation and maintenance for ordinary watercourses
Water Company (as sewerage undertakers)	• Effectual drainage of property • Cost and practicalities of sewer rehabilitation works • Sustainable drainage systems in their control • Drainage Area Plans • Sewerage Risk Management Plans • Operation and maintenance regimes for sewerage network
Riparian Owners	• Operation and maintenance of channels in their control • Reporting of flooding incidents

Table 4.1 Responsibilities for Surface Water Management in England and Wales. Source: Ofwat (2011) with additional information from Frost (2002)

4.6. Paradigm changes

Johnson et al. (2005) examines the relationship between flood disasters and a policy response, arguing that a decade of floods encouraged a rapid and unstructured rush into policy changes, ready to generate for the next reactive change. Much water legislation can be

viewed in this light, which could explain interesting dichotomies within the interaction of the responsible institutions.

Johnson and Priest's (2008) consider whether the rapid progression between 'land drainage', 'flood defence' then 'flood risk management', has moved away from the state managed model and created different divisions of risk/responsibility between the state, public agencies, private sector and citizens, Butler and Pidgeon (2011) further debate these redistributions of responsibility, with increased emphasis on the responsibilities of private citizens. Watson et al. (2009) suggest that national institutions have actually strengthened their control, despite using language emphasising partnerships and collaborative governance. They also mention the reallocation of responsibility for policy implementation between public, private and civic groups and hypothesise that this reflects an international shift from government to governance.

Johnson and Priest's (2008) point out that while Defra has overall responsibility for flood risk management, by using operating partners for all day to day operations, it is taking a noticeably hands off approach, "*reflecting a more general movement in society towards increased individual responsibility*". Escobar and Demeritt (2012) go further in regarding the use of intermediary agencies, such as the EA, as a mechanism to deliver government policy at arms' length from Ministers and the political process.

In future, Defra intends to *"facilitate innovation, improve value for money, maintain accountability and deliver flood risk management through public–private partnerships"*, (Johnson and Priest, 2008), a new development confirmed by the 'Partnership Offer' made by Defra Network (2013), where Defra actively seek commercial partnerships to finance flood management systems. Defra and EA (2012) explain further in their document "Partnership Pays", that from April 2012 projects will be assessed under the new policy of 'Partnership Funding'. More detail is given in their flood strategy document:

> *"... a new partnership approach to funding could make government money available to pay a share of any worthwhile scheme... Projects can still go ahead if costs can be reduced or other funding can be found locally."* (Defra and EA, 2011)

Haughton et al. (2010) perceive a neoliberal agenda at work in these developments, at the same time as noting the loss of local knowledge. As drainage engineers are phased out by Local Authorities, an increase is noticeable in hiring consultants and contracting out projects. Penning-Rowsell (1987) observed 25 years ago that consultants were gaining an undue level of influence on policy makers, raising concerns that all parties involved in flood project appraisal have an interest in maximising investment levels.

4.7. Summary

This chapter reviewed legislation, directives, institutional and stakeholder roles, as part of rapidly changing policy. This illuminated the legislative framework underpinning water management, and explored the relative roles of stakeholder institutions following recent changes in legislation. Key issues exposed are summarised in Table 4.2 for further exploration in subsequent chapters.

Key Issues:	
n.d.	Riparian rights established by common law and case law over centuries
	The right is upheld to pass drained water down to the next landowner
1932	IDBs are established by Drainage Regulations
1980	Highways Act allocates road drainage to Highways Authorities and Agency
	Road storm water surges are passed down to waterourses and sewers
1989	Water Act privatises water resources, including sewerage provision
	Pressure of storm water on combined sewers is noted
	Movement away from state managed model first observed
1991	Drainage Act moves drainage focus away from agriculture and into town
	MAFF grant aid ended for field drainage, leading to reduced maintenance
	Primary drainage responsibilities shared between IDBs and LAs
1995	EA established by Environment Act with permissive powers to manage rivers, flood risk, and environment.
2000	EU Directive promotes environmental management on catchment basis
2001	Defra formed to merge environmental concerns with rural affairs; much operational responsibility is delegated to EA
2001	PPG25 issued by DTLR for planning guidance
2006	PPG25 replaced and updated by PPS25, naming EA as statutory consultee
	EA takes 'yes, if' approach to planning permission
	Powers available to planners rarely used to mitigate drainage pressure
	Sequential test used by developers to obtain planning permission
2007	EU Directive requires flood assessments, planning and public access to information
2008	Pitt reviews effect of 2007 flood and makes recommendations to government regarding allocation of flood responsibility
2010	Major changes in flood management in UK: • FWMA promotes sustainable water management; • EA is allocated overall responsibility for flooding; • LAs assume responsibility for local surface water - lack of expertise is noted • RMAs named and obliged by the FWMA to collaborate and share data • SuDS mainstreamed into construction practices, but ongoing responsibility unclear
2012	NPPF replaces PPS25 with ‘presumption in favour of sustainable development’
	Flood zone definitions become more subjective
2012	Partnership offers made by Defra to private sector

Table 4.2 Summary of key policy issues for flood and drainage.

5. Results

All data was obtained from the River Severn catchment area, which covers approximately 11,000km^2 and has a population of nearly 2.3 million. The area is predominantly rural and 90% of the land is currently used for agriculture (Environment Agency, 2009), so representative samples were selected from rural and urban locations, These include the source spring in the Cambrian Mountains, a hill tributary in mid Wales, a small town in Shropshire, upland Shrewsbury and lowland Worcester (Figure 5.1).

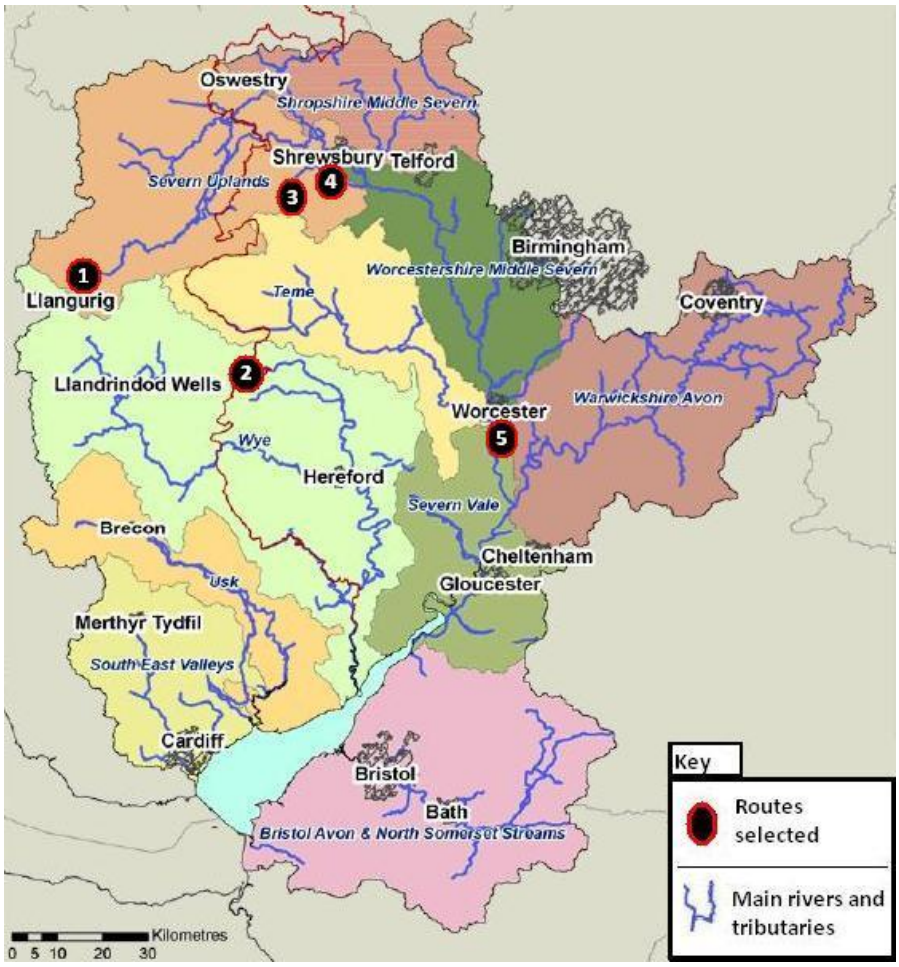


Figure 5.1. Severn catchment area, showing sample locations. Source: EA (2009a, p38), annotated.

5.1. Preliminary investigations

An initial visit to Worcester and Shrewsbury confirmed many of the findings from the literature review in section 2.3. Older buildings were indeed well protected from flood plains by natural means such as high ground or located away from rivers (Figure 5.2. to Figure 5.3), while new developments appeared at risk of periodic flooding (Figure 5.4).

Figure 5.2 Raised older riverside buildings, Shrewsbury. Photograph taken by author. June 2013

Figure 5.3 Riverside Cathedral on raised ground, Worcester. Photograph taken by author, May 2013

New buildings in Figure 5.4 are set back from the river by a 'wildflower meadow' which is (as per the sign), in the process of being established - presumably advocated as flood storage.

Figure 5.4. New riverside buildings on low ground, Worcester. Photograph taken by author, May 2013

5.2. Tracking a planning application

On 7th March 2013 Taylor Wimpy developers submitted a planning application to Shropshire Council for a housing development in Sutton Grange, Shrewsbury, near Lea Brook, a tributary of the River Severn. This is a greenfield site, on existing arable farmland, including a popular walking and wildlife space known as Rea Brook Valley. The proposed level of development is described as 'dense' by local objectors: with 292 houses in 16 hectares, mainly 3-5 bed detached, plus 38 smaller social housing units (Shropshire Council planning portal, [n.d.]). The topography of the site is shown in Figure 5.5:

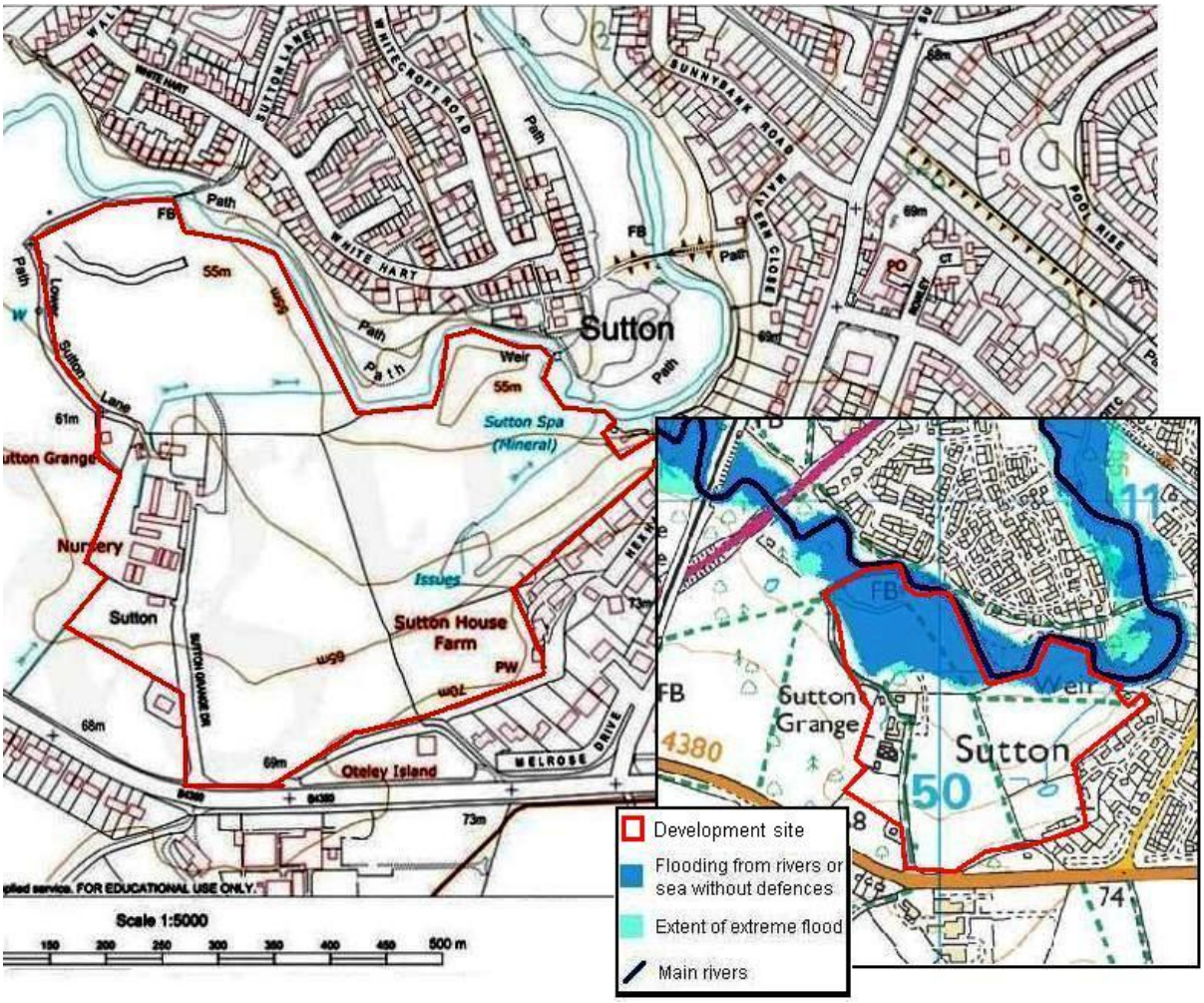


Figure 5.5 Proposed site map, showing contours, site boundary and flood zones. Sources: EDINA [n.d.], EA [n.d.]a, SC planning portal [n.d.] – combined and annotated by author.

Despite the area sourcing a mineral spring, being traversed by Rea brook, with drainage crossing the site for another nearby spring, plus acting as local flood storage (Environment Agency, [n.d.]a), the initial application states that there is no flood risk in the development, nor a risk of increasing the flood risk elsewhere. The construction starts at 57m Above Ordnance Datum (AOD) while the brook normally flows at 52m AOD (Shropshire Council planning portal,

[n.d.]), joining the River Severn 3km downstream at 50m AOD, and the 1:100 flood zone reaches 55.4m AOD (Environment Agency, [n.d.]a).

A Flood Risk Assessment (FRA) was submitted by Taylor Wimpy on 14th March 2013, emphasising SuDS provision, raised first floor level of 600mm and a pumping station for drainage. The pumping station is certainly necessary in order to pump foul drainage from such a low site. By locating all houses just south of the flood zone, the site can be designated as zone 1 (no flood risk), where the sequential test does not apply.

While SuDS does indeed reduce run off from developed areas, it is not a panacea in low ground, where it will simply add to the water table and consequent flood risk. The FRA accepts that:

> *"The management of storm water generated by the development itself will be the principle flood risk to this development. Infiltration based systems have been investigated and will have limited application for this site. The preferred outfall would therefore be to the watercourse to the north of the site as per the existing undeveloped site."* FRA, 14/3/2013. Shropshire Council Planning Portal, [n.d.]

In other words, it is proposed to drain storm water into Rea Brook, which is likely to exacerbate the flood risk on the site as well as passing more water towards the Severn before Coleham Head, placing more pressure on the flood defences installed there.

The Environment Agency (EA) raised a number of objections, to which the developers responded with a rearranged layout, and redesign of drainage. The EA have subsequently stated they are now able to lift their standing objections, with some conditions, including:

> *"..implementation of compensatory flood storage works and improvements to the 1 in 100 year plus climate change modelled river level ... approved in writing by the Local Planning Authority."*
>
> and
>
> *"no new structures (including gates, walls and fences) or raising of ground levels on land below 55.6m AOD".*

EA comment, 14/6/2013. Shropshire Council Planning Portal [n.d.]

This effectively approves construction of houses less than 4m above standard flow levels, 100m from the watercourse, a decision suggesting that the EA is keen to approve, despite the flood risk, as long as some concessions are made by the developer.

5.3. Interviews

Semi-structured interviews were conducted with contacts at key drainage institutions, in order to triangulate data and deepen understanding of operational issues. All interviews used a

written list of questions (see Appendix I: Interview questions) as a framework, permitting interesting avenues to be followed where possible.

5.3.1. Lower Severn Internal Drainage Board (LSIDB)

This interview with a staff civil engineer on 11th July 2013 confirmed that the key statute for drainage is still the 1991 Land Drainage Act, updating the wartime approach of its 1930s precursor. It was mentioned that the 2010 Flood Act had changed the emphasis to cooperative working between institutions. It was noted that the 2010 Flood and Water Management Act, by placing local authorities in a key operational role with very little warning, had put unexpected pressure on local authorities, to which few of them were immediately ready to respond.

Boundaries are felt to be generally well defined, normally along contour lines, as IDBs have long been the primary body managing drainage in their areas. As a consequence, handovers at boundaries are well practiced, interacting with local authorities, the EA and landowners. All drainage water is pumped or gravity fed to the nearest watercourse, ultimately flowing to the main river. There is rarely any interaction with sewerage pipes. It was mentioned that supervision and reporting of IDBs in general is historically unclear and can lead to IDBs being regarded as arcane institutions under little control.

Relationships with partners are generally good, although in many respects IDBs work alone. Institutions are now cooperating as instructed, with IDBs and Local Authorities sharing information, as are Water Companies and the EA. Pressure on greenfield sites for development is continuous, and while IDBs are not statutory consultees like the EA, they have good long-standing relationships with the EA and planners, and using these links are able to insist on mitigatory flood storage plans in most cases. Landowners normally manage their own drainage, although obligations are dictated by statutes 14-16, & 25 of the 1991 Land Drainage Act, wherein the IDB is empowered to enforce remedial work on drainage ditches.

Just as the literature review observes that an agricultural approach has given way to an environmental focus, so it has within IDBs:

> *"The emphasis on agricultural ditch clearing has changed in the past 20 years to a gentler, more ecological approach. These days, drains are often re-profiled in stages to minimise ecological impact, and there is more emphasis now placed on flood awareness."*

5.3.2. Worcestershire County Council (WCC)

(Drainage powers delegated to Wychavon District Council)

This interview with a Senior Assistant Engineer on 15th July 2013 discussed institutional, legislative and planning issues around drainage. It was explained that WCC is unusual in that a strong engineering department was retained at Wychavon after the 1998 local floods while

other local authorities reduced staff. Consequently, when the LLFAs were designated in 2010, WCC opted to delegate operational drainage work back to the district council partnership, due to their longstanding skills and experience combined with strong local knowledge. Other councils were not so fortunate and are struggling to maintain their new responsibilities, with no extra staff. Consultants are used frequently in many councils, presenting short term attitudes and often holding less local knowledge.

Main statutes supporting this role include 1991 Land Drainage Act and 2010 Flood and Water Management Act, and main partners are landowners, farmers, WCC and the EA. Their relationship with the EA can be hindered by difficulties in building contacts, as staff there are moved frequently between roles, and often lack the experience and local knowledge to make effective decisions. The EA approach was alluded to as "*boilerplate', using checkboxes to work through an assessment, whereas we use experience and local knowledge*".

Good relationships are maintained with the Local Planning Authority, and while they are not statutory consultees, still have regular input to drainage and flooding decisions by planners. The interviewee had observed an increase in planning applications following the new National Planning Policy Framework, but no major changes in drainage or flood risk. The sequential test was described, with an explanation of how developers routinely propose SuDS systems to prove on paper that they are reducing the surface run-off from a site.

Drainage from highways and residential areas was discussed, confirming that most residential surface water is discharged into a storm sewer or soakaway, while most highway drainage water discharges eventually into a watercourse. Distinguishing between highway drains, land drains and sewers is complex, but follows a fairly well established definition (confirmed in ICE, 2010). Mention was made of changes in agricultural land use for commercial reasons: with less deep ploughing in modern farming methods leading to higher runoff levels. This issue is generally acknowledged, and now approached as an educational issue.

Finally, it was emphasised that it is unreasonable to expect the LLFAs take responsibility for all surface water: *"It's never going to happen - excess water simply comes from excessive rainfall. Forcing LLFAs to take responsibility for all surface water as a kneejerk reaction to recent floods, but without providing additional staff, is a recipe for failure."*

5.3.3. Agricultural Landowner

This interview with a mid-Wales hill farmer in August 2013 confirmed farm ownership of land under the Werns brook tracked in section 5.4.3 below, and under the nearby highway. This land has been in family ownership since the 1930s, so the layout and installation of drainage under the dedicated highway was recalled in detail.

Comment was made that passing highway runoff water along drainage pipes potentially contaminates the brook, in a way that the old infiltration ditches did not. This comment

confirms previous observations that understanding of the benefits of soakaways and SuDS is very deep-rooted in rural areas. In common with other local people he had also noticed the current unwillingness of the EA to dredge small rivers.

Most drainage on the farm and buildings uses soakaways, and the traversing brook is well maintained as part of farm maintenance in order to provide water for livestock, so supervision by the Local Authority is unobserved. Heavy rains can often carry debris down fields and across the road, but an agricultural JCB is always used to clear obstructions before it causes a problem or is noticed by any institution. This brook along with local springs, is clearly regarded as a valuable water source, rather than as a drainage ditch, and is treated accordingly.

5.3.4. Environment Agency (EA)

The following information was obtained from several conversations in August 2013 with different EA Officers from the Partnership & Strategic Overview Team.

It was confirmed that the EA in Wales has been replaced by National Resource Wales and operates as a different entity, using standard procedures for working together, especially at border areas (see Box 5-1).

In order to control a flood problem, smaller brooks and canals are often designated as main rivers, in order that trash screens and flows can be proactively managed. This had been reviewed in 2003 for flooding purposes, Shrewsbury being a good example of a high risk town tightly managed by the EA. For the same reasons, interventions can be made on private land in order to improve drainage and manage flood risk.

Dredging is used only when really required, avoiding environmental disruption where possible, but always seeking a risk/benefits balance. Finally, it was pointed out the historically dredging was only performed for navigational purposes and that clearing blockages under bridges is the responsibility of the Highways Authority rather than the EA.

The EAs permissive powers enable funding limitations to be managed effectively, prioritising the issues affecting the largest number of people or assets threatened by floods. Again this is driven by seeking a balance and assessing the risk involved. Regarding planning consultation, it was felt that most EA input is heeded: "*it's a balancing act, the main point is that the Local Authority must feel comfortable with the risk, as they are the primary decision maker*".

5.3.4.1. Planning Influence

Finally it is noted that the EA are seeking Advisors with planning experience, to provide "*more emphasis on influencing Local Authorities early on in the planning process ... by pro-actively influencing developers during pre-application discussions",* see Appendix II : Environment Agency, Planning Advisor role, for details.

5.4. Tracking Surface Water – Transect Walks

5.4.1. Methodology and tools

Map based investigations were made using geospatial information obtained from the EDINA Digimap, paper Ordnance Survey (OS) maps, EA flood map, and on occasion Google maps. The Digimap service is an online mapping service that gives access to interactive Ordnance Survey maps at differing scales and levels of detail. It permits the user to annotate and print any of these maps, or to download the annotated copy for further processing. These maps were used to perform theoretical "transect walks", as well as providing the basis for physical tracking. In the samples taken below, detailed contours are examined in order to estimate multiple rainwater runoff routes and track this flow all the way to the sea.

Physical tracking permits further observations where this is relevant. For instance, boundaries indicating change in the type of land ownership need to be noted, as do climate conditions. Physical catchment conditions have already been considered during sample selection, to ensure representative sampling. Subsequently these have minimal impact on institutional issues and do not constitute required data.

5.4.2. Sample 1 – Mountain Source, Ceredigion: Mapped Runoff Routes

The first sample investigates the area above the source of the River Severn, tracking runoff paths down the mountain. These are depicted in detail in Figure 5.6, and an overview showing the full path to the sea shown in Figure 5.7.

Starting from Pen Pumlumon hilltop (741m AOD), it was estimated that rain falling on the north and west of the peak (green route in Figure 5.6 and Figure 5.7) would run downhill to Afon Gwerin stream, then to Afon Hengwm (Hengwm river), and thence to Nant-y-Moch Reservoir, then out via Afon Rheidol (Rheidol River) and onwards to the Irish Sea. Conversely, rain falling on the south of the peak (red route) would run south into the source of the River Wye (Afon Gwy), which migrates several times between England and Wales before passing into the Severn just before the estuary. Finally, rain falling to the east of the peak (blue route) runs directly into the source of the Severn (Afon Hafren), then through Powys, Shropshire, Worcestershire and Gloucestershire where it forms the estuary.

The Wye is not designated a main river until Rhayader in southern Powys, 26 km from the source, whereas the Severn is so designated at Llanidloes, within 14 km of its source. Afon Rheidol is considered a main river from the reservoir, within 5 km of its source. This designation is significant in that it denotes management by the EA rather than drainage board or local authority. From these points onwards, these rivers are the responsibility of either the EA or Natural Resources Wales (NRW). The movement of the Wye typifies the ease with which rivers both traverse and form county and country boundaries in their journey. Inevitably this complicates the administration of rivers.

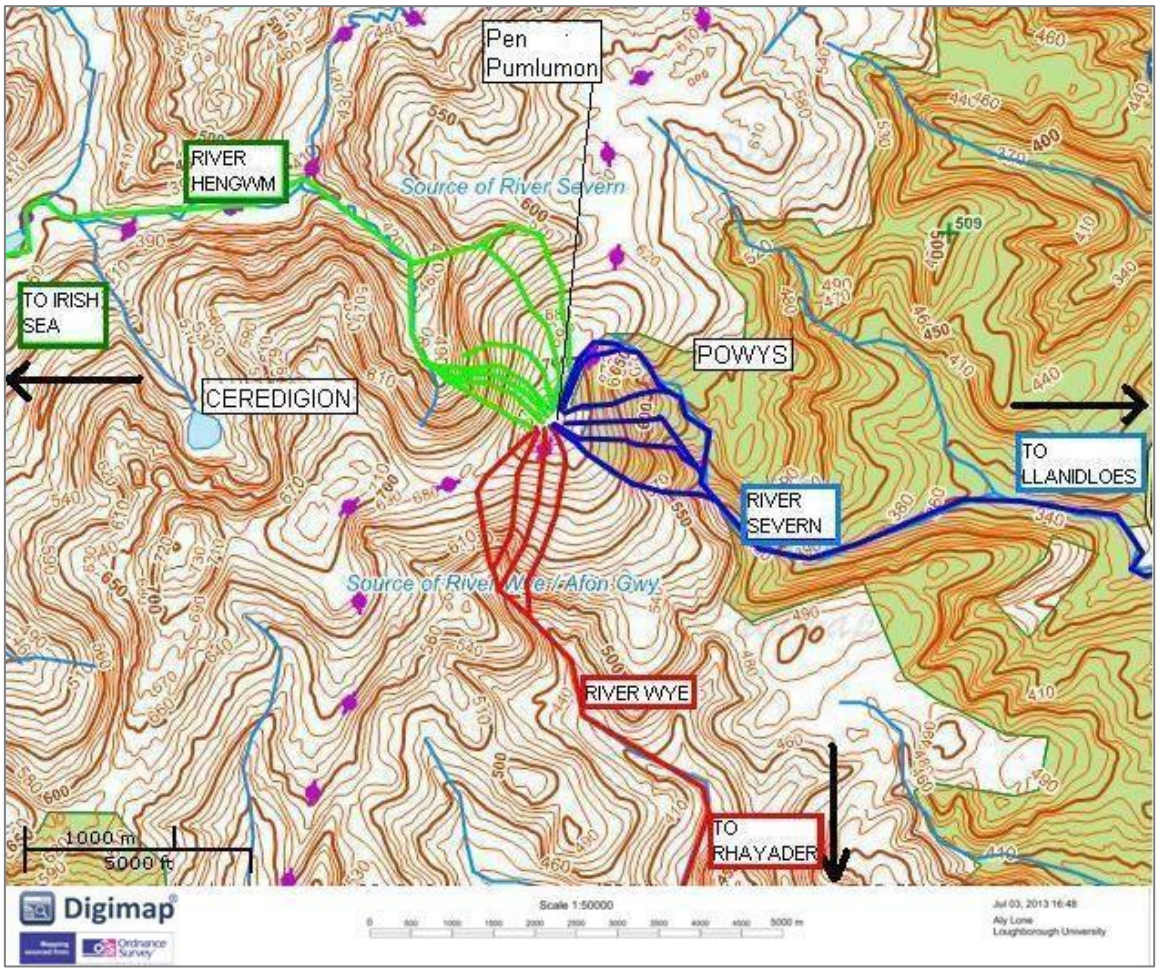


Figure 5.6 Map of estimated rain runoff routes from Pen Pumlumon, Ceredigion. Source: EDINA, [n.d.], annotated.

Figure 5.7 Map of estimated rain runoff routes from Pen Pumlumon, Ceredigion, to sea. Source: EDINA, [n.d.], annotated.

5.4.3. Sample 2– Powys: Theoretical & Physical Transect Walks

Moving east, to the border between Wales and England, the land is still hilly and hillside springs are common. The River Severn is 30km to the north, but all these local rivers are its tributaries. Routes were tracked from a hill known local as Rhos Hill (380m AOD) (Figure 5.8).

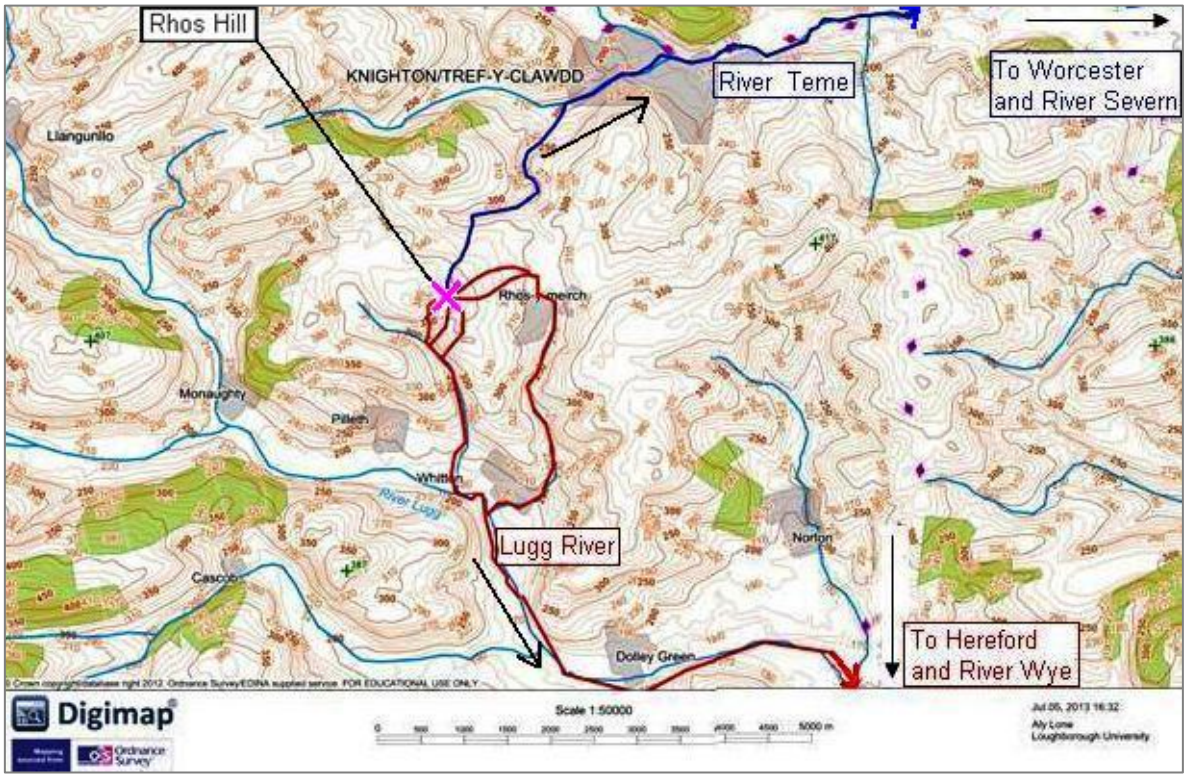


Figure 5.8 Map of estimated rain runoff routes from Rhos Hill, Powys, towards main rivers. Source: EDINA, [n.d.], annotated.

The blue route indicates that rain falling to the north of the peak continues north to Knighton and the River Teme, which is a main river from Knighton onwards and therefore managed by the EA. Before this point watercourses are the responsibility of Powys council. The River Teme flows west to Worcester, where it joins the River Severn as it heads south.

All red routes indicate that any rain falling to the other sides of the hilltop will ultimately run south into the river Lugg, and thence to Leominster and Hereford. The easterly red route is physically tracked for 3.5km, passing downhill as either surface or sub-surface flow, emerging as a spring and forming a new stream called the Werns (Figure 5.9). This watercourse travels south through farmland (see landowner interview, section 5.3.3), joining the river Lugg at Whitton village 3km further south. The Lugg feeds the River Wye at Hereford, which later joins the River Severn in the estuary, as mentioned above.

Figure 5.9 The Werns stream, 1km from its source springs. Whitton, Powys. Photograph taken by author, July 2013.

These routes all start in Powys; once crossing the English border they traverse Worcester and Gloucestershire, then enter the Severn estuary, heading for the Irish Sea.

Figure 5.10 shows the shorter route to sea from this source, with Wye routes marked red and Severn routes blue.

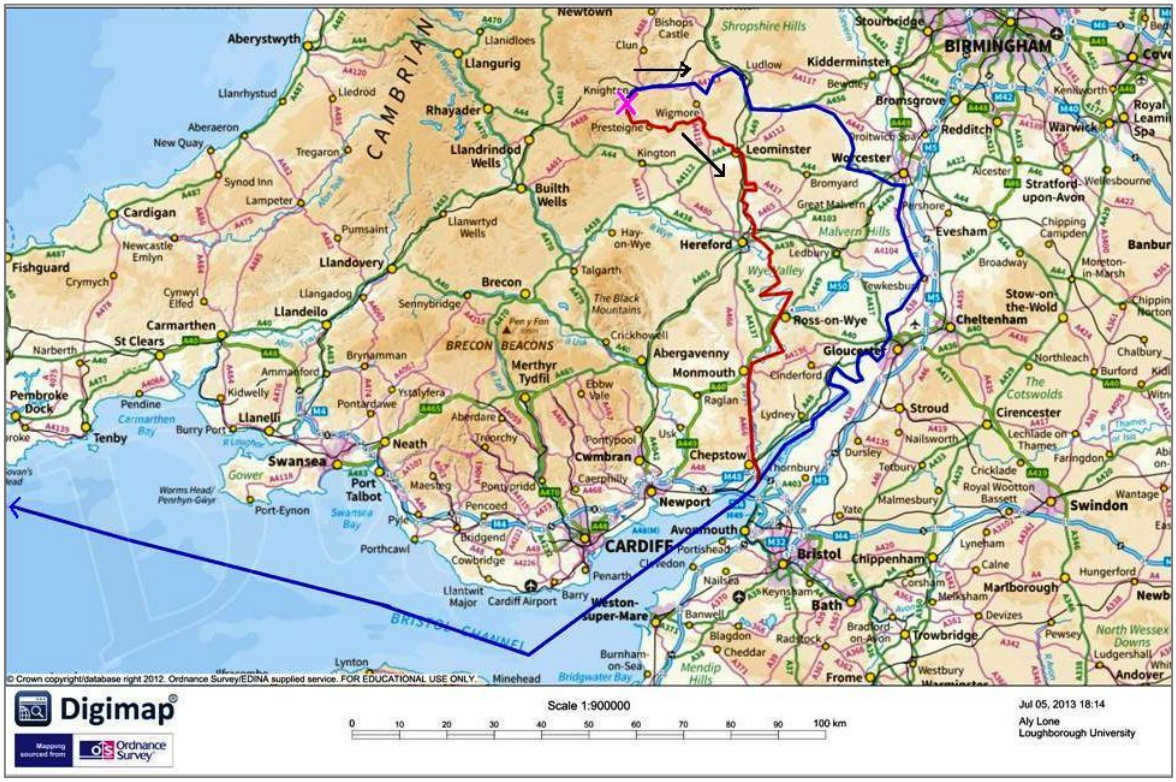
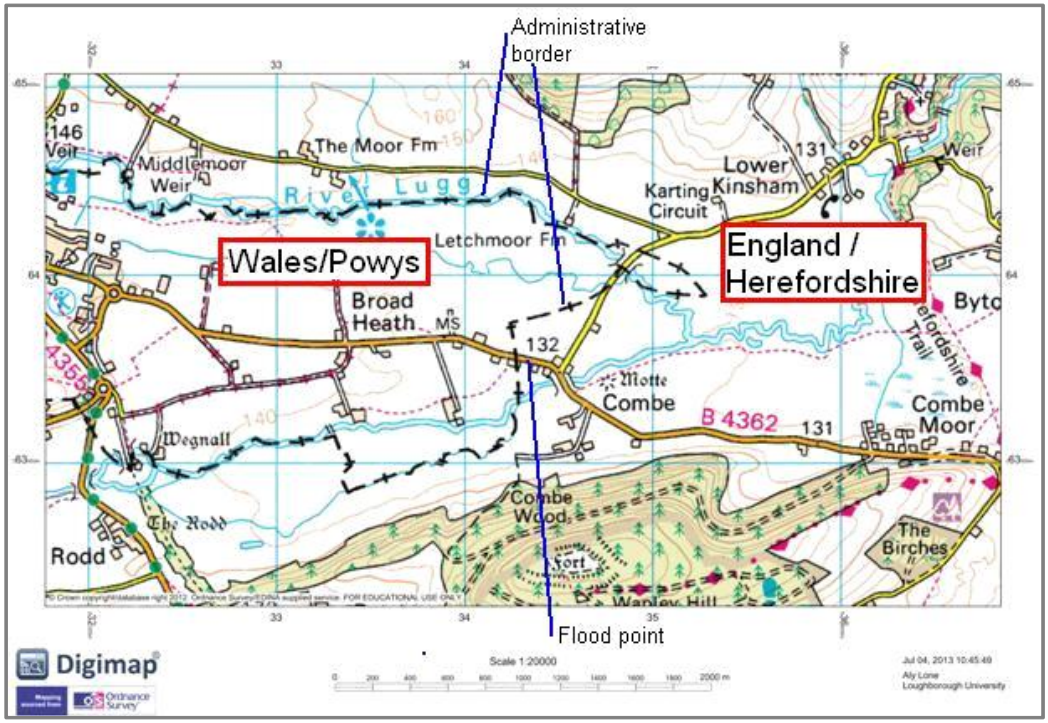


Figure 5.10 Map of estimated rain runoff routes from Rhos Hill, Powys, towards sea. Source: EDINA, [n.d.], annotated.

Cross boundary issues

In this border area, confusion over responsibility at complex boundaries appears to lead to lack of maintenance. Once the River Lugg travels 8km from Rhos Hill, it crosses a renowned flood point known as 'Combe corner' which frequently cuts off a main highway on a meandering border between England and Wales.



Map showing shifts in administration on Welsh border. Source: EDINA, [n.d.], annotated.

"Combe corner" Photograph by author, Feb 2013

The map shows the watercourse control moving from Powys, to shared control, back to Powys, then to Herefordshire control within just a few kilometres. The highway shifts across borders in the same way. Visiting the site during low waters, it appears silted and liable to flood easily. It seems likely that there could be confusion caused by such varied borders, either between Highways Authorities or between EA and NRW. In addition, the locals mention that the EA discourage dredging, on environmental grounds.

Box 5-1: Cross border river and possible administrative confusion

5.4.4. Sample 3 – Pontesbury: Theoretical & Physical Transect Walks

The third sample location starts near Pontesbury in upland Shropshire, 14km to the west of Shrewsbury. There are three local Internal Drainage Boards (IDBs) near, but not in, Shrewsbury: Powysland, Melverley and Rea IDBs, colour coded by location in Figure 5.11. The location of Pontesbury was surveyed as well as Shrewsbury because it falls on the border of an IDB zone, therefore the drainage body is Rea IDB (see Figure 5.11), as well as Shropshire Council in some areas. Rea Brook travels into Shrewsbury from the east, passing just to the north of Pontesbury, and is designated a main river by the EA from Marten Pool, some 13km west of Pontesbury.

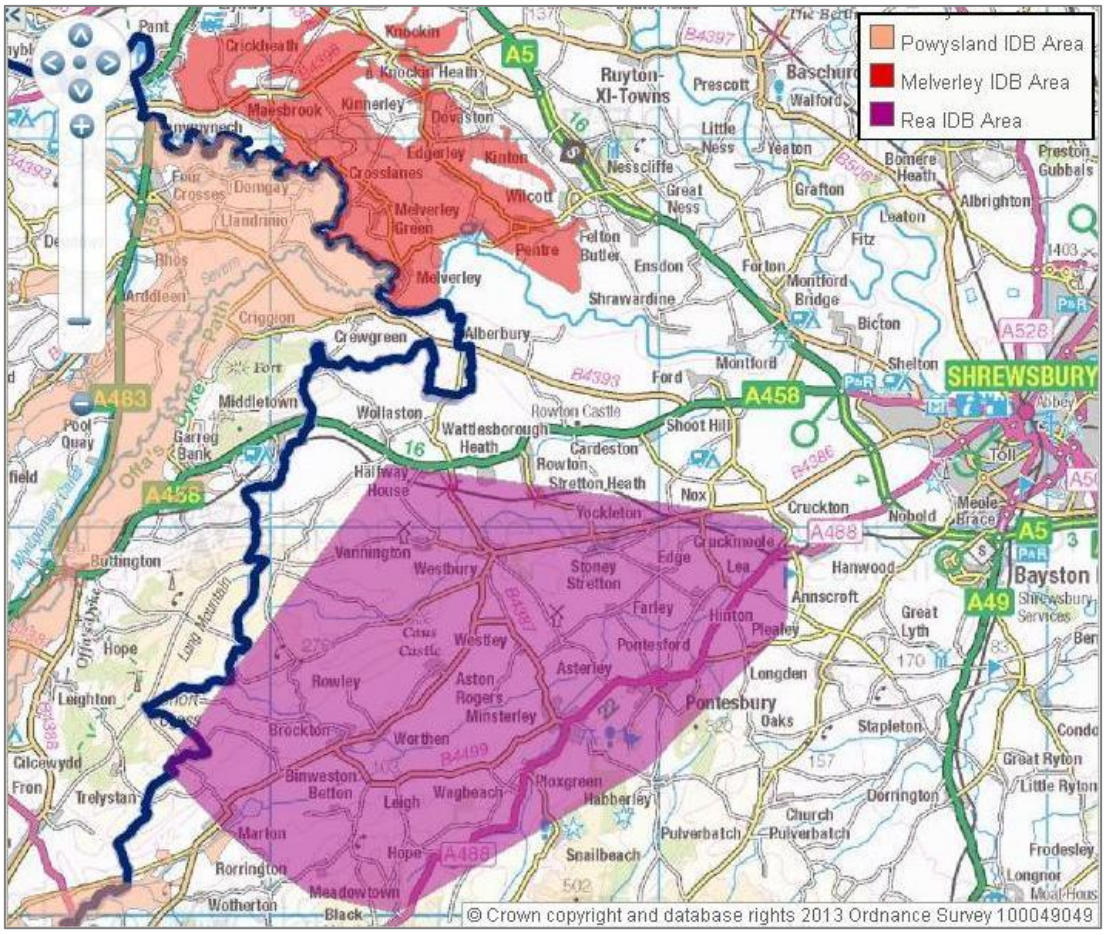


Figure 5.11. Location of IDBs near Shrewsbury. Source: SC, 2012a

In order to explore a variety of surface water, a track was plotted to cover the IDB zone, highway flow, subsurface flow, small town drainage, surface water risk zone (Pontesbury town is rated medium risk by SC flood map), agricultural landowner, organisational landowner, a rural area, ordinary watercourse and main river flowing towards Shrewsbury.

The selected starting point is on Earl's Hill (Figure 5.12), 1km south-east of Pontesbury, in a nature reserve managed by Shropshire Wildlife Trust.

Figure 5.12 Top of Earl's Hill, starting point for Sample 3. Photograph taken by author, July 2013

Water falling on the west side of this peak would run west, either overland or underground along the red line shown in Figure 5.13, down the hill, into the Rea IDB zone, then across the track and down to the stream. The unnamed stream flows north until it meets Grove Lane where it is culverted under the road, then north across farmland to Main Road in Pontesford, where it vanishes under a trading development before joining Habberley Brook to become Pontesford Brook. This brook then crosses private land, followed by farmland and finally joins Rea Brook which joins the Severn in Shrewsbury. Rea Brook passes out of the IDB zone at Cruckmeole, 4 km west of Shrewsbury, but as it is a main river, is always managed by the EA rather than Rea IDB or Shropshire Council.

Conversely, rain falling to the east of the survey point will follow the blue line down the hill until it enters Habberley Brook. This passes through woods then farmland, entering the IDB zone and skirting woodland as it moves north, crossing more farms until it meets Main Road and becomes Pontesford Brook and continues as above.

The third (pink) route runs north down the hill, then along road gullies until it passes into combined sewer pipes presumed to run under Main Road. These then pass into Pontesford where sewerage pipes probably carry storm water under the roads, following the gradient down to the treatment works north of Pontesbury. Advertised sewerage upgrades for Pontesbury area suggest that the system may still be combined, and water passes with foul water to the sewage plant. After treatment, this water discharges into an unnamed stream which joins the Rea Brook 1km further north and continues as above.

In order to explore issues with drainage in a small town, a fourth route was also plotted from the edge of Pontesbury, and is shown following a green route, starting at the junction of Habberley and Grove Roads,

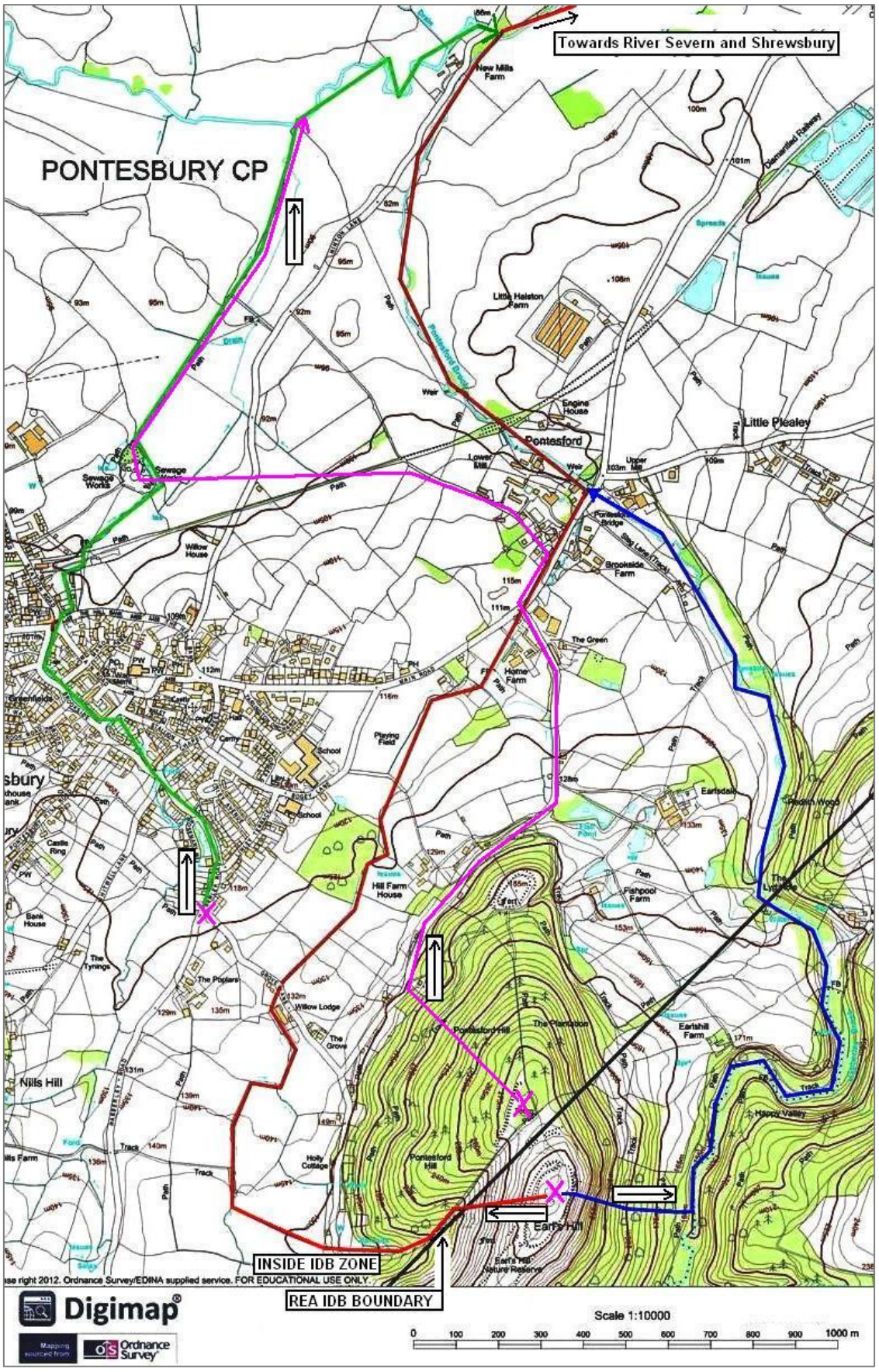


Figure 5.13 Map of estimated rain runoff routes from Earl's Hill, Pontesbury, towards main rivers. Source: EDINA, [n.d.], annotated.

Rain falling here would move north along the gulley in Habberley Road, flowing into the brook via highway drainage higher up Habberley Road. It then continues to flow north in this open stream until it is culverted under the junction with Main Road, to emerge on the north side. Here, it can be observed (Figure 5.14) that houses are armed with sandbags, despite the dry weather. A local resident explains that these new houses flood whenever the drainage brook expands across the road. Locally, it was well known that the previous car park in that location had flooded regularly; yet planning permission was still granted for these new-builds.

Figure 5.14 New houses permanently sandbagged, Pontesbury. Photograph taken by author, July 2013.

5.4.5. Sample 4 – Shrewsbury: Theoretical & Physical Transect Walks

Shrewsbury is the first major English town on the River Severn and is particularly prone to flooding due to its proximity to the Welsh uplands, compounded by meandering river loops through the city. Demountable flood defences have been installed, as shown in Figure 5.15, to protect the community whilst respecting the fine heritage features in the town.

Figure 5.15. Demountable flood defences in Frankwell, Shrewsbury. Source: BBC Shropshire, 2013.

EA ([n.d.]a) indicates two areas in the town which are especially vulnerable to flooding: Frankwell and Coleham Head, both of which are now protected by demountable flood defences as well as improved drainage and pumping stations. These were installed in 2003 to eliminate the four acknowledged sources of flooding in the area: river overtopping, groundwater flow/seepage, breaching of existing riverside walls, and inadequate drainage (EA, 2004). Shrewsbury town has also been identified at being generally susceptible to surface water flooding within 'Water Cycle Study' (Shropshire Council, 2010) and SWMP (Shropshire Council, 2012). Calculated risk here differs according to source, as SC blue squares, or wetspots, (as Shropshire Council (SC) call them) remove three out of four EA blue squares and add five new ones (Shropshire Council, 2012, p6). An interview with Worcestershire drainage engineer indicated exactly the same contradictions, stating that EA frequently differs from local knowledge.

The annotated flood map in Figure 5.16 shows the flood defences, along with main rivers, flow direction, flood zones plus highlights in green and red the location of the two vulnerable areas. It can be observed that both 'wetspots' occur where a tributary enters the Severn.

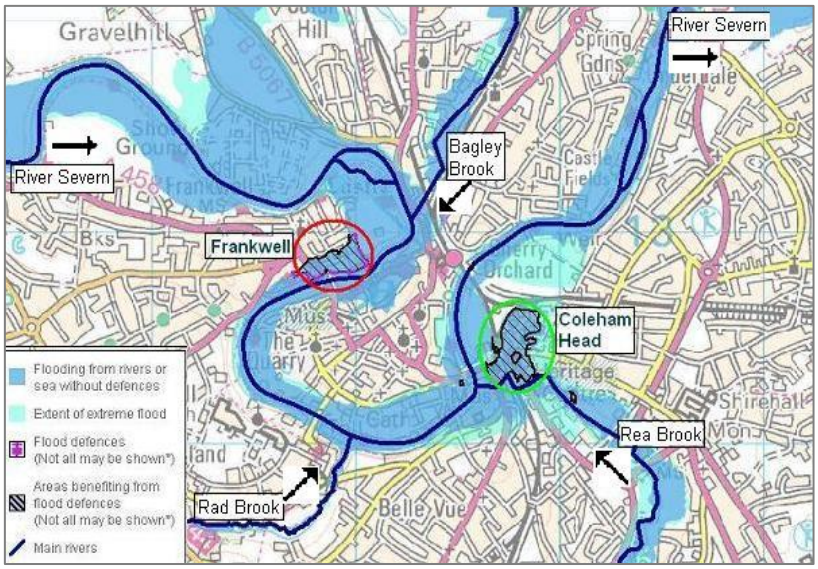


Figure 5.16. Flood map for Shrewsbury, showing Frankwell and Coleham Head flood defences. Source: EA [n.d.]a, annotated by author

Three 'brooks' traverse the town to outfall into the Severn; all are designated as main rivers therefore are the responsibility of the EA, There are very few other natural watercourses in town, small streams mapped transpired to be impossible to find on a site visit, so are presumed to be culverted. As is evident from Figure 5.17, these main rivers can be quite minor, but are managed by the EA due to the flood risks in Shrewsbury (interview with EA Risk Management Advisor, 1/8/13).

As a unitary authority since 2009, Shropshire Council has replaced all district councils in the former 2-tier authority.

Figure 5.17 The Rad Brook, in west Shrewsbury. Photograph taken by author, July 2013.

Transect walks were plotted (Figure 5.18) to cover Shrewsbury town drainage and storm sewers, highway drainage, residential housing, and a 'wetspot' (Shropshire Council, 2012). These start west of the River Severn at a high point (starred) in Woodfield Road, with flows diverging in two directions: either passing north-east through Frankwell (shown in blue), directly into the Severn, or south (shown in red) into the Rad Brook which shortly passes into the Severn.

The original high point was adjusted during the physical transect walk, as the starred start point was clearly uphill from the mapped high contour. On the theoretical walk it was surmised that the flow would follow the contour lines, but fieldwork demonstrated that the surface flow would follow the gullies of the road down Woodfield Road, passing into sub-highway drainage at the first drain opening. As drainage maps are not in the public domain, it has been assumed that drain paths pass under the roads and follow land contours.

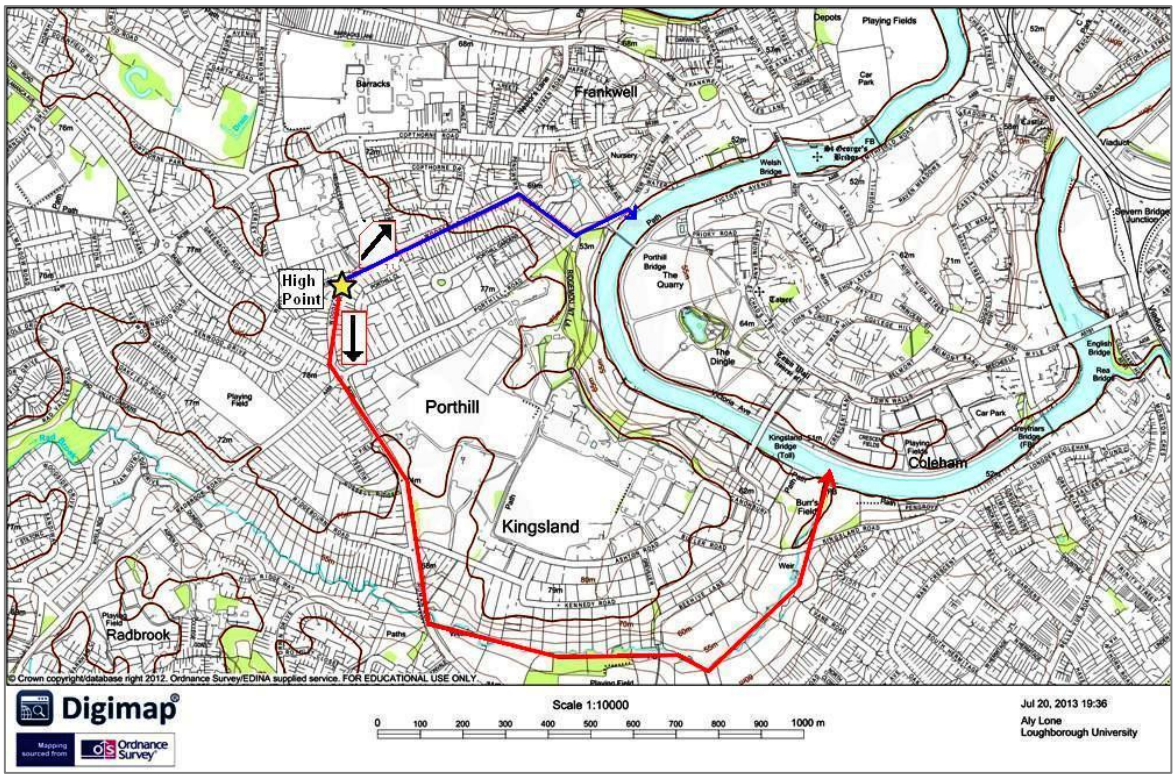


Figure 5.18 Map of estimated rain runoff routes from Woodfield Rd, Shrewsbury, towards main rivers. Source: EDINA, [n.d.], annotated.

Tracking rain falling on a householder's drive on the apex, water can take one of two possible paths: it could either flow north east onto to Woodfield Rd (blue route, Figure 5.18), where it would travel along the gulley until it enters a highway storm drain. In this case, water would continue to travel under Woodfield Rd then flow south east through Frankwell. Then it is likely to turn under New St and outfall to the river just north of Porthill Bridge.

Alternatively, (red route) it could initially flow south onto Woodfield Rd and would enter a highway drain, continuing under the road until the drain turns southeast under Roman Road and eventually outfalls to the Rad Brook in Kingsland (Figure 5.17). It then flows 1000m before flowing into the River Severn after Kingsland Bridge, joining the raindrop from the east side of the drive.

5.4.6. Sample 5 – Worcester: Theoretical & Physical Transect Walks

As an old style 2-tier council, WCC partners the six district councils and Lower Severn IDB. The Preliminary Flood Risk Assessment for WCC states that: *"There are no 'Nationally Significant Flood Risk Areas' identified in Worcestershire for the purposes of the Flood Risk Regulations"* (WCC, 2011).

As Worcester is a renowned flood plain, this presumably means that all areas are now well protected by the raised landscaped banks and amenity areas on the riverbanks (Figure 5.19).

Figure 5.19 Raised path and bank alongside River Severn, north Worcester. Photograph taken by author, May 2013

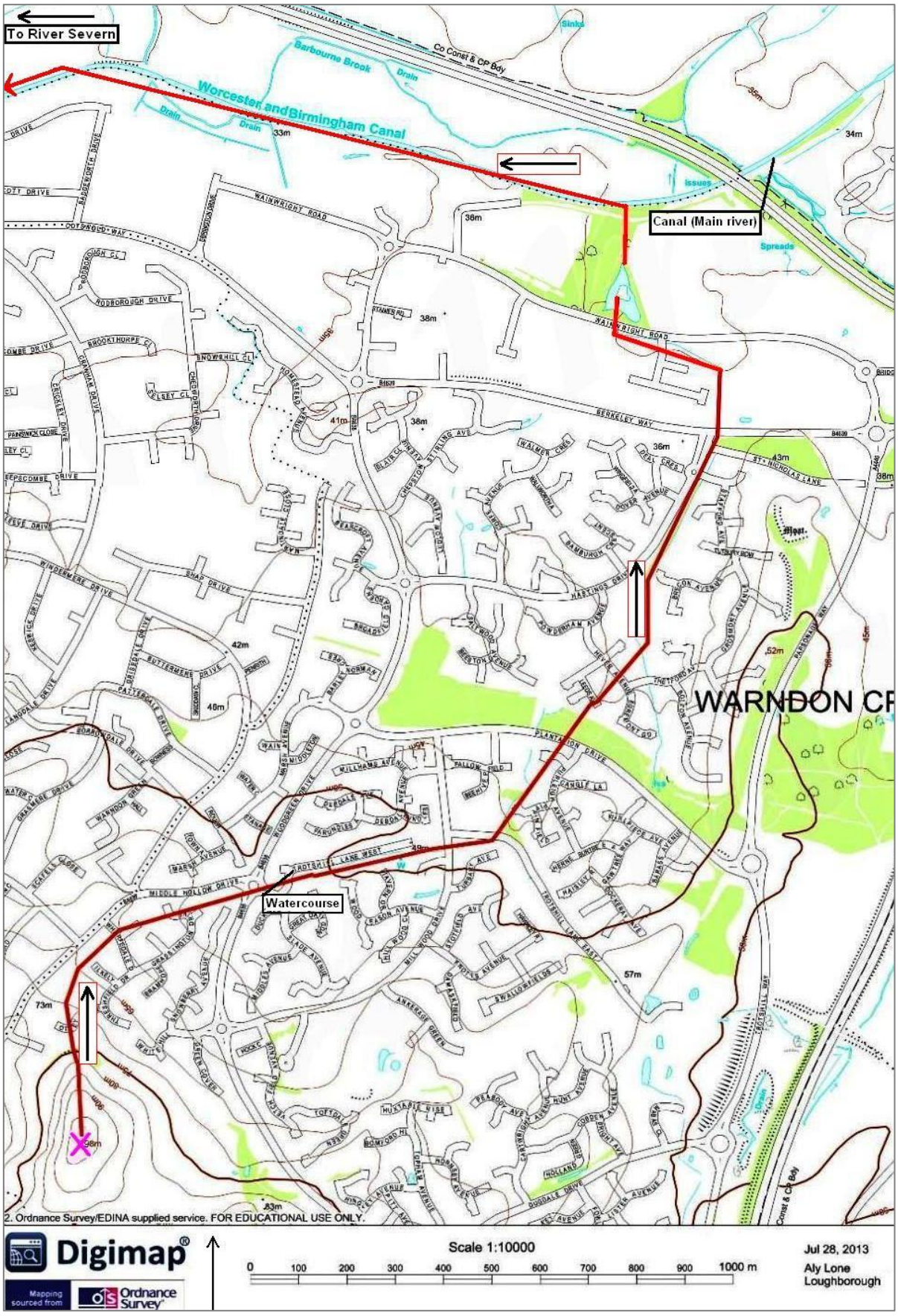


Figure 5.20 Map of estimated rain runoff routes from Leopard Hill, Worcester, towards main rivers. Source: EDINA, [n.d.], annotated.

Here, the transect route has been selected to include the Worcester and Birmingham canal, as well as public land, urban road drainage, sub-surface drainage and low lying terrain.

This route starts on the top of Leopard Hill in North Worcester (Figure 5.20), within parkland above a relatively modern housing development showing evidence of SuDS paving. The flow travelling north would therefore partially infiltrate both the green hill and lower housing drives and would then travel to some extent as a subsurface flow, following contours directly until it reaches the canal or is subsumed within streams heading in the same direction. Surface flow would follow a similar route shown in red, flowing off the hill into Oteley Close then north along road gullies and eventually sub-highway storm drainage, under the roundabout. Alongside Trothill Road there is a stream, where storm drainage is likely to discharge. This then flows north through this residential area until it is presumed to reach the canal within an inaccessible industrialised area.

Inside the city, the canal is designated as a main river, so while it is owned and managed by British Waterways, it is the responsibility of the EA. The watercourse is on public land and is managed by the Local Authority.

5.5. Limitations in data

Tracking an urban route in person enriches mapped data by allowing the contours to be confirmed, drainage grills, culverts and outfalls to be identified (Figure 5.21), watercourses to be tracked and any local impedance to flow (such as blocked drains or road humps) to be observed. Another benefit is the ability to speak to residents to gain unexpectedly useful local knowledge, and the observation of flood clues, such as sandbags. For the most part, distinction between boundaries and ownership were often less clear in rural areas than on the OS map, but visible ownership signs, such as that of the Shropshire Wildlife Trust, could be noted.

However, in towns, the transect walks had limited usefulness: it remained unclear what underground route the drains would take, outfalls to the river were rarely visible, and surface flows could not be confirmed. Furthermore, information about urban terrain is of limited use, as most of the route is underground.

Figure 5.21 Outfall to Pontesbury Brook, presumed from highway drainage. Photograph taken by author, July 2013

In general, all routes and locations have been selected to provide a variety of influences and terrains; however this form of selection can carry its own bias.

Jones (2000) explains the process of subsurface flow as infiltrating water soaking down to bedrock and following this layer downhill until infiltrating the nearest watercourse. Where necessary, it has been assumed that this will occur as described and that bedrock will run roughly parallel to surface contours – however, this may not always be the case.

Highway drains may discharge into a combined sewer, storm sewer, watercourse or soakaway (ICE, 2010), but as sub-surface drainage maps are not in the public domain, it is impossible to know which route is followed. It has therefore been assumed that highway drains will follow roads and land slopes until they can discharge into a nearby watercourse. Where there is no watercourse, a sewer is assumed for discharge, or a soakaway in rural areas.

Finally, unusually dry weather conditions during fieldwork meant that the likely movement of surface water at wetter times had to be surmised rather than observed.

5.6. Summary

This chapter collates results from interview, planning applications, maps, transect walks, and field observations. It remains now to analyse this data into the required mapping and conclusions.

6. Analysis

This chapter takes the collated results and develops the required mapping, to illustrate spheres of institutional influence.

6.1. Diagram Methodology

Originally, consideration was given to Venn diagrams, to demonstrate any overlaps in influence. However, examination of policy and field data indicates responsibilities split into three different types: drainage, flood risk and supervision, with very few intersections. These layers, combined with fluctuating ownership and drainage responsibilities, suggest linear colour coded diagrams instead. The final diagrams combine coloured and labelled boxes, scaled in parallel on a layered horizontal axis, to illustrate different forms of ownership and responsibility. The water flow is presented as a scaled foundation, using blue lines to express the different channel types and direction. Responsibility is divided into the three layers, with ownership expressed separately, to reflect the disconnect observed between the two concepts. As terrain changes have already been illustrated on maps in the results chapter, these are not included here.

These diagrams show the first 10km flow distance of each route selected. This decision stems from the observation that the Environment Agency (EA) has responsibility for all main rivers, which provides very little complexity to research. However, additional pie charts have been plotted from each sample point to the Severn Bridge at the estuary, where the main river designation ends. These pie charts demonstrate the breakdown of drainage responsibility only, depicting the entire route.

One route has been plotted from each sample location, selected to demonstrate a fully representative view of source data. As in the results chapter, these are shown in order of river flow, enabling a sense of the shift from mountains to lowlands, from rural to increasingly urbanity. All these diagrams derive from data supplied by maps and field work, compiled in Appendix III: Raw Data for Analysis.

6.2. Data Interpretation

Judgements about layers of responsibility are based on the policy investigation in chapter 4. It is observed that landowners are entitled to pass water on, but they have limited liability for drainage (ICE, 2010). However they may be instructed to carry out drainage work by the Local Authority or IDB, indicating that overall responsibility for drainage lies with the drainage body, even when land is privately owned. Similarly, the Local Authority is defined as responsible for all types of flood risk since 2010, including surface and groundwater, and this is illustrated. No entity appears to take responsibility for supervision when water is unchannelled, so this area is marked as undefined although the EA supervises all channelled flows.

6.3. Diagrams

6.3.1. Sample 1 – Mountain Source, Ceredigion

Figure 6.1 takes the blue route from the Severn's source, mapped in Figure 5.6 and illustrates the responsibilities for this remote rural area. This diagram is notable for its simplicity, but demonstrates several points which remain valid throughout:

- Ownership bears no link to responsibility - riparian rights are mostly limited to rights over the water rather than management duties.
- Where water is unchannelled, supervision is undefined – no body appears to hold responsibility for this aspect.
- There are several administrative splits: the EA's role is divided between EA and Natural Resources Wales (NRW); also the early flow passes across two Local Authorities (LAs). Rivers commonly pass over (even acting as) administrative boundaries, requiring close coordination between drainage bodies. See Box 5-1 for examples where this coordination appears ineffective.

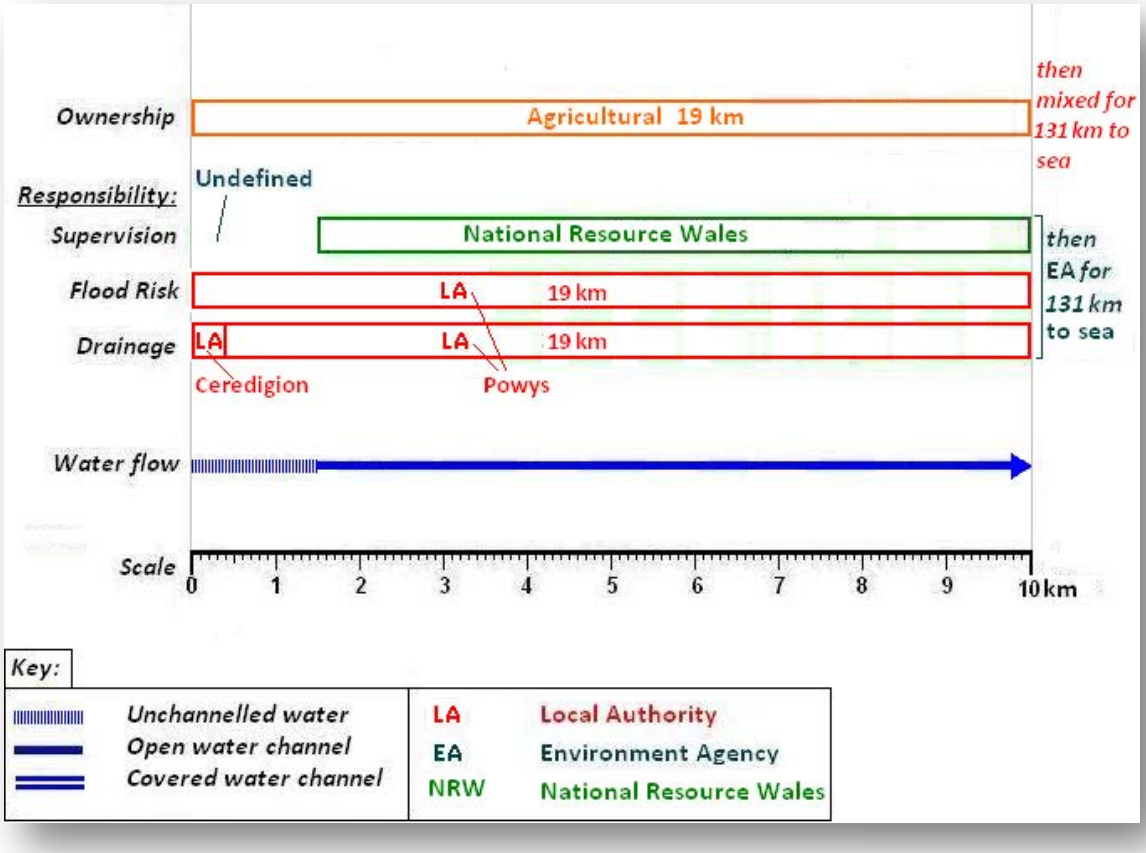


Figure 6.1 Diagram to demonstrate layers of responsibility, ownership and channel type. Ceredigion, blue route

Ownership for the first 19km is entirely agricultural, reflecting the remote setting.

Repeated handover points between EA and NRW need careful management for the full path to sea, as the river Wye flows south along the Wales/England boundary. These administrative splits can clearly be seen in Figure 6.2 showing the entire route, and the repeated division of responsibilities between the two EA bodies and the LAs. Apart from the split between EA bodies, this chart is still quite simple, and shows significant influence from the second LA.

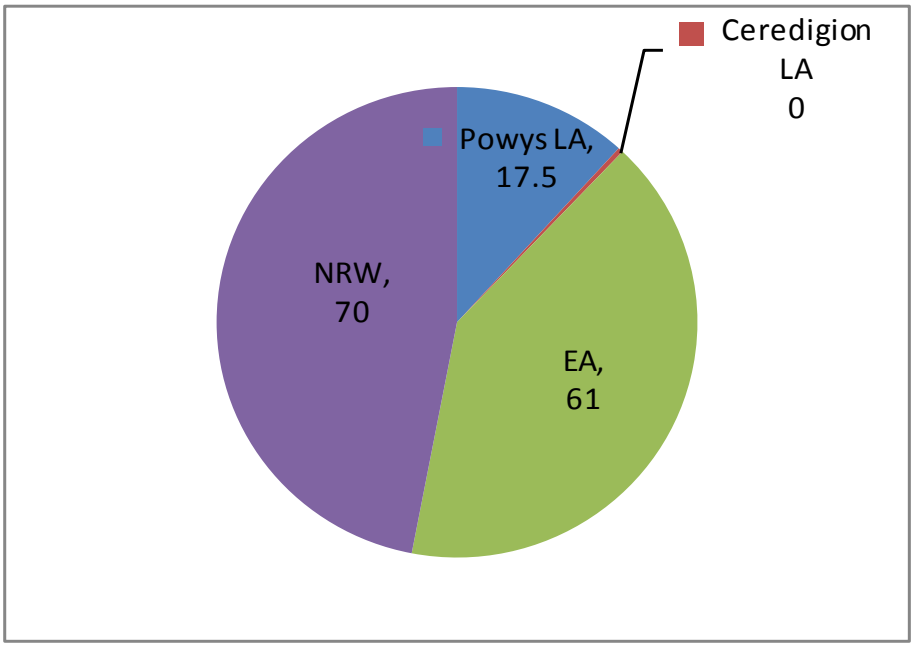


Figure 6.2 Chart showing drainage responsibilities in km, along entire route. Ceredigion, blue route

6.3.2. Sample 2 – Border Hills, Powys

Figure 6.3 depicts the southern red route from rural mid-Wales Figure 5.8, and demonstrates the three previous points from 6.3.1, as well as two new general points:

- Increased influence from the EA is evident here, due to the main river designation within 4km of source. This is typical of less remote settings, and will grow more pronounced.
- There is only one LA before the EA takes over, and only one handover point between EA and NRW. Administratively, this is still quite straightforward; this now appears typical of rural settings.

The first watercourse feeds the river Lugg just as it is designated a main river, so drainage responsibility passes to the NRW before crossing the English border, then falls under the EA 5km east. This makes three organisations liable for drainage within the first 10km.

Ownership in this case is mostly agricultural with private ownership through the villages until it reaches Leominster; it then acquires a mix of private, business and agricultural owners. This still has no effect on drainage liabilities which remain with the EA.

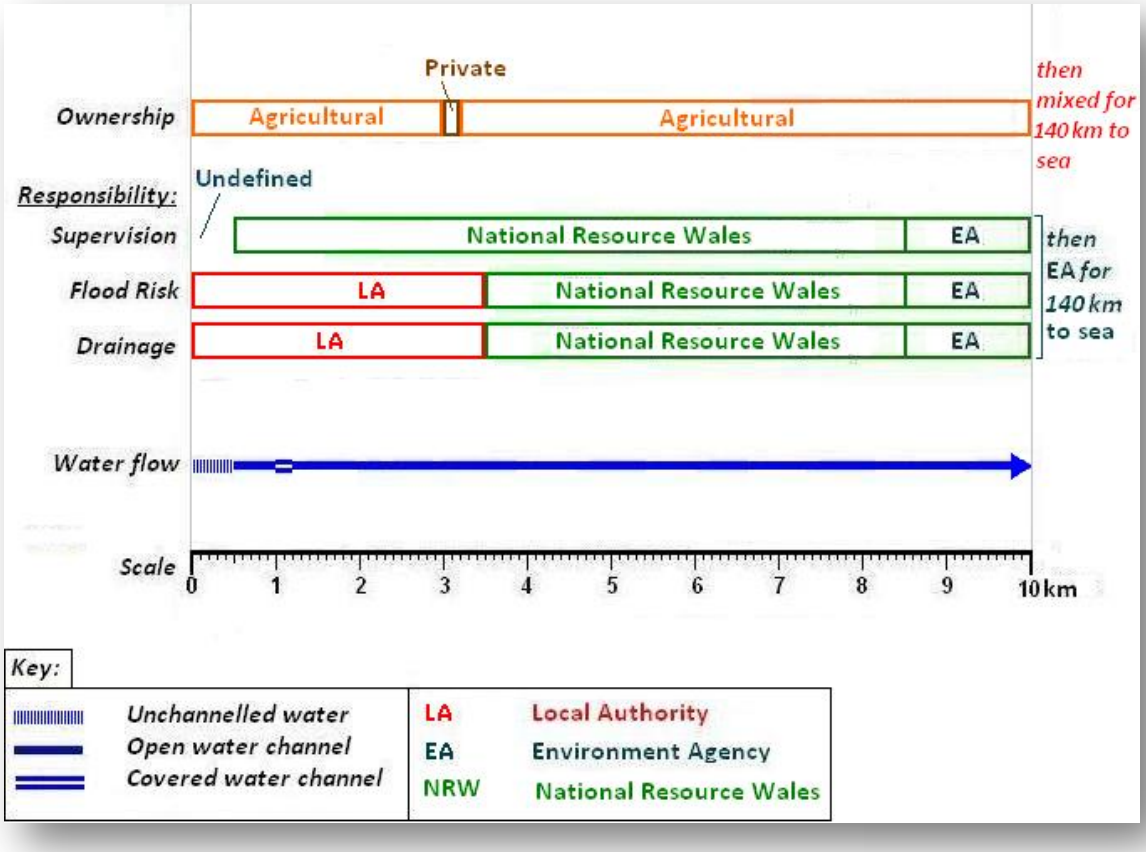


Figure 6.3 Diagram to demonstrate layers of responsibility, ownership and channel type. Powys, red route.

Viewing the entire length of this sample in Figure 6.4, the EA now dominates drainage responsibilities:

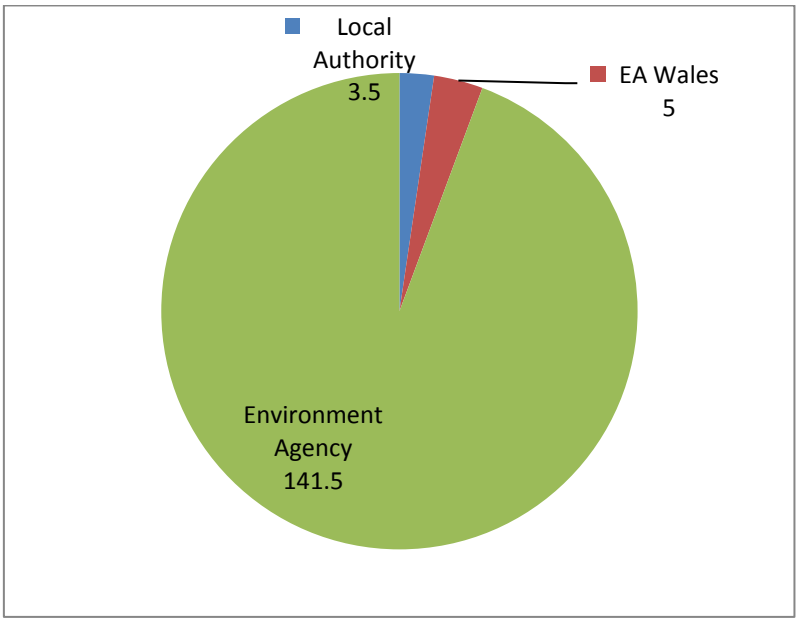


Figure 6.4 Chart showing drainage responsibilities in km, along entire route. Powys, red route

6.3.3. Sample 3 – Upland small town, Pontesbury

This location (Figure 5.13, pink route) is semi- urban and is growing more complex (Figure 6.5). The following are notable points here:

- Urban drainage responsibility is much more diverse, as the Highways Authority (HA) manages road drainage and discharges into combined or storm sewers run by the Water Company (WC).
- Rea Internal Drainage Board (IDB) manages the remaining drainage, with repeated handovers to different bodies.
- Shropshire LA is liable for flood risk but not drainage, due to the presence of Rea IDB. The LA may even own land but the IDB, WC or HA still manage drainage, while the LA must manage flood risk throughout. This raises a question around the feasibility of managing flood risk without controlling drainage.
- Piped channels are more common for urban areas, and water is harder to track reliably.
- The undefined area mentioned in 6.3.1 still applies, but grows smaller in urban areas as the runoff area reduces and surface water is controlled sooner.

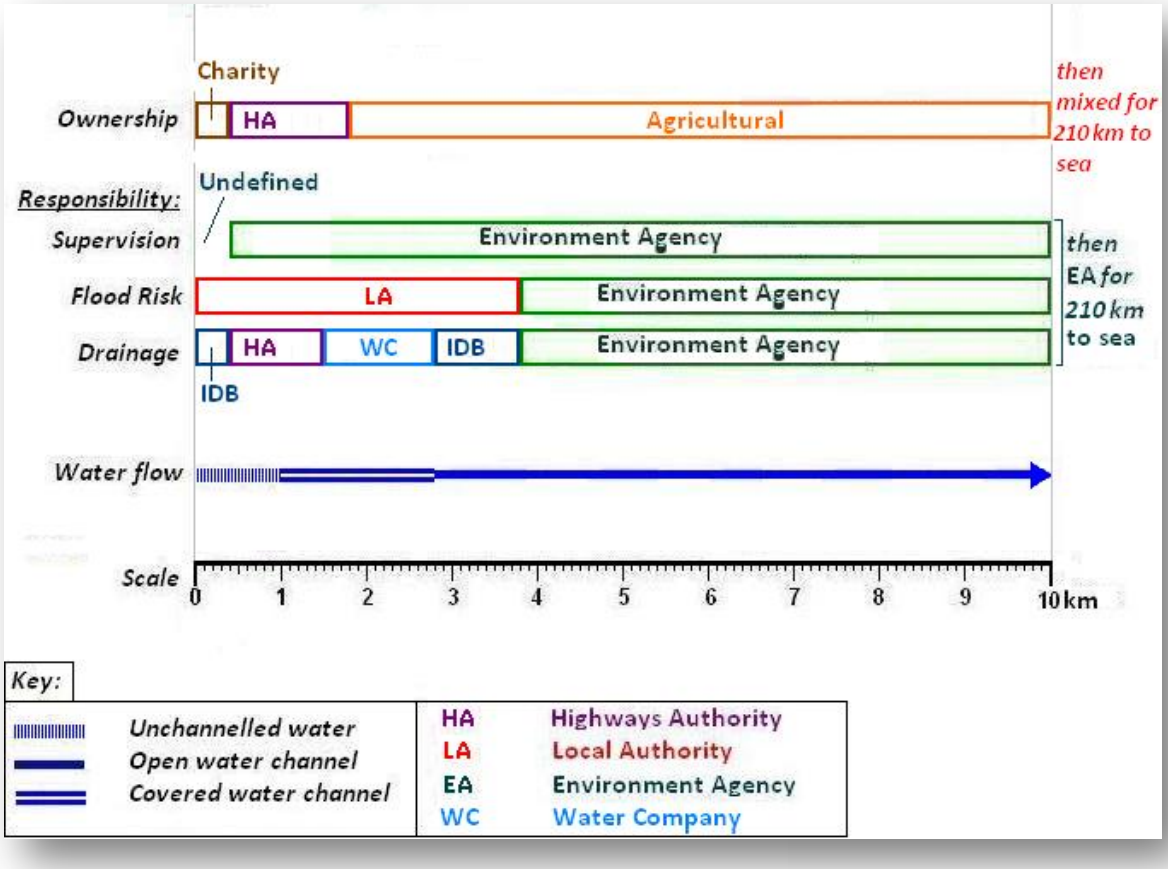


Figure 6.5 Diagram to demonstrate layers of responsibility, ownership and channel type. Pontesbury, pink route.

It is assumed here that HA own the road even where water is managed by WC, but when off-road the WC remains responsible for piped sewers across agricultural land.

Figure 6.6 shows overwhelming influence by the EA over the entire route from Pontesbury, with multiple drainage bodies affecting just the first 4km across town.

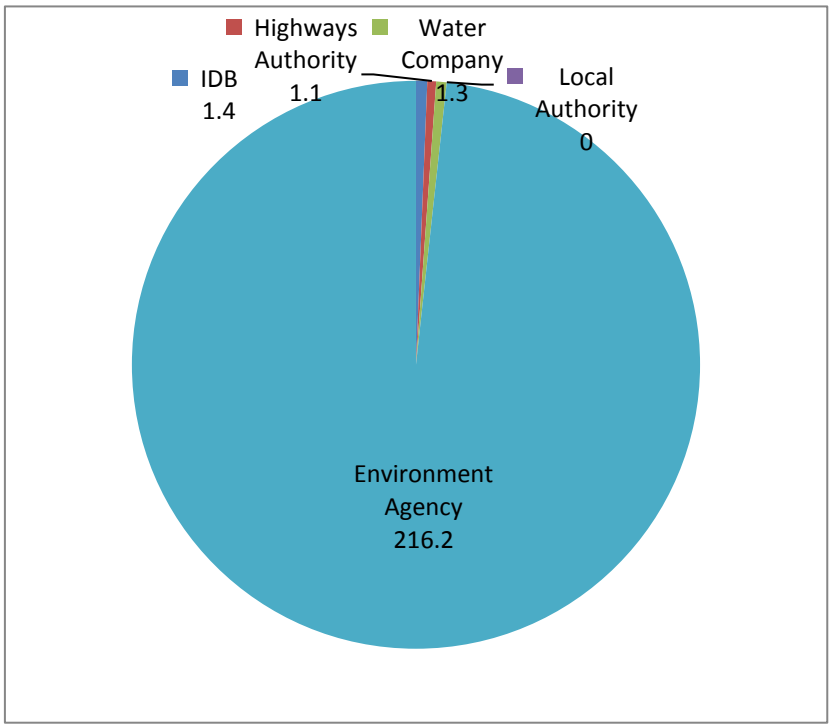


Figure 6.6 Chart showing drainage responsibilities in km, along entire route. Pontesbury, pink route

6.3.4. Sample 4 – Upland town, Shrewsbury

Figure 6.7 examines the blue route in Figure 5.18, showing increased urban influences of HA and WC as raised in 6.3.3, with several new points:

- Ownership across the town now has closer links to the drainage responsibility chain, which again shows urban diversity.
- The EA has huge influence in this flood-prone town, managing all but the first kilometre for all aspects.
- Shropshire LA have almost no drainage duties at all, and very little flood risk management
- Undefined run-off is now a tiny proportion, mostly under householder ownership.
- All non-river water is piped as it passes across town.
- HA and WC appear to dominate urban drainage management.

In this case, Shropshire LA is assumed to own public areas within the town, and highway drainage is assumed to pass into storm sewers managed by SevernTrent WC.

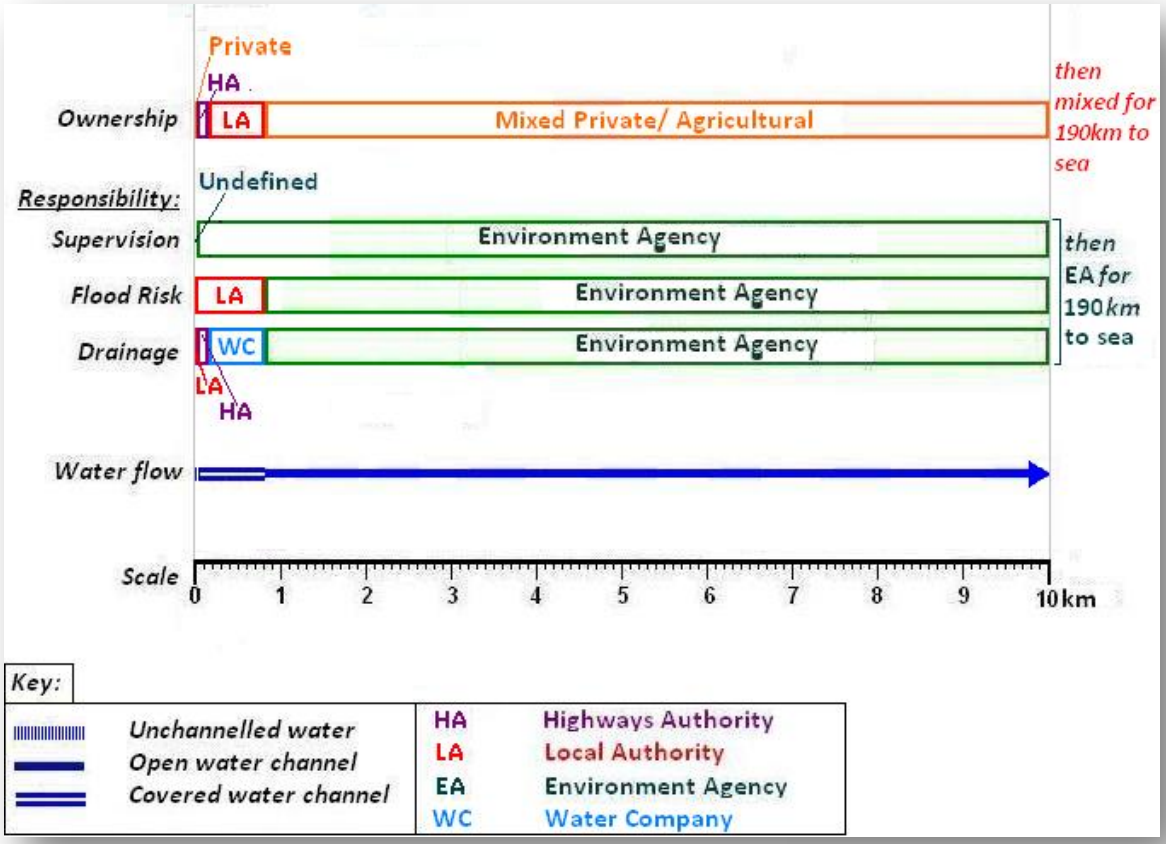


Figure 6.7 Diagram to demonstrate layers of responsibility, ownership and channel type. Shrewsbury, blue route.

Across the entire route (Figure 6.8), the role of the EA continues to increase, with other influences now barely visible, affecting only the first kilometre.

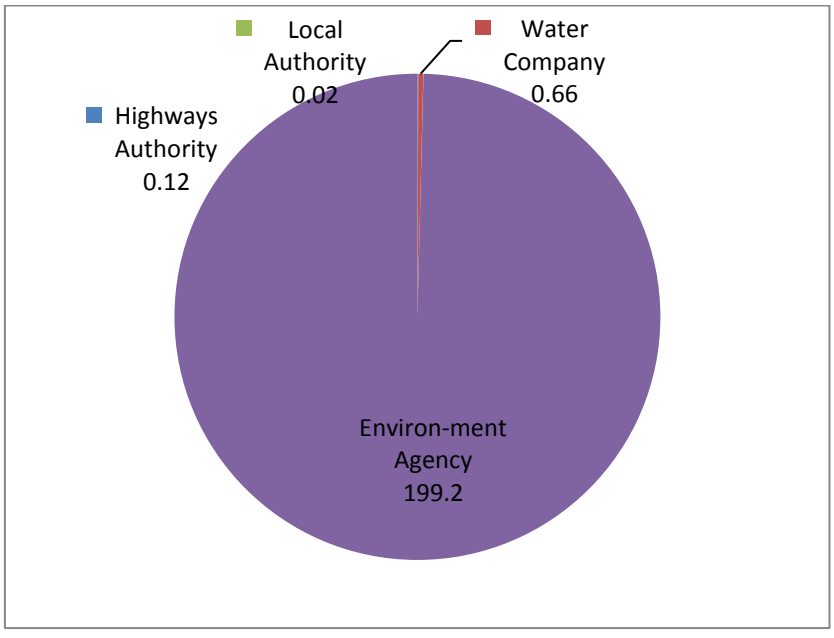


Figure 6.8 Chart showing drainage responsibilities in km, along entire route. Shrewsbury, blue route.

6.3.5. Sample 5 – Lowland city, Worcester

Figure 6.9 charts the red route in Figure 5.20, showing city influences, such as parkland, canal, business parks, and highway drainage. The parkland start-point gives unusually long undefined area for a city; this would be minimal where rain falls on a road or drive. Otherwise this diagram continues the urban trends observed above. The canal in this case is managed by EA, in order to control the flood risk through the city (interview with EA Risk Management Advisor, 1/8/13).

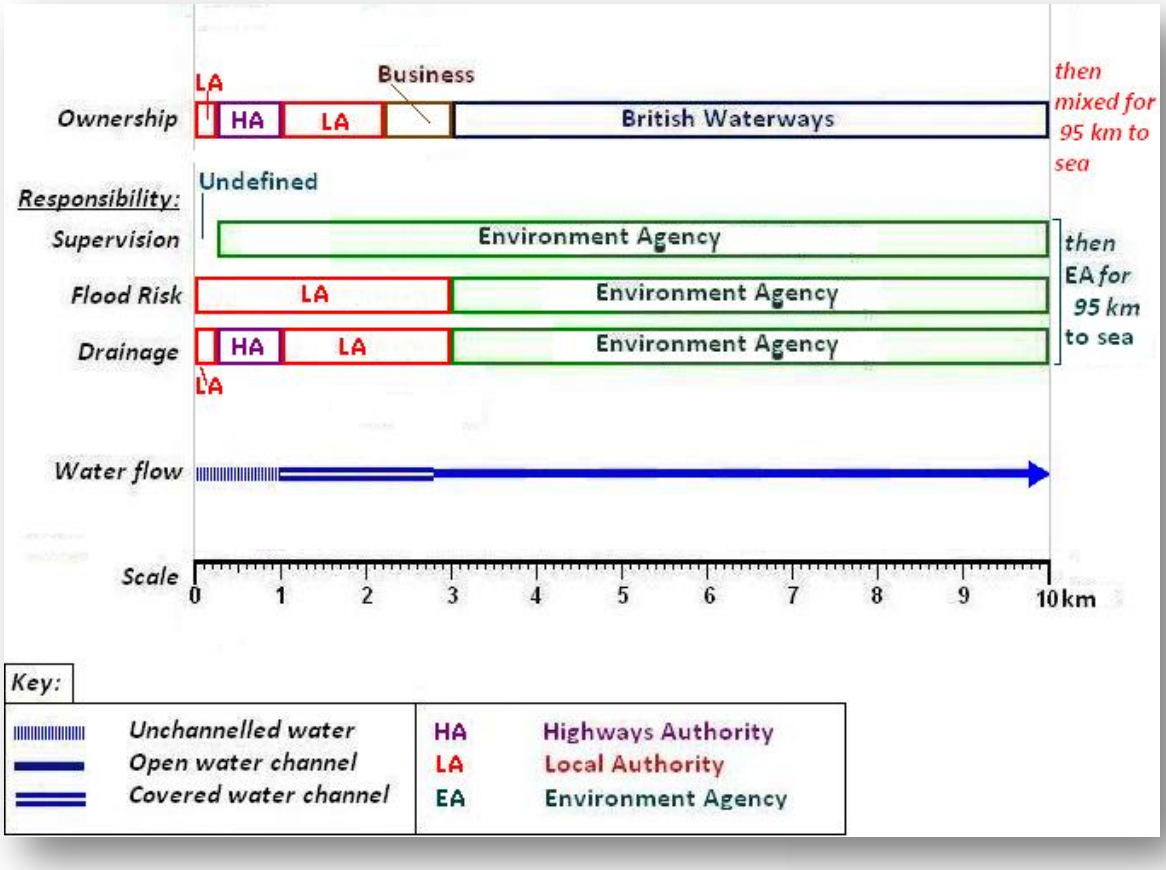


Figure 6.9 Diagram to demonstrate layers of responsibility, ownership and channel type. Worcester, red route.

Figure 6.10 shows a higher relative LA influence, owing to the shorter remaining length of the river before the estuary. The EA influence still predominates overall.

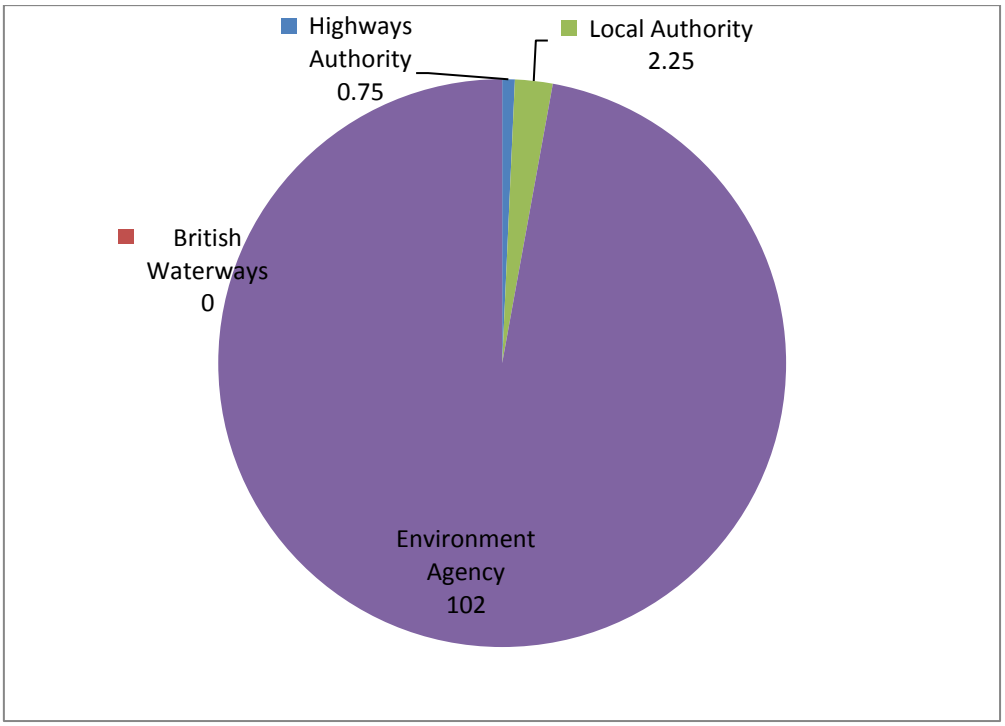


Figure 6.10 Chart showing drainage responsibilities in km, along entire route. Worcester, red route

6.4. Limitations in mapping

It was not possible to investigate all aspects of ownership, therefore certain assumptions have been made. In general, ownership is divided by type of owner rather than depicted as specified entities. It is assumed that in the absence of evidence to the contrary, all land under roads is owned by the highways authority / agency; conversely, it is assumed that land traversed by sewerage pipes rarely belongs to the Water Company. Rural land is assumed to be agricultural unless it is visibly privately or business owned; while urban public areas are assumed to be Local Authority owned. All data assumptions made in section 5.5 also apply here.

Water flows have been measured using Digimap measuring tools, but these cannot take full account of meanders, so flow distances are all approximate.

As water flows along a main river, upstream management influences grow in the water downstream. This makes the range of antecedent institutional management especially wide for lowland rivers such as in Worcester. There are limitations in presenting such responsibility changes over a large area, so only the initial flow been mapped; however preceding influences in the river should remain a consideration.

6.5. Summary

These analysis diagrams demonstrate a number of points regarding the changing influences along flow routes. These include noticeable changes when sampling shifts from rural to increasingly urban settings: institutional influences are different; drainage management changes more frequently; the EA increasingly manages more of the flow; more water is piped underground; and unchannelled surface water reduces significantly. Other key issues are visible over all terrains, these include: the continuous split between ownership and responsibility; multiple drainage handovers between institutions; very high influence of the EA; and the imposition of flood-risk responsibility upon a body which does not fully control drainage.

These and other observations will be considered in the concluding chapter.

7. Conclusion and Recommendations

This chapter reviews the original research questions in the light of results and analysis, recaps findings from the analysis chapter, then presents further observations and recommendations.

7.1. Reflections

Aims and objectives

The primary aim was: 'To present a visual mapping of the institutional responsibilities for surface water within the case study areas: illustrating movement of a raindrop across the areas of institutional ownership.'

This mapping was presented in the analysis chapter and discussed in detail, along with plotted charts and annotated maps.

The original objectives were:

To establish the roles, responsibilities and interactions of all surface water stakeholders

The roles and responsibilities of relevant institutions were primarily established in the policy review, with some historical data from the literature reviewing to broaden understanding. This then combined with interview and field data to analyse the interactions of stakeholders and illustrate these in the analysis.

To track specific theoretical flows of water across a catchment, considering the implications of runoff and infiltration, as well as constructed drainage, sewers and all watercourses

Flows were tracked using maps and transect walks to consider all forms of water, and illustrated on annotated maps, demonstrating multiple routes.

To illustrate the changes in institutional management as a visual mapping

Management was depicted on highly accessible line diagrams, in order to simplify a complex series of rights and responsibilities.

To summarise pertinent background information to facilitate these objectives

Such background data was summarised in the literature review and more importantly the policy investigation; indeed the analysis would not have been possible without the policy review.

Box 7-1: Reviewing Aim and Objectives

7.1.1. Methodology

The combination of methods successfully generated diverse and meaningful results. The variety of data sources proved useful for triangulating data and enriching the analysis.

Some limitations were mentioned in results; in particular that the physical transect walks offered only a marginal increase in geographical data over the theoretical mapping. However, it did permit the acquisition of local knowledge which provided valuable insights.

Amongst contacts, although initial information was issued, Shropshire Flood Manager proved extremely difficult to contact by phone or email, and SevernTrent failed to supply any contact at all, despite their many automated responses to requests. In addition, investigating institutional failures in interaction proved difficult without the candid discussions which could only result from in-depth relationships.

7.2. Observations

Certain issues were raised within the analysis section, firstly, how can a Local Authority (LA) control flood risk when it has only partial control over drainage? The 1991 Land Drainage Act has been updated by the 2010 Flood and Water Management Act without real any attempt to integrate drainage with flood management. As seen in section 2.1, flooding and drainage are inextricably linked, but discrepancies remain between flood risk and drainage responsibility. The distinction between land ownership and the various levels of responsibility is also interesting and somewhat surprising. Along with the observation of split layers of responsibility, these suggest that this field is lacking in the holistic approach which is fundamental to both river basin management and disaster risk management.

It is also noticeable from diagrams that water companies and highways authorities act as primary drainage managers in urban settings, normally implementing this underground; while rural surface water is very visible, easy to manage and controlled by drainage bodies. Frequent handovers between stakeholders regularly take place in urban settings, requiring close coordination and increasing the risk of confusion in a crisis.

Also clear from the diagrams is the fact that the Environment Agency (EA) dominates management of river water. Given the frequent mention of loss of local knowledge and the EAs apparent lack of teeth it is not clear that the EA is equipped for this responsibility. Similarly, lack of resource and loss of embedded knowledge within the LAs make it hard to see how they can carry out their required flood management responsibilities. This loss of continuity and institutional memory may simply be an inevitable casualty of centralised accountability.

Other observations arose from combining data: for instance, it must be remembered that subsurface flow still contributes to drainage as well as flooding. This is marked as initial flow on annotated maps but not distinguished on diagrams, however is always present and

contributing to open drainage flow. Planning guidance advocates infiltration systems (SuDS) in order to reduce a site's overall runoff rate, but appears not to consider the implications of infiltration on groundwater flooding. This is especially significant important in lowland areas. If ground is saturated due to proximity to a floodplain, infiltration systems will fail to function, and are likely to add to the problem. This is mentioned in Shropshire Council's surface water management plan, where linkages are drawn with groundwater, sewer and surface water flooding (Shropshire Council, 2012) but apparently not considered in planning decisions.

From the planning request tracked in section 5.2 it appears that SuDS are now routinely added to developments without any real consideration of these implications. It is apparently regarded as a method of obtaining planning permission, allowing a 'sustainable' tag to be added to new developments. However it is far from the panacea implied in the National Planning Policy Framework, and such limitations must be considered before planning permission is granted. Planners do need to balance local needs with flood risk, but bowing to the pressure of developers fails to appreciate the gravity of the current flood problem.

The recent shift from state to non-state actors is evidenced by privatisation of water supply, the increasing powers of non-elected agencies such as the EA, and the trend towards business partnership by Defra. While pushing flood responsibility down to the LAs is advertised as a move to local resilience and support for communities, without additional powers or resource this seems unlikely to succeed. In practice, as many urban watercourses are designated main rivers, most flood-prone towns have this risk managed by the EA, who are less accountable than the LA.

Further research suggestions

- Given more time it would have been instructive to investigate in more depth the legal responsibilities for flood risk and supervision, as well as ownership - for instance the 'undefined' surface water flood responsibility, or the apparent 'layers of responsibility'.
- Given the limited availability of urban drainage information, it would be useful to build in-depth relationships with contacts to obtain sewerage maps and more candid interviews. More detailed diagrams could then be built based on fewer assumptions.
- Given the huge role played by the EA in drainage and supervision, it would now be instructive to investigate in depth their ability to perform this role.
- Following a route in metropolitan city would be instructive and could pinpoint urban trends, although another river basin would be required for this.

Box 7-2: Further research suggestions

7.3. Recommendations

Planning regulations in England and Wales need urgent review and tighter enforcement, in order to provide rivers with viable flood storage without inundating new housing. Planning control is the first layer of proactive surface water management and as long as identified issues remain unaddressed (Table 4.2), the flood problem will continue to grow. The recent planning changes with their 'presumption in favour' should be recognised as a step in the wrong direction.

Lessons could be learned from other countries, especially Scotland, around flood insurance, links with planning, participation of all stakeholders and especially accountability. Coordinated proactive management has made a real difference there and demonstrate that change is really feasible if the political will is strong enough.

The Environment Agency's role is demonstrated as far-reaching and essential; this agency should provide advocacy for wise catchment management at a senior level. Sadly this role appears under-powered and over-cautious, particularly with their 'yes, if' approach to developers. More zealous leadership could lead to an agency holding real conviction, leading the cause for effective surface water management in the manner observed in Scotland. Better still, fully elected and accountable controlling bodies would be a movement back in the right direction.

Loss of local drainage knowledge should be stemmed by either knowledge management or investment in technical roles at a local level. The current trend of funding flood schemes through business partnerships can only aggravate such issues, and show little merit other than saving money in the short term.

Finally, the distinction between pluvial and fluvial flooding needs to be recognised as misleading. To mitigate risk effectively requires anticipation and proactive management, which in the case of flood risk means managing surface water and drainage long before tributaries fill the river. If the issue of flooding is to ever move on from insurance, protection and rehabilitation it must be managed intelligently and before this accumulation of risk.

Water legislation in the UK has developed organically and in a fragmentary manner (see Table 4.2); consequentially is divided into issues of drainage, flooding, environment and water resource. This fragmentation obstructs the proactive management of water and generates the observed contradictions between flood risk, drainage and ownership. Better integrated legislation based around river basin management, restoring the link between cause and effect, could ensure holistic management of this vital resource and growing problem.

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Appendix I: Interview questions

1. Environment Agency

1/8/13: Flood & Coastal Risk Management Advisor, Partnerships & Strategic Overview Team

General

Is a map or list available for main rivers, other than the flood map?

What are the standard statutes used in your role?

In practice, what are the limitations of EA's "permissive powers"?

Who are your main partners?

What are the challenges in working with those partners?

Do EA responsibilities overlap with other authorities?

Some very minor urban watercourses (even canals) are designated as main rivers – why is this?

Where a canal is designated a main river who manages it, EA or British waterways?

Is there any confusion between EA and EA in Wales at the border rivers?

Is there enough staff to cover statutory duties?

Planning

Drainage mitigation (section 106 Town/Country planning) ruling in PPS25 – how often is this enforced on developers?

Do developers contribute in any way to flood mitigation? Should they?

How often is EA advice a)heeded and b)feedback given to EA c) passed up to Secretary of State for Environment for determination?

What are the implications of the new National Planning Policy Framework (NPPF) for drainage?

Drainage

Are combined sewers a problem for storm water mgt?

Do you feel it is possible to manage floods only by managing the rivers, while others manage the smaller drains that fill the river?

Do you see a distinction between drainage and flood risk?

Do you feel the EA works proactively to manage flood risk? Can you give examples?

2. WCC Local Authority (delegated to Wychavon District)

15/7/13 Senior Assistant Engineer - Wychavon District Council

General

What are the standard statutes used in your role?

Do you interact much with Lower Severn IDB?

What form does EA supervision take?

What is the usual distinction between district & county for drainage and flood risk?

Who are your main partners?

What are the challenges in working with those partners?

Do LA powers overlap with other authorities, or are boundaries clear?

Planning

Are you involved in planning? Who else should I talk to?

Drainage mitigation (section 106) ruling – how often is this enforced on developers?

Do developers contribute in any way to flood mitigation? Should they?

EA survey (section 105) ruling – how often is this enforced on developers or is the FRA always done by developers?

How often is EA advice a) heeded and b) feedback given to EA c) passed up to Secretary of State for determination?

What are the implications of the new National Planning Policy Framework (NPPF) for drainage?

Is SuDS appropriate for flood plains?

How is the exception test used in practice – "wider sustainable benefits that outweigh flood risk" means what exactly?

Drainage

Is a map available for watercourses under your jurisdiction or is OS map enough?

Is there sufficient distinction in practice between sewers and drains?

Are combined sewers a problem?

Are there still regular maintenance teams to clear culvert screens and watercourses in town?

When rain leaves a house gutter does it pass into a sewer or a road drain?

Where do residential road / highway drains discharge – sewers? Watercourses? Soakaways?

3. SCC Local Authority (Unitary)

Flood and Water Manager,

This interview was not conducted as the Flood Manager went on holiday for 3 weeks without warning, after which it was too late for inclusion.

General

What are the standard statutes used in your role?

Is there an IDB for the Upper Severn? Rea, Powysland, Melverley?

What form does EA supervision take?

Who are your main partners?

What are the challenges in working with those partners?

Do LA powers overlap with other authorities, or are boundaries clear?

Is there enough staff to cover statutory duties?

Planning

Drainage mitigation (section 106) ruling in PPS25 – how often is this enforced on developers?

Do developers contribute in any way to flood mitigation? Should they?

EA survey (section 105) ruling – how often is this enforced on developers or is the FRA always done by developers?

How often is EA advice a)heeded and b)feedback given to EA c) passed up to Secretary of Environment for determination?

What are the implications of the new National Planning Policy Framework (NPPF) for drainage?

Regarding the Sutton Grange development, near Oteley Rd, what changes were made by Taylor Wimpey to get past EA objections? Surely improved drainage will simply reduce flood plain storage and exacerbate flood risk elsewhere?

How is the exception test used in practice – “wider sustainable benefits that outweigh flood risk” means what exactly?

Drainage

Is a map available for watercourses under your jurisdiction especially where it flows underground?

Is there sufficient distinction in practice between sewers and drains?

Are combined sewers a problem?

Are there still regular maintenance teams to clear culvert screens and watercourses in town?

When rain leaves a house gutter does it pass into a sewer or a road drain?

Where do highway drains discharge – sewers/watercourses/soakaways? Is this data publically available?

Do you see a distinction between drainage and flood risk?

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4. Lower Severn IDB

11/7/13 Civil Engineer - Lower Severn Internal Drainage Board

General

What are the standard statutes used in your role? 1991, 2010?

In practice, what are the limitations of IDB's "permissive powers"?

Do IDBs manage every watercourse up to main rivers?

Who are your main partners?

What are the challenges in working with those partners?

Do IDB powers overlap with local authorities?

Do IDB powers overlap with EA?

Is there increased emphasis on flood protection? Since when?

Do development pressures affect IDBs?

Drainage

Is a map available for drains under your jurisdiction? Or is the OS map complete? What about culverts?

This may not affect IDBs but is there sufficient distinction in practice between sewers and drains?

This may not affect IDBs but: Are combined sewers a problem?

The complexity of IDB working was mentioned in the Pitt review as needing review with regard to sub-catchment boards – has this been implemented? See p27 ICE 12

Have you worked with Agricultural Land Tribunals and in what circumstances?

Any other comments on institutional responsibilities?

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5. Severn Trent

This interview was not able to be conducted, as many requests failed to elicit a non-automated response

General

Do water company powers overlap with other authorities?

Who are your main partners?

What are the challenges in working with those partners?

What are the standard statutes used in your role?

Drainage

Is a map available for sewers under your jurisdiction?

Is there sufficient distinction in practice between sewers and drains?

Are combined sewers a problem for sewage mgt?

Does the right for anyone to drain to a sewer cause you a problem?

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6. Agricultural Landowner

1/8/13: Owner , Whitton, Powys

Do you own the land under the road, or does the highways agency?

Do you know where highways drains discharge?

Are you aware of any riparian rights or responsibilities regarding the stream across your land?

Do you use any drainage system on the farm or just soakaways?

Is there an issue here with excess surface water during excess rainfall?

Are you aware of any direction or supervision by Powys CC or the EA regarding drainage or floods?

Have you noticed changes in agricultural land use for commercial reasons, with less deep ploughing?

Appendix II : Environment Agency, Planning Advisor role

Planning Advisor - Sustainable Places

The way we work is changing so this is an exciting time to join our team. We will be continuing our current level of technical response to planning consultations but are developing our skills to become more evidence led and strategic, with more emphasis on influencing Local Authorities early on in the planning process.

You'll achieve this by pro-actively influencing developers during pre-application discussions, Local Authorities through their strategic development plans and through our role as a statutory consultee on planning applications.

Apply at: https://ig24.i-grasp.com/fe/tpl_ea01.asp?s=4A515F4E5A565B1A&jobid=75248,1461587159&key=33461748&c=565835767754&pagestamp=seusqjljiohujsijuk

Appendix III: Raw Data for Analysis

This data was derived by measurements on Digimap

Owner	**Source 1**	**Powys 2**	**Pontes 3**	**Shrews 4**	**Worc 5**
LA				140 - 800m	0 - 250m
					1 - 2.4km
HA			400 - 1800m	20 - 140m	250 - 1000
BW	N/A	N/A	N/A	N/A	3 - 10km
AGRIC	0 - 19km	0 - 3km	1.8 - 18.8km		
		3.2 - 35km			
PRIVATE		3 - 3.2 km		0 - 20m	
ORG			0 - 400m		
BUSINESS					2.4 - 3km
MIXED	19 - 150km		18.8 - 220km	0.8 - 200km	10 - 105km
Supervision					
UNDEFINED	0 - 1.5km	0 - 500m	0 - 400m	0 - 20m	0 - 250m
EA	1.5 - 150km	0.5 - 150km	400m - 220km	0.020 - 200km	250m - 105km
Flood Risk					
UNDEFINED	0 - 1.5km	0 - 500m	0 - 400m	0 - 20m	0 - 250m
LLFA	1.5 - 19km	0.5 - 3.5km	400 - 3800m	20 - 800m	250 - 3000
EA	19 - 150km	3.5 - 150km	3.8 - 220km	0.8 - 200km	3 - 105km
Drainage					
IDB	N/A	N/A	0 - 400m	N/A	N/A
			2.8 - 3.8km		
HA	N/A	N/A	400 - 1500m	20 - 140m	250 - 1000
WC	N/A	N/A	1500 - 2800m	140 - 800m	
BW	N/A	N/A	N/A	N/A	
LA	1.5 - 19km	0 - 3.5km		0 - 20m	0 - 250m
					1 - 3km
EA	19 - 150km	3.5 - 150km	3.8 - 220km	0.8 - 200km	3 - 105km
Water channel					
UNDEFINED	0 - 1.5km	0 - 500m	0 - 1000m	0 - 40m	0 - 250m
COVERED		1000 - 1200	1000 - 2800m	40 - 800m	250 - 1000
OPEN	1.5 - 150km	500 - 1000	2.8 - 220km	0.8 - 200	1 - 105km
		1.2 - 150km			

Appendix IV: Raw Data for Pie Charts

This data was derived by interpolating data in Appendix III

	Source
LA (Powys)	17.5
LA (Ceredigion)	0.5
Environment Agency	61
EA Wales	70

	Powys
Local Authority	3.5
EA Wales	5
Environment Agency	141.5

	Pontesbury
IDB	1.4
Highways Authority	1.1
WC	1.3
Local Authority	0
Environment Agency	216.2

	Shrewsbury
Highways Authority	0.12
WC	0.66
Local Authority	0.02
Environment Agency	199.2

	Worcester
Highways Authority	0.75
British Waterways	0
Local Authority	2.25
Environment Agency	102

Appendix V: Work Plan and Schedule

KEY
Scheduled
Completed on time
Completed late
Complete early
Not required
Late - flagged for action