

**Dacorum Borough Council  
St Albans City & District Council  
Three Rivers District Council  
Watford Borough Council**

Strategic Flood Risk Assessment  
Volume I  
August 2007

**Halcrow Group Limited**

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# Foreword

The purpose of this Strategic Flood Risk Assessment (SFRA) study is to assess and map all forms of flood risk from groundwater, surface water, sewer and river sources, taking into account future climate change predictions, and use this as an evidence base to locate future development primarily in low flood risk areas. The outputs from the SFRA will help the Four Council's to prepare sustainable policies for the long-term management of flood risk and improve existing emergency planning procedures.

Issues of emergency planning, disaster recovery and climate change have been topping the news headlines this summer as a result of the devastating flooding which occurred in the Midlands, North East and Thames Region, following record levels of rainfall (worst affected areas were Sheffield, Hull, Gloucestershire and Oxfordshire and Berkshire).

By comparison, the level of flood risk is lower within the study area, particularly along the chalk tributaries (Rivers Ver, Gade, Bulbourne and Chess). Here, the catchment topography is such that river flooding will only affect a relatively narrow and well-defined corridor, as opposed to the expansive and low-lying floodplains of Hull, for example. The main issues relate to the capacity of surface water and sewer drains, which can result in localised flooding following heavy rainfall. As experienced recently on the 20<sup>th</sup> July 2007, this localised flooding can cause disruption to traffic as well as damage to property.

The main pockets of higher flood risk (from rivers) tend to be localised. They are located along the Upper River Lee through Harpenden and Wheathampstead and the Upper River Colne through Colney Heath, London Colney and Watford. Within and around these areas it is important that effective flood risk management policies are implemented and that future development does contribute to increased flood risk. This will be achieved by implementing the recommendations provided in the SFRA.

# Executive Summary

## *Project Overview*

Dacorum Borough Council, St Albans City & District Council, Watford Borough Council and Three Rivers District Council (hereafter referred to as the Four Councils) are located in West Hertfordshire and together comprise a study area of some 480km<sup>2</sup>. The main towns are Tring, Berkhamsted, Hemel Hempstead, Kings Langley, St Albans, Watford, London Colney and Rickmansworth. Much of the study area is designated green belt and as a result urban development is restricted to concentrated zones, which tend to be located in or proximal to river valleys.

The three main catchments within the study area and their respective watercourses are the Colne (Upper River Colne, Ver, Chess, Gade and Bulbourne), Lee (Upper River Lee) and Thame (River Thame). Flooding from the Upper River Colne and Upper River Lee has occurred many times in the past, including recent flooding in 2000, 2001 and 2007. It is estimated that over 2,500 properties are at significant risk of flooding, encompassing around 4% of the total land area. The risk of flooding posed to properties arises from a number of sources including river, surface water, sewers and groundwater.

In February 2007, the Four Councils commissioned Halcrow Group Limited to produce a Level 1 Strategic Flood Risk Assessment (SFRA) in accordance with Planning Policy Statement 25 (PPS25) and its Companion Guide, Making Space for Water (2003) and the Thames Catchment Flood Management Plan (2007). Using readily available information, the principle aim of the SFRA is to map all forms of flood risk and use this as an evidence base to locate new development primarily in low flood risk areas.

In addition, the outputs from the SFRA will enable the Four Council's to:

- Prepare appropriate policies for the management of flood risk;
- Inform the sustainability appraisal so that flood risk is taken account of, when considering options and in the preparation of strategic land use policies;
- Identify the level of detail required for site-specific Flood Risk Assessments (FRAs), and

- Determine the acceptability of flood risk in relation to emergency planning capability.

The SFRA should be regarded as a 'living' document and reviewed on a regular basis in light of better flood risk information and emerging policy guidance.

#### *Site Allocations and the Sequential Test Process*

In accordance with PPS25, areas of 'low', 'medium' and 'high' risk have been mapped using data collected from the Environment Agency, Hertfordshire Highways, British Waterways, Thames Water and Three Valleys Water. This has included information on flooding from surface water (land drainage), groundwater, artificial water bodies and sewers.

A preliminary review of around 400 indicative sites has been made as part of the SFRA to identify levels of risk from all sources of flooding. Of these, 53 sites are found to intersect with the 'high' risk flood zone and 4 sites intersect with the 'medium' flood risk zone. A further 100 sites are found to be at possible risk from other sources of flooding. Each Council will need to apply the Sequential Test to all sites within the 'high' and 'medium' risk flood zones to demonstrate that there are no reasonably available sites in areas with less risk of flooding that would be appropriate to the type of development or land use proposed. In many cases there is a very small area of overlap between the site boundary and area at risk of flooding and therefore opportunities reduce flood risk within the site should be taken such as using low-lying waterside areas for recreation, amenity and environmental purposes.

Where the need to apply the Exception Test is identified, if the Council's consider that there is an insufficient number of suitable sites for development, the scope of the SFRA could be widened to a Level 2 assessment. It is recommended that this is undertaken by a suitably qualified chartered engineer.

#### *Guiding Council Policy*

Following a review of emerging best practice, guidance from national policies and a project workshop to engender a partnering approach, the following core areas have been identified for the Councils' flood policy documents:

- Protect the functional floodplain from development
- Direct vulnerable development away from flood affected areas

- Ensure all new development is ‘Safe’, meaning that dry pedestrian access to and from the development is possible without passing through the 1 in 100 year plus climate change floodplain, and emergency vehicular access is possible
- Promote the use of sustainable urban drainage systems in all flood zones to achieve Greenfield discharge rates on both Greenfield and Brownfield sites
- Support flood alleviation measures under consideration by the Environment Agency by safeguarding possible sites for flood storage and other channel works
- Seek developer contributions via S106 planning obligations (in consultation with the Environment Agency) to fund strategic flood risk management facilities and bring benefit to the wider community

For the purpose of clarity, a Supplementary Planning Document should be developed in light of the suggested policies and guidance notes, outlining the minimum requirement of the Environment Agency in response to PPS25. Furthermore, as a means of managing existing and future risk within the study area, it is recommended that the Four Councils review their adopted flood risk response plans in light of the findings and recommendations of the SFRA.

#### *Future Studies*

Within the study area there are several formal flood defences and many informal defences (such as road and rail embankments), which provide protection to significant areas of residential houses, commercial premises and highway infrastructure. It is recommended that more detailed modelling studies are undertaken in selected areas to provide better information on the flood hazard associated with the failure of flood risk management infrastructure. The outputs from these studies will enable the Council’s Emergency Planning teams to refine existing emergency response plans and will provide Development Control with more accurate and consistent information with which to guide future development.

# 1

## Introduction

### 1.1

#### ***Overview***

In February 2007 Dacorum Borough Council, St Albans City & District Council, Three Rivers District Council and Watford Borough Council (hereafter referred to as the 'Four Councils') commissioned Halcrow to produce a Strategic Flood Risk Assessment in accordance with Planning Policy Statement 25: Development and Flood Risk (PPS25) (see ***Appendix A***). The study complies with the requirements of the Project Brief, however, the methodology and the deliverables have been aligned to the recently published document: Development and Flood Risk, a Practice Guide Companion to PPS25 (February 2007).

The Strategic Flood Risk Assessment (SFRA) will inform the site selection process for future development sites and provide recommendations for policies to deal with non-allocated sites. The SFRA will feed into the Local Authorities Sustainability Appraisals of the Local Development Documents (LDDs) and will enable informed decisions to be made relating to land use and development allocation within the respective Development Plan Documents (DPDs).

For this study, a Level 1 SFRA approach has been agreed with the Four Councils and the Environment Agency. A Level 1 SFRA is defined in the Practice Guide Companion to PPS25, as a desk-based study using existing information to allow application of the Sequential Test on the basis of Table D1 of PPS25 and to identify whether application of the Exception Test is likely to be necessary.

It is important to recognise that the SFRA is a 'living' document in that as new information becomes available (such as improved river models) updates will be made to the Flood Maps (see ***Volume II***) and SFRA document, to ensure that the best information is used to guide the site selection process for future developments.

### 1.2

#### ***Study Area***

The study area is 481.3km<sup>2</sup> and is comprised of four local councils: Dacorum Borough Council, St Albans City & District Council, Watford Borough Council and Three Rivers District Council, all located in West Hertfordshire. The main towns in the study area are Tring, Berkhamsted, Hemel Hempstead, Kings Langley, St Albans, Watford, London Colney and Rickmansworth. Much of the

study area is designated green belt and as a result urban development is restricted to concentrated zones, which tend to be located in or proximal to river valleys. The study area includes the north-west sector of the M25, parts of the A1, M1, M40 and M4 motorways.

A considerable proportion of the study area is at risk of flooding, with approximately 4% of the land area and 2,500 properties affected by the 100 year flood event. The risk of flooding posed to properties arises from a number of sources including river, surface water, sewers and groundwater.

### 1.2.1

#### *Main Watercourses & Topography*

The three main catchments within the study area and their respective watercourses are the Colne (which includes the Upper River Colne, Ver, Chess, Gade and Bulbourne), Lee (Upper River Lee) and Thame (River Thame) (see ***Volume II, Tile A1***).

The entire Colne catchment covers an area of 1014km<sup>2</sup> and extends from southern Bedfordshire (Luton) in the northernmost part of the area, southwards through western Hertfordshire. (Watford area), eastern Buckinghamshire and Surrey where the River Colne joins the Thames nears Staines. The Upper Colne catchment includes the majority this area (approximately 875km<sup>2</sup>) and only excludes a 13km stretch of the Colne from the confluence with the Misbourne at Denham to the confluence with the Thames at Staines. In terms of the SFRA study area, the southern-most boundary of Three Rivers is located approximately 5km upstream of the confluence with the Misbourne. The catchment area to this point is 722km<sup>2</sup>.

The north-western boundary of the catchment follows the chalk escarpment of the Chiltern Hills at approximately 200 to over 250m AOD, overlooking the Vale of Aylesbury. The north-western half of the catchment is characterised by the rolling chalk hills of the Chilterns formed on the dip slope of the escarpment, falling to the southeast to less than 50m AOD on the edge of the Colne Valley. These hills, which are typically 100 to 150m AOD, are incised by south easterly flowing tributaries of the River Colne (the Ver, Gade, Bulbourne and Chess).

The River Colne flows from northeast to southwest from approximately 75m AOD near Hatfield, through Watford, to approximately 45m AOD at Rickmansworth. The main tributaries along this reach are the Ver (with a catchment area of 135km<sup>2</sup>), a chalk stream flowing southwards from Markyate and Redbourn through St. Albans to the confluence with the Colne; the Mimms Hall



Brook; and the Ellen Brook both flow to the east of the Upper Colne and confluences with the Colne at Colney Heath.

At Rickmansworth, the Rivers Gade and Chess (the catchment area of the Chess to the confluence with the Colne is 97km<sup>2</sup>) join the River Colne and the river changes direction and flows to the south through a wider, well defined floodplain, approximately 750m to 1km wide. Like the Ver, the Gade, Bulbourne and Chess are chalk streams flowing south to south-easterly through the Chilterns.

The River Gade flows through Hemel Hempstead, where it is joined by the River Bulbourne which flows through Berkhamsted (the Bulbourne catchment area is 66km<sup>2</sup>). The River Gade then continues to flow southwards through Kings Langley, Abbott's Langley and Watford to the confluence with the Colne. The catchment of the Gade at the confluence with the River Colne is 185km<sup>2</sup>.

Another critical component of the Colne catchment is the Grand Union Canal (GUC) which was built in the 19<sup>th</sup> century for the purpose of commercial transport. It passes through Tring where it is fed by British Waterway's reservoirs (Tringford, Startopend, Marsworth and Wilstone) and the Wendover Arm (which is primarily fed by springs issuing from the south of Tring), and then continues through Northchurch, Berkhamsted and Boxmoor alongside the River Bulbourne (Appendix C). The canal then continues in a southerly direction alongside the River Gade through Hemel Hempstead, Kings Langley, Abbott's Langley and finally Watford, before it turns in a south westerly direction at the confluence with the Colne and continues through Rickmansworth and on towards Denham. There are several sections of canalised river and many exchanges between the Canal and the Bulbourne and Gade.

The other major catchment is the Upper Lee. The Upper River Lee refers to the River Lee from its source at Limbury near the M1 motorway in Luton, Bedfordshire to the south east of the village of Wheathampstead. The catchment area to this point is 102km<sup>2</sup>. The main urban areas within the study area (in St. Albans City and District Council) are Harpenden, Batford and Wheathampstead.

Within the north-western area of Dacorum the chalk escarpment of the Chiltern Hills divides the Colne and Thame catchments. The Upper Thame catchment extends from the west of Tring north westwards to Hulcott (including the villages of Wilstone and Long Marsworth, as well as four British Waterway's reservoirs). The catchment area to the north western boundary of Dacorum is 33km<sup>2</sup>. Beyond

Hulcott, the River Thame flows in a south westerly direction through Aylesbury and Thame down to the confluence with the River Thames to the south of the village of Dorchester.

### 1.2.2

#### *Geology & Soils*

The Colne Valley is a dip slope river system situated between geological formations of the chalk of the Chiltern Hills to the north and west, and the Tertiary Lambeth Group of the London Basin to the south and east. These formations are largely overlain by Pleistocene periglacial and glacial drift deposits, and recent fluvial deposits.

Most of the Colne catchment comprises the Upper Chalk dipping at a shallow angle to the south east. Older Middle and Lower Chalk are exposed where the upper reaches of the Colne tributaries (rivers Ver, Gade, Bulbourne, Chess and Misbourne) have formed incised valleys cutting through the Upper Chalk.

On the higher interfluvial areas of the Chiltern Hills, the chalk is overlain by drift deposits, comprising predominantly of clay-with-flints, with smaller outcrops of pebbly clay and sand. There are also occasional small outcrops of Reading Beds. On the edge of the Colne Valley, the drift deposits change to glacial sand and gravel with head deposits. In the St. Albans and Hatfield areas the glacial sand and gravel is overlain and mixed with boulder clay.

In the bottoms of the river valleys of the Colne and its larger tributaries (Ver, Chess, Gade and Bulbourne) there are deposits of recent gravels, overlain by river alluvium. This sequence becomes thicker and more extensive downstream of Rickmansworth.

In the Upper Lee catchment most of the underlying geology is loam over chalk. However, urban growth in the catchment since the 1960s has resulted in the widespread construction of impermeable surfaces resulting in increased runoff and consequent fluvial flooding. The geology of the various water courses in the study area are summarised in Table 1-1.

Upper Colne Valley (Colney Heath area)	Thin alluvium overlying glacial till and glacial gravels
Mimmshall Brook	Cut through London clay and Reading beds to expose Upper Chalk, flows into swallow holes at Water End, emerging in the Lea Valley
Middle Colne (Watford area)	River alluvium lining the bottom of a chalk valley with glacial gravels on the valley sides
Lower Colne (Rickmansworth to Denham)	River alluvium overlying river gravel and glacial gravel in a chalk valley
Rivers Ver, Gade, Bulbourne and Chess	Recent gravels overlain by river alluvium. Groundwater fed chalk 'bournes', dry in their upper reaches in summer
Upper Lee	Loam over chalk

**Table 1-1 Geology of the catchments in the study area**

## 2

## SFRA Approach & Methodology

### 2.1

#### ***SFRA Aims***

The aims of PPS25 planning policy on development and flood risk are to ensure that flood risk is taken into account at all stages of the planning process to avoid inappropriate development in areas at risk of flooding, and to direct development away from areas at highest risk (see **Appendix A**). Where new development is necessary in such areas, exceptionally, the policy aims to make it safe without increasing flood risk elsewhere and where possible, reducing flood risk overall. 'Safe' in the context of this study means that dry pedestrian access to and from the development is possible without passing through the 1 in 100 year plus climate change floodplain, and emergency vehicular access is possible.

The aim of this SFRA therefore is to map all forms of flood risk and use this as an evidence base to locate new development primarily in low flood risk areas (Zone 1). Where development cannot be located in Flood Zone 1 the planning authority will need to apply the Sequential Test to land use allocations and, where necessary, the Exception Test. In addition, it allows a planning authority to:

- Prepare appropriate policies for the management of flood risk;
- Inform the sustainability appraisal so that flood risk is taken account of, when considering options and in the preparation of strategic land use policies;
- Identify the level of detail required for site-specific Flood Risk Assessments (FRAs), and
- Determine the acceptability of flood risk in relation to emergency planning capability.

The findings of the SFRA will feed directly into the preparation of Local Development Documents, including the Core Strategy and Site Allocation DPDs.

### 2.2

#### ***Outcomes of the SFRA Process***

A Strategic Flood Risk Assessment provides sufficient data and information to enable a planning authority to apply the Sequential Test to land use allocations and, where necessary, the Exception Test (see **Sections 2.3** and **2.4**).

PPS25 also indicates that Sustainability Appraisals should be informed by the SFRA for their area. Under the Town and Country Planning (Local Development - England) Regulations 2004, a Sustainability Appraisal (SA) is required for all LDFs. The purpose is to promote sustainable development through better integration of sustainability considerations in the preparation and adoption of plans. The Regulations stipulate that SAs for LDFs should meet the requirements of the SEA Directive. A SFRA is used as a tool by a planning authority for the production of development briefs, setting constraints, identifying locations of emergency planning measures and requirements for Flood Risk Assessments.

It is important to reiterate that PPS25 is not applied in isolation as part of the planning process. The formulation of Council policy and the allocation of land for future development must also meet the requirements of other planning policy. Clearly a careful balance must be sought in these instances, and the SFRA aims to assist in this process through the provision of a clear and robust evidence base upon which informed decisions can be made.

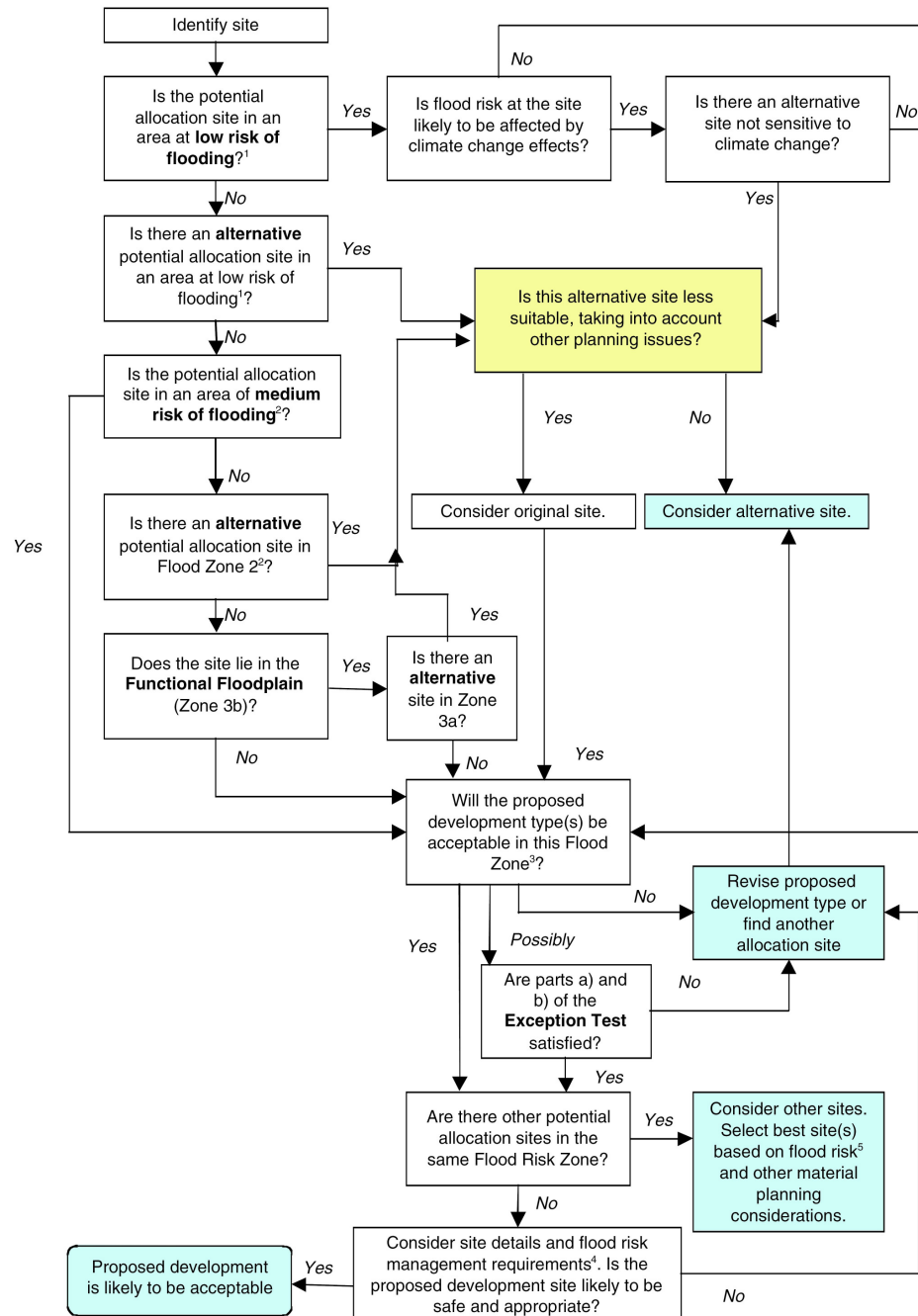
## **2.3**

### ***The Sequential Test***

A planning authority applies the Sequential Test to demonstrate that there are no reasonably available sites in areas with less risk of flooding that would be appropriate to the type of development or land use proposed. **Figure 2-1** shows the Sequential Test process as advocated in PPS25.

Preference should be given to locating new development in Flood Zone 1 (see **Section 2.1.3**). If there is no reasonably available site in Flood Zone 1, the flood vulnerability (see Table D.2 in PPS25) of the proposed development can be taken into account in locating development in Flood Zone 2 (Medium Probability) and then Flood Zone 3 (High Probability).

Within each Flood Zone new development should be directed to sites with lower flood risk (towards the adjacent zone of lower probability of flooding) from all sources as indicated by the SFRA.



**Figure 2-1 Application of the Sequential Test – Source: Development and Flood Risk: A Practice Guide Companion ‘Living Draft’**

## 2.4

### *The Exception Test*

If, following application of the Sequential Test, it is not possible, or consistent with wider sustainability objectives, for the development to be located in zones of lower probability of flooding, the Exception Test can be applied. This test provides a method of managing flood risk while still allowing necessary development to occur.

The Exception Test is only appropriate for use when there are large areas in Flood Zones 2 and 3, where the Sequential Test alone cannot deliver acceptable sites, but where some continuing development is necessary for wider sustainable development reasons (the need to avoid social or economic blight and the need for essential civil infrastructure to remain operational during floods). It may also be appropriate to use it where restrictive national designations such as landscape, heritage and nature conservation designations, e.g. Areas of Outstanding Natural Beauty (AONBs), Sites of Special Scientific Interest (SSSIs) and World Heritage Sites (WHS), prevent the availability of unconstrained sites in lower risk areas.

For the Exception Test to be passed:

- a) It must be demonstrated that the development provides wider sustainability benefits to the community which outweigh flood risk, informed by a SFRA where one has been prepared. If the Development Plan Document has reached the 'submission' stage (see Figure 4 of PPS12: Local Development Frameworks) the benefits of the development should contribute to the Core Strategy's Sustainability Appraisal;
- b) The development should be on developable previously-developed land or, if it is not on previously developed land, that there are no reasonable alternative sites on developable previously-developed land; and,
- c) A flood risk assessment must demonstrate that the development will be safe, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.

It is possible that each Council will need to apply the Exception Test as several indicative sites fall within Flood Zone 3, although it is not possible to fully determine this until the Sequential Test process has been undertaken (see **Section 5.8**).

## 2.5

### ***Level 1 SFRA Methodology***

A Level 1 SFRA is defined in the Practice Guide Companion to PPS25, as a desk-based study using existing information to allow application of the Sequential Test (see **Figure 2-1**) and to identify whether application of the Exception Test is likely to be necessary.

The main tasks undertaken during the study were as follows:

- a) Understanding the planning context (see **Chapter 3**)  
A review of the Local Development Framework process and Local Policy was undertaken for each Council to get a clear picture of the challenges faced by the planning teams, and the various opportunities and constraints guiding the site allocation process.
- b) Gathering data and reviewing it for suitability (see **Chapter 4**)  
A quality review of flood risk information was carried out by an experienced core team. The team reviewed the collected data, assessed its significance and quality, and advised on which data would be needed to drive the SFRA. The main approach adopted during the SFRA was to build on previous studies and gathered information.
- c) Producing strategic flood risk maps (see **Chapter 5**)  
A series of GIS maps were produced using the data gathered in the early phases of the study. The main outputs are PPS25 Flood Maps for the entire study area taking into account flooding from all sources, including climate change impacts up to the year 2115. Other maps contain information on topography, flood defences and structures, historical flooding and future flood alleviation scheme options. Hardcopy maps are provided in **Volume II** of the SFRA report, along with GIS layers and PDF copies.
- d) Providing flood policy recommendations (see **Chapter 6**)  
A workshop was held to discuss flood risk management policies with the aim of making recommendations for the purpose of development control as well as providing guidance to those undertaking detailed Flood Risk Assessments. Reference was made to national flood policy documents to ensure that the recommended policies are in-line with current thinking and best practice. The Environment Agency made a valuable contribution to this part of the SFRA by providing specific policy guidance.



e) Assessing flood warning and emergency planning (see **Chapter 7**)

The existing flood warning system was reviewed and future improvements to flood warning were identified through discussions with the Environment Agency with the aim of providing broad recommendations to improve emergency planning.

## **2.6**

### ***Need for Level 2 SFRA***

Where the need to apply the Exception Test is identified, due to there being an insufficient number of suitably available sites for development within zones of lower flood risk or due to possible increases in flood risk arising from climate change, the scope of the SFRA may need to be widened to a Level 2 assessment.

This increased scope involves a more detailed review of flood hazard (flood probability, flood depth, flood velocity, rate of onset of flooding) taking into account the presence of flood risk management measures such as flood defences. This could include 2D modelling and breach/overtopping analysis for certain locations (e.g. Grand Union Canal in Berkhamsted).

Level 2 SFRA outputs include:

- An appraisal of the condition of flood defence infrastructure and likely future policy;
- An appraisal of the probability and consequence of breach or overtopping of flood defence infrastructure;
- Maps showing distribution of flood risk across zones;
- Guidance on appropriate policies for making sites which satisfy parts a) and b) of the Exception Test safe; and the requirements for satisfying part c) of the Exception Test, and
- Guidance on the preparation of FRAs for sites with varying flood risk across the flood zone.

In general, the Level 2 SFRA should aim to provide clear guidance on appropriate risk management measures for adoption on sites within Flood Zone 3, which are protected by existing defences (see **Section 4.6**). This should minimise the extent to which individual developers need to undertake separate studies on the same problem. Recommendations have been provided in this SFRA on where there may be possible benefit to undertaking a Level 2 SFRA (see **Chapter 8**). However, this

cannot be fully determined until the Sequential Test has been undertaken by each Council on all possible site allocations.

## 3 Policy Framework

### 3.1

#### ***Overview***

This section provides an overview of the planning policy framework relevant to the Strategic Flood Risk Assessment (SFRA) of Dacorum District, St Albans City and District, Three Rivers District and Watford District.

Information contained in the SFRA on flooding and flood risk will provide evidence to facilitate the preparation of robust policies for flood risk management. The SFRA should be used to inform the Sustainability Appraisal of Local Development Documents (LDDs) and will enable informed decisions to be made relating to land use and development allocation within the respective Development Plan Documents (DPDs).

### 3.2

#### ***Planning Policy Framework***

#### 3.2.1

##### *UK Planning System*

The UK planning system has a comprehensive hierarchy of policies and plans, beginning with national guidance which provides a broad framework for regional plans through to development plans at the local level. Development plans are intended to provide clear guidance for prospective developers. They are prepared following public and stakeholder involvement and are intended to reconcile conflicts between the need for development and the need to protect the wider built and natural environment.

The Government is currently implementing reforms to the planning system with Planning Policy Statements (PPS) replacing Planning Policy Guidance (PPG), Regional Spatial Strategies (RSS) replacing Regional Planning Guidance (RPG) and Local Development Frameworks (LDF) replacing Structure and Local Plans and Unitary Development Plans.

The following paragraphs provide an overview of the relevant policy documents and a brief explanation of their significance for the SFRA.

### 3.3

#### ***National Policy***

#### 3.3.1

##### *Planning Policy Statement 1: Creating Sustainable Communities (2005)*

PPS1 sets out the Government's objectives for the planning system. It confirms that good planning should deliver the right development in the right place and

time, and protect the environment. It identifies sustainable development as the core principle underpinning planning and requires that development plans ensure it is pursued in an integrated manner.

### 3.3.2

#### *Planning Policy Statement 3: Housing (2006)*

PPS3 has been developed in response to recommendations in the Barker Review of Housing Supply (March 2004). Its principal aim is to underpin the necessary step change in housing delivery, improving the supply and affordability of housing in all communities including rural areas.

PPS3 states that the Government's key housing policy goal is to ensure that everyone has the opportunity of living in a decent home, which they can afford, in a community where they want to live. The specific outcomes that the planning system should deliver are:

- Well designed, high quality housing that is built to a high standard;
- A mix of market and affordable housing for all households in all areas;
- A sufficient quantity of housing, taking into account need and demand and seeking to improve choice;
- Housing developments in suitable locations offering a good range of community facilities and with good access to jobs, key services and infrastructure;
- A flexible, responsive supply of land; which is used efficiently and effectively, including the use of previously developed land.

Housing policies should help to deliver sustainable development objectives, in particular seeking to minimise environmental impact taking account of climate change and flood risk, and take into account market information, in particular housing need and demand.

### 3.3.3

#### *Planning Policy Statement 9: Biodiversity and Geological Conservation (2005)*

PPS9 sets out policies on protection of biodiversity and geological conservation through the planning system. The broad aim is that development should have minimal impacts on biodiversity and geological conservation interests and enhance them where possible. Appropriate weight should be attached to the need to protect international and national designated sites.

- 3.3.4 *Planning Policy Guidance 15: Planning and the Historic Environment (1994)*  
PPG15 sets out policies on the protection of the historic environment and recognises that planning plays an important role in preserving built and natural heritage.
- 3.3.5 *Planning Policy Guidance 17: Planning for Open Space and Recreation (2002)*  
PPG17 recognises the importance that public open spaces, green areas and recreational rights of way can play in supporting regeneration and contributing to local quality of life.
- 3.3.6 *Planning Policy Statement 25: Development and Flood Risk (2006)*  
PPS25 sets out a plan led approach to flood risk. It confirms that all forms of flooding and their impact on the natural and built environment are material planning considerations. It clarifies the sequential test that matches types of development to degrees of flood risk and strengthens the requirement to include flood risk assessments at all levels of the planning process. Regional planning bodies and local planning authorities (LPA) should, inter alia, reduce flood risk by safeguarding land from development that is required for current and future flood management e.g. conveyance and storage of flood water and flood defences.
- 3.3.7 *Town and Country Planning Amendments*  
Amendments to the Town and Country Planning (General Development Procedure) Order 1995 came into force on 1 October 2006 introducing further requirements for LPA to consult the Environment Agency before determining applications for development in flood risk areas.
- The Town and Country Planning (Flooding) (England) Direction 2007 was published in December 2006. To safeguard against inappropriate development in flood risk areas, it introduces a requirement for LPA to notify the Secretary of State of any application for major development (e.g. 10 or more dwellings) in a flood risk area which it proposes to approve against Environment Agency advice. The Direction came into force on 1 January 2007.
- 3.4 ***Regional Policy***
- 3.4.1 *Regional Planning Guidance for the South East (2001)*  
Regional Planning Guidance for the South East (RPG9) covers the period up to 2016 and sets the regional planning policy framework for the area. It sets out the housing requirement for each county within the region, which includes Hertfordshire. RPG9 acknowledges that climate change is likely to exacerbate the

risk of flooding and requires that development should be guided away from areas at risk or likely to be at risk in future from flooding.

#### 3.4.2

*The Secretary of State's Proposed Changes to the Draft Revision to the Regional Spatial Strategy for the East of England and Statement of Reasons (December 2006)*

RPG9 is to be replaced by a new Regional Spatial Strategy entitled the East of England Plan. The Draft East of England Plan was prepared by the East of England Regional Assembly in 2004. It was the subject of an Examination in Public and the Panel Report was published in June 2006. The Secretary of State published for consultation Proposed Changes to the Draft Revised East of England Plan in December 2006. The deadline for consultation responses was 9 March 2007.

For the period 2001 to 2021, the Proposed Changes Report sets out the following additional dwelling requirements for the Four Councils:

- Dacorum - 12,000,
- St Albans - 7,200,
- Three Rivers - 4,000, and
- Watford - 5,200.

The additional dwelling figure for Dacorum includes the provision of some additional dwellings for any expansion of Hemel Hempstead within the St Albans City and District area (the number of additional dwellings is to be determined through the LDD process).

The Proposed Changes Report proposes 50,000 additional jobs in the period 2001 to 2021 in the London Arc (which includes The Four Councils), but does not disaggregate the total figure.

Policy WAT4: Flood Risk Management prioritises the defence of existing properties from flooding and the location of new development in areas that have little or no risk from flooding. Paragraph 10.14 of the supporting text requires SFRA's to take into account the impact of climate change.

Beyond 2021 (up to 2031), the Four Councils expect growth rates to continue. The most significant increases in growth are expected to be in Dacorum and St. Albans, although there will also be further increases within Three Rivers and Watford. These increases will need to be considered in future updates to the SFRA. Planning

Policy Statement: Planning and Climate Change (a supplement to PPS1) which is currently out to consultation will help to support this process.

### **3.5**

#### ***Local Policy***

#### **3.5.1**

*Hertfordshire Structure Plan Review 1991 – 2011 (April 1998)*

In the period 1991 to 2011, the Structure Plan sets out the following additional dwelling requirements for the Four Councils:

- Dacorum – 7,200,
- St Albans - 6,300,
- Three Rivers - 4,000, and
- Watford - 4,700.

The Local Plans that follow set out the detailed policies that are used to facilitate, direct and control new development in the relevant Council areas.

#### **3.5.2**

*Adopted Dacorum Local Plan 1991 - 2011 (April 2004)*

The Adopted Dacorum Local Plan Review refers to the requirement to provide 7,200 additional dwellings in Dacorum in the period 1991 to 2011.

The total housing completions as of 1<sup>st</sup> April 2006 was 5,811 dwellings (over a total of 15 years of the Local Plan). The outstanding proposal sites for 5 or more dwellings are 1,122 (information taken from the 2005/06 Annual Monitoring Report).

The relevant Adopted Dacorum Local Plan 1991 – 2011 policy (April 2004) is Policy 107: Development in Flood Risk Areas. This policy advocates a precautionary approach to flood risk will be taken when considering development based on the sequential approach set out in Planning Policy Guidance Note 25. Policy 124: Water Conservation and Sustainable Drainage Systems is also relevant to this study. This policy highlights that applicants will be expected to demonstrate that they have incorporated water conservation and sustainable drainage practices into the design of their proposals (refer to Dacorum Borough Council Supplementary Planning Document: Water Conservation, July 2005)

#### **3.5.3**

*St Albans District Plan Review 1994*

The St Albans District Plan Review refers to the provision of 7,200 net additional dwellings in the District in the period 1986 to 2001. The Hertfordshire Structure Plan Review proposes the provision of 6,300 net additional dwellings in the District in the period 1991 to 2011.

From 1991 to 2005, 5,705 additional dwellings have been completed (90% of the Structure Plan requirement in 75% of the plan period). New residential development has been concentrated in the towns of St Albans and Harpenden, 7 large villages and Napsbury and the Hill End/Cell Barnes hospital sites.

The policy relevant to this study is Policy 84: Flooding and River Catchment Management. This specifies what must be demonstrated to gain planning permission in areas at risk of flooding.

#### 3.5.4

##### *St Albans District Issues and Options Consultation (May 2006)*

St Albans District Council published a Joint Issues and Options Consultation document as part of the Local Development Framework and the Sustainable Community Strategy in May 2006. This consultation document covered all three DPD's (Core Strategy, Development Control Policies and Site Allocations) and the Sustainable Community Strategy.

Subsequently there was a joint consultation on a Core Strategy Supplementary Issues and Options paper published in November 2006 by Dacorum Borough Council titled Growth at Hemel Hempstead. This relates to Dacorum's housing figures and the proposed growth of Hemel Hempstead into St Albans Green Belt land.

#### 3.5.5

##### *Three Rivers Local Plan (July 2001)*

The Three Rivers Local Plan refers to the provision of a net total of 4,000 new dwellings in the District in the period 1991 to 2011.

Table 2 in the Local Plan refers to 2,015 additional dwellings being completed in the 7 years up to March 1998. It also refers to a five year housing land supply, as agreed with the Home Builders Federation and Hertfordshire County Council, to provide a further 968 new dwellings. Other sources of supply identified in Table 2 bring the total housing supply identified for the period 1991 to 2011 to 4,250 additional dwellings.

The updated housing trajectory to 2021 refers to the total projected supply of dwellings to be 1,741.

The policy relevant to this study is Policy N5: Flood Prevention and River Corridors. This specifies what must be demonstrated to gain planning permission in areas at risk of flooding.



### 3.5.6

#### *Watford District Plan 2000 (December 2003)*

The Watford District Local Plan refers to making provision for 4,700 new dwellings in the District in the period 1991 to 2011.

Table 3 of the Local Plan refers to 3,148 additional dwellings being completed in the 10 years to March 2001. Other sources of supply identified in Table 3, including sites allocated for development between 2001 and 2011, bring the total supply of housing land identified for the period 1991 to 2011 to 4,816 additional dwellings.

Policy SE27 Flood Prevention states that the Council will resist any development which has potential to contribute to flood risk and have an adverse impact on river channel instability or damage to wildlife habitats. Built development in the functional flood plain, where excess water flows or is stored at times of flood, should be “wholly exceptional” and limited to essential infrastructure that has to be there.

### 3.5.7

#### *Watford Annual Monitoring Report 2006*

The purpose of the Watford Annual Monitoring Report 2006 is to:

- Review the progress of the work programme contained in the Local Development Scheme, with regard to production of new local development documents
- Assess the effectiveness of existing planning policies
- Identify whether any policies are not being implemented, or should be amended or replaced

Future housing development is considered in this report. The target set in the East of England Plan is 5200 units (until 2021). This creates an average annual requirement of 260 for every financial year up to 2021.

The net annual completions of dwellings from 1991/92 to 2005/2006 were 4550 units, with 1406 build in the last 5 financial years. The estimated projection for development from 2006/07 up to 2010/11 is 1403 units.

### 3.5.8

#### *Local Development Documents: Core Strategy and Site Allocation DPDs*

Each local authority in our study area is currently at a different stage in the preparation of their Local Development Documents in particular the Core Strategy and Site Allocation DPDs. Below is an overview of their current position and

programme for the preparation of these key documents which will inform Stage 2 of the SFRA (See Appendix L for timetables):

#### Dacorum Borough Council

The 1<sup>st</sup> Local Development Scheme (LDS) for Dacorum came into effect on 13 April 2005. Its programme began in October 2004, immediately after commencement of the Town and Country (Local Development) (England) Regulations 2004. A revised LDS was submitted to the Government Office in March 2007. The dates outlined below reflect the dates of this revised scheme. Progress has been made on the Core Strategy and Site Allocations LDDs.

Work on the Core Strategy began in June 2005 with the commencement of a preliminary consultation on emerging issues. Consultation on an Issues and Options Paper took place in May 2006 (ended on 2 June 2006). The Panel Report following the Examination into the Regional Plan recommended significant additional Growth at Hemel Hempstead resulting in the decision to go out for further informal consultation. Consultation on a Core Strategy Supplementary Issues and Options Paper (relating to Growth at Hemel Hempstead and a possible Green Belt Review) commenced in November 2006 (from 29 November 2006 to 16 February 2007). Pre-submission consultation on the Preferred Options is due January 2008.

Work on the site allocation commenced in October 2005 with a request for sites to be submitted for consideration for Development. These have been put together to form a Schedule of Site Appraisals which was published in November 2006. An issues and Options Paper went out for consultation in November (29 Nov to 16 February). Pre- submission consultation on the Preferred Options is due in November 2008.

Work on a Development Brief for Maylands Gateway and a Masterplan for the wider Maylands Business Area are currently being prepared by Consultants. This work will feed into the East Hemel Hempstead Action Area Plan DPD. Work on the Development Control Policies DPD is due to commence towards the end of 2007.

#### Watford Borough Council

In December Watford put their initial Issues and Options Paper for the Core Strategy out for consultation. However, given that Watford consulted on a number of Planning briefs, projects and the Town Centre Strategy at the same time, the

response was not seen as sufficient enough to be used as a representative audit of Watford's strategic issues and options. Since then Watford produced a number of topic papers and undertook a number of stakeholder consultations. Additional Issues and Options work, including further work on evidence is planned until June 2007, such as further stakeholder consultations. As part of that process a Strategic Housing Land Availability study and an update to the current Employment Land study will be commissioned. Watford will move to the Preferred Options by the end of 2007.

Watford has not progressed far with the Site Allocations DPD. However, the Housing Capacity study provides a good base for the Site Allocations DPD. As part of the Issues and Options stage, information on newly received sites had been collected and partially converted into GIS information since 2006/2007. Watford has planned to move to the preferred option stage for the site allocations by mid summer 2008.

On other DPDs, Watford is currently consulting on the Residential Design DPD until mid April and planned its adoption by the end of 2007. A Development Control DPD is proposed to progress towards the end of 2008.

#### Three Rivers District Council

Three Rivers have undertaken some Issues and Options consultation in relation to the Core Strategy in 2006. Three Rivers plan to undertake further I&O consultation in the summer and this will include broad locations for housing, retail and employment. A draft report will be produced in April 2007 along with GIS shape files for the broad locations. Three Rivers will move to the Preferred Options by the end of 2007. No progress has yet been made on the Site Allocations DPD however preparation is due to be completed in November 2007. This will be followed by 9 months of pre-submission consultation and the preferred options stage will commence in October 2008.

#### St Albans City and District Council

St Albans undertook an initial round of issues and options consultation in 2006 on a document that covered all three DPDs. St Albans will be moving forward with the Core Strategy issues and options in July 2007 with the preferred options stage timetabled for January 2008. No progress has been made on Site Allocations DPD although it is envisaged that a document will be ready for consultation by April 2008.

### **3.6**

#### **3.6.1**

### ***Possible Funding Mechanisms***

#### ***Planning Obligations***

Funding flood risk defences and other facilities is likely to be an important policy consideration. Circular 05/2005 provides for S106 planning obligations to be sought where they meet the tests set out in the Circular. Such obligations are intended to secure contributions from developers to address the impact of new development, without which such development should not be permitted. Such impacts can include flood water conveyance/storage and flood defences.

There have been a number of recent initiatives to achieve enhanced contributions via S106 planning obligations. One of the most advanced schemes involves a tariff-based funding system covering development in the Expansion Areas in Milton Keynes. The objective of the approach is to ensure that Expansion Area development is supported by appropriate facilities, amenities and infrastructure. Milton Keynes' tariff includes flood risk management and drainage provision.

The Four Councils may wish to consider the potential of S106 planning obligation contributions to fund (or part fund) strategic flood risk management facilities. In some cases it may be reasonable for the developer to contribute to the up-grade or replacement of existing flood defences and surface water infrastructure, or to flood alleviation schemes which provide benefit to the wider community.

#### **3.6.2**

#### ***Planning Gain Supplement***

The Government's decision how to take forward the Planning-gain Supplement (PGS) proposed in the Barker Review of Housing Supply (2004) will influence how S106 planning obligations can be used to secure strategic flood risk management contributions. The Government's PGS consultation (December 2005) proposes that flood defence should remain within the scope of S106 planning obligations.

The Government published a further PGS consultation setting out their proposals for a new system of planning obligations in England in December 2006. These include scaling back S106 planning obligations to cover only development site environmental impact, which would include flood defence, and ensure they run smoothly alongside PGS. Representations had to be submitted by 28 February 2007.

### 3.7

#### ***Summary***

All of the above Development Plans and draft DPDs include development proposals involving growth in homes, jobs and infrastructure. This development has the potential to impact upon flood risk over the next 10 to 15 years, for example by contributing to increased runoff. Subject to detailed design, development on Greenfield sites can reduce the capacity to store and carry water flows.

The findings of the SFRA will inform the preparation of policies relating to flooding, managing flood risk, land use and development allocations within future DPDs. (see ***Chapter 6***)

## 4

## Data Collection and Review

### 4.1

#### ***Overview***

Throughout the data collection and review process it has been critical to make best use of the significant amount of information which already exists with respect to flood risk (held by the Environment Agency, British Waterways, Hertfordshire Highways, Thames Water and other key consultees). This has included a review of:

- Historical flooding information from Environment Agency flood reports and various stakeholder consultations (including Hertfordshire Highways, Dacorum Environmental Forum Water Group and British Waterways)
- Environment Agency Flood Zone Maps and detailed flood risk mapping outputs (e.g. Upper Colne and Upper Lee river models)
- Detailed information on the condition status and flood risk associated with major flood defences and flow control structures (from the National Fluvial and Coastal Defence Database)
- Past flood risk assessment reports and flood risk management strategies (e.g. Upper Colne and Upper Lee Flood Risk Management Strategies, flood risk assessments for private residential and commercial developments)

A full data register is provided in ***Appendix B***.

### 4.2

#### ***Consultation Process***

Consultation has formed a key part of the data gathering stage of the SFRA. The following stakeholders were consulted during the SFRA (see ***Appendix C*** for a complete contacts list):

- *Dacorum Borough Council, St Albans City & District Council, Watford Borough Council and Three Rivers District Council*

The Planning Officers and Planning Policy Managers from each of the Local Authorities were consulted on the development of their Local Development Documents (Core Strategy and Site Allocations) (see ***Section 3.5***).

- *Environment Agency*  
The Environment Agency Development Control, Flood Mapping and Flood Incident Management teams from the North East Thames Region office (Hatfield) were consulted on the SFRA approach. This is essential given that the Environment Agency is a Statutory Consultee under PPS25 and therefore must be in agreement with regard to the scope, key findings and recommendations of the SFRA. In addition, the Environment Agency was consulted on data availability/suitability, historical fluvial and groundwater flooding, and past flood risk assessments (see **Sections 4.3 to 4.8**).
- *British Waterways*  
British Waterways were consulted to gain a full understanding of the interaction between the river and the Grand Union Canal and in particular on the potential for overtopping and breach of the canal and feeder reservoirs (see **Section 4.3.5**).
- *Hertfordshire Highways*  
Hertfordshire Highways were consulted on known surface water (land) drainage, sewer and groundwater flooding (see **Sections 4.3.3 and 4.3.4**).
- *Dacorum Environmental Forum Water Group*  
The Dacorum Environmental Forum Water Group was consulted on historical flooding (from all sources) in Dacorum (see **Section 4.3**).
- *Thames Water and Three Valleys Water*  
Thames Water and Three Valley were consulted regarding known incidents of water supply and sewer flooding (see **Section 4.3.4**).

As part of the consultation process, a workshop was held to allow key stakeholders to share their experience and knowledge of flooding issues across the study area. It specifically reviewed the draft flood maps, provided feedback on the initial findings, and contributed to the development of flood risk management policies. The benefits of adopting a partnering approach (as advocated by PPS25) are significant and have helped to ensure that the findings and recommendations of the SFRA are relevant and workable for each Council.

### 4.3

#### ***Environment Agency Flood Zone Maps***

The Environment Agency Flood Zone Maps show the areas potentially at risk of flooding from rivers or the sea, ignoring the presence of defences (although areas benefiting from formal defences are identified). PPS25 defines the flood zones as follows:

##### **Zone 1 - Low Probability**

This zone comprises land assessed as having a less than 1 in 1000 annual probability of river or sea flooding in any year ( $<0.1\%$ ).

##### **Zone 2 - Medium Probability**

This zone comprises land assessed as having between a 1 in 100 and 1 in 1000 annual probability of river flooding ( $1\% - 0.1\%$ ) or between a 1 in 200 and 1 in 1000 annual probability of sea flooding ( $0.5\% - 0.1\%$ ) in any year.

##### **Zone 3a - High Probability**

This zone comprises land assessed as having a 1 in 100 or greater annual probability of river flooding ( $>1\%$ ) or a 1 in 200 or greater annual probability of flooding from the sea ( $>0.5\%$ ) in any year.

##### **Zone 3b - The Functional Floodplain**

This zone comprises land where water has to flow or be stored in times of flood. SFRAs should identify this Flood Zone (land which would flood with an annual probability of 1 in 20 ( $5\%$ ) or greater in any year or is designed to flood in an extreme ( $0.1\%$ ) flood, or at another probability to be agreed between the LPA and the Environment Agency, including water conveyance routes).

The Flood Zone Maps have been produced from a combination of sources:

- National generalised computer model
- Detailed local hydraulic modelling
- Historic flood event outlines

The Environment Agency Flood Zone Map is continuously being improved as new studies are undertaken, detailed hydraulic models are constructed and more



flooding data and information becomes available. Within the study area, for example, the Environment Agency has recently commissioned a flood mapping study for the Upper River Colne. This will involve the development of an updated hydraulic river model. It is anticipated that the study will be completed by the end of 2008 and will provide improved flood zones maps for the entire Upper River Colne (note: this will not include the chalk tributaries). It is recommended that outputs from mapping studies such as these are used to update future versions of the SFRA (see **Section 8.5**).

The Gade, Bulbourne, Ver and Chess Flood Zone 3 (High Probability) and Flood Zone 2 (Medium Probability) have recently been improved. The original Environment Agency Flood Zone Map was based on a Digital Terrain Model with a coarse 5m resolution resulting in significant inaccuracies. The Environment Agency has now improved the modelling to include LiDAR (Light Detection and Ranging) data for the Chess and Ver, and photogrammetry for the Gade and Bulbourne. These provide a resolution of 1m and a vertical accuracy of +/- 15cm. As well as the improvements to the DTM, the inflow points have been aligned to the 1:10,000 scale river centre line (this was a significant limitation in the original modelling). These improved outlines are considered to be more accurate than the original Environment Agency Flood Zone Maps and have therefore been used during the flood mapping process.

The headwater tributaries to the River Colne and the River Thame Flood Zone Maps are based on the coarse digital terrain model and have not undergone any further improvement. These are considered to provide a conservative representation of Flood Zones 2, 3a, and 3b, which is acceptable for a Level 1 SFRA.

Both the Upper River Colne (including the Mimmshall Brook) and Upper River Lee have been mapped using detailed hydraulic models as part of wider strategy studies. An assessment of their suitability is provided in **Section 4.4** and **Appendix D**.

#### **4.4**

##### ***Detailed Hydraulic Modelling***

Several detailed flood risk studies have been commissioned by the Environment Agency for the Upper River Lee (Upper River Lee Flood Risk Management Strategy, 2007 and Lee Hydrology and Mapping Study, 2007) and Upper River Colne (Upper Colne Flood Risk Management Strategy, 2005). These studies involved the development of detailed hydraulic models and production of flood

maps for a range of return periods (for undefended and defended situations, including climate change scenarios). Following checks on their suitability and several site visits to ground-truth the model outputs, it was decided to use these in preference to the existing Environment Agency Flood Zone Maps. A technical review of these is provided in **Appendix D**.

## 4.5

### ***Historical Flooding***

Historical evidence of flooding in the study area has been gathered from past studies and reports and through consultation with key stakeholders. In accordance with PPS25, this has included a review of historical flooding from all sources (i.e. fluvial, groundwater, surface water, drainage and sewerage infrastructure and other artificial water bodies such as canals and reservoirs).. This information has been mapped to support the site allocation process and inform site-specific flood risk assessments (see **Volume II, Tiles B1-B10**).

### 4.5.1

#### *Fluvial Flooding*

The study area has a history of fluvial flooding however in some catchments it is more common than others, particularly in those areas where the geology consists of clay and loam rather than chalk (e.g. Upper River Colne around London Colney and Colney Heath and Upper River Lee around Batford and Wheathampstead). Recorded flood events have affected properties within the study area since 1879 with the most recent being in 2003. Detailed information on the locations impacted, flood magnitudes and damages are provided in **Appendix E**.

#### Upper Colne Catchment

In the Upper Colne catchment the urban areas most commonly impacted by fluvial flooding are Watford, Colney Heath and London Colney. Watford has been affected by flooding many times over the last century. Properties in Lower High Street, Water Lane and Bushey Mill Lane have a long history of flooding. The winter 2000/2001 flooding has been described as the ‘most severe flooding for at least 20 years’ in Watford - 20 commercial properties were flooded and roads were inundated for several days. This flooding has been estimated by the Environment Agency as greater than a 1 in 50 year event with the highest flows recorded in the River Colne in Watford.

London Colney (in St. Albans City and District Council) was affected by flooding in September 1992 and Winter 2000/2001. Properties in Lowbell Lane, Colne Gardens, Waterside and Willowside have a long history of flooding. Much like Watford, the winter 2000/2001 event was described by residents as ‘unprecedented

in living memory' - 38 properties flooded. The flood was thought to be caused by rapid runoff from relatively impermeable clay areas and from urban areas.

Colney Heath (in St. Albans City and District Council) has been affected by flooding in 1947, 1979, 1992, 1993 and 2000 with some houses having been flooded once every 10 years. Properties in St Mark's Close and Park Lane have a long history of flooding. In the 1992 and 2000/2001 flood events 6 properties on Park Lane and 1 property on St Marks's close were flooded.

#### River Ver Catchment

In the River Ver catchment, the urban areas most commonly impacted by fluvial flooding are Markyate and Redbourn. Notably, there is no firm evidence of historic fluvial flooding from the River Ver in St Albans, prior to the construction of the lake in Verulam Park, the Fighting Cocks Public House does purport to have flooded in the late 16<sup>th</sup> Century (a plaque on the outside of the pub describes this).

Further upstream, the towns of Markyate and Redbourn were affected by flooding in June 1993 and October 1993. In Markyate a total of 34 properties in Roman Way, London Road, Hicks Road and Church End were flooded. This event is thought to have been caused by the capacity of a culvert in Markyate being inadequate to pass peak flows arising from heavy rainfall in the catchment. This also caused flooding downstream in Redbourn where 3 properties were flooded (along Redbournbury Lane). In 2003 a Flood Alleviation Scheme (FAS) was designed and constructed in Markyate (see **Section 4.6**). This consisted of a large earth dam which was designed to retain flood waters. No reported flooding has occurred in Markyate since the FAS was constructed in 2003, although this is likely to be due to the fact that there have been no significant flows within this reach of the Ver (usually a dry chalk valley).

#### Upper Lee Catchment

In the Upper Lee catchment the most common areas impacted by flooding are Wheathampstead and Batford. Wheathampstead has been affected by flooding in 1968, 1978, 1979, 1984, 1987, 1992, 1998 and 2007. The Village centre and shops (Station Road) around Mill culvert have a history of flooding. Table 4-1 shows the estimated magnitudes/return period of the flood events in Wheathampstead.

Flood Event	Estimated Return Period
Sep-68	1 in 5 to 1 in 20 years
May-78	Unknown

<b>Flood Event</b>	<b>Estimated Return Period</b>
Dec-79	1 in 5 to 1 in 20 years
Aug-84	1 in 5 to 1 in 20 years
Sep-87	1 in 5 years
Oct-87	Less than 1 in 5 years
May-92	1 in 50 to 1 in 75 years
Sep-92	Less than 1 in 5 years
Sep-98	1 in 20 to 1 in 50 years
May-07	1 in 5 to 1 in 20 years

**Table 4-1 Estimated magnitudes/return period of the flood events in Wheathampstead**

Wheathampstead was recently flooded in May 2007. The High Street, Mill Walk, Ash Grove and King Edward Place were flooded to various extents. The maximum depth of flooding recorded by the Environment Agency was 90mm which was in the car park to the rear of the estate agents on the High Street. The flow route suggested that water flowed out of the right bank of the Lee at the upstream side of the Mill Walk foot bridge, round the pharmacy on the corner of the High Street and Mill Walk joining the flow route between the estate agents and the pharmacy. The rear of a garden on Ash Grove was flooded and the carpets of the estate agent on the High Street.

Batford has been affected by flooding in 1959, 1962, 1968, 1972, 1975, 1984, 1992 and 1998. Properties on the Lee Valley Industrial Estate, Lower Luton Road and Coldharbour Lane have a history of flooding. Table 4-2 shows the estimated return periods of historical flood events in Batford.

<b>Flood Event</b>	<b>Estimated Return Period</b>
Jul-59	Unknown
Jul-62	Unknown
Sep-68	1 in 5 to 1 in 20 years
Dec-72	Unknown
May-75	Unknown
Jun-84	1 in 5 to 1 in 20 years
Aug-84	1 in 5 to 1 in 20 years
May-92	1 in 50 to 1 in 75 years
Sep-92	Less than 1 in 5 years

**Table 4-2 Estimated return periods of flood events in Batford**

It is evident that since the 1960s there has been frequent flooding in Batford and Wheathampstead. The lakes at Luton Hoo are thought to provide some attenuation of flood flows upstream of Batford and Wheathampstead, however continual urban development in Luton is thought to have gradually resulted in increased flows during flood events, reducing the attenuation provided by the lakes.

#### River Gade and Bulbourne Catchments

No previous fluvial flood events have been recorded by the Environment Agency in the Gade or Bulbourne, although overbank flooding from the Gade is known to occur in Gadebridge Park (recent event in March 2007). Additionally, the Hemel Hempstead Gazette (archived in Hemel Hempstead Central Library) describes major flooding events in the Gade and Bulbourne catchments in 1879 and 1947. The magnitude of these region-wide (i.e. southern England) flood events has been estimated as 1 in 100 years for the 1879 event and 1 in 50 years for the 1947 event. In 1879, properties were flooded at the junction of the Bulbourne and the Grand Union Canal, as well as in Boxmoor, Bury Mill End, King's Langley and Great Gaddesden. It should be noted that these flood events occurred before the Hemel Hempstead flood relief scheme was constructed in 1959 (see **Section 4.6**). This offers significant protection to Hemel Hempstead to beyond a 100 year standard of protection as well as some protection to Apsley and Kings Langley. Since this became operational no further fluvial flooding has occurred in these areas.

Flood events have also been noted in 1977 and 1988, where Aldbury flooded (north of Berkhamsted) at the junction of Station Road. In 1992 flooding occurred in Chaulden, Aldbury and Tring (Cow Lane, Western Road; Park Road, Wingrave Road, Rosebery Way). Flooding was reported in 1996 however this is thought to be attributed to surface water or groundwater sources, rather than fluvial.

#### River Thames catchment

There is no recorded fluvial flooding in the headwaters of the River Thames catchment, although the area is characterised by a number of small drainage ditches which do contribute to surface water (land drainage) flooding (see **Section 4.5.3**).

#### Data appraisal

A comparison has been made between historical fluvial flooding data and information gathered from various sources and the Environment Agency historical flood maps (see **Volume II, Tiles B1 to B9**). It is evident that there is good

correspondence between the data sets suggesting that the historical fluvial flooding map provided by the Environment Agency will be suitable for verifying the PPS25 Flood Zones and informing the Sequential Test process. Some missing data was identified which has been added to the map.

#### 4.5.2

##### *Groundwater Flooding*

Groundwater flooding has been observed in a number of locations, including the urban areas of Tring, St Albans, Rickmansworth and Watford (Appendix F). The Environment Agency has kept a record of groundwater flooding since 2000 (see **Table 4-3 and Volume II, Tiles B1 to B9** which map the locations of all historical flooding from groundwater). Although the extent of this information is limited for this SFRA, the Environment Agency database will provide a useful source of flood history data for future updates to the SFRA.

GIS ref.	Date	Location
EA_GW1	09-Dec-02	Langdon Street, Tring, HP23 6SD
EA_GW2	27-Sep-02	Langdon Street, Tring, HP23 6SD
EA_GW3	14-Dec-00	Fishpool Street, St. Albans, AL3 4RT
EA_GW4	02-Apr-01	Beverly Gardens, St. Albans, AL4 9BJ
EA_GW5	09-Feb-06	Harper Lane, St. Albans, AL5 3AJ
EA_GW6	06-Nov-06	Kewferry Road, Rickmansworth, HA6 2NS
EA_GW7	19-Feb-04	Church Street, Batchworth, Rickmansworth, HP23 6SD
EA_GW8	01-Jul-05	Victoria Road, Watford, WD24 5AZ

**Table 4-3 Environment Agency records of groundwater flooding**

##### Upper Colne Catchment

The Upper Colne Flood Defence Strategy Inception Report highlighted that the Colne catchment down to Watford suffered exceptionally high ground water conditions in Winter 2000/2001. Groundwater levels were described as the highest on record and were as high as 0.5m below the ground surface (estimated to be greater than the 1 in 100 year return period).

An MSc study was commissioned in 2004 by the Environment Agency to investigate the extent and distribution of groundwater flooding during the winter of 2000/01 in the North East Thames Region. Incidences of possible groundwater flooding were sourced from a range of stakeholders (including the Environment Agency, Thames Water and Local Authorities). A summary of the key findings is provided below:

- River Ver Catchment  
Groundwater flooding in Winter 2000/01 was primarily limited to dry valleys, particularly high in the headwaters of the Ver. The cause of the groundwater flooding was thought to be exacerbated by developments on the floodplain further downstream. This resulted in extensive property and road damage in Winter 2000/01.
- River Gade Catchment  
Groundwater flooding was confined to dry valleys, caused by the emergence of new springs above ground level. All flooding principally impacted agricultural land.
- River Bulbourne Catchment  
Groundwater emergence was confined to the river valley where the river flows through urban areas. Standing water, probably spring fed, upstream of normal winter source occurred along the Bulbourne. Flooding principally occurred on local agricultural land.
- Upper Lee Catchment  
No incidences of groundwater flooding were found in the main urban areas of Wheathampstead and Batford. Groundwater flooding in the Lee was confined to the river valley. Most groundwater flooding in the Lee was thought to be sub-surface (within the sewer network) and is unlikely to have emerged above ground level.

During the data collection exercise, consultation was undertaken with Hertfordshire Highways to identify known local groundwater flooding issues. Site specific examples of groundwater flooding are summarised below, categorised by Council (the preceding reference code can be used to locate the flooding incident in the maps provided in *Volume II, Tiles B1 to B9*).

#### Dacorum Borough Council

##### ***DM\_GW1:*** Delmerend Lane, Flamstead

Groundwater flooding regularly occurs on Delmerend Lane adjacent to Lower Sawpit Wood. A borehole has been installed in an attempt to monitor the problem.

##### ***DM\_GW2:*** Puddephats Farm, Gaddesdon Row

Puddephats Lane is regularly flooded from groundwater. This issue has been identified in the Hertfordshire Highways Integrated Works Programme (IWP) 2007/8.

***DM\_GW3*** Nettleden Road

Nettleden Road at the crossing with Roman Farm and Nettleden Farm is regularly flooded from groundwater.

St Albans City and District Council

***SA\_GW1*** Sandridge and Marshalswick

In Winter 2000/2001 a groundwater 'lake' extended from the north of Sandridge to Jersey Farm in Marshalswick as groundwater levels rose by approximately 4.5m. Properties on the corner of Marshalswick (House Lane) were evacuated for 6 months and Sandridge was close to evacuation as groundwater rose through the floor of the houses. This was thought to be a 1 in 250 year flood event. St. Albans City and District have since sunk a borehole in the vicinity to monitor groundwater levels and now provide a warning system in association with the Environment Agency.

***SA\_GW2*** Redbourn

In Winter 2000/2001 the main high street through the town flooded as groundwater rose to the surface. This caused a continuous stream of water through the main town. Following this, Thames Water built a pipeline to divert drainage into the River Red. The flooding persisted for 6 months (October to May) and was partly attributed to the topography of the area which is essentially a dry valley passing through the centre of Redbourn.

***SA\_GW3*** Gaddesden Lane, Church End

In Winter 2000/2001 properties in Hemel Hempstead Road flooded as Gaddesden Lane effectively became a river. This resulted in the road being closed for 6 months. This was caused by a combination of groundwater rising to the surface and land drainage from the fields north and south of Gaddesden Lane towards Church End.

Watford Borough Council

***WD\_GW1 & WD\_GW2*** Kingsfield Road and Cedar Road, Oxhey

Large swallow holes have appeared in the past which are thought to be caused by groundwater.



**WD\_GW3:** Molteno Road (off Langley Road), Watford

This areas suffered significant groundwater flooding 8 - 10 years ago resulting in houses being demolished and residents relocated.

**WD\_GW4:** Gade Avenue, Watford

The final works of ducting and installation (near the met line bridge) of some signals as part of a Traffic Management scheme were delayed in Gade Avenue due to groundwater flooding.

#### Three Rivers District Council

Although Hertfordshire Highways do not hold any record of groundwater flooding within Three Rivers, the Environment Agency database does include two references to groundwater flooding in Rickmansworth (see **Table4-3**).

#### 4.5.3

##### *Surface Water (Land Drainage) Flooding*

The Environment Agency holds no records of historical surface water flooding, however a monitoring system has recently been set up, which will provide a useful resource for future updates to the SFRA.

Consultation was undertaken with Hertfordshire Highways and the Dacorum Environmental Forum Water Group to identify known local drainage issues (surface water flooding). Known areas of surface water flooding are summarised below (categorised by Council) and are shown in **Volume II, Tiles B1 to B9** (the preceding reference code can be used to locate the flooding incidents in the flood history maps).

The most recent significant surface water flooding occurred on the 20<sup>th</sup> June 2007 following an intense, short duration rainfall event. Around 6-13 mm fell within 1 hr in Harpenden, Markyate, Wheathampstead and Chenies (recorded at rain gauges) equating to around a 1 in 1 to 1 in 2 year return period storm. This caused surface water flooding to areas of Dacorum Borough Council, St. Albans City and District Council and Watford Borough Council, resulting in disruption to traffic, and damage to commercial and residential premises. In total, Hertfordshire Fire Service attended around 60 calls relating to flooding across the county. Around Three Rivers District Council there was less rainfall and as such less surface water flooding. All recorded surface water flooding locations from this recent event have been added to the historical flood maps (**Volume II, Tiles B1 to B9**) and are included in the sections below.

Dacorum Borough Council

***DM\_SW1:*** Chequers Hill, Friar's Wash

Flooding regularly occurs on Chequers Hill where it crosses under the A5 and the River Ver at Junction 9 of the M1. The source of the flooding is not clearly understood and thought to be either from fluvial flooding (River Ver) or surface water flooding, attributed to the topography of the field being lower than that of the road.

***DM\_SW2:*** A5 roundabout, Junction 9 M1

The A5 roundabout (owned by the Highways Agency) is subject to regular flooding. The source of the problem is not clearly understood and is thought to be either from fluvial flooding (River Ver) or surface water flooding, attributed to the topography of the surrounding land.

***DM\_SW3:*** Bede Cottage, Frithsden

Bede Cottage regularly floods from surface water drainage running off the surrounding fields. This problem is currently under investigation by Hertfordshire Highways.

***DM\_SW4:*** Parsons Close, Flamstead

Properties on Parsons Close in Flamstead are frequently flooded due to surface water runoff from the fields to the north. A solution to this problem is currently being considered possibly involving re-profiling of the road.

***DM\_SW5:*** Two Ponds Lane, Northchurch

Surface water flooding occurs on Two Ponds Lane, Tring Road, Boswick Lane and Duswell Lane. This is thought to be attributed to the land owner making modifications to the land (i.e. reshaping the fields) at the end of Two Ponds Lane (private road). As a result, water weirs over Two Ponds Lane and cuts over the main 'A' road (Tring Road) and down Boswick Lane and into the River Bulbourne. These roads are regularly flooded. Hertfordshire Highways are investigating this further.

***DM\_SW6:*** Buncefield Lane, Leverstock Green

Buncefield Lane at the crossing with Green Lane in Leverstock Green is impacted by surface water flooding. It has been suggested that the clearing of ditches and gullies may solve the problem. Entec, who represent the owners of a potential Housing Proposal site here (site H38) have also informed Dacorum Borough Council that the balancing pond is flooding over the site. They have engaged other

water experts to investigate solutions to this involving a possible new balancing pond on site or off site to the south.

***DM\_SW7:*** Church Street, Bovingdon

Flooding from surface water drainage occurs at the confluence of Church Street and Green Lane. This is attributed to the convergent topography of area. Flooding from this mechanism occurred in 1946 and is known as 'The Great Flood of Bovingdon'. There is an important pond feature at this location, known as 'The Dock', which should be retained to reduce the likelihood of future surface water flooding.

***DM\_SW8:*** Junction of Cupid Green Lane with Dodds Lane, Cupids Green

At the junction of Cupid Green Lane and Dodds Lane, there is a low point in the topography, resulting in surface water ponding and subsequent disruption to the flow of traffic.

***DM\_SW9:*** Long Marston, Tring

Long Marston has been flooded twice, most recently in May 2007. The exact flooding source and mechanism is not fully understood. However, the area had been subject to continuous medium to heavy rainfall for 48 hours prior to the flooding. An open drainage ditch runs through the village next to the main road. It forms part of the network of ditches and channels which combine to form the Upper Thame. The flooded properties were located on the opposite side of the road to the drainage ditch however the ditch itself was not over topping and was not therefore the direct source of the flood water. It is thought that the flooding may have arisen from overland flow from the surrounding saturated farm land. Approximately 7 residential properties and the local pub were flooded.

Flooding of Long Marston also occurred in 2003 via the same mechanism, resulting in internal flooding to 15-20 residential properties.

Other areas which are known to have suffered minor surface water flooding include:

***DM\_SW10:*** Two Waters Road and Corner Hall, Hemel Hempstead

***DM\_SW11:*** Nicky Line Bridge, Queensway

***DM\_SW12:*** The Central Library in Combe Street

***DM\_SW13:*** Heights Hall in Jupiter Drive

***DM\_SW14:*** Redbourne Road

***DM\_SW15:*** Cherry Tree Lane  
***DM\_SW16:*** Longlands  
***DM\_SW17:*** Piccotts End  
***DM\_SW18:*** Fishery Road, Boxmoor  
***DM\_SW19:*** Old Fishery Lane, Boxmoor  
***DM\_SW20:*** Goldfield Road, Tring  
***DM\_SW21:*** Hyde Meadows, Bovingdon  
***DM\_SW22:*** Water Lane, Kings Langley  
***DM\_SW23:*** High Street, Bedmond  
***DM\_SW24:*** Beechfield Road, Boxmoor  
***DM\_SW25:*** Everest Way, Hemel Hempstead  
***DM\_SW26:*** Stoney Croft, Aldbury  
***DM\_SW27:*** Wheelers Lane, Hemel Hempstead  
***DM\_SW28:*** Lawn Lane, Hemel Hempstead  
***DM\_SW29:*** Pluto Rise, Hemel Hempstead  
***DM\_SW30:*** New Park Drive, Hemel Hempstead  
***DM\_SW31:*** Green Lane, Bovingdon  
***DM\_SW32:*** Belswains Lane, Bennetts End  
***DM\_SW33:*** Buckers Lane, Nash Mills  
***DM\_SW34:*** Leighton Buzzard Road, Great Gaddesden  
***DM\_SW35:*** Brown Low Road, Berkhamsted  
***DM\_SW36:*** Nettleden Road, Great Gaddesden  
***DM\_SW37:*** Duckmore Lane, Tring  
***DM\_SW38:*** High Street Green, Hemel Hempstead  
***DM\_SW39:*** Valley Lane, Markyate  
***DM\_SW40:*** Windmill Road, Bottom Hill  
***DM\_SW41:*** Chad Lane, Flamstead  
***DM\_SW42:*** Green Lane, Flamstead  
***DM\_SW43:*** Bradden Lane, Great Gaddesden  
***DM\_SW44:*** Gaddesden Row, Great Gaddesden  
***DM\_SW45:*** Ledgemore Lane, Great Gaddesden

St Albans City and District Council

***SA\_SW1:*** Southdown Road, Harpenden

Surface water flooding regularly occurs down Southdown Road from the confluence of drainage from the north and south west. Three balancing ponds were created in the open area adjacent to the road to take all water from the highways in Harpenden. The High Street used to be prone to flooding, however, since the construction of the balancing ponds, this has been reduced.

***SA\_SW2:*** Kimpton Bottom, North of Harpenden

Kimpton Bottom (on the B652), adjacent to the Animal Welfare Centre, is regularly flooded by surface water drainage from the fields to the North West and South East. This causes standing water in the Animal Welfare Centre.

***SA\_SW3:*** Hemel Hempstead Road and Church End confluence, Redbourn

Surface water flooding occurs frequently on Church End at the bottom of Redbourn. This is thought to be attributed to numerous defunct land drainage pipes which during high rainfall transport water downhill through North Common, along Hemel Hempstead Road towards Church End.

***SA\_SW4:*** The Grove, Harpenden

The roundabout at the end of Southdown Road in Harpenden (at Pipers Lane and Cross Lane) is in a low spot and hence is subject to surface water flooding on a regular basis. This is exacerbated by the fact that groundwater levels are high and the ground saturated leading to high surface water runoff rates.

***SA\_SW5:*** Marshalls Way, Marshalls Heath

Serious surface water flooding occurs to the properties in Marshalls Way. This is attributed to the topography of the land which encourages the drainage of water from the North, North East and North West into the low spot at Marshalls Way. This is being investigated further by Hertfordshire Highways with the possibility of sinking a borehole here to monitor groundwater levels (subject to the Environment Agency's approval).

***SA\_SW6:*** Gaddesden Lane, Redbourn

Four cottages along Gaddesden Lane are repeatedly severely flooded from M1 runoff surcharging the balancing pond and flooding the road. This flooding may be reduced by the future M1 widening scheme.

***SA\_SW7:*** Derwent Road, Kinsbourne Green

Surface water runoff from adjacent fields causes flooding of properties in Derwent Road. Land drainage works, soakaways and planting have been implemented to reduce this flooding. Newer developments in close vicinity have recently been built with raised floor levels to protect them from this surface water flooding.

***SA\_SW8:*** Luton Road, Harpenden

Flooding of Luton Road regularly occurs (at the bottom of the valley). Although a number of linked soakaways have been implemented, they cannot always discharge runoff following heavy rainfall.

***SA\_SW9:*** Lower High Street, Harpenden

The Lower High Street floods from surface water and often reaches the threshold level of commercial premises. This is attributed to the topography whereby the River Ver it likely to have originally drained through the High Street.

***SA\_SW10:*** Station Road, Harpenden

Surface water flows down Grove Road and on to Station Road where it spills onto the Common flooding gardens and drives.

***SA\_SW11:*** Lower Luton Road, Batford

Lower Luton Road regularly floods from surface water this is thought to be due to insufficient drainage system capacity.

***SA\_SW12:*** High Street, Sandridge

3 properties are frequently flooded in the High Street in Sandridge. This is thought to be attributed to insufficient highway drainage capacity.

***SA\_SW13:*** Jersey Lane, Jersey Farm

The houses around Jersey Farm (right corner of St Albans) were built on top of a spring. Soakaways and highway drainage systems were constructed to store the water however during times of heavy rainfall they often release water rather than take it away.

***SA\_SW14:*** Cambridge Road, St Albans,

***SA\_SW15:*** Guildford Road, St Albans

***SA\_SW16:*** Headly Road, St Albans

Localised surface water flooding occurs of Cambridge Road, Guildford Road and Headly Road. The combined sewer system in this vicinity often becomes surcharged because much of the drainage runs under the houses flooding many backyards. 1 or 2 properties have been flooded in exceptional circumstances.

***SA\_SW17:*** Prospects Road, St Albans

Prospects Road has also experienced localised surface water flooding in heavy rainfall events.

Other areas which are known to have suffered minor surface water flooding include:

SA\_SW18: Garnett Drive, St Albans  
SA\_SW19: Ely Road, St Albans  
SA\_SW20: Eaton Road, St Albans  
SA\_SW21: Harness Way, St Albans  
SA\_SW22: Hill End, St Albans  
SA\_SW23: Lemsford Road, St Albans

#### Watford Borough Council

##### ***WD\_SW1:*** Hunton Bridge, Abbots Langley

Localised flooding occurs on Watford Road due to the low point in the topography resulting in regular surface water flooding.

##### ***WD\_SW2:*** Radlett Road and Balmoral Road, Watford

Properties 58 – 74 Radlett Road are frequently flooded. The outlet pipe to the river has a flap valve, which cannot outfall when water levels in the river are high. As a consequence, water backs up through the drain causing manholes to ‘pop’ and water to flow on the surface of the road, flooding gardens and properties. These pipes are the responsibility of Thames Water. Herts Highways intend to work alongside Thames Water to introduce a new drainage scheme in August 2007 to help alleviate this flooding problem.

##### ***WD\_SW3:*** Radlett Road – electricity sub-station, Watford

There is an electricity sub station on the corner between Radlett Road and Bushey Mill Lane which has been close to flooding on a number of occasions. Herts Highways have expressed concerns with regard to the H&S implications for not only Sub-station employees but also the residents of Watford served by this sub station, should the power supply to these residents be terminated in a flood event. This could result in evacuation and the need for temporary accommodation. The sub-station is estimated to serve 40-50% of Watford’s population and hence is a critical asset which needs to be defended.

##### ***WD\_SW4:*** Lower High Street, Watford

Lower High Street is flooded when the River Colne rises hence the surface water drainage systems cannot discharge into the river, causing backup and flooding of commercial properties. Recent flooding occurred around the Bushy Arches in response to the heavy rainfall on the 20<sup>th</sup> July 2007. An Environment Agency

Scheme to reduce flooding from this mechanism is planned for 2008/2009. Frogmore Cottages located on the slip road adjacent to B&Q flood regularly due to inadequate drainage capacity. This is currently being investigated by Herts Highways.

***WD\_SW5:*** Riverside Road, Watford

Properties along Riverside Road regularly flood from surface water runoff as a result of low convergent topography of the area. Large parts of Riverside Road were flooded recently on the 20<sup>th</sup> July 2007; although it is unknown whether residential properties were flooded.

***WD\_SW6:*** Wiggshall Road, Watford

Properties along Wiggshall Road regularly flood from surface water drainage. There is an open culvert which runs to behind the Fishers Estate. When the river rises, this reaches capacity and spills over into Fishers Industrial Estate and Wiggshall Road. A new pump was installed 4 years ago, which was designed to cope with 'normal' – 'heavy' rainfall and flash storm water. However, flooding still occurs due to the low topography and limited pump capacity (most recently during the 20<sup>th</sup> July 2007 event). In addition, when water levels in the river are high the pump is not able to discharge water and is therefore ineffective. Although opening the sluice gates at rear of Riverside works will alleviate part of this problem, it creates further surface water flooding along Jellicoe Rd, Stripling Way and Fishers Industrial Estate. Wiggshall Bridge and Stripling Road flooded recently on the 20<sup>th</sup> July 2007.

***WD\_SW7:*** A41 Underpass, Watford

The A41 underpass is a topographically low spot and hence is subject to surface water flooding on a regular basis.

***WD\_SW8:*** Falcon Way, Watford

Properties along Falcon Way regularly flood from surface water.

***WD\_SW9:*** Water Lane and Bushey Hall Lane, Watford

Historically, flooding regularly occurred along Water Lane due to an insufficient highway drainage system comprised primarily of soakaways. In 2002/2003 a pumped storage system was implemented to drain water from the highway and the bridge. Since these drainage improvements were implemented, flooding of Water Lane has not occurred. However these drainage improvements were only implemented on the Watford side of the bridge, which within the boundary of



Watford Borough Council hence Bushey Hall Lane, which is in the Borough of Hertsmere continues to flood from highway drainage.

***WD\_SW10:*** Bushey Mill Lane and Radlett Road Junction, Watford

At the confluence of Radlett Road and Bushey Mill Lane there is a topographic low point resulting in regular surface water flooding.

Three Rivers District Council

***TR\_SW1:*** Uxbridge Road, Rickmansworth

Properties are flooded on Uxbridge Road when water levels in the River Colne rise causing the surface water drainage system to backup. Localised fluvial flooding directly from the River Colne also occurs here.

***TR\_SW2:*** Harefield Road, Rickmansworth

Harefield Road is a low spot in the topography and hence is subject to regular surface water flooding. This is also thought to be exacerbated by a high water table in the surrounding area and under capacity highway drainage systems and culverts.

***TR\_SW3:*** High Street, Rickmansworth

The majority of the drainage systems in Rickmansworth drain into the Town Ditch (70% of highway drainage). The conveyance capacity of the Town Ditch is limited by: its dimensions, poor maintenance (siltation), use as a water feature in back gardens and numerous flat culverts (Bury Lane) and bridge crossings. When the Town Ditch reaches full capacity during a flood event, the surface water drainage systems cannot discharge into the ditch causing backup and flooding of commercial properties on the High Street and properties in adjoining roads (Ebury Road and Wensum Way). Herts Highways are in discussion with Thames Water regarding the need to undertake regular maintenance of their surface water drainage systems.

***TR\_SW4:*** St Clement Danes School, Rickmansworth

St Clements Dane School has experienced flooding from surface water runoff from the adjacent road during heavy rainfall events.

***TR\_SW5:*** Church Street, Rickmansworth

During high intensity short duration rainfall events surface water flooding occurs on Church Street from the roundabout towards the Town Ditch.

Other areas which are known to have suffered minor surface water flooding include:

TR\_SW6: Malvern Way, Croxley Green

TR\_SW7: The Mead, Carpenders Park

#### 4.5.4

##### *Drainage and Sewerage Infrastructure Flooding*

Flooding from drainage and sewerage infrastructure has been recorded in a number of locations in the study area including the towns of London Colney, Colney Heath, Watford, South Oxhey and Rickmansworth. This information has been sourced from Environment Agency Flood Reports.

In 1992 and 2000/2001, flooding in London Colney was worsened by surface water and foul sewer flooding from a local trunk sewer. Reports from property owners indicated that sewage was present in the floodwaters. In 1988, 112 properties were flooded in the South Oxhey area, 42 by a mixture of foul and surface water and 70 by surface water only. In 1988 in Rickmansworth around Uxbridge Road, 15 properties experienced flooding from foul sewerage systems. 14 properties experienced flooding of rear gardens and 12 properties were flooded from surface water.

Additional data was collected on historical sewer flooding from Thames Water. The data received was provided at postcode level, hence no street level information on flooding was available. The total number properties flooded from overloaded sewers in the last ten years were recorded which was further divided into the number of properties flooded by surface water, foul water and combined sewers (see **Appendix F** for a full breakdown). In summary it is evident that over the last ten years St Albans has experienced the highest total number of properties flooded from overloaded sewers followed by Three Rivers, Watford and Dacorum. Overloaded foul water sewers are found to be the dominant source of flooding.

Council	Total no. properties flooded from sewers	Total no. properties flooded by surface water sewers	Total no. properties flooded by foul water sewers	Total no. properties flooded by combined sewers
St. Albans	89	5	80	4
Dacorum	23	3	17	3
Watford	37	14	23	0

Council	Total no. properties flooded from sewers	Total no. properties flooded by surface water sewers	Total no. properties flooded by foul water sewers	Total no. properties flooded by combined sewers
Three Rivers	69	34	34	1

**Table 4-4 Thames Water sewer flooding records over the last 10 years**

#### 4.5.5

##### *Reservoirs and Other Artificial Water Retaining Structures*

As part of the SFRA it is necessary to consider the risk of overtopping or breach of reservoirs and canals. British Waterways were consulted to determine the risk of flooding from these sources.

##### Grand Union Canal

The Grand Union Canal has a significant number of interactions with the Rivers Bulbourne, Gade and Colne (flow occurs from the canal to the river and vice versa, including a number of canalised sections and mill streams). Following consultation with British Waterways it is evident that there are no historical records of canal overtopping or breach (or related damages) in the study area. British Waterways attribute this to the following:

- the significant number of connections between the canal and river via numerous large weir structures. As such water levels within the canal are controlled and overtopping is highly unlikely to occur;
- along most of its course the canal is raised slightly above the river and therefore any water overtopping from the canal would be discharged into the river;
- where the rivers and canal are at similar levels and are in close proximity to one another hence the area between them is naturally wet encouraging the growth of watercress, which provides storage for any water discharged from either water body;
- there are no canal embankments with a high probability or consequence of failure as defined by British Waterways. All canal embankments in the study area have a designated low/medium risk of failure;
- the canal is fairly self supporting (fixed lateral weirs) given that there are no major control sluices other than a large flood control structure at Batchworth; and,
- there are a large number of locks and fairly short pounds throughout the canal system. As such any break outs would be expected to be contained

within the canal. Significant flooding could only occur if two lock gates were to fail simultaneously which is unlikely given that no such failures have occurred in the UK over the last 200 years.

Although British Waterways consider the risk of breach or overtopping to be relatively low, there are significant sections of embankment in Berkhamsted which are up to 3m higher than surrounding ground levels. If this failed or overtopped there could be significant damage to adjacent residential properties and commercial premises, as well as the potential for loss of life. The residual risk areas associated with overtopping and breach have been mapped as uniform risk areas (or flood cells) (see *Volume II, Tiles E1 to E9*). It is recommended that a Level 2 SFRA is undertaken here to refine the flood hazard information and ensure that any future allocated or windfall developments include adequate mitigation against any residual risks (see *Section 8.2*). It is also recommended that within Dacorum a Level 2 SFRA should be undertaken for Hemel Hempstead town centre in order to fully assess flood risk should a culvert blockage occur. These assessments will help to minimise the extent to which individual developers make their own assessment of the residual risk of overtopping or blockage (a process which is highly complex and depending on the assumptions adopted can produce significantly different results).

#### Water Supply Reservoirs

British Waterways own four water supply reservoirs to the north of Tring. These are Startopsend, Marsworth, Tringford and Wilstone reservoirs. Startopsend is designated as Category A under the Reservoirs Act 1975, given its proximity to property and potential for loss of life should a breach or overtopping occur (Startopsend and Marsworth are located immediately to the north of a significant embankment structure). The other reservoirs are designated as Category B. All reservoirs have undergone annual inspections by an Inspecting Engineer and ten year reviews by the Supervising Reservoir Engineers. British Waterways have provided assurance that the water supply reservoirs are actively managed and that all the required safety standards are met.

The most significant raised embankment with the potential for loss of life is Startopsend. It is likely that should any major development be proposed in the area to the north of the reservoir that an extended scope SFRA (Level 2) would be required to determine the residual risk of overtopping or breach of the embankment and inform appropriate mitigation measures.

Under the Reservoirs Act 1975, there is now a requirement for all reservoir undertakers (including Thames Water, Environment Agency and British Waterways) to develop Flood Plans for their Statutory Reservoirs. This will also include the Markyate and Hartsbourne Stream Flood Storage Areas which are designed to store water on an intermittent basis. This work will be undertaken from 2007 onwards and will include detailed breach and overtopping analysis. It is recommended that the outputs from these studies and refined information on residual risk are incorporated into future updates to the SFRA.

#### 4.6

##### ***Flood Defences***

Flood defences are structures which affect flow in times of flooding and therefore prevent water from entering property. They generally fall into one of two categories: 'formal' or 'informal'. A 'formal' defence is a structure which has been specifically built to control floodwater. It is maintained by its owner (this is not necessarily the Environment Agency) so that it remains in the necessary condition to function. An 'informal' defence is a structure that has not necessarily been built to control floodwater and is not maintained for this purpose. This includes road and rail embankments and other linear infrastructure (buildings and boundary walls) which may act as water retaining structures or create enclosures to form flood storage areas in addition to their primary function.

An assessment of major informal defences has been undertaken by inspecting Flood Zone 3 (modelled flood extents) for all main watercourses. There are approximately 18 road and railway embankments which cross the River Colne which could provide a barrier to flow and result in upstream flood storage (see ***Volume II, Tile G1***). Should any changes be planned in the vicinity of these crossings, it would be necessary to assess the potential impact on flood risk to ensure that flooding is not made worse either upstream or downstream. Smaller scale informal defences should be identified as part of site-specific detailed FRA's and the residual risk of their failure assessed (see ***Section 6.5***).

In accordance with the scope of a Level 1 SFRA, a high level review of formal flood defences has been carried out using data from the NFCDD. This is a good starting point for identifying significant flood defences and potential areas benefiting from defence, but the quantity and quality of information provided differs considerably between structures. The NFCDD is intended to give a reasonable indication of the condition of an asset and should not be considered to contain consistently detailed and accurate data (this would be undertaken as part of a Level 2 SFRA where the need arises).

A total of 96 formal flood defences were assessed and mapped (see *Volume II, Tiles C1 to C9*). Of these, the Chess Wall and Lower Colne Improvement Scheme raised defences in Rickmansworth, the Markyate and Hartsbourne Stream Flood Storage Areas and Hemel Hempstead flood relief culvert can be considered major flood defence structures – a relatively small number in a study area of this size. A brief review of these is provided below (also see *Volume II, Tiles G1* for locations of the main formal and informal defences):

**Hartsbourne Stream Flood Storage Area** (design Standard of Protection = 200 years, current overall condition status = good) is a significant defence located to the east of Carpenders Park, at the upstream end of the Hartsbourne Stream (a tributary of the River Colne which flows through Carpenders Park and Oxhey, to the south of Watford). The embankment forming the dam at the downstream end of the FSA is 280m in length and 6m high. Flow out of the FSA is controlled by a culvert through the embankment. The defence provides protection to property within South Oxhey along the entire reach of the stream down to the confluence with the Colne.

**Markyate Flood Storage Area** (design Standard of Protection = 200 years, current overall condition status = good) is a significant defence located at the upstream end of the River Ver, to the north of Markyate. The earth embankment forming the dam at the downstream end of the FSA is 235m in length and 3.5m high. Flow out of the FSA is controlled by a culvert through the embankment. The defence provides protection to property within Markyate and possibly some limited protection to Redbourn.

**Hemel Hempstead Flood Relief Culvert** (estimated Standard of Protection = 100 years, overall condition status = unknown) was constructed in 1959 to provide flood defence to Hemel Hempstead, Apsley and parts of Kings Langley. The scheme involved the construction of a relief culvert from Bury Mill (located on the River Gade, to the north of Hemel Hempstead) to Kings Park Industrial Estate (in Kings Langley, also on the River Gade) (*see Volume II, Tile A1*). The structure is owned by Thames Water (part of their sewerage infrastructure) and is therefore not listed in the NFCDD. Although requested from Thames Water, no information has been provided on its maintenance regime, condition status or the location of connections. It is known that there are inflows along the length of the culvert from the River Bulbourne and from numerous surface water drains. Furthermore, it is known that with the present inlet weir configuration (located at Bury Mill, Hemel Hempstead), the majority of flow from the River Gade is

directed through the culvert rather than the river channel, which flows through the centre of Hemel Hempstead. As such, it is reasonable to assume that considerable flooding of residential, commercial and industrial properties could occur in the event of a failure (i.e. collapse) or significant blockage.

**The Chess Wall** (design Standard of Protection 100 years, overall condition status = good) is a 125m-long raised concrete defence, which was constructed as part of the River Chess Flood Defence Scheme. It is located to the north of the Batchworth area of Rickmansworth, and provides flood protection to residential and commercial properties within Rickmansworth town centre.

**Lower Colne Improvement Scheme works** included two significant raised defences (design Standard of Protection = 100 years, condition status = good) designed to protect Rickmansworth from flood waters from the Grand Union Canal. The first, located to the south-east of Batchworth Lake, is a 350m-long sheet piled wall which was constructed as part of the Lower Colne Improvement Scheme (estimated Standard of Protection 100 years). It provides protection to a residential area and some commercial properties, including a supermarket. The second, a 155m-long embankment, is located immediately downstream of the sheet piled wall. It appears to extend the defended area so that protection is provided across the whole of the residential area to the south of the Grand Union Canal.

There are many other less significant flood defences which provide localised protection to residential and commercial areas. These include:

- A 300m-long slightly raised earth embankment (referred to as the Boxmoor embankment in the NFCDD) protects a small number of residential properties in Hemel Hempstead from flooding from the River Bulbourne (Standard of Protection = 5 years). It is located to the north of the A4251, just upstream of the Bulbourne's confluence with the River Gade.
- A low earth embankment (referred to as the Frogmore Mill embankment in the NFCDD), which is 240m in length, provides flood defence to a small number of residential properties and commercial buildings on the right bank of the River Gade (Standard of Protection = 5 years). It is located in Apsley, to the north of London Road (A4251) and Mill Street.
- A series of culverts (totalling approximately 480m in length) carries the River Bulbourne through an industrial area and residential areas in central Berkhamsted. The culverts are noteworthy because there is a residual risk

of flooding given the possibility that one or more of them could become blocked. Flooding of industrial, residential and some commercial property could occur in the event of a blockage. It should be noted that as part of the Stag Lane development proposal in Berkhamsted, a significant length of culvert will be opened up and restored as natural channel. This will help to reduce the risk of flooding.

- The villages of Wheathampstead and Batford should also be noted, as historically they have both been affected by flooding events. Each village has a number of small-scale flood defences which do not provide considerable protection individually but which collectively provide flood protection to residential, commercial and industrial properties.

Of the 96 structures included in this review, 69 (72%) have a re-inspection interval of 6 months. The data contained in the NFCDD have therefore been updated, or at least verified, in the last 6 months. The remaining structures have re-inspection intervals of between 12 months and 36 months according to their level of importance.

From this review several areas have been identified as ‘Areas Benefiting from Defence’ or ABDs. Within these areas there is a high residual risk of flooding as a result of failure of the flood management infrastructure or exceedance of the design standard of the flood management infrastructure. This is discussed in more detail in **Section 5.5**.

#### 4.7

##### ***Topographical Data***

Environment Agency Light Detection and Ranging (LiDAR) data (covering the Colne, Ver, Chess, Lee and Thame catchments) and Photogrammetry data (covering the Bulbourne and Gade catchments) was collected and reviewed. This was used to construct a high-resolution Digital Terrain Model (DTM) (including 2m and 5m contour data – see **Volume II, Tiles D1 to D9**) which assisted the:

- verification of the PPS25 Flood Zone Maps;
- delineation of Functional Floodplain (Flood Zone 3b) in areas where no other data existed;
- delineation of major surface and groundwater flooding areas; and,
- identification of areas for future flood storage.

This information may be used by the Councils’ Development Control teams to review the general topography within and around a proposed development, as well



as to guide future updates to the SFRA enabling the identification of ‘low spots’ which may be liable to surface water flooding.

#### **4.8**

##### ***Site-Specific Flood Risk Assessments - Developers***

Consultation was undertaken with the Environment Agency to identify major Flood Risk Assessments (FRA’s) which had been carried out within the study area. These were reviewed at the Environment Agency North East Thames office in Hatfield. Further FRA’s made available by the LPA’s were also reviewed.

The FRA’s were produced and submitted as part of planning applications for developments ranging from relatively small scale residential sites of several units to significant mixed-use developments in excess of 3ha. Most had been carried out within the past three years (therefore current) and all were undertaken in accordance with Planning Policy Guidance Note 25: Development and Flood Risk.

In some cases the FRAs contained modelling (water level) information which was used to verify the PPS25 Flood Zone Maps, as well as information relating to residual flood risk associated with failure or exceedance of formal flood management infrastructure (e.g. breach or overtopping of the Chess Wall in Rickmansworth or Grand Union Canal in Berkhamsted). This review also allowed additional information on historical flooding from fluvial, ground water and surface water sources to be collected and incorporated into the mapping outputs (see *Volume II, Tiles B1 to B9*).

#### **4.9**

##### ***Flood Risk Management Strategies - Environment Agency***

The Environment Agency advocates a strategic approach to flood risk management on a ‘whole catchment’ basis. In line with this thinking, a number of flood risk management strategies have been undertaken by the Environment Agency within the Thames region, encompassing many of the river systems within the study area. Most notably, these include the Thames Catchment Flood Management Plan (2007), the Upper Lee Flood Risk Management Strategy (2007) and Upper Colne Flood Risk Management Strategy (2005). A brief overview of these and their main recommendations for flood risk management is provided below.

##### **4.9.1**

###### ***Thames CFMP***

The Thames Region Catchment Flood Management Plan (CFMP) is a high-level strategic planning document through which the Environment Agency will work

with other stakeholders to identify and agree policies for long-term flood risk management over the next 50 to 100 years.

A summary consultation document was published in 2007 outlining proposed flood risk management policies for the Thames Region. It takes into account the likely impacts of climate change and future development across the region. The plan does not propose specific or detailed measures but identifies where further work is needed.

The four main messages from the Thames Region CFMP are:

- Flood defences cannot be built to protect everything;
- Climate change will be the major cause of increased flood risk in the future;
- The floodplain is our most important asset in managing flood risk; and
- Development and urban regeneration provide a crucial opportunity to manage the risk.

*i) Key CFMP messages for the Upper Colne and headwater tributaries:*

The overall approach for flood risk management in these areas involves:

- Restoring river channels, water meadows and the natural floodplain;
- Reducing run-off from agricultural land;
- Using structural measures to control water levels and retain more water on floodplains; and
- Constructing engineered schemes to store floodwater.

A key aim is to prevent development that compromises the capacity of the flood plain to retain water. Also, future maintenance on river channels should aim to increase the capacity of the flood plain. The application of PPS25 is critical to ensuring that this aim is achieved.

*ii) Key CFMP messages for the chalk tributaries to the Colne, Upper Lee and River Thame:*

The main messages for flood risk management in these catchments are as follows:

- There does not need to be a radical change in the way that flood risk is managed in these areas given the relatively low risk levels.
- The Environment Agency will continue to maintain watercourses, increase flood awareness and provide appropriate flood warnings.
- Flood risk should be considered for all new developments through the use of Planning Policy Guidance Note 25 (PPS25): Development and Flood Risk;

The main action identified within the CFMP is for the Environment Agency to make sure that flood risk is managed appropriately in these areas by applying PPS25. This is reflected within the flood policy recommendations provided in **Section 6.4**.

#### 4.9.2

##### *Upper Lee Flood Risk Management Strategy, 2007*

The Environment Agency's overall objective for this study was to produce a Flood Risk Management Strategy for the Upper Lee catchment, in accordance with Flooding and Coastal Defence Project Appraisal Guidance (FCDPAG2) and the Thames Catchment Flood Management Plan (Thames CFMP).

The study considered a significant number of options for flood reduction within the Upper Lee catchment. These options included the construction of new flood storage areas, improvement of Luton Hoo Lake, the construction of flood wall and bunds, channel upgrading, and the improvement of key structures which were providing constriction to flow. Furthermore a number of non-structural solutions to flood risk management were proposed.

The following structural options are relevant with respect to the study area (St. Albans City and District Council):

- *Houghton Brook FSA in Luton* – this option was found to be economically viable and would provide flood benefit to areas within central Luton but this would not extend as far as Wheathampstead or Batford;
- *Improvement works to Luton Hoo Lakes* – this option was found to provide minimal additional protection to Batford and Wheathampstead and was therefore found to be uneconomical;
- *Channel upgrading at Batford* – this option involved the construction of a flood bund and wall, in addition to river bed re-grading. Although technically viable the scheme was found to be uneconomical; and,

- *Improvement works at Wheathampstead* – this option comprised construction of a bund and wall, in conjunction with improvements to the Old Mill Culvert at Wheathampstead. Again, although technically it was found to be uneconomical.

Given the low benefit-cost ratios for the identified structural schemes it was recommended that an integrated approach to flood risk management be adopted within this areas of the Upper Lee catchment, focusing on non-structural measures, improvements to the maintenance regime and selected further studies. The following recommendations were made:

- Encourage people living within Flood Zone 3 to sign-up to the Flood Warnings Direct service offered by the Environment Agency;
- Ensure all proposed developments comply with Planning Policy Statement Note 25: Development and Flood Risk;
- Raise the awareness of flood risk and promote self help measures;
- Liaise with Local Authorities to identify opportunities to claim back areas of functional floodplain (e.g. reduce the footprints of existing commercial premises);
- Improve the existing flood forecasting and flood warning capability; and,
- Develop an evacuation plan and undertake emergency planning exercises in high risk areas.

#### 4.9.3

##### *Upper Colne Flood Risk Management Strategy, Position Statement, 2005*

The first phase of the Upper Colne Strategy Study started in September 2001 during which the following final reports were produced:

- Chalfont St Giles and Chalfont St Peter, Pre-Feasibility Study, January 2004 (report no: WHR437, Rev 3)
- London Colney and Colney Heath, Pre-Feasibility Study, January 2004 (report no: WHR438, Rev 3)
- Watford, Pre-Feasibility Study, January 2004 (report no: WHR 436, Rev 3)
- Inception Report, February 2004 (report no: WHR278, Rev1)
- Inception Report Addendum (report no: WHR439, Rev 1)

The second phase of the strategy study started in November 2003 culminating in the publication of a position statement in 2005. From the search for potential flood storage areas, the results of the pre-feasibility studies and examination of the

strategy model flood outlines, the following strategic options were identified for future consideration. It should be noted that no further work has been undertaken on any of the identified options since the publication of this report in 2005.

#### Flood Storage Areas (FSAs)

In general, there were found to be no locations for flood storage within the Upper Colne which would result in a substantial reduction in downstream flood risk. The only likely options were three flood storage areas (FSAs) in the headwaters of the Mimmshall Brook (see ***Volume II, Tile G***). These were assessed as being potentially effective in terms of improving levels of flood protection, although their economic viability was not fully determined.

Other areas along the Upper River Colne were assessed for flood storage, although they were considered to be ineffective. These included the following areas; London Colney (FSA at Bowmansgreen Lake), London Colney to M25 (FSA upstream of the M25 culvert) and M25 to Watford (FSA on the existing floodplain area).

Additional areas for flood storage were also considered for the chalk tributaries (Ver, Chess, Gade and Misbourne), although it was thought that these would have a negligible effect on flooding in the Upper Colne due to the time lag between the chalk catchment response and the clay catchment response to rainfall; the clay catchment response being very rapid compared to that of the chalk catchment. A 'peaky' flood on the Upper Colne would have long since passed downstream before any FSA in the chalk catchments would begin to fill.

#### Upper Colne – London Colney: Flood Walls and Bunds

The option elements for London Colney indicated in the pre-feasibility study were:

- Adjacent to the Industrial Area: Short brick-faced floodwall 0.2m to 0.5m high, 295m long
- Between the Bridges in the Village Centre (North Side): Brick-faced floodwall 0.75m to 1.0m high, 130m long.
- Waterside (North Side): Flood bund 0.75m to 1.0m high, 140m long and brick-faced floodwall 1.25 maximum height, 40m long.
- Waterside (South Side): Flood bund 1.5m maximum height, 100m long.
- Along Salisbury Hall Brook: Re-align 200m of Salisbury Hall Brook, construct flood bund between re-aligned brook and gardens and a 40m section of flood bund between Waterside and Salisbury Brook.

- Between the Bridges in the Village Centre (South Side): Brick-faced floodwall maximum height 1.5m, 75m long.
- Adjacent to Lowbell Lane: Flood bund 1.2m to 1.5m high, 195m long and flood wall 1.2m average height, 85m long.

#### Upper Colne – Watford: Lower High Street Area

The option elements for the Lower High Street area indicated in the pre-feasibility study were:

- Flood Wall on Right Bank adjacent to Gasworks, 1.2m high by 300m long
- Flood Gate on Right Bank across Vehicle Access Bridge
- Low Flood Wall on Left Bank adjacent to Gasworks, 0.5m high by 150m long
- Raise Pipeline and Access Bridges over River near Gasworks
- Clear Debris out of River Bed
- Remove Rookery and Silk Mill Sluices and Replace with Low Weirs

#### Upper Colne – Watford: Riverside Road Area

The option elements for the Riverside Road area indicated in the pre-feasibility study were:

- Flood Wall on Left Bank, 0.75m high by 180m long
- Remove Rookery Sluice Gate and Replace with Low Weir
- Remove Silk Mill Sluice and Replace with Low Weir

#### Upper Colne – Watford: Wiggshall Road Area

The option for the alleviation of flooding of Wiggshall Road and Wiggshall Industrial Estate was as follows:

- A low bund some 200m long around the edge of the sports ground of about 0.5m height.

## 5

# Strategic Flood Risk Mapping

### 5.1

#### *Overview*

This chapter provides a clear description of what data has been used for the purpose of strategic flood risk mapping. It is based on the findings of the data collection and review exercise which included an assessment of suitability (see **Chapter 4**). A number of maps have been produced across the study area in accordance with emerging best practice, guidance from PPS25 (and its Companion Guide) and the terms of the SFRA contract. Hard copies of these are provided in **Volume II** of this report (high level 1:75,000 maps are provided for all Councils whereas only the relevant detailed 1:25,000 maps are provided for each Council). ArcView GIS layers and pdf's are also available for inspection.

The mapping outputs provided in **Volume II** are as follows:

- **Tile A:** Location Plan (1:75,000 scale) -
- **Tiles B1 to B10:** Historical Flooding (1:75,000 and 1:25,000 scale)
- **Tiles C1 to C9:** Structures and Defences (1:75,000 and 1:25,000 scale)
- **Tiles D1 to D9:** Topography (1:75,000 and 1:25,000 scale)
- **Tiles E1 to E9:** Flood Map (2007) (1:75,000 and 1:25,000 scale)
- **Tiles F1 to F9:** Flood Map (2025-2115) (1:75,000 and 1:25,000 scale)
- **Tile G1:** Existing and Future Flood Alleviation Schemes (1:75,000 scale)
- **Tile H1:** Hydrometry and Flood Warning (1:75,000 scale) –Fluvial Flooding – Delineation of PPS25 Flood Zones

All historical fluvial flooding incidents are mapped in **Volume II, Tiles B1 to B9**, along with all other sources of flooding. The PPS25 Flood Zones are provided in **Volume II, Tiles E1 to E9**.

#### 5.1.1

#### *Zone 3b – Functional Floodplain*

Functional Floodplain Zone 3b is defined as those areas in which water has to flow or be stored in times of flood. Within this study functional floodplain has been defined by the following criteria:

- Land subject to flooding in the 20 year flood event
- Land which provides a function of flood conveyance or flood storage, through natural processes or by design (e.g. washlands, flood storage areas)

- Areas which would naturally flood with an annual exceedance probability of 1 in 20 (5% Annual Exceedance Probability, AEP) or greater, but which are prevented from doing so by existing buildings, defences and other flood risk management infrastructure will not normally be defined as Functional Floodplain

The PPS25 Companion Guide recommends that all areas within Zone 3 should be considered as Zone 3b Functional Floodplain unless, or until, an appropriate FRA shows to the satisfaction of the Environment Agency that it can be considered as falling within Zone 3a (High Probability). In some areas, detailed models have been used to define the functional floodplain. In other areas it has been necessary to make conservative assumptions about the extent of the functional floodplain in the absence of historical flood outlines and detailed models.

The approach used to map Zone 3b for each watercourse is summarised in **Table 5-1**.

Watercourse	Zone 3b Data Source
Upper River Lee	Lee Hydrology and Mapping Study (2007) modelled 1 in 20 year flood outlines
Upper River Colne and Mimmshall Brook	Upper Colne Flood Risk Management Strategy (2005) modelled 1 in 50 year flood outlines
Headwater tribs to the River Colne	Zone 3b is assumed to be the same as Zone 3a
River Ver, Gade, Bulbourne and Chess	In undeveloped areas, Zone 3b is assumed to be the same as Zone 3a. In developed areas, Zone 3b has been estimated from the topographical model and available soil maps.
River Thames	Zone 3b is assumed to be the same as Zone 3a

**Table 5-1 Flood Zone 3b (Functional Floodplain) mapping**

### 5.1.2

#### *Zone 3a – High Probability*

The High Probability Zone 3a is defined as those areas within the study area which are situated within the undefended 1 in 100 year (or 1% AEP) flood extent. A number of approaches have been used to define the extent of Zone 3a, including the use of detailed hydraulic modelling studies and refined two-dimensional modelling using J-Flow. In those areas for which detailed mapping outputs are not available, the Environment Agency's Flood Map based on a relatively coarse



national computer model has been adopted to enable the application of the Sequential Test. The approach used to map Zone 3a is summarised in **Table 5-2**.

Watercourse	Zone 3a Data Source
Upper River Lee	Lee Hydrology and Mapping Study (2007) modelled 1 in 100 year flood outlines
Upper River Colne and Mimmshall Brook	Upper Colne Flood Risk Management Strategy (2005) modelled 1 in 100 year flood outlines
Headwater tributaries to the River Colne	Environment Agency Flood Map outlines based on coarse national computer model (using JFlow)
River Ver, Gade, Bulbourne and Chess	Improved Environment Agency Flood Map outlines based on detailed topographic data (2007)
River Thame	Environment Agency Flood Map outlines based on coarse national computer model (using JFlow)

**Table 5-2 Flood Zone 3a (high probability) mapping**

### 5.1.3

#### *Zone 2 – Medium Probability*

The Medium Probability Zone 2 is defined as those areas within the study area which are situated between the undefended 1 in 1000 year (0.1% AEP) and 1 in 100 year (1% AEP) flood extents. The Environment Agency's Flood Map includes a 1 in 1000 year flood outline and this has been adopted in most areas, although the results from more detailed models have been used where available. The approach used to map Zone 2 for each watercourse is summarised in **Table 5-3**.

Watercourse	Zone 2 Data Source
Upper River Lee	Lee Hydrology and Mapping Study (2007) modelled 1 in 1000 year flood outlines
Upper River Colne and Mimmshall Brook	The greater of the Environment Agency Flood Map flood extent (based on coarse national computer model) or Upper Colne Flood Risk Management Strategy (2005) modelled 1 in 200 year flood extent
Headwater tributaries to the River Colne	Environment Agency Flood Map outlines based on coarse national computer model (using JFlow)
River Ver, Gade, Bulbourne and Chess	Improved Environment Agency Flood Map outlines based on detailed topographic data (using JFlow)
River Thame	Environment Agency Flood Map outlines based on coarse national computer model (using JFlow)

**Table 5-3 Flood Zone 2 (medium probability) mapping**

#### 5.1.4

##### *Zone 1 – Low Probability*

The Low Probability Zone 1 is defined as those areas within the study area which are situated outside of the undefended 1 in 1000 year flood extent. For the purpose of the SFRA maps, this includes all land that is outside of Zone 2 and Zone 3 flood risk areas. It is important to note however that for sites greater than one hectare it will still be necessary for a developer to produce a site-specific FRA which takes account of all sources of flooding, including surface water, groundwater and sewer sources (see **Section 6.5**)

#### 5.2

##### ***Surface Water (Land Drainage) and Groundwater Flooding***

Flooding from surface water (land drainage) and groundwater sources has been mapped using the historical data collected in **Section 4.5**. GIS ‘points’ have been used to indicate where minor surface water and groundwater flooding occurs on a regular basis (minor being defined as flooding which causes no damage to property and minimal disruption to traffic), whilst GIS ‘polygons’ have been used to delineate areas where major surface water and groundwater flooding occurs (major being defined as flooding which causes damage to property and/or significant disruption to the flow of traffic).

This is not considered to be exhaustive and since the data are based on historical events rather than predictive modelling (and therefore may not represent very rare events) the full extent of these flooding mechanisms may not have been captured. It is therefore recommended that during future updates to the SFRA, additional reviews and consultations are undertaken to ensure that the best information is used to inform site allocations.

Flood risk from surface water and groundwater sources is included in the historical flood maps (**Volume II, Tiles B1 to B9**) with a reference code to **Sections 4.5.2 and 4.5.3** and is combined with all sources of flooding in the overall flood map (**Volume II, Tiles E1 to E10**) used to guide the Sequential Test.

#### 5.3

##### ***Sewer Flooding***

Flooding from overloaded sewers (from surface water, foul water and combined sewers) has been mapped using the historical data collected in **Section 4.5**. This spans a period of 10 years (1997 to 2007) and therefore future updates to the SFRA should ensure that the most recent data is used. Furthermore, Thames Water only provide sewer flooding records at a relatively coarse resolution (first part of post code, e.g. HP1) which limits the use of the data for the purpose of spatial planning. In future updates to the SFRA, Thames Water may provide full

location information. In the meantime there is an onus on developers to assess sewer flood risk as fully as possible as part of site-specific FRAs (*see Section 6.5*)

Sewer flood risk has been classified according to the number of properties flooded from overloaded sewers within each main postcode area. The categorisation is as follows:

- Low sewer flooding risk: 0 to 5 properties
- Medium sewer flooding risk: 5 to 15 properties
- High sewer flooding risk: > 15 properties

Flood risk from arising from overloaded sewers is presented in a separate high-level historical flooding map (see *Volume II, Tile B10*).

## 5.4

### *Climate Change*

In its November 2006 publication of the predicted effects of climate change on the United Kingdom, Defra described how sea levels in Eastern England would increase by over 1m in the next 100 years. The publication also sets out how short duration rainfall could increase by 30% and flows by 20%, and suggests winters will become generally wetter whilst summers, although drier, will be characterised by more intense rainfall events. These effects will tend to increase both the size of flood zones associated with the sea and rivers, and the amount of flooding experienced from other sources.

Current guidance on incorporating climate change effects into flood risk assessments is as follows (see *Table 5-4*).

Parameter	1990 to 2025	2025 to 2055	2055 to 2085	2085 to 2115
Peak rainfall intensity	+5%	+10%	+20%	+30%
Peak river flow	+10%	+20%		
Offshore wind speed	+5%		+10%	
Extreme wave height	+5%		+10%	

**Table 5-4 Climate change guidance (from PPS25)**

A review of the floodplain topography and sensitivity testing of the available hydraulic models using the 20% increase on peak flows from 2025 to 2115 suggests that the changes in the aerial extent of inundation are likely to be negligible. This is because the floodplains in the study area are well-defined (the

effect of climate change on flat areas by contrast can be dramatic). In areas where no detailed modelling exists, this finding is supported by the relatively small difference in the aerial extents of Flood Zone 2 (Medium Probability) and Flood Zone 3a (High Probability). However, it is important to note that changes in the depth of flooding as a result of climate change will have a significant impact on flood hazard.

In order to reflect this, the following approaches have been used to map/represent the impacts of climate change on Flood Zone 2 (Medium Probability), Flood Zone 3a (Functional Floodplain) and Flood Zone 3b (High Probability) (see **Table 5-5**). A qualitative assessment of the impact of climate change on Flood Zone 2 (Medium Probability) suggests that as a result of the well-defined floodplains any increase in extent will be minimal. For the purpose of planning it is recommended that a buffer of 10m (measured from the edge of the existing Flood Zone 2) is added to represent future climate change. Given the inherent uncertainty over the extent of this zone no additional mapping of this zone has been undertaken.

<b>Watercourse</b>	<b>Climate Change Assumptions</b>
Upper River Lee	<i>Future Flood Zone 2 = Present Flood Zone 2 + 10m buffer</i> <i>Future Flood Zone 3b = Present 1 in 20 year flow +20%</i> <i>Future Flood Zone 3a = Present 1 in 100 year flow +20%</i>
Upper River Colne and Mimmshall Brook	<i>Future Flood Zone 2 = Present Flood Zone 2 + 10m buffer</i> <i>Future Flood Zone 3b = Present 1 in 50 year flow +20%</i> <i>Future Flood Zone 3a = Present 1 in 100 year flow +20%</i>
All tribs to the Colne and the River Thame	<i>Future Flood Zone 2 = Present Flood Zone 2 + 10m buffer</i> <i>Future Flood Zone 3b = Present Flood Zone 3a</i> <i>Future Flood Zone 3a = Present Flood Zone 2</i>

**Table 5-5 Climate change mapping (*Future* = 2025 – 2115, *Present* = 2007)**

It is expected that flood risk from groundwater, sewer or surface water flooding will generally increase due to the expected wetter winters (causing more frequent and prolonged groundwater flooding) and incidence of short-duration high intensity rainfall events associated with summer convective storms (causing more frequent surface water and sewer flooding). Further guidance on how planning should secure new development to the effects of climate change will soon be available in the new Planning Policy Statement: Planning and Climate Change (a supplement to PPS1). It is recommended that future updates to the SFRA take account of this and other emerging guidance (see **Section 8.5**).

Both high-level and detailed climate change maps are provided in ***Volume II, Tiles F1-F9***.

## **5.5**

### ***Residual Risk***

Residual flood risks can arise due to:

- the failure of flood management infrastructure such as a breach of a raised flood defence, blockage of a surface water conveyance system, overtopping of an upstream storage area, or failure of a pumped drainage system; or,
- a severe flood event that exceeds a flood management design standard and results in, for example, overtopping.

There are several major formal flood defences which provide protection to local communities, namely, the Markyate Flood Storage Area, Hartsbourne Stream Flood Storage Area, Hemel Hempstead flood relief culvert, Lower Colne Improvement Scheme raised defences and Chess Wall (see ***Section 4.6***). With each of these there is a residual risk of overtopping, breach or blockage, which could result in significant damage to buildings and highway infrastructure as well as posing danger to life. There is also a residual risk of overtopping or breach of the Grand Union Canal in Berkhamsted which could affect a large area of residential housing.

Within the flood maps (***Volume II, Tiles E1 to E9***), major residual risk zones have been mapped. These are treated uniformly and are represented in the GIS as a simple outline of the expected affected area. Actual levels of residual risk will vary spatially depending on flow routes, velocities, flood depths and proximity to the breach or overtopping location. In the event that the Exception Test needs to be applied to specific site allocations, the scope of the SFRA should be extended to a Level 2 assessment to refine information on the flood hazard in these locations.

All structures and defences are mapped in ***Volume II, Tiles C1 to C9***. These should be referenced by those proposing development to identify the possibility of localised residual risks as well as opportunities for deculverting and restoring the natural channel.

## 5.6

### ***Review of Indicative Sites***

A preliminary review of indicative sites has been made as part of the SFRA to identify levels of risk from all sources of flooding (this was undertaken for the purpose of the planning workshop to work through the Sequential Test for selected sites). Each Council is at a different stage within the site allocation process and therefore Table 5-6 does not necessarily reflect the actual number of development sites (in particular St. Albans is at a very early stage in the process; the 3 sites listed were selected specifically for the workshop).

It should be noted that the Sequential Test has not yet been undertaken across all sites so the distribution of risks are likely to change. **Table 5-6** provides a summary of sites according to PPS25 Flood Zones (the full list of sites including all other sources of flooding is provided in **Appendix G**)

Council	Total No. of Indicative Sites	No. Sites intersecting with Flood Zone 3b	No. Sites intersecting with Flood Zone 3a	No. Sites intersecting with Flood Zone 2	No. Sites in Flood Zone 1 affected by other sources of flooding
Dacorum	159	20	3	3	14
Watford	187	7	5	1	58
Three Rivers	52	12	3	0	29
St. Albans	3	2	1	0	3

**Table 5-6 Flood Zone classification of indicative sites**

It is apparent that each Council currently have indicative sites which intersect with Zone 3b Functional Floodplain. In most cases there is a very small area of overlap between the site boundary and Zone 3b and therefore opportunities to apply the Sequential Test within the site should be taken. In some cases, however, where the site falls wholly within Zone 3b it may be necessary to consider swapping the site to a lower flood risk zone via the Sequential Test process (see **Figure 2-1**).

## 6

# Flood Risk Management Policy Recommendations

### 6.1

#### *Overview*

This chapter provides recommendations for what should be included in the Council's policy for flood risk management as well as providing guidance to developers on the preparation of site-specific FRAs. Council policy is considered essential to ensure that the recommended development control conditions can be imposed consistently at the planning application stage.

The policy recommendations provided in this chapter are not exhaustive and it is therefore recommended that the Councils refer to the following key flood risk management documents in order to fully inform their own flood risk management policies. It is recommended that for the purpose of clarity, a Supplementary Planning Document should be developed in light of the suggested policies and guidance notes, outlining the minimum requirement of the Environment Agency in response to PPS25 (see *Section 8.3*).

- **Planning Policy Statement 25: Development and Flood Risk** – sets out national policy for development and flood risk and supports the Government's objectives for sustainable communities.
- **Thames Catchment Flood Management Plan** - strategic planning document through which the Environment Agency will work with other stakeholders to identify and agree policies for long-term flood risk management over the next 50 to 100 years.
- **Making Space for Water** - outlines the Government's proposals for forward planning of flood management over the next 20 years advocating a holistic approach to achieve sustainable development. The protection of the functional floodplain is central to the strategy.
- **Water Framework Directive** - European Community (EC) water legislation which requires all inland and coastal waters to reach good ecological status by 2015.

### 6.2

#### *Future Flood Alleviation Schemes*

During the Upper Colne Flood Risk Management Strategy, sites for potential flood storage were identified on the River Colne and its major tributaries. A further review has been made during this study resulting in the identification of additional

sites for future flood storage (see **Volume II, Tile G1**). Although the technical and economic viability of these potential schemes is in question, it is recommended that where practicable these areas are safeguarded from development (see **Section 8.3**) until they are discounted by the Environment Agency during future updates to the strategy (the date of this is unknown).

It should be noted that three of the potentially viable storage areas identified during the Upper Colne Strategy are located in the headwaters of the Mimmshall Brook in Hertsmere Borough Council (see **Section 4.9.3**). It is recommended that discussions are held with Hertsmere Borough Council to ensure that they are aware of the possible need to safeguard these areas (the potential need for this should also be included within the Hertsmere Borough SFRA). In addition, the areas identified for other structural flood risk management measures as part of the Upper Colne Strategy Study (see **Section 4.9.3**) should be reviewed in the context of allocated and non-allocated sites.

In some cases it may be reasonable for future developers to contribute (in full or in part) to the cost of such flood alleviation schemes which provide benefit to the wider community (further information on developer contributions can be found in Annex G of PPS25).

## **6.3**

### **6.3.1**

## ***Policy Recommendations***

### ***Main Policy Considerations***

As part of the SFRA, a workshop was held with the planning teams from each Council and other key stakeholders. A key aim of the workshop was to define flood risk management objectives and identify key policy considerations. The Environment Agency was a key contributor to this exercise and as such the policy objectives and considerations provided in this section are in line with the broad objectives of the Thames CFMP and Making Space for Water.

It is recommended that the following flood risk objectives are taken into account during the policy making process and, where appropriate, used to strengthen or enhance the development control policies provided in **Section 6.3.2**.

### **Flood risk objective 1: Achieve flood risk reduction through spatial planning and site design**

- Use the Sequential Test to locate new development in least risky areas, giving highest priority to Flood Zone 1.



- Use the Sequential Test within development sites to inform site layout by locating the most vulnerable elements of a development in the lowest risk areas. For example, the use of low-lying ground in waterside areas for recreation, amenity and environmental purposes can provide an effective means of flood risk management as well as providing connected green spaces with consequent social and environmental benefits.
- Identify long-term opportunities to remove development from the functional floodplain through land swapping.
- Build resilience into a site's design (e.g. flood resistant or resilient design, raised floor levels).
- Ensure development is 'Safe'. For residential developments to be classed as 'safe', dry pedestrian should be provided to and from the development without crossing through the 1 in 100 year plus climate change floodplain.

#### **Flood risk objective 2: Enhance and restore the river corridor**

- For any riverside developments an assessment of the condition of existing assets (e.g. bridges, culverts, river walls) should be made. Refurbishment or /and renewal should be made to ensure the lifetime is commensurate with lifetime of the development. Developer contributions should be sought for this purpose.
- Those proposing development should look for opportunities to undertake river restoration and enhancement as part of a development to make space for water. Enhancement opportunities should be sought when renewing assets (e.g. deculverting, the use of bioengineered river walls, raising bridge soffits to take into account climate change)
- Avoid further culverting and building over of culverts. All new developments with culverts running through their site should deculvert rivers for flood risk management and conservation benefit.
- Set development back from rivers, with a minimum 8 metre wide undeveloped buffer strip.

#### **Flood risk objective 3: Reduce surface water runoff from new developments**

- SUDS should be a requirement for all new development.
- All sites greater than one hectare in size require the following:
  - SUDS,
  - Greenfield discharge rates,
  - 1 in 100 year on-site attenuation taking into account climate change.
- Space should be specifically set-aside for SUDS and used to inform the overall site layout.

**Flood risk objective 4: Safeguard functional floodplain and areas for future flood alleviation schemes**

- Protect Greenfield functional floodplain from future development and reinstate areas of functional floodplain which have been developed (e.g. reduce building footprints or relocate to lower flood risk zones).
- Identify sites where developer contributions could be used to fund flood risk management schemes identified in the Upper Colne flood risk management strategy.

**Flood risk objective 5: Improve flood awareness and emergency planning**

- Improve the emergency planning process using the outputs from the SFRA.
- Encourage all those within Flood Zone 3a and 3b (residential and commercial occupiers) to sign-up to Flood Warnings Direct service operated by the Environment Agency.
- Ensure robust emergency (evacuation) plans are implemented for new developments greater than one hectare in size.

6.3.2

*Development Control Policies*

For the purposes of development control, detailed policies will need to be set out to ensure that flood risk is taken account of appropriately for both allocated and non-allocated ‘windfall’ sites. The following reflects the minimum requirements under PPS25 (reference should be made to Tables D.1-D.3 in PPS25).

Future Development within Flood Zone 1

In this zone, developers and local authorities should realise opportunities to reduce the overall level of flood risk in the area and beyond through the layout and form of the development. There is no significant flood risk constraint placed upon future developments within the Low Probability Flood Zone 1, although for sites greater than one hectare or above, the vulnerability from other sources of flooding should be considered as well as the effect of the new development on surface water runoff.

Typically, a Drainage Impact Assessment will be required to demonstrate that runoff from the site is reduced, thereby reducing surface water flood risk. This will involve the use of SUDS techniques which should take into account the local geological and groundwater conditions (see **Section 6.6** for SUDS guidance). For sites larger than one hectare, the post development runoff volumes and peak flow

rates should be attenuated to the Greenfield (pre-development) condition (see requirements set out in **Section 6.5.3** which should be applied to Greenfield and brownfield sites alike).

#### Future Development within Flood Zone 2

Land use within Medium Probability Flood Zone 2 should be restricted to the 'water compatible', 'less vulnerable' and 'more vulnerable' category. Where other planning pressures dictate that 'highly vulnerable' land uses should proceed, it will be necessary to ensure that the requirements of the Exception Test are satisfied (see **Section 2.4**). The following should be considered:

- A detailed site-specific Flood Risk Assessment should be prepared in accordance with PPS25 and Council Development Control policies
- Floor levels should be situated above the 1% (100 year) plus climate change predicted maximum level plus a minimum freeboard of 300mm
- The development should be safe, meaning that dry pedestrian access to and from the development should be possible above the 1 in 100 year plus climate change flood level and emergency vehicular access should be possible during times of flood.
- SUDS should be implemented to ensure that runoff from the site (post development) is reduced. For sites greater than one hectare the post development runoff volumes and peak flow rates should be attenuated to the Greenfield (pre-development) condition for both Greenfield and brownfield sites (see **Section 6.5.3**). Space should be set-aside for SUDS.
- The proposed development should be set-back from the watercourse with a minimum 8m wide undeveloped buffer zone, to allow appropriate access for routine maintenance and emergency clearance.

#### Future development within High Probability Flood Zone 3a

Land use within High Probability Flood Zone 3a should be restricted to the 'less vulnerable' uses to satisfy the requirements of the Sequential Test. For 'more vulnerable' uses it is necessary to ensure that the requirements of the Exception Test are satisfied. The following should be considered:

- A detailed site-specific Flood Risk Assessment should be prepared in accordance with PPS25 and Council Development Control policies. Properties situated within close proximity to formal defences or water retaining structures (reservoirs/canals) will require a detailed breach and overtopping assessment to ensure that the potential risk to life can be safely managed throughout the lifetime of the development (see **Section 5.7**). The nature of any breach failure analysis should be agreed with the Environment Agency.
- The development should not increase flood risk elsewhere, and opportunities should be taken to decrease overall flood risk (such as use of SUDS and deculverting). This can be achieved by developing land sequentially, with areas at risk of flooding favoured for green space.
- Floor levels should be situated above the 1% (100 year) plus climate change predicted maximum level plus a minimum freeboard of 300mm. Within defended areas the maximum water level should be assessed from a breach analysis.
- The development should allow dry pedestrian access to and from the development above the 1 in 100 year plus climate change flood level and emergency vehicular access should be possible during times of flood. An evacuation plan should be prepared (see **Section 7.3**). With respect to new developments, those proposing the development should take advice from the LPA's emergency planning officer and for large-scale developments, the emergency services, when producing an evacuation plan as part of a FRA. All access requirements should be discussed and agreed with the Environment Agency.
- Basements should not be used for habitable purposes. Where basements are permitted for commercial use, it is necessary to ensure that the basement access points are situated 300 mm above the 1 in 100 year flood level plus climate change.
- SUDS should be implemented to ensure that runoff from the site (post development) is reduced. For sites greater than one hectare the post development runoff volumes and peak flow rates should be attenuated to the Greenfield (pre-development) condition for both Greenfield and brownfield sites (see **Section 6.5.3**).

- The proposed development should be set-back from the watercourse with a minimum 8m wide undeveloped buffer zone, to allow appropriate access for routine maintenance and emergency clearance.

#### Future development within Functional Floodplain Zone 3b

Development should be restricted to 'water-compatible uses' and 'essential infrastructure' that has to be there. 'Essential infrastructure' in this zone must pass the Exception Test and be designed and constructed to remain operational in times of flood and not impede water flow.

### 6.3.3

#### *Council Specific Policy Issues*

Within each Local Authority there are specific policy issues which should be given more emphasis within the Councils' flood risk management policy documents. These are:

#### Dacorum Borough Council

- Manage residual flood risk through emergency planning, site design and protection measures. The key residual flood risks are blockage/collapse scenarios of Hemel Hempstead flood relief culvert and the potential overtopping/breach of the GUC in Berkhamsted
- Maximise opportunities to deculvert and restore/enhance the river corridor (Berkhamsted – the opening up of the Stag Lane culvert is a good example of this)
- Protect functional floodplain (in Greenfield and previously developed areas) along the River Gade and River Bulbourne (long-term management of flood risk can be achieved through the protection and reinstatement of natural floodplain processes)

#### St. Albans City and District Council

- Protect possible areas for future flood storage which could reduce downstream flood risk (see **Volume II, Tile G1**)
- Avoid future development in known groundwater flood risk areas around Sandridge
- Reinstatement functional floodplain through land swaps and/or reduction of commercial building footprints in Batford

- Increase flood awareness through collaboration with the Environment Agency and encourage self-help measures in areas subject to frequent flooding (Wheathampstead, Batford, London Colney and Colney Heath)

#### Watford Borough Council

- Recognise the importance of SUDS and the need to manage surface water flood risk (particularly around Lower High Street and along Radlett Road)
- Protect the functional floodplain and prevent infill development
- Consider land swaps to relocate vulnerable developments to Flood Zone 1
- Identify opportunities for developer contributions towards Flood Alleviation Schemes through consultation with the Environment Agency (see **Section 4.9**)

#### Three Rivers District Council

- Continue to protect functional floodplain and enhance ecological/amenity value (Chess Valley and Colne Valley)
- Work with other stakeholders (Thames Water, Herts Highways) to manage surface water flood risk (High Street, Rickmansworth)
- Implement policies for development behind defences to ensure that the residual risk of flooding is managed (e.g. set back developments, developer contributions to maintenance) (Lower Colne Improvement raised defences in Rickmansworth)
- Work with the Environment Agency to raise public awareness and highlight the responsibilities of riparian owners to maintain the river channel (Town Ditch, Rickmansworth)

#### 6.3.4

##### *Sensitive Development Locations*

Assuming that future site allocations and windfall sites are guided by PPS25 and the recommendations provided in this report, there are only a few locations in which development would significantly increase flood risk elsewhere.

The first of these is the Sandridge and Marshalswick area of St. Albans. This area has a significant risk of groundwater flooding (see **Sections 4.5.2, 6.3.3 and Volume II, Tile B5**) and it is therefore recommended that future development in this location is avoided.

The second area is around the Lower High Street in Watford (see *Volume II, Tile B9*). Within this area, there is a significant risk of surface water flooding which could be exacerbated by further development within Watford town centre if suitable controls on drainage are not implemented. In order to manage this flood risk it is critical that all developments implement SUDS.

In general, throughout the study area, any development (including developments in Low Probability Flood Zone 1) which does not incorporate Sustainable Urban Drainage Systems (SUDS) may increase the risk of surface and/or fluvial flooding both on-site and off-site (downstream). As such effective development control policies should be implemented in accordance with the SUDS recommendations provided in this report (see *Section 6.5 and 8.3*).

## 6.4

### 6.4.1

#### ***Guidance to Developers***

##### *Overview*

A SFRA is a strategic document that provides an overview of flood risk throughout the study area. Site-specific Flood Risk Assessments (FRAs) will be required for most proposed developments and the level of detail will depend on the level of flood risk at the site (see general details about FRA requirements in Appendix E in PPS25). The onus is on the developer to provide this information in support of a planning application.

Since the release of PPS25 in December 2006, the Environment Agency has power of direction over the determination of planning applications, which can be refused on the grounds of flood risk. Should the Council wish to disregard the advice of the Environment Agency then in exceptional circumstances the planning application could be put before the Secretary of State. It is therefore imperative that developers hold discussions over the need for Flood Risk Assessment (FRA) early on within the planning process. Consultation should be undertaken with the Environment Agency and the relevant Council to ensure that the Council's policies on flood risk management are respected and taken account of, and that the scope of the FRA is commensurate with the level of flood risk. The following reflects best practice on what should be addressed within a detailed FRA. Those proposing development should also be directed towards Annex F of PPS25 (*Figure 6-1* shows the recommended process of undertaking an FRA as part of an individual planning application).

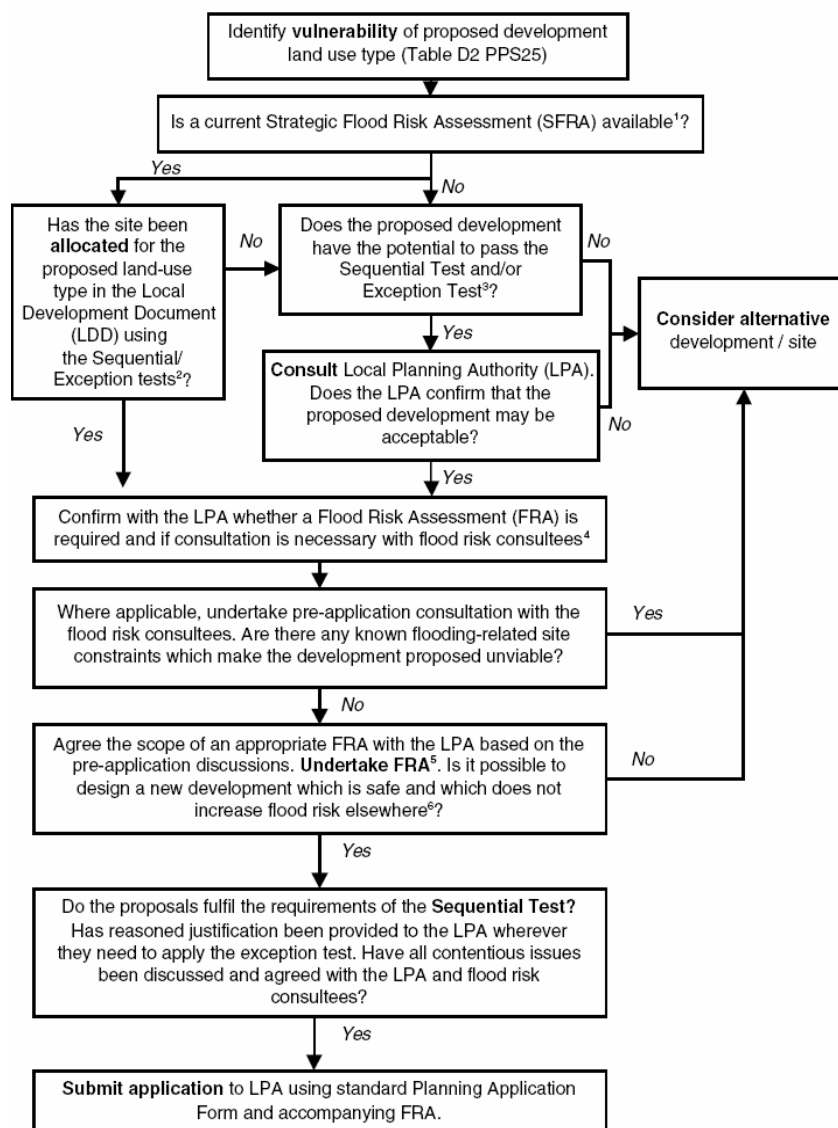


Figure 6-1 Guidance for developers for individual planning applications

#### 6.4.2

#### *Proposed Developments within Functional Floodplain Flood Zone 3b*

In line with PPS25, development will not normally be allowed in the Functional Floodplain unless it is classified as a ‘water compatible’ or ‘essential infrastructure’ use.



#### 6.4.3

##### *Proposed Developments within High Probability Flood Zone 3a*

All FRA's supporting proposed development within High Probability Zone 3a should assess the proposed development against all elements of the Council's flood policy, and include an assessment of the following:

- The vulnerability of the development to flooding from other sources (e.g. surface water drainage, groundwater) as well as from river flooding. This will involve discussion with the Council and the Environment Agency to confirm whether a localised risk of flooding exists at the proposed site.
- The vulnerability of the development to flooding over the lifetime of the development (including the potential impacts of climate change), i.e. maximum water levels, flow paths and flood extents within the property and surrounding area. The Environment Agency may have carried out detailed flood risk mapping within localised areas that could be used to underpin this assessment. Where available, this will be provided at a cost to the developer. Where detailed modelling is not available, hydraulic modelling by suitably qualified engineers will be required to determine the risk of flooding to the site.
- The potential of the development to increase flood risk elsewhere through the addition of hard surfaces, the effect of the new development on surface water runoff, and the effect of the new development on depth and speed of flooding to adjacent and surrounding property. This will require a detailed assessment to be carried out by a suitably qualified engineer.
- It is highlighted that all forms of flooding need to be considered as localised flooding may also occur, typically associated with local catchment runoff following intense rainfall passing directly over the borough. This localised risk of flooding must also be considered as an integral part of the detailed Flood Risk Assessment.
- A demonstration that residual risks of flooding (after existing and proposed flood management and mitigation measures are taken into account) are acceptable. Measures may include flood defences, flood resistant and resilient design, escape/evacuation, effective flood warning and emergency planning.
- Details of existing site levels, proposed site levels and proposed ground floor levels. All levels should be stated relevant to Ordnance Datum.

It is essential that developers thoroughly review the existing and future structural integrity of informal defences, if present, upon which the development will rely (i.e. over the lifetime of the development), and ensure that emergency planning measures are in place to minimise risk to life in the unlikely event of a defence failure (see **Section 7.3**). This would be particularly important for development that could potentially be affected as a result of a breach of the Grand Union Canal.

#### 6.4.4

##### *Proposed Development within Medium Probability Zone 2*

For all sites within Medium Probability Zone 2, a scoping level FRA should be prepared based upon readily available existing flooding information, sourced from the Environment Agency. If there is a significant flood risk from other sources (e.g. groundwater or sewer flooding) is identified then a more detailed FRA should be prepared. It will be necessary to demonstrate that the residual risk of flooding to the property is effectively managed throughout, for example, the provision of raised floor levels and the provision of planned evacuation routes or safe havens.

#### 6.4.5

##### *Proposed Development within Flood Zones 1 and 2*

The risk of alternative sources of flooding (e.g. surface water, sewage, and/or groundwater) must be considered, and sustainable urban drainage techniques must be employed to ensure no worsening of existing flooding problems elsewhere within the area.

The SFRA provides specific recommendations with respect to the provision of sustainable flood risk mitigation opportunities that will address both the risk to life and the residual risk of flooding to development within particular ‘zones’ of the area. These recommendations should form the basis for the site-based FRA (see **Section 6.6**).

#### 6.4.6

##### *Raised Floor Levels & Basements (Freeboard)*

The raising of floor levels above the 1 in 100 year (1% probability peak) flood level will ensure that the damage to property is minimised. Given the anticipated increase in flood levels due to climate change, the adopted floor level should be raised above the 1 in 100 year flood level assuming a 20% increase in flow over the next 20 to 100 years.

It is highlighted that many of those areas currently situated within Medium Probability Zone 2 could become part of the High Probability Zone 3. This is important as it means that properties that are today at relatively low risk will, in 20 to 100 years, be within High Probability Zone 3a. It is imperative therefore that

planning and development control decisions take due consideration of the potential risk of flooding in future years.

Floor levels should be situated a minimum of 300mm above the 1 in 100 year flood level plus climate change flood level, determined as an outcome of the site-based FRA, or 600mm above the 1 in 100 year flood level if no climate change data is available. The height that the floor level is raised above flood level is referred to as the 'freeboard', and is determined as a measure of the residual risks.

The use of basements within flood affected areas should be discouraged. Where basements are permitted however, it is necessary to ensure that the basement access points are situated 300mm above the 1 in 100 year flood level plus climate change. The basement must have unimpeded access and waterproof construction to avoid seepage during flooding conditions. Habitable uses of basements within flood affected areas should not be permitted.

#### 6.4.7

##### *Development Behind Defences*

Areas behind defences (see **Sections 4.6 and 5.6**) are at particular risk due to breach or overtopping, resulting in the rapid on-set of fast-flowing, deep water flooding with little or no warning. Risks will therefore be highest closest to these defences and as such it is recommended that the LPA's should set back developments and ensure that those proposing developments develop robust evacuation plans as part of their FRA in consultation with the Environment Agency.

Consideration of flood risk behind defences should be made as part of detailed FRAs. Developers should review **Volume II, Tiles C1 to C9** to determine the location of structures and defences in proximity to the site and therefore identify the possibility of localised residual flood risk. The FRA should take into account:

- the potential mechanisms of failure of flood defence infrastructure;
- the standard of protection and design freeboard;
- the asset condition of the flood defence;
- the height of the flood defence infrastructure and retained water levels compared to ground levels;
- the potential location, width and invert level of breach(es) in the flood defences;
- the duration of water levels during a flood event or tidal cycle;
- the period it would take the operating authority to close the breach;

- the period it would take for water to drain from the flooded area following a breach or overtopping event.

In addition to it is recommended that should any development be proposed in a defended flood area, the potential cumulative impact of loss of storage on flood risk elsewhere should be considered.

#### 6.4.8

##### *Car Parks*

Car parking may be appropriate in areas subject to shallow, low velocity flooding (in High Probability Zone 3a) provided sufficient flood warning is available, and appropriately located and worded signs are in place. However, this would need to be discussed and agreed with the Local Planning Authority and Environment Agency. As part of a FRA, the developer should consider the likelihood of people being able to move their cars within the flood warning time.

### 6.5

#### ***Sustainable Urban Drainage Systems***

#### 6.5.1

##### *Overview*

PPS1: Delivering sustainable development and PPS25 requires that LPAs should promote SUDS. LPAs should ensure policies encourage sustainable drainage practices in their LDDs. SUDS is a term used to describe the various approaches that can be used to manage surface water drainage in a way that mimics the natural environment. The management of rainfall (surface water) is considered an essential element of reducing future flood risk to both the site and its surroundings. Indeed, reducing the rate of discharge from urban sites to Greenfield runoff rates is one of the most effective ways of reducing and managing flood risk within the area.

#### 6.5.2

##### *Types of SUDS Systems*

SUDS may improve the sustainable management of water for a site by:

- reducing peak flows to watercourses or sewers and potentially reducing the risk of flooding downstream;
- reducing volumes of water flowing directly to watercourses or sewers from developed sites;
- improving water quality compared with conventional surface water sewers by removing pollutants from diffuse pollutant sources;
- reducing potable water demand through rainwater harvesting;
- improving amenity through the provision of public open space and wildlife habitat; and,

- replicating natural drainage patterns, including the recharge of groundwater so that base flows are maintained.

Any reduction in the amount of water that originates from any given site is likely to be small however if applied across the catchment, the cumulative effect from a number of sites could be significant with respect to flood risk reduction.

There are numerous different ways that SUDS can be incorporated into a development. The appropriate application of a SUDS scheme to a specific development is heavily dependent upon the topography and geology of the site and the surrounding areas. Careful consideration of the site characteristics is necessary to ensure the future sustainability of the adopted drainage system. The most commonly found components of a SUDS system are described below:

- Pervious surfaces: Surfaces that allow inflow of rainwater into the underlying construction or soil.
- Green roofs: Vegetated roofs that reduce the volume and rate of runoff and remove pollution.
- Filter drains: Linear drains consisting of trenches filled with a permeable material, often with a perforated pipe in the base of the trench to assist drainage, to store and conduct water; they may also permit infiltration.
- Filter strips: Vegetated areas of gently sloping ground designed to drain water evenly off impermeable areas and to filter out silt and other particulates.
- Swales: Shallow vegetated channels that conduct and retain water, and may also permit infiltration; the vegetation filters particulate matter.
- Basins and ponds (including wetlands) where water may be stored on the surface. Basins are free from water during dry weather flow conditions, while ponds are permanently wet
- Infiltration Devices: Sub-surface structures to promote the infiltration of surface water to ground. They can be trenches, basins or soakaways.
- Bioretention areas: Vegetated areas designed to collect and treat water before discharge via a piped system or infiltration to the ground.

For more guidance on SUDS, the following documents and websites are recommended as a starting point for those proposing development:

- Planning Policy Statement 25: Development and Flood Risk, Communities and Local Government, December 2006

- Development and Flood Risk: A Practice Guide Companion to PPS25, 'Living Draft', Communities and Local Government, 2007
- *Sustainable Drainage Systems – Draft Best Practice Guidance (August 2006)* – specifically for the Thames Region, providing a clear hierarchy for SUDS requirements at the planning application stage (available from the Environment Agency Development Control teams)
- Interim Code of Practice for Sustainable Drainage Systems, National SUDS Working Group, 2004 (see [www.ciria.org.uk/suds](http://www.ciria.org.uk/suds) for emerging SUDS selection toolkits)

### 6.5.3

#### *Application of SUDS for the Proposed Allocation and Future Development*

It is recommended that as part of an outline planning application and site-specific FRA, those proposing development will need to provide the following (for both Greenfield and brownfield sites);

- Information to demonstrate how the principles of Sustainable Drainage Systems have been applied to the development identifying what techniques will be used;
- A SUDS design strategy which identifies the most suitable options (taking into account specific site constraints) for the design of the surface water drainage system and how it will affect the site layout;
- Plans which show that land has been specifically set aside for SUDS; and,
- Calculations of the Greenfield discharge rate for the site and required attenuation volume for the 1 in 100 year rainfall event with consideration of the effects of climate change
- A long term management plan to identify future maintenance requirements and responsibilities

Due to the relatively permeable soil characteristics throughout much of the study area (large areas of alluvium and loam over gravels and chalk within the valleys and upland areas, see **Section 1.3.2**) it is recommended that priority is given to the use of infiltration drainage techniques, as opposed to discharging surface water to watercourses or directly to the sewer system. However, in areas where there is a high water table, where there are groundwater source protection zones or where there are localised impermeable soils (or more widespread areas of London Clay), infiltration techniques will not be viable. Within these areas it will be necessary to adopt other SUDS techniques such as basins and ponds, which focus on storing water above the ground surface. Other water efficiency measures such as living roofs and rainfall harvesting should also be encouraged on all new development.

It should be noted that whilst there are no specific provisions for the adoption of SUDS techniques, existing legislation, such as Section 38 of the Highways Act, 1980 and the Town and Country Planning Act, 1990, can provide a mechanism for their adoption. However, this requires early consultation with the relevant stakeholders to ensure responsibilities for long term maintenance are agreed and a robust management plan is defined. Further guidance on this is provided in the CIRIA publication (C625 Model Agreements for SUDS) which aims to facilitate the uptake of SUDS by providing a mechanism for maintenance, either as a planning obligation under Section 106 of the Town and Country Planning Act, or as a condition attached to planning permission.

# 7

## Flood Warning and Emergency Planning

### 7.1

#### *Existing Flood Warning System*

The current flood warning service in the study area is operated by the Environment Agency. The Agency monitors rainfall and river levels 24 hours a day at a number of Flood Warning telemetry stations throughout the study area and uses this information to forecast the probability of flooding. Flood warnings are issued using a set of four codes, each indicating the level of risk with respect to flooding. The warnings issued are Flood Watch, Flood Warning, Severe Flood Warning and All Clear. A Flood Warning is issued if property is expected to flood and a Severe Flood Warning if there is extreme danger to life. The 'All Clear' is issued to indicate receding flood waters.

Within the study area there are a total of 8 Flood Warning Areas covering specific reaches of each watercourse.

- Upper River Colne and its tributaries from North Mymms to Maple Cross
- Lower River Colne, Frays River and Wraybury River from Maple Cross to Staines
- River Ver from Markyate to Bricket Wood
- River Gade and Bulbourne from Great Gaddesdon to Rickmansworth
- River Chess from Chesham to Rickmansworth
- Upper River Lee from Houghton Regis to Harpenden
- Upper River Lee from Harpenden to Hertford
- River Thame and its tributaries from Long Marston to Thame

Within each area the Environment Agency promotes those within Flood Zone 3 to sign up to the Floodline Warnings Direct Service (FWD) which has recently replaced the Automatic Voice Messaging System (AVM). The FWD service enables individuals, emergency services, local authority emergency planners and response teams to be effectively warned by delivering warnings simultaneously via telephone, mobile, pager, fax, email, SMS text messaging, digital TV and radio.

In areas where there is a good network of telemetry stations the full FWD service (high level service) is available. This includes the Main River Colne and Upper River Lee. The tributaries to the Colne however only have a low level of flood warning service, which consists of broadcasted messages through the media.



## 7.2

### ***Future Improvements to Flood Warning***

The on-going National Flood Risk Area/Flood Warning Area Project being undertaken by the Environment Agency is working towards refining the flood risk areas, thus providing a more targeted flood warning service to local communities. The flood risk areas represent areas of similar land use, floods from the same scenario and floods of similar return period. The risk areas will form flood warning areas based on communities in the floodplain; a flood warning area will consist of one or more flood risk areas.

Within the study area it is proposed that there will be a total of 40 new Flood Warning Areas (i.e. each Main River is broken down into several Flood Warning Areas on a community/flood risk basis). The exact definition of the splits between Flood Warning Areas remains subject to further consultation with key stakeholders. Additionally, on the tributaries to the Colne (Ver, Chess, Bulbourne and Gade) there will be a need for the Environment Agency to install new telemetry. This will also allow the full FWD service to be implemented throughout the study area.

The new system will be in operation by the 31<sup>st</sup> January 2008 (although the chalk tributaries will continue to operate a low level of service until the necessary telemetry has been installed – a date for this is not known at present) and will provide more accurate and area specific information for use by the Local Authorities emergency planning teams, local communities and emergency services.

## 7.3

### ***Emergency Planning Recommendations***

It is recommended that each Council's Emergency Response Plan is reviewed and updated in light of the findings of the SFRA to ensure that safe evacuation and access for emergency services is possible during times of flood both for existing developments and those being promoted as possible sites within the LDF process. It is further recommended that the Local Authorities work with the Environment Agency to promote the awareness of flood risk to maximise the number of people signed up to the FWD service (previously this has involved targeted mail shots to those identified as living within Flood Zone 3a). Within the study area particular attention should be given to vulnerable people including those with impaired hearing or sight and those with restricted mobility.

With respect to new developments, those proposing the development should take advice from the LPA's emergency planning officer and for large-scale

developments, the emergency services, when producing an evacuation plan as part of a FRA. As a minimum these plans should include information on:

How flood warning is to be provided

- Availability of existing warning systems
- Rate of onset of flooding and available warning time and
- Method of dissemination of flood warning

What will be done to protect the infrastructure and contents

- How more easily damaged items could be relocated
- The potential time taken to respond to a flood warning
- Ensuring safe occupancy and access to and from the development
- Occupant awareness of the potential frequency and duration of flood events
- Provision of safe (i.e. dry) access to and from the development
- Ability to maintain key services during an event
- Vulnerability of occupants and whether rescue by emergency services may be necessary and feasible
- Expected time taken to re-establish normal practices following a flood event

In some areas, particularly for existing properties and proposed developments behind defences, it may be necessary to extend the scope of the SFRA to Level 2 (see **Section 5.7** and **Sections 8.1 and 8.2**). The outputs from detailed overtopping and breach analysis of the key defences will provide refined hazard information on flood depths, velocities and flow paths, which could be used by the LPA emergency planning teams to define new or refine existing emergency plans for these areas.

## 8 Recommendations

A number of recommendations have been made throughout this report on the basis of the findings of the SFRA. These are summarised below.

### 8.1 *Site Allocation Process*

It is recommended that the outputs from this study are used as an evidence base from which to direct new development to areas of low flood risk (Flood Zone 1). Where development cannot be located in Flood Zone 1, each planning authority should use the flood maps to apply the Sequential Test to their remaining land use allocations.

Where the need to apply the Exception Test is identified, due to there being an insufficient number of suitable sites for development within zones of lower flood risk, the scope of the SFRA will need to be widened to a Level 2 assessment. The need for a Level 2 SFRA cannot be fully determined until the Council's have applied the Sequential Test. It is recommended that as soon the need for the Exception Test is established, Level 2 SFRA(s) are undertaken by a suitably qualified engineer so as to provide timely input to the overall LDF process.

### 8.2 *Additional Studies*

It is recommended that more detailed modelling studies are undertaken by the Councils in selected areas to provide better information on the flood hazard associated with the failure of flood risk management infrastructure. The areas and brief scope of works are:

- Berkhamsted – detailed assessment of the residual risk of overtopping or breach of the Grand Union Canal
- Hemel Hempstead – Assessment of residual risk of blockage or collapse of the Hemel Hempstead flood relief culvert
- Rickmansworth – Assessment of the residual risk of overtopping or breach of the Lower Colne Improvement Scheme raised defences and Chess Wall

The outputs from these studies would enable the Council's Emergency Planning teams to refine existing emergency response plans and would provide

Development Control with more accurate and consistent information with which to guide the location and form of future development.

### **8.3**

#### ***Council Policy***

It is recommended that for the purpose of clarity, a Supplementary Planning Document should be developed in light of the suggested policies and guidance notes, outlining the minimum requirement of the Environment Agency in response to PPS25.

It is recommended that the following core considerations should be included within the Councils' flood risk management policy documents:

- Protecting the functional floodplain from development
- Directing vulnerable development away from flood affected areas
- Ensuring all new development is 'Safe', meaning that dry pedestrian access to and from the development is possible without passing through the 1 in 100 year plus climate change floodplain, and emergency vehicular access is possible
- Promoting the use of sustainable urban drainage systems in all flood zones to achieve Greenfield discharge rates on both Greenfield and Brownfield sites
- Supporting flood alleviation measures under consideration by the Environment Agency by safeguarding possible sites for flood storage and other channel works
- Seeking developer contributions (to be determined in consultation with the Environment Agency) via S106 planning obligations to fund (or part fund) strategic flood risk management facilities and bring benefit to the wider community.

### **8.4**

#### ***Emergency Planning***

It is recommended that each Councils' Emergency Response Plans are reviewed and updated in light of the findings of the SFRA to ensure that safe evacuation and access for emergency services is possible during times of flood both for existing developments and those being promoted as possible sites within the LDF process. It is further recommended that the Four Councils work with the Environment Agency to promote the awareness of flood risk and encourage communities at risk to sign-up to the Environment Agency Flood Warning Direct service.

## 8.5

### ***Future Updates to the SFRA***

The SFRA should be retained as a 'living' document and reviewed on a regular basis in light of better flood risk information and emerging policy guidance. It is recommended that outputs from the following studies are used to update future versions of the SFRA report and associated maps:

- Upper River Colne Strategic Flood Risk Mapping (Environment Agency, due to complete in 2008) – will provide refined PPS25 Flood Zones for the Upper River Colne
- Flood Plans for Statutory Reservoirs (British Waterways and Environment Agency, due for completion in 2008/2009) - will provide detailed information on the residual risk of breach or overtopping of the Tring reservoirs, Markyate Flood Storage Area and Hartsbourne Stream Flood Storage Area
- Low Flows study on the Gade (Three Valleys Water, due for completion in 2007) – will provide more information on the Hemel Hempstead flood relief culvert and its impact on river levels along the Gade
- Planning Policy Statement: Planning and Climate Change (supplement to PPS 1) (DCLG, due to be released in 2007) – will provide further guidance on how planning should secure new development to the effects of climate change

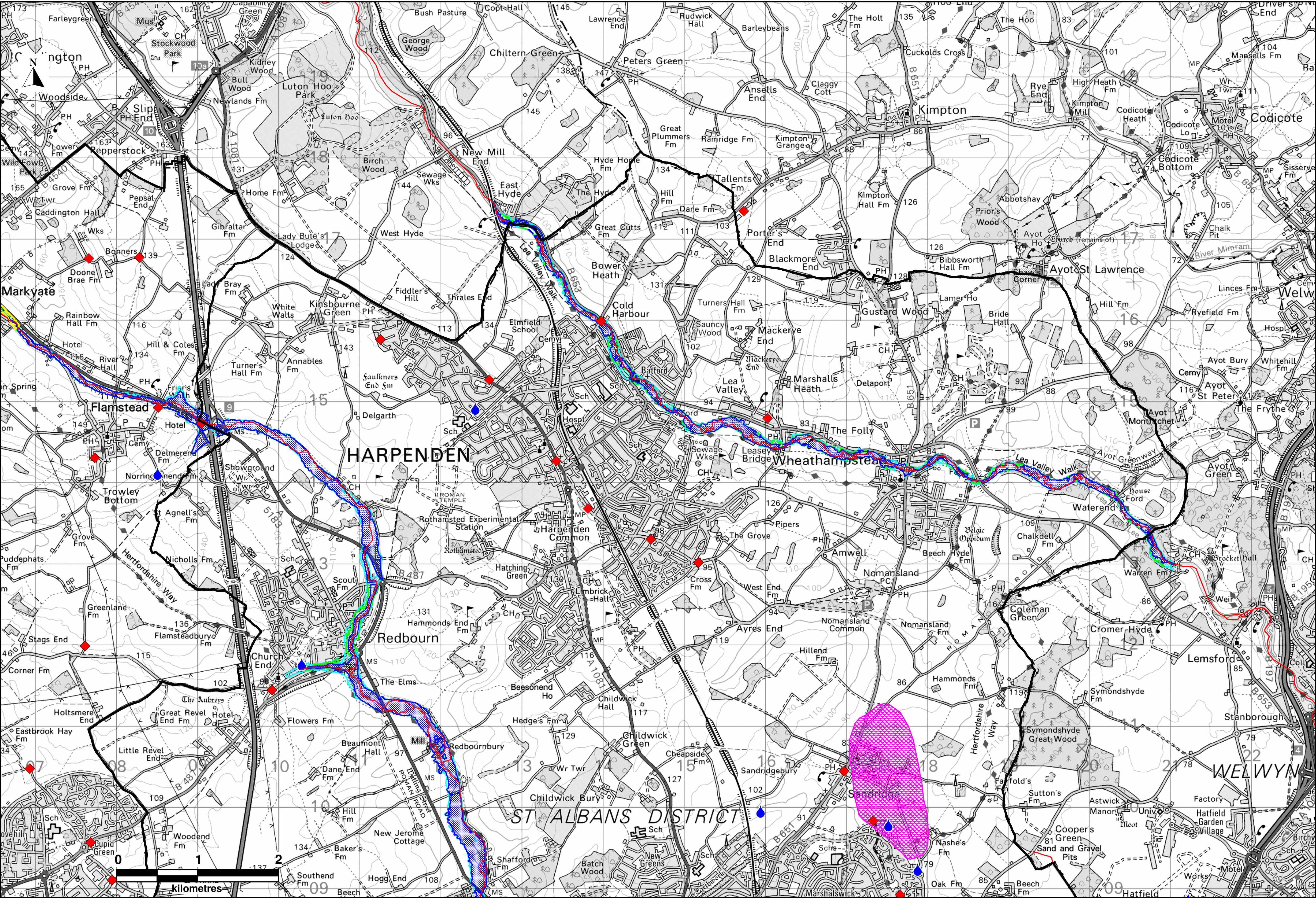
## 9 Glossary

- 1) Defra - Department of Environment, Food and Rural Affairs Development.
- 2) DCLG - Department of Community and Local Government.
- 3) Environment Agency - The leading public body for protecting and improving the environment in England and Wales.
- 4) Planning Policy Statements - The Government has updated its planning advice contained within Planning Policy Guidance Notes (PPGs) with the publication of new style Planning Policy Statements (PPSs).
- 5) 'Making Space for Water' (Defra 2004) - The Government's new evolving strategy to manage the risks from flooding and coastal erosion by employing an integrated portfolio of approaches, so as: a) to reduce the threat to people and their property; b) to deliver the greatest environmental, social and economic benefit, consistent with the Government's sustainable development principles, c) to secure efficient and reliable funding mechanisms that deliver the levels of investment required.
- 6) Planning Policy Statement 25 (PPS 25): Development and Flood Risk - PPS 25 reflects the general direction set out in 'Making Space for Water'.
- 7) The South East Plan - It is a new Regional Spatial Strategy which identifies the vision for the region through to 2026. It will set a new housing requirement for each district or borough.
- 8) Local Development Framework - The Local Development Framework (LDF) consists of a number of documents which together form the spatial strategy for development and the use of land.
- 9) Development Plan Document (DPD) - A spatial planning document within the Council's Local Development Framework which set out policies for development and the use of land. Together with the Regional Spatial Strategy they form the development plan for the area. They are subject to independent examination.
- 10) Core Strategy - The Development Plan Document which sets the long-term vision and objectives for the area. It contains a set of strategic policies that are required to deliver the vision including the broad approach to development.
- 11) Supplementary Planning Document (SPD) - Provides supplementary guidance to policies and proposals contained within Development Plan Documents. They do not form part of the development plan, nor are they subject to independent examination.
- 12) Sustainability Appraisal (SA) - Appraisal of plans, strategies and proposals to test them against broad sustainability objectives.
- 13) Sustainable Development - Development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (The World Commission on Environment and Development, 1987).
- 14) Strategic Environmental Assessment (SEA) - European Community Directive (2001/42/EC) on the assessment of the effects of certain plans and programmes on the environment.
- 15) Flood Risk Management Hierarchy - PPS 25 reaffirms the adoption of a risk-based approach to flooding by following stepped hierarchical measures at all stages in the planning process. Avoidance/prevention is the first measure, followed by substitution, control and then mitigation.

- 16) Strategic Flood Risk Assessment (SFRA) - A Strategic Flood Risk Assessment is used as a tool by a planning authority to assess flood risk for spatial planning, producing development briefs, setting constraints, informing sustainability appraisals and identifying locations of emergency planning measures and requirements for flood risk assessments.
- 17) The Sequential Test - Informed by a SFRA, a planning authority applies the Sequential Test to demonstrate that there are no reasonably available sites in areas with less risk of flooding that would be appropriate to the type of development or land use proposed.
- 18) The Exception Test - If, following application of the Sequential Test, it is not possible (consistent with wider sustainability objectives) to demonstrate that there are no reasonably available sites in areas with less risk of flooding that would be appropriate to the type of development or land use proposed, the Exception Test may apply. PPS 25 sets out strict requirements for the application of the Test.
- 19) Flood Risk Vulnerability - PPS 25 provides a vulnerability classification to assess which uses of land may be appropriate in each flood risk zone.
- 20) Environment Agency Flood Map - Nationally consistent delineation of 'high' and 'medium' flood risk, published on a quarterly basis by the Environment Agency.
- 21) Formal Flood Defence - A structure built and maintained specifically for flood defence purposes.
- 22) Informal Flood Defence - A structure that provides a flood defence function, however has not been built and/or maintained for this purpose (e.g. boundary wall).
- 23) AEP - Annual Exceedance Probability, for example 1% AEP is equivalent to 1% probability of occurring in any one year (or, on average, once in every 100 years).
- 24) Functional Floodplain Zone 3a - Defined as areas at risk of flooding in the 5% AEP (20 year) design event.
- 25) High probability Zone 3a - Defined as areas at risk of flooding in the 1% AEP (100 year) design event.
- 26) Medium probability Zone 2 - Defined as areas at risk of flooding in events that are greater than the 1% AEP (100 year), and less than the 0.1% AEP (1000 year) design event.
- 27) Low Probability Zone 1 - Defined as areas outside Zone 2.
- 28) Residual Risk - The risk which remains after all risk avoidance, reduction and mitigation measures have been implemented.
- 29) Habitable Room - A room used as living accommodation within a dwelling but excludes bathrooms, toilets, halls, landings or rooms that are only capable of being used for storage. All other rooms, such as kitchens, living rooms, bedrooms, utility rooms and studies are counted.
- 30) LiDAR - Light Detection and Ranging (LiDAR) is an airborne terrain mapping technique which uses a laser to measure the distance between the aircraft and the ground.
- 31) JFlow - A computer river model based on routing a flood calculated by Flood Estimation Handbook methodology along a river corridor the levels of which are derived from a Side Aperture Radar (SAR) remote sensed Digital Terrain Model.
- 32) Flood Estimation Handbook - The latest hydrological approach for the estimate of flood flows in UK.
- 33) Previously Developed (Brownfield) Land - Land which is or was occupied by a building (excluding those used for agriculture and forestry). It also includes land within the curtilage of the building, for example a house and its garden would be considered to be previously developed land.

- 1) Watford Pre-Feasibility Study, Final Report, Environment Agency Thames Region, January 2004
- 2) London Colney and Colney Heath Pre-Feasibility Study, Final Report, Environment Agency Thames Region, January 2004
- 3) Upper Colne Flood Defence Strategy (4293), Inception Report, Environment Agency Thames Region, February 2004
- 4) Upper Colne Flood Risk Management Strategy (4293), Position Statement, Environment Agency Thames Region, June 2005
- 5) An Investigation of the extent and distribution of groundwater flooding during the winter of 2000/01 in the North East Area of the Thames Region, University of Birmingham: JMM Jones, September 2004
- 6) Identification of Flood Risk in Dacorum, Hertfordshire and Flood Hazard Management, A Report to Dacorum Borough Council, Flood Hazard Research Centre, December 1998
- 7) Development and Flood Risk: A Practice Guide Companion to PPS25 'Living Draft', A Consultation Paper, Communities and Local Government, February 2007
- 8) Upper Lee Flood Risk Management Strategy, Volumes I and II, Environment Agency Thames Region, 2007
- 9) Lee Hydrology and Mapping Study, Environment Agency Thames Region, 2007
- 10) Planning Policy Statement 25: Development and Flood Risk, Communities and Local Government, 2006
- 11) Regional Planning Guidance for the South East, 2001
- 12) Hertfordshire Structure Plan Review 1991 – 2011, April 1998
- 13) Adopted Dacorum Local Plan 1991 – 2011, Dacorum Borough Council, April 2004
- 14) Dacorum District Issues and Options Consultation, Dacorum Borough Council, May 2006
- 15) St Albans District Plan Review, St Albans City and District Council, 1994
- 16) St Albans District Issues and Options Consultation, St Albans City and District Council, May 2006
- 17) Three Rivers Local Plan, Three Rivers District Council, July 2001
- 18) Watford District Plan 2000, Watford Borough Council, December 2003
- 19) Thames Region Catchment Flood Management Plan, Summary Document, Environment Agency, January 2007
- 20) Flooding and Coastal Defence Project Appraisal Guidance FCDPAG 2 Strategic Planning and Appraisal, 2001, MAFF
- 21) Making Space for Water, 2005, Defra
- 22) Water Framework Directive, 2003, European Community (200/60/EC)





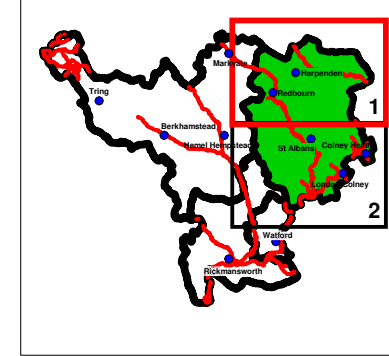
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Project:- DACORUM BOROUGH COUNCIL, ST ALBANS DISTRICT COUNCIL, THREE RIVERS DISTRICT COUNCIL, WATFORD BOROUGH COUNCIL STRATEGIC FLOOD RISK ASSESSMENT

Tile E5:- FLOOD MAP (2007)  
ST ALBANS DISTRICT COUNCIL

Rev.	By	Date	Description
A	AJ Bryan	25.06.07	Alterations made following Workshop & Environment Agency comments.
Drawn By :- A J Bryan		Revision A	Drawing Scale :- 1:25,000
Checked By :- L R Markeson		Status FINAL	Drawing No. :- WN/CBAD/DRAWING - 005
Approved By :- P L Wilkinson		Sheet No. :- 1 of 2	Date :- 21st May 2007
		Plot Scale :- 1:1 @ A1	Issuing Office :- Waltham Cross

Location Plan:-



Legend:-

	Council Boundary		Watercourse Centre Line
	Flood Zone 2 (Medium Probability)		Grand Union Canal
	Flood Zone 3a (High Probability)		Main Defences
	Flood Zone 3b (Functional Floodplain)		Major Residual Risk
	Major Groundwater Flooding Locations		Minor Groundwater Locations
	Major Surface Water Flooding Locations		Minor Surface Water Locations

Dacorum Borough Council  
Civic Centre  
Marlowes  
Northway  
Rickmansworth  
Herts, HP1 1HH

Three Rivers District Council  
Three Rivers House  
Northway  
Rickmansworth  
Herts, WD3 1PL

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Council Offices, Civic Centre  
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Herts, AL1 3JE

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PPS25: Flood Zones Definition

<b>Zone 1 Low Probability</b>
<b>Definition</b> This zone comprises land assessed as having a less than 1 in 1000 annual probability of river or sea flooding in any year (<0.1%).
<b>Appropriate uses</b> All uses of land are appropriate in this zone.
<b>FRA requirements</b> For development proposals on sites comprising one hectare or above the vulnerability to flooding from other sources as well as from river and sea flooding, and the potential to increase flood risk elsewhere through the addition of hard surfaces and the effect of the new development on surface water run-off, should be incorporated in a FRA. This need only be brief unless the factors above or other local considerations require particular attention. See Annex E for minimum requirements.
<b>Policy aims</b> In this zone, developers and local authorities should seek opportunities to reduce the overall level of flood risk in the area and beyond through the layout and form of the development, and the appropriate application of sustainable drainage techniques.
<b>Zone 2 Medium Probability</b>
<b>Definition</b> This zone comprises land assessed as having between a 1 in 100 and 1 in 1000 annual probability of river flooding (0.1% - 0.1%) or between a 1 in 200 and 1 in 1000 annual probability of sea flooding (0.5% - 0.1%) in any year.
<b>Appropriate uses</b> The water-compatible, less vulnerable and more vulnerable uses of land and essential infrastructure in Table D.2 are appropriate in this zone. The highly vulnerable uses in Table D.2 are only appropriate in this zone if the Exception Test (see para. D.9) is passed.
<b>FRA requirements</b> All development proposals in this zone should be accompanied by a FRA. See Annex E for minimum requirements.
<b>Policy aims</b> In this zone, developers and local authorities should seek opportunities to reduce the overall level of flood risk in the area through the layout and form of the development, and the appropriate application of sustainable drainage techniques.
<b>Zone 3a High Probability</b>
<b>Definition</b> This zone comprises land assessed as having a 1 in 100 or greater annual probability of river flooding (>1%) or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year.
<b>Appropriate uses</b> The water-compatible and less vulnerable uses of land in Table D.2 are appropriate in this zone. The highly vulnerable uses in Table D.2 should not be permitted in this zone. The more vulnerable and essential infrastructure uses in Table D.2 should only be permitted in this zone if the Exception Test (see para. D.9) is passed. Essential infrastructure permitted in this zone should be designed and constructed to remain operational and safe for uses in times of flood.
<b>FRA requirements</b> All development proposals in this zone should be accompanied by a FRA. See Annex E for minimum requirements.
<b>Policy aims</b> In this zone, developers and local authorities should seek opportunities to: i. reduce the overall level of flood risk in the area through the layout and form of the development and the appropriate application of sustainable drainage techniques; and ii. relocate existing development to land in zones with a lower probability of flooding; and iii. create space for flooding to occur by restoring functional floodplain and flood flow pathways and by identifying, allocating and safeguarding open space for flood storage.
<b>Zone 3b The Functional Floodplain</b>
<b>Definition</b> This zone comprises land where water has to flow or be stored in times of flood. SFRAs should identify this Flood Zone (land which would flood with an annual probability of 1 in 20 (5%) or greater in any year or is designed to flood in an extreme (0.1%) flood, or at another probability to be agreed between the LPA and the Environment Agency, including water conveyance routes).
<b>Appropriate uses</b> Only the water-compatible uses and the essential infrastructure listed in Table D.2 that has to be there should be permitted in this zone. It should be designed and constructed to: - remain operational and safe for uses in times of flood; - result in no net loss of floodplain storage; - not impede water flow; and - not increase flood risk elsewhere. Essential infrastructure in this zone should pass the Exception Test.
<b>FRA requirements</b> All development proposals in this zone should be accompanied by a FRA. See Annex E for minimum requirements.
<b>Policy aims</b> In this zone, developers and local authorities should seek opportunities to: i. reduce the overall level of flood risk in the area through the layout and form of the development and the appropriate application of sustainable drainage techniques; and ii. relocate existing development to land with a lower probability of flooding.

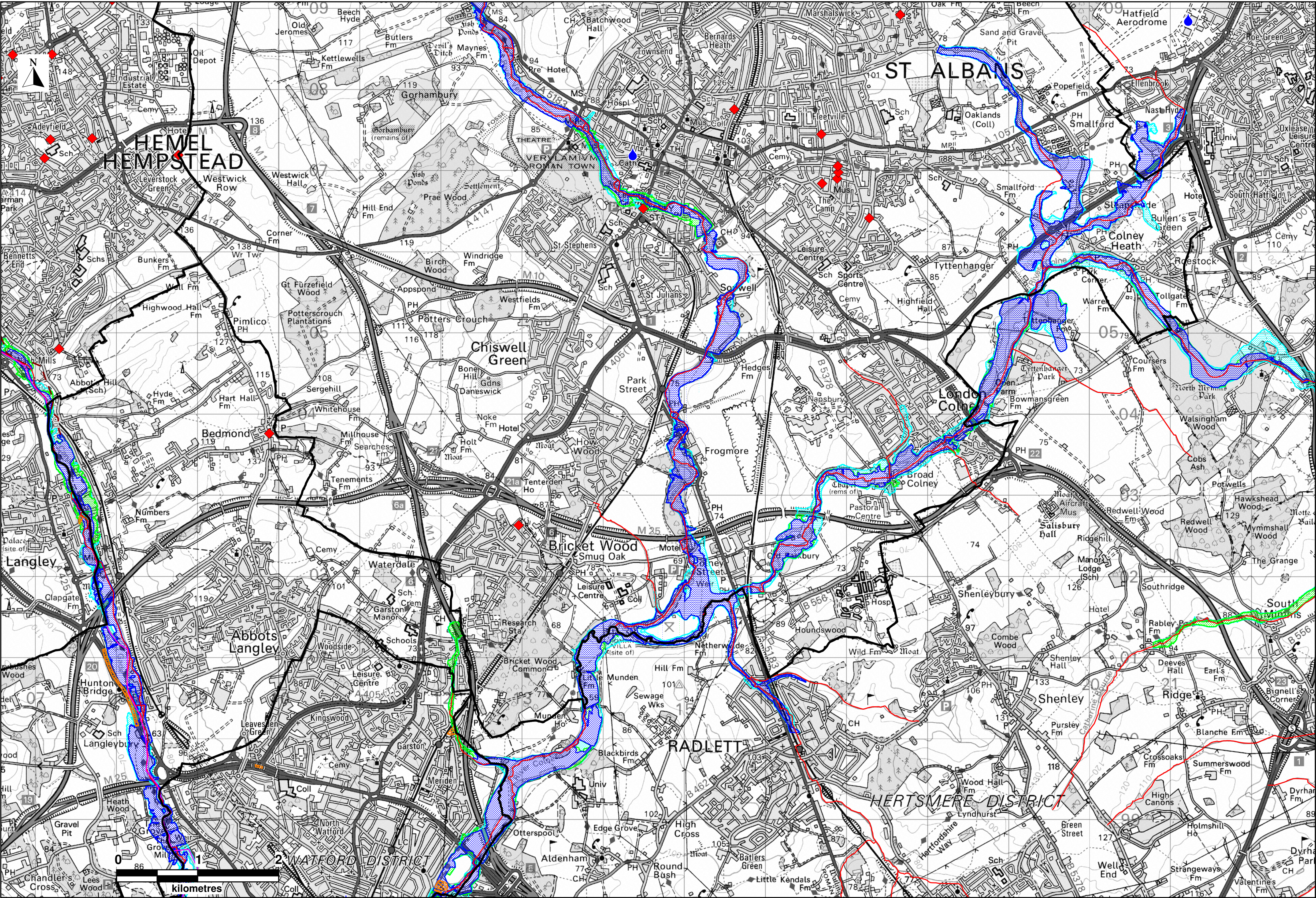
PPS25: Flood Risk Vulnerability and Flood Zone "Compatibility"

Flood Risk Vulnerability Classification	Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	✓	Exception Test Required	✓	✓
Zone 3a	Exception Test Required	✓	✗	Exception Test Required	✓
Zone 3b "functional floodplain"	Exception Test Required	✓	✗	✗	✗
✓ : Development is appropriate ✗ : Development should not be permitted					

PPS25: Flood Risk Vulnerability Classification

Essential Infrastructure	- Essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk, and strategic utility infrastructure, including electricity generating power stations and grid and primary substations.
Highly Vulnerable	- Police stations, Ambulance stations and Fire stations and Command Centres and telecommunications installations required to be operational during flooding. - Emergency dispersal points - Basement dwellings. - Caravans, mobile homes and park homes intended for permanent residential use. - Installations requiring hazardous substances consent.19
More Vulnerable	- Hospitals. - Residential institutions such as residential care homes, children's homes, social services homes, prisons and hostels. - Buildings used for: dwelling houses; student halls of residence; drinking establishments; nightclubs; and hotels. - Non-residential uses for health services, nurseries and educational establishments. - Landfill and sites used for waste management facilities for hazardous waste.20 - Sites used for holiday or short let caravans and camping, subject to a specific warning and evacuation plan.
Less Vulnerable	- Buildings used for: shops; financial, professional and other services; restaurants and cafes; hot food takeaways; offices; general industry; storage and distribution; non-residential institutions not included in 'more vulnerable'; and assembly and leisure. - Land and buildings used for agriculture and forestry. - Waste treatment (except landfill and hazardous waste facilities). - Mineral working and processing (except for sand and gravel working). - Water treatment plants. - Sewage treatment plants (if adequate pollution control measures are in place).
Water-compatible Development	- Flood control infrastructure. - Water transmission infrastructure and pumping stations. - Sewage transmission infrastructure and pumping stations. - Sand and gravel workings. - Docks, marinas and wharves. - Navigation facilities. - MCO defence installations. - Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location. - Water-based recreation (excluding sleeping accommodation). - Lifeguard and coastguard stations. - Amenity open space, nature conservation and biodiversity, outdoor sports and recreation and essential facilities such as changing rooms. - Essential ancillary sleeping or residential accommodation for staff required by uses in this category, subject to a specific warning and evacuation plan.





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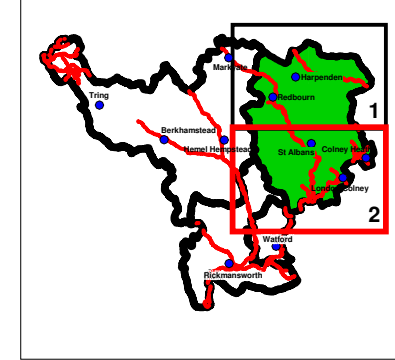
Project:- DACORUM BOROUGH COUNCIL, ST ALBANS DISTRICT COUNCIL, THREE RIVERS DISTRICT COUNCIL, WATFORD BOROUGH COUNCIL STRATEGIC FLOOD RISK ASSESSMENT

Tile E6:- FLOOD MAP (2007)  
ST ALBANS DISTRICT COUNCIL

Rev.	By	Date	Description
A	AJ Bryan	25.06.07	Alterations made following Workshop & Environment Agency comments.

Drawn By	:- A J Bryan	Revision	A	Drawing Scale	:- 1:25,000	Drawing No.	:- WN/CBAD/DRAWING - 005
Checked By	:- L R Markeson	Status	FINAL	Sheet No.	:- 2 of 2	Date	:- 21st May 2007
Approved By	:- P L Wilkinson			Plot Scale	:- 1:1 @ A1	Issuing Office	:- Waltham Cross

Location Plan:-



Legend:-

	Council Boundary		Watercourse Centre Line
	Flood Zone 2 (Medium Probability)		Grand Union Canal
	Flood Zone 3a (High Probability)		Main Defences
	Flood Zone 3b (Functional Floodplain)		Major Residual Risk
	Major Groundwater Flooding Locations		Minor Groundwater Locations
	Major Surface Water Flooding Locations		Minor Surface Water Locations



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Three Rivers House  
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## PPS25: Flood Zones Definition

### Zone 1 Low Probability

**Definition**  
This zone comprises land assessed as having a less than 1 in 1000 annual probability of river or sea flooding in any year (<0.1%).

**Appropriate uses**  
All uses of land are appropriate in this zone.

**FRA requirements**  
For development proposals on sites comprising one hectare or above the vulnerability to flooding from other sources as well as from river and sea flooding, and the potential to increase flood risk elsewhere through the addition of hard surfaces and the effect of the new development on surface water run-off, should be incorporated in a FRA. This need only be brief unless the factors above or other local considerations require particular attention. See Annex E for minimum requirements.

**Policy aims**  
In this zone, developers and local authorities should seek opportunities to reduce the overall level of flood risk in the area and beyond through the layout and form of the development, and the appropriate application of sustainable drainage techniques.

### Zone 2 Medium Probability

**Definition**  
This zone comprises land assessed as having between a 1 in 100 and 1 in 1000 annual probability of river flooding (1% - 0.1%) or between a 1 in 200 and 1 in 1000 annual probability of sea flooding (0.5% - 0.1%) in any year.

**Appropriate uses**  
The water-compatible, less vulnerable and more vulnerable uses of land and essential infrastructure in Table D.2 are appropriate in this zone. The highly vulnerable uses in Table D.2 are only appropriate in this zone if the Exception Test (see para. D.3) is passed.

**FRA requirements**  
All development proposals in this zone should be accompanied by a FRA. See Annex E for minimum requirements.

**Policy aims**  
In this zone, developers and local authorities should seek opportunities to reduce the overall level of flood risk in the area through the layout and form of the development, and the appropriate application of sustainable drainage techniques.

### Zone 3a High Probability

**Definition**  
This zone comprises land assessed as having a 1 in 100 or greater annual probability of river flooding (>1%) or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year.

**Appropriate uses**  
The water-compatible and less vulnerable uses of land in Table D.2 are appropriate in this zone. The highly vulnerable uses in Table D.2 should not be permitted in this zone.

The more vulnerable and essential infrastructure uses in Table D.2 should only be permitted in this zone if the Exception Test (see para. D.3) is passed. Essential infrastructure permitted in this zone should be designed and constructed to remain operational and safe for users in times of flood.

**FRA requirements**  
All development proposals in this zone should be accompanied by a FRA. See Annex E for minimum requirements.

**Policy aims**  
In this zone, developers and local authorities should seek opportunities to:  
i. reduce the overall level of flood risk in the area through the layout and form of the development and the appropriate application of sustainable drainage techniques; and  
ii. relocate existing development to land in zones with a lower probability of flooding; and  
iii. create space for flooding to occur by restoring functional floodplain and flood flow pathways and by identifying, allocating and safeguarding open space for flood storage.

### Zone 3b The Functional Floodplain

**Definition**  
This zone comprises land where water has to flow or be stored in times of flood. SFRRs should identify this Flood Zone (land which would flood with an annual probability of 1 in 20 (5%) or greater in any year or is designed to flood in an extreme (0.1%) flood, or at another probability to be agreed between the LPA and the Environment Agency, including water conveyance routes).

**Appropriate uses**  
Only the water-compatible uses and the essential infrastructure listed in Table D.2 that has to be there should be permitted in this zone. It should be designed and constructed to:  
- remain operational and safe for users in times of flood;  
- result in no net loss of floodplain storage;  
- not impede water flow; and  
- not increase flood risk elsewhere.  
Essential infrastructure in this zone should pass the Exception Test.

**FRA requirements**  
All development proposals in this zone should be accompanied by a FRA. See Annex E for minimum requirements.

**Policy aims**  
In this zone, developers and local authorities should seek opportunities to:  
i. reduce the overall level of flood risk in the area through the layout and form of the development and the appropriate application of sustainable drainage techniques; and  
ii. relocate existing development to land with a lower probability of flooding.

## PPS25: Flood Risk Vulnerability and Flood Zone "Compatibility"

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

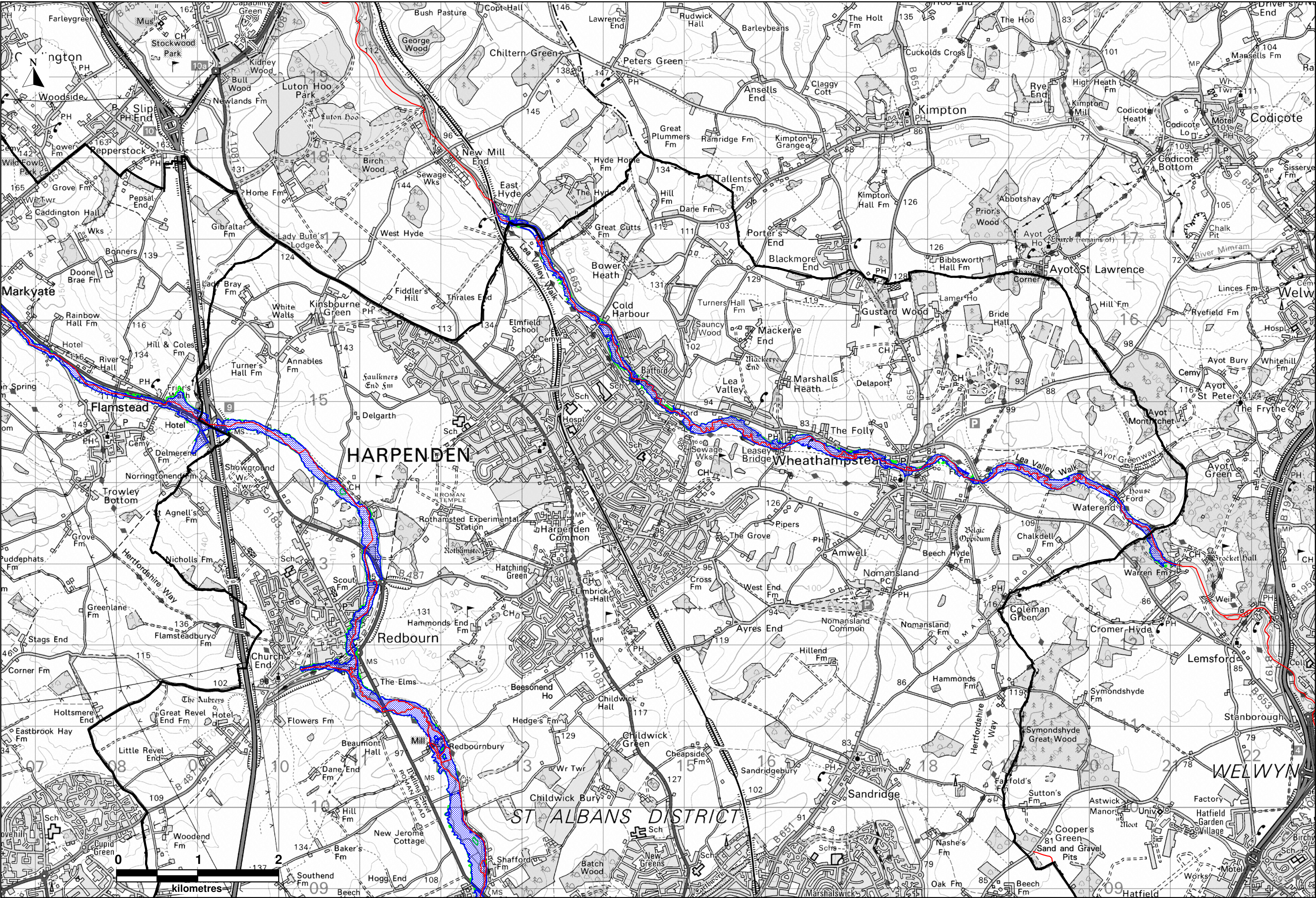
✓ : Development is appropriate

✗ : Development should not be permitted

## PPS25: Flood Risk Vulnerability Classification

Essential Infrastructure	<ul style="list-style-type: none"><li>Essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk, and strategic utility infrastructure, including electricity generating power stations and grid and primary substations.</li></ul>
Highly Vulnerable	<ul style="list-style-type: none"><li>Police stations, Ambulance stations and Fire stations and Command Centres and telecommunications installations required to be operational during flooding.</li><li>Emergency dispersal points</li><li>Basement dwellings.</li><li>Caravans, mobile homes and park homes intended for permanent residential use.</li><li>Installations requiring hazardous substances consent, 19</li></ul>
More Vulnerable	<ul style="list-style-type: none"><li>Hospitals.</li><li>Residential institutions such as residential care homes, children's homes, social services homes, prisons and hostels.</li><li>Buildings used for: dwelling houses; student halls of residence; drinking establishments; nightclubs; and hotels.</li><li>Non-residential uses for health services, nurseries and educational establishments.</li><li>Landfill and sites used for waste management facilities for hazardous waste 20.</li><li>Sites used for holiday or short-let caravans and camping, subject to a specific warning and evacuation plan.</li></ul>
Less Vulnerable	<ul style="list-style-type: none"><li>Buildings used for: shops; financial, professional and other services; restaurants and cafes; food takeaways; offices; general industry; storage and distribution; non-residential institutions not included in 'more vulnerable'; and assembly and leisure.</li><li>Land and buildings used for agriculture and forestry.</li><li>Waste treatment (except landfill and hazardous waste facilities).</li><li>Minerals working and processing (except for sand and gravel working).</li><li>Water treatment plants.</li><li>Sewage treatment plants (if adequate pollution control measures are in place).</li></ul>
Water-compatible Development	<ul style="list-style-type: none"><li>Flood control infrastructure.</li><li>Water transmission infrastructure and pumping stations.</li><li>Sewage transmission infrastructure and pumping stations.</li><li>Sand and gravel workings.</li><li>Docks, marinas and wharves.</li><li>Navigation facilities.</li><li>MCO defence installations.</li><li>Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location.</li><li>Water-based recreation (excluding sleeping accommodation).</li><li>Lifeguard and coastguard stations.</li><li>Amenity open space, nature conservation and biodiversity, outdoor sports and recreation and essential facilities such as changing rooms.</li><li>Essential ancillary sleeping or residential accommodation for staff required by uses in this category, subject to a specific warning and evacuation plan.</li></ul>





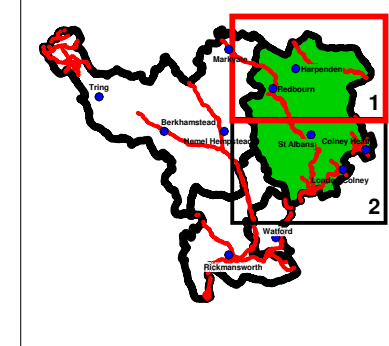
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Project:- DACORUM BOROUGH COUNCIL, ST ALBANS DISTRICT COUNCIL, THREE RIVERS DISTRICT COUNCIL, WATFORD BOROUGH COUNCIL STRATEGIC FLOOD RISK ASSESSMENT

Tile F5:- FLOOD ZONES (2025-2115)  
ST ALBANS DISTRICT COUNCIL

Rev.	By	Date	Description
A	AJ Bryan	25.06.07	Alterations made following Workshop & Environment Agency comments.
Drawn By :- A J Bryan		Revision A	Drawing Scale :- 1:25,000
Checked By :- L R Markeson		Status FINAL	Drawing No. :- WN/CBAD/DRAWING - 013
Approved By :- P L Wilkinson			Sheet No. :- 1 of 2
			Plot Scale :- 1:1 @ A1
			Date :- 21st May 2007
			Issuing Office :- Waltham Cross

Location Plan:-



Legend:-

- Council Boundary
- Watercourse Centre Line
- Flood Zone 3a (High Probability)
- Grand Union Canal
- Flood Zone 3b (Functional Floodplain)



Dacorum Borough Council  
Civic Centre  
Marlowes  
Northway  
Rickmansworth  
Herts, HP1 1PH



Three Rivers District Council  
Three Rivers House  
Northway  
Rickmansworth  
Herts, WD3 1PL



St Albans District Council  
Council Offices, Civic Centre  
St Peters Street  
St Albans  
Herts, AL1 3JE



Watford Borough Council  
Town Hall  
Watford  
Herts, WD17 3EX



www.halcrow.com  
Windsor House  
Britannia Road  
Waltham Cross  
Hertfordshire  
EN8 7NX

## PPS25: Flood Zones Definition

### Zone 1 Low Probability

**Definition**  
This zone comprises land assessed as having a less than 1 in 1000 annual probability of river or sea flooding in any year (<0.1%).

**Appropriate uses**  
All uses of land are appropriate in this zone.

**FRA requirements**  
For development proposals on sites comprising one hectare or above the vulnerability to flooding from other sources as well as from river and sea flooding, and the potential to increase flood risk elsewhere through the addition of hard surfaces and the effect of the new development on surface water run-off, should be incorporated in a FRA. This need only be brief unless the factors above or other local considerations require particular attention. See Annex E for minimum requirements.

**Policy aims**  
In this zone, developers and local authorities should seek opportunities to reduce the overall level of flood risk in the area and beyond through the layout and form of the development, and the appropriate application of sustainable drainage techniques.

### Zone 2 Medium Probability

**Definition**  
This zone comprises land assessed as having between a 1 in 100 and 1 in 1000 annual probability of river flooding (1% - 0.1%) or between a 1 in 200 and 1 in 1000 annual probability of sea flooding (0.5% - 0.1%) in any year.

#### Appropriate uses

The water-compatible, less vulnerable and more vulnerable uses of land and essential infrastructure in Table D.2 are appropriate in this zone.

The more vulnerable and essential infrastructure uses in Table D.2 should only be permitted in this zone if the Exception Test (see para. D.9) is passed. Essential infrastructure permitted in this zone should be designed and constructed to remain operational and safe for uses in times of flood.

**FRA requirements**  
All development proposals in this zone should be accompanied by a FRA. See Annex E for minimum requirements.

**Policy aims**  
In this zone, developers and local authorities should seek opportunities to reduce the overall level of flood risk in the area through the layout and form of the development, and the appropriate application of sustainable drainage techniques.

### Zone 3a High Probability

**Definition**  
This zone comprises land assessed as having a 1 in 100 or greater annual probability of river flooding (>1%) or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year.

#### Appropriate uses

The water-compatible and less vulnerable uses of land in Table D.2 are appropriate in this zone. The highly vulnerable uses in Table D.2 should not be permitted in this zone.

The more vulnerable and essential infrastructure uses in Table D.2 should only be permitted in this zone if the Exception Test (see para. D.9) is passed. Essential infrastructure permitted in this zone should be designed and constructed to remain operational and safe for uses in times of flood.

**FRA requirements**  
All development proposals in this zone should be accompanied by a FRA. See Annex E for minimum requirements.

**Policy aims**  
In this zone, developers and local authorities should seek opportunities to reduce the overall level of flood risk in the area through the layout and form of the development and the appropriate application of sustainable drainage techniques; and i. relocate existing development to land in zones with a lower probability of flooding; and ii. create space for flooding to occur by restoring functional floodplain and flood flow pathways; and by identifying, allocating and safeguarding open space for flood storage.

### Zone 3b The Functional Floodplain

**Definition**  
This zone comprises land where water has to flow or be stored in times of flood. SFRAs should identify this Flood Zone (land which would flood with an annual probability of 1 in 20 (5%) or greater in any year or is designed to flood in an extreme (0.1%) flood, or at another probability to be agreed between the LPA and the Environment Agency, including water conveyance routes).

#### Appropriate uses

Only the water-compatible uses and the essential infrastructure listed in Table D.2 that has to be there should be permitted in this zone. It should be designed and constructed to: remain operational and safe for uses in times of flood; result in no net loss of floodplain storage; not impede water flow; and not increase flood risk elsewhere.

Essential infrastructure in this zone should pass the Exception Test.

**FRA requirements**  
All development proposals in this zone should be accompanied by a FRA. See Annex E for minimum requirements.

**Policy aims**  
In this zone, developers and local authorities should seek opportunities to: reduce the overall level of flood risk in the area through the layout and form of the development and the appropriate application of sustainable drainage techniques; and i. relocate existing development to land with a lower probability of flooding.

## PPS25: Flood Risk Vulnerability and Flood Zone "Compatibility"

Flood Risk Vulnerability Classification	Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	✓	Exception Test Required	✓	✓
Zone 3a	Exception Test Required	✓	✗	Exception Test Required	✓
Zone 3b "functional floodplain"	Exception Test Required	✓	✗	✗	✗

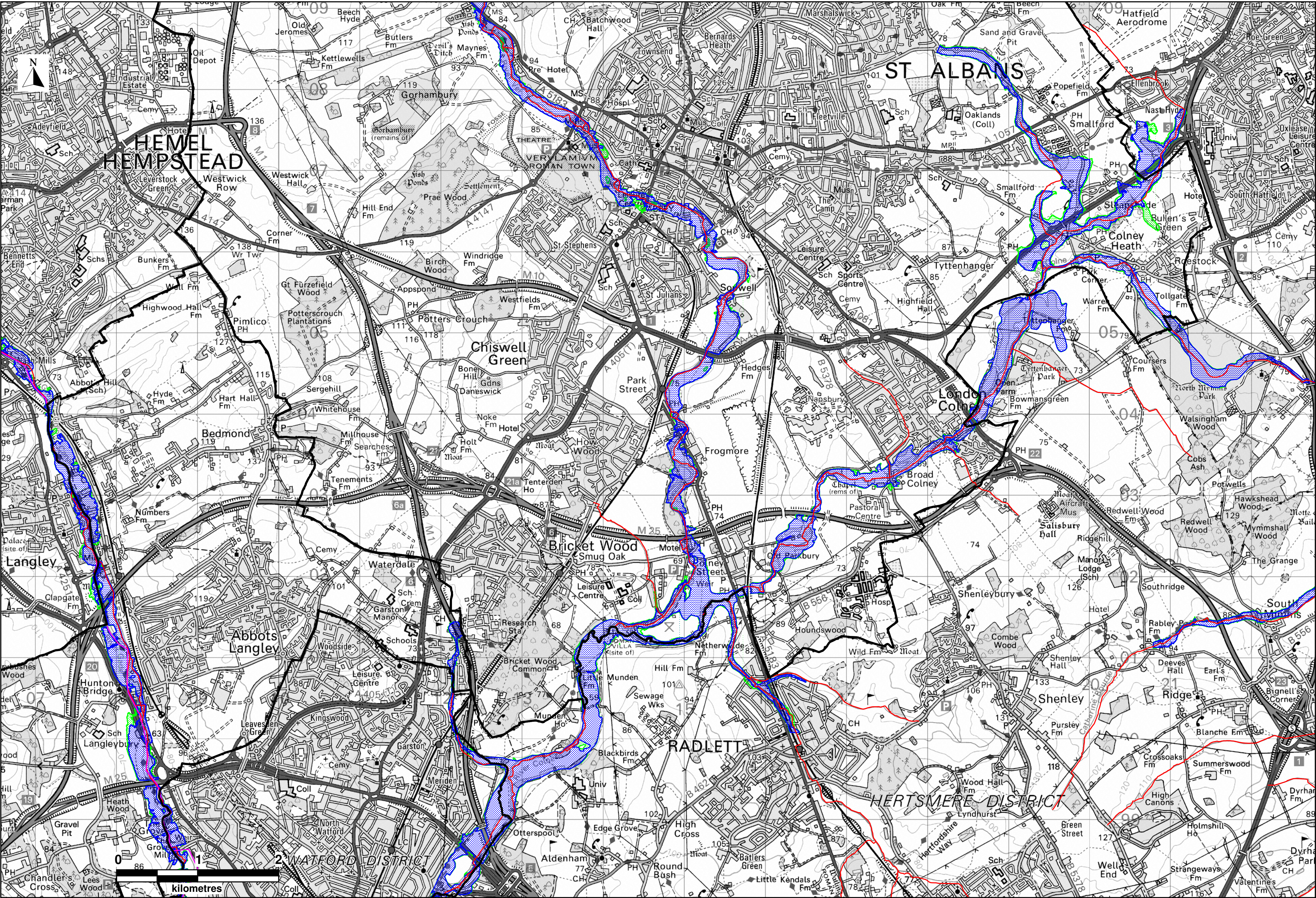
✓ : Development is appropriate

✗ : Development should not be permitted

## PPS25: Flood Risk Vulnerability Classification

Essential Infrastructure	Essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk, and strategic utility infrastructure, including electricity generating power stations and grid and primary substations.
Highly Vulnerable	Police stations, Ambulance stations and Fire stations and Command Centres and telecommunications installations required to be operational during flooding. Emergency dispersal points. Basement dwellings. Caravans, mobile homes and park homes intended for permanent residential use. Installations requiring hazardous substances consent.19
More Vulnerable	Hospitals. Residential institutions such as residential care homes, children's homes, social services homes, prisons and hostels. Buildings used for: dwelling houses; student halls of residence; drinking establishments; nightclubs; and hotels. Non-residential uses for health services, nurseries and educational establishments. Landfill and sites used for waste management facilities for hazardous waste.20 Sites used for holiday or short-let caravans and camping, subject to a specific warning and evacuation plan.
Less Vulnerable	Buildings used for: shops; financial, professional and other services; restaurants and cafes; hot food takeaways; offices; general industry; storage and distribution; non-residential institutions not included in 'more vulnerable'; and assembly and leisure. Land and buildings used for agriculture and forestry. Waste treatment (except landfill and hazardous waste facilities). Minerals working and processing (except for sand and gravel working). Water treatment plants. Sewage treatment plants (if adequate pollution control measures are in place).
Water-compatible Development	Flood control infrastructure. Water transmission infrastructure and pumping stations. Sewage transmission infrastructure and pumping stations. Silt and gravel workings. Docks, marinas and wharves. Navigation facilities. MCO defence installations. Ship building, repairing and dismantling, dockside fish processing and integration and compatible activities requiring a waterside location. Water-based recreation (excluding sleeping accommodation). Lifeguard and coastguard stations. Amenity open space, nature conservation and biodiversity, outdoor sports and recreation and essential facilities such as changing rooms. Essential ancillary sleeping or residential accommodation for staff required by uses in this category, subject to a specific warning and evacuation plan.





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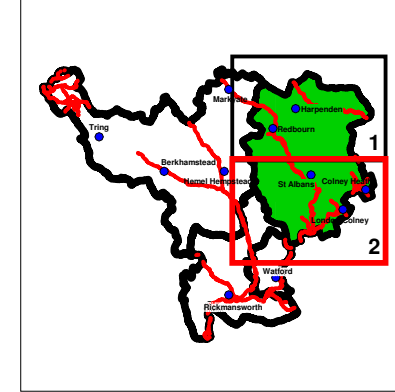
Project:- DACORUM BOROUGH COUNCIL, ST ALBANS DISTRICT COUNCIL, THREE RIVERS DISTRICT COUNCIL, WATFORD BOROUGH COUNCIL STRATEGIC FLOOD RISK ASSESSMENT

Tile F6:- FLOOD ZONES (2025-2115)  
ST ALBANS DISTRICT COUNCIL

Rev.	By	Date	Description
A	A J Bryan	25.06.07	Alterations made following Workshop & Environment Agency comments.

Drawn By	:- A J Bryan	Revision	A	Drawing Scale	:- 1:25,000	Drawing No.	:- WN/CBAD/DRAWING - 013
Checked By	:- L R Markeson	Status	FINAL	Sheet No.	:- 2 of 2	Date	:- 21st May 2007
Approved By	:- P L Wilkinson	Plot Scale	:- 1:1 @ A1	Issuing Office	:- Waltham Cross		

Location Plan:-



Legend:-

- Council Boundary
- Watercourse Centre Line
- Flood Zone 3a (High Probability)
- Grand Union Canal
- Flood Zone 3b (Functional Floodplain)

Dacorum Borough Council  
Civic Centre  
Three Rivers House  
Marlowes  
Northway  
Rickmansworth  
Herts, HP1 1RH

Three Rivers District Council  
Three Rivers House  
Northway  
Rickmansworth  
Herts, WD3 1RL

St Albans District Council  
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St Peters Street  
St Albans  
Herts, AL1 3JE

Watford Borough Council  
Town Hall  
Watford  
Herts, WD17 5EX

www.halcrow.com  
Windsor House  
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EN8 7NX

PPS25: Flood Zones Definition

**Zone 1 Low Probability**  
**Definition**  
This zone comprises land assessed as having a less than 1 in 1000 annual probability of river or sea flooding in any year (<0.1%).  
**Appropriate uses**  
All uses of land are appropriate in this zone.  
**FRA requirements**  
For development proposals on sites comprising one hectare or above the vulnerability to flooding from other sources as well as from river and sea flooding, and the potential to increase flood risk elsewhere through the addition of hard surfaces and the effect of the new development on surface water run-off, should be incorporated in a FRA. This need only be brief unless the factors above or other local considerations require particular attention. See Annex E for minimum requirements.  
**Policy aims**  
In this zone, developers and local authorities should seek opportunities to reduce the overall level of flood risk in the area and beyond through the layout and form of the development, and the appropriate application of sustainable drainage techniques.

**Zone 2 Medium Probability**  
**Definition**  
This zone comprises land assessed as having between a 1 in 100 and 1 in 1000 annual probability of river flooding (1% - 0.1%) or between a 1 in 200 and 1 in 1000 annual probability of sea flooding (0.5% - 0.1%) in any year.  
**Appropriate uses**  
The water-compatible, less vulnerable and more vulnerable uses of land and essential infrastructure in Table D.2 are appropriate in this zone.  
**FRA requirements**  
All development proposals in this zone should be accompanied by a FRA. See Annex E for minimum requirements.  
**Policy aims**  
In this zone, developers and local authorities should seek opportunities to reduce the overall level of flood risk in the area through the layout and form of the development, and the appropriate application of sustainable drainage techniques.

**Zone 3a High Probability**  
**Definition**  
This zone comprises land assessed as having a 1 in 100 or greater annual probability of river flooding (>1%) or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year.  
**Appropriate uses**  
The water-compatible and less vulnerable uses of land in Table D.2 are appropriate in this zone.  
**FRA requirements**  
All development proposals in this zone should be accompanied by a FRA. See Annex E for minimum requirements.  
**Policy aims**  
In this zone, developers and local authorities should seek opportunities to:  
i. reduce the overall level of flood risk in the area through the layout and form of the development and the appropriate application of sustainable drainage techniques; and  
ii. create space for flooding to occur by restoring functional floodplain and flood flow pathways and by identifying, allocating and safeguarding open space for flood storage.

**Zone 3b The Functional Floodplain**  
**Definition**  
This zone comprises land where water has to flow or be stored in times of flood. SFRAs should identify this Flood Zone (land which would flood with an annual probability of 1 in 20 (5%) or greater in any year or is designed to flood in an extreme (0.1%) flood, or at another probability to be agreed between the LPA and the Environment Agency, including water conveyance routes).  
**Appropriate uses**  
Only the water-compatible uses and the essential infrastructure listed in Table D.2 that has to be there should be permitted in this zone. It should be designed and constructed to:  
- remain operational and safe for uses in times of flood;  
- result in no net loss of floodplain storage;  
- not impede water flow; and  
- not increase flood risk elsewhere.  
**FRA requirements**  
All development proposals in this zone should be accompanied by a FRA. See Annex E for minimum requirements.  
**Policy aims**  
In this zone, developers and local authorities should seek opportunities to:  
i. reduce the overall level of flood risk in the area through the layout and form of the development and the appropriate application of sustainable drainage techniques; and  
ii. relocate existing development to land with a lower probability of flooding.

PPS25: Flood Risk Vulnerability and Flood Zone "Compatibility"

Flood Risk Vulnerability Classification	Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
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Zone 2	✓	✓	Exception Test Required	✓	✓
Zone 3a	Exception Test Required	✓	✗	Exception Test Required	✓
Zone 3b (functional floodplain)	Exception Test Required	✓	✗	✗	✗

✓ : Development is appropriate  
✗ : Development should not be permitted

PPS25: Flood Risk Vulnerability Classification

Essential Infrastructure	Essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk, and strategic utility infrastructure, including electricity generating power stations and grid and primary substations.
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Less Vulnerable	Buildings used for: shops; financial, professional and other services; restaurants and cafes; hot food takeaways; offices; general industry; storage and distribution; non-residential institutions not included in 'more vulnerable'; and assembly and leisure. Land and buildings used for agriculture and forestry. Waste treatment (except landfill and hazardous waste facilities). Minerals working and processing (except for sand and gravel working). Water treatment plants. Sewage treatment plants (if adequate pollution control measures are in place).
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