

Appendix D: Catchment-level Assessment of Cumulative Impacts of Flood Risk

1.1 Introduction

Cumulative impacts are defined as the effects of past, current and future activities on the environment.

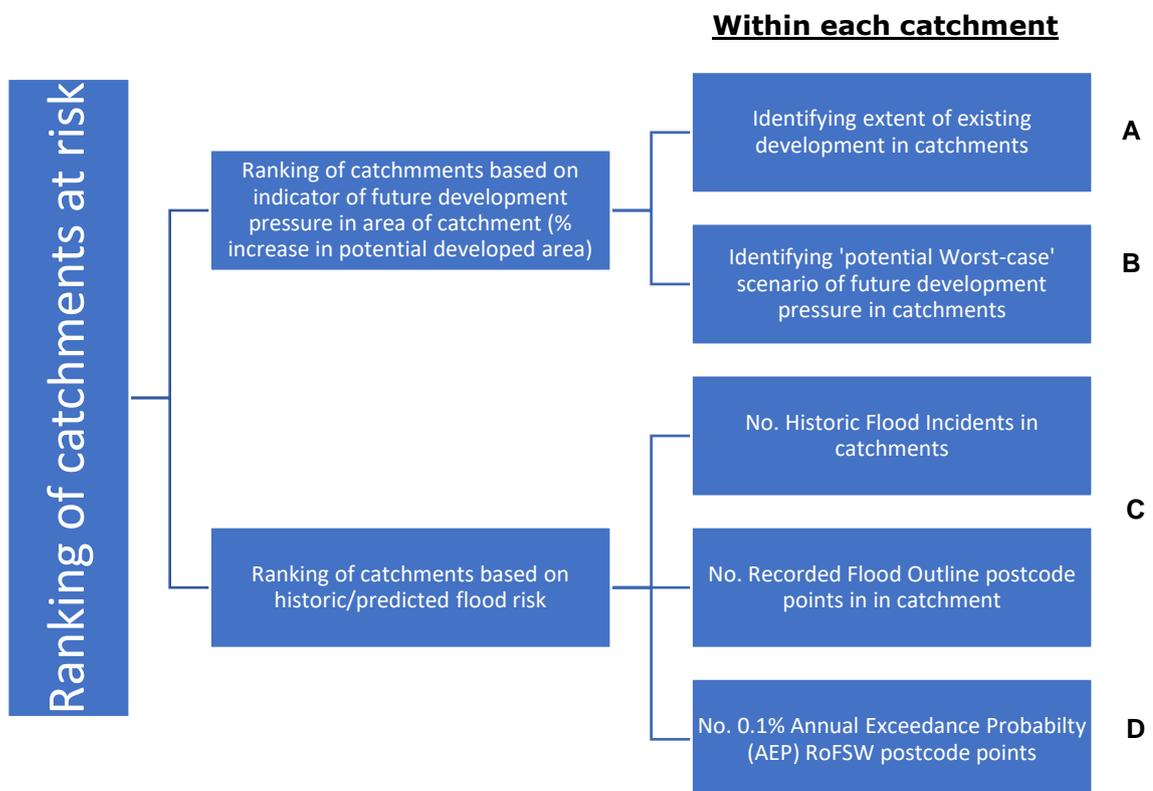
Under the 2018 NPPF¹, strategic policies and their supporting Strategic Flood Risk Assessments (SFRAs), are required to 'consider cumulative impacts in, or affecting, local areas susceptible to flooding' (para. 156).

To understand the impact of future development on flood risk in South West Hertfordshire, historic flood risk data has been compared with potential change in developed area within each river catchment defined within the Water Framework Directive (WFD). This identifies the catchments where development may have the greatest impact on flood risk, and further assessment would be required within a Level 2 Strategic Flood Risk Assessment (SFRA) or site-specific Flood Risk Assessment (FRA).

Where catchments have been identified as sensitive to the cumulative impact of development, the assessment concludes with potential strategic planning policy suggestions to manage the risk.

1.2 Method

Figure 0-1: Overview of the method used within the Cumulative Impacts Assessment.



¹ Ministry of Housing, Communities and Local Government (2018) National Planning Policy Framework. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/728643/Revised_NPPF_2018.pdf

1.2.1 Assessing Existing and Future Development Scenarios

A. Existing Development Scenario

To understand the level of existing development within South West Hertfordshire, the 2017 – 2018 residential and non-residential committed development sites collected as part of the Smart Herts Development monitoring programme was used. The data describes areas of ongoing or committed development in South West Hertfordshire.

The Hertfordshire Local Enterprise Partnership (LEP) and OS Vector Map urban extents were initially tested to representing the existing urban extent in the study area. However, combining the dataset with the committed sites resulted in duplication of developed area within the catchments.

Subsequently, the existing development area within each catchment was represented using the Smart Herts committed development data alone.

B. Indicator of Development Pressure

To understand areas of South West Hertfordshire likely to experience the greatest pressure for future growth, all potential future development sites received for consideration within the Local Plan process were analysed. Sources of sites included Call for Sites, Brownfield Registers,

This analysis has been used as an **indicator** of areas likely to be subject to the greatest development pressure in future. This is the only indicator available at this time, because Local Plans are not yet sufficiently advanced to show allocated development areas. It is important to recognise that this approach inevitably suggests a very high development impact, because it effectively assumes that all sites could be developed. In reality, many of the suggested sites would not be allocated for development in Local Plans.

The data allowed calculation of the overall area of submitted / suggested sites within each catchment, illustrating the relative pressures on the catchments. This data was used, with the existing development extent, to identify catchments likely to be under the greatest pressure for development.

Table 0-1: Summary of datasets used within South West Hertfordshire Cumulative Development Scenario.

Dataset	Coverage	Source of data	Use of data
Data used to define river catchments			
Catchment Boundaries	SW Hertfordshire Study Area	Water Framework Directive (WFD) Catchments	Existing development / Flood risk
Data used to estimate future development pressure			
Smart Herts Committed Developments 2017 - 2018	SW Hertfordshire Study Area	Hertfordshire County Council (HCC)	Existing development
All sites received as part of the Local Plan process (including Call for Sites, Brownfield)	Dacorum BC, St. Albans CADC, Three Rivers DC, Watford BC	Dacorum BC, St. Albans CADC, Three Rivers DC, Watford BC	Indicator of relative development pressure

Dataset	Coverage	Source of data	Use of data
Register, Spatial Policy Areas etc.)			
Data used to rank catchments by flood risk			
Risk of Flooding from Surface Water (RoFSW) flood extent	SW Hertfordshire Study Area	Environment Agency (EA)	Potential flood risk
Recorded Flood Outline (fluvial flood risk)	SW Hertfordshire Study Area	Environment Agency (EA)	Historic flooding
Surface Water Management Plan (SWMP) hotspots	SW Hertfordshire Study Area	Hertfordshire County Council (HCC)	Historic flooding
Flood Incidents	SW Hertfordshire Study Area	Hertfordshire County Council (HCC)	Historic flooding
Postcode points	SW Hertfordshire Study Area	Ordnance Survey (Open source)	Proxy for people at risk

1.2.2 Assessment of Flood Risk

A composite flood risk score was derived for each catchment, by taking an average ranking of both recorded (historic incidents) and modelled (predicted) flood risk.

To understand the relative flood risk within the catchments, a ranking system of 1 - 15 was adopted, with the worst-case flood risk numbered '1'.

The ranked categories were:

C. Historic Flood Risk

- HCC Flood Incidents (total within catchment boundary) - individual reports of flooding at specific locations.
- EA Recorded Flood Outline (number of postcode points affected) - flood extents mapped following flood events (largely relates to fluvial flooding). This was intersected with postcode points, to approximate the number of people affected.

D. Predicted Flood Risk

- Risk of Flooding from Surface Water (RoFSW) 1 in 1,000-year extent (number of postcode points at risk)
 - This was intersected with postcode points, to approximate the number of people predicted to be affected by surface water flooding.
 - The dataset was clipped to remove the extent of Flood Zone 2, so only surface water flood risk was assessed (to prevent double counting of fluvial flood risk)

After ranking, the catchments were also visually assessed against the HCC Surface Water Management Plan (SWMP) hotspot areas. The hotspots have been identified

through previous or ongoing analysis of surface water flood risk in Hertfordshire, and can be correlated with the RoFSW data and flood incident data to understand existing flood risk issues.

1.2.3 Assessment assumptions and limitations

The study has been undertaken using the best available data. The assumptions made in assessing and ranking the impacts of cumulative development on catchments within South West Hertfordshire are summarised in Table 0-2.

Table 0-2: Assumptions and limitations of the assessment

Assessment aspect	Assumption made	Details of limitation in method	Justification of method used
Development pressure	<i>Inclusion of all sites received by Councils during the Local Plan process</i>	<p>The study assessed the potential impact of all sites received during the Local Plan process.</p> <p>This included sites which will not ultimately be suitable for allocation, as well as more strategic development areas which are often developed in phases. As a result, it presents a 'worst case' assessment of growth, which overestimates the risk within each catchment.</p>	<p>Although this method has significant limitations; at this stage it is the best available indicator of development pressures. It identified relative levels of development pressure across all settlements and catchments.</p> <p>It also provided a consistent approach for the four Districts and Boroughs, which was independent of their current stages of individual Local Plan development and site allocation.</p>
	<i>Assumption of housing density and impermeable areas</i>	<p>As potential development densities were not known for all of the sites, it was assumed that the entire area of the site would contribute surface water runoff to the wider catchment. In reality, landscaping and requirements for SuDS within sites lessen the impacts of new development.</p>	<p>The assessment considered the 'worst case' development scenario, if surface water runoff was not controlled from new developments. With housing densities and proportions of undeveloped areas not known, the approach overestimates the potential impact,</p>

Assessment aspect	Assumption made	Details of limitation in method	Justification of method used
			but is the best available indicator.
Flood risk	<i>Overlap between fluvial and surface water flood extents</i>	<p>The Risk of Flooding from Surface Water mapping identifies the lowest points in the landscape, and therefore low-lying river floodplains are also classified as being at surface water risk. This can lead to 'double counting' of flood risk.</p> <p>To remove areas also known to be at fluvial flood risk, Flood Zone 2 was extracted from the surface water mapping. However, this method can also remove localised areas of surface water flood risk (such as flow paths and areas of ponding).</p>	<p>To prevent double counting and a bias towards fluvial flood risk, Flood Zone 2 was extracted from the Risk of Flooding from Surface Water dataset.</p> <p>Significant localised surface water flood risk was also identified by the SWMP hotspots and recorded flood incidents.</p>
	<i>Use of postcode point data to represent people and properties affected by historic /predicted flood risk</i>	As postcode points represent the central location of a postcode area, there may have been properties at the edges of a catchment or the study area which were counted within the neighbouring area, or not picked up at all.	The postcode points were an available open source dataset. Postcode area sizes are also relative to the density of properties in a location, providing better data coverage in areas where a greater number of people/properties were likely to be affected.

1.2.4 Identifying highest risk catchments

The catchments were first assessed independently against potential development pressures and flood risk.

The matrix shown in Table 0-2 then used to identify the combined risk of development growth and flood risk, using:

- Indicator of potential change in developed area within a catchment (%)
- The catchment flood risk ranking (1 – 15, with 1 being the highest)

Table 0-3: Matrix of flood risk and future development pressure

WHOLE CATCHMENT				
% Change		Catchment Ranking by Flood Risk Incidents		
		9 to 12	6 to 8	1 to 5
		Low	Medium	High
0 to 3%	Low			
4 to 10%	Medium			
11 to 21%	High			

1.3 Outcomes

Table 0-4 and Figure 0-2 provide an overview of the results from the cumulative impacts assessment.

Table 0-4: Highest five ranked catchments in South West Hertfordshire for potential development pressure and flood risk

	Highest ranked catchments for potential development growth	Highest ranked catchments for flood risk
1	Ver <i>St. Albans</i>	Upper Colne and Ellen Brook <i>St. Albans</i>
2	Upper Colne and Ellen Brook <i>St. Albans</i>	Ver <i>Dacorum, St. Albans</i>
3	Gade (Bulbourne to Chess) <i>Dacorum, Three Rivers, Watford</i>	Colne Chess to Thames <i>Three Rivers</i>
4	Colne Ver to Gade <i>St. Albans, Three Rivers, Watford</i>	Colne Upper East Arm incl. Mimshall Brook <i>St. Albans</i>
5	Bulbourne <i>Dacorum</i>	Lee Luton Hoo to Hertford <i>St. Albans</i>

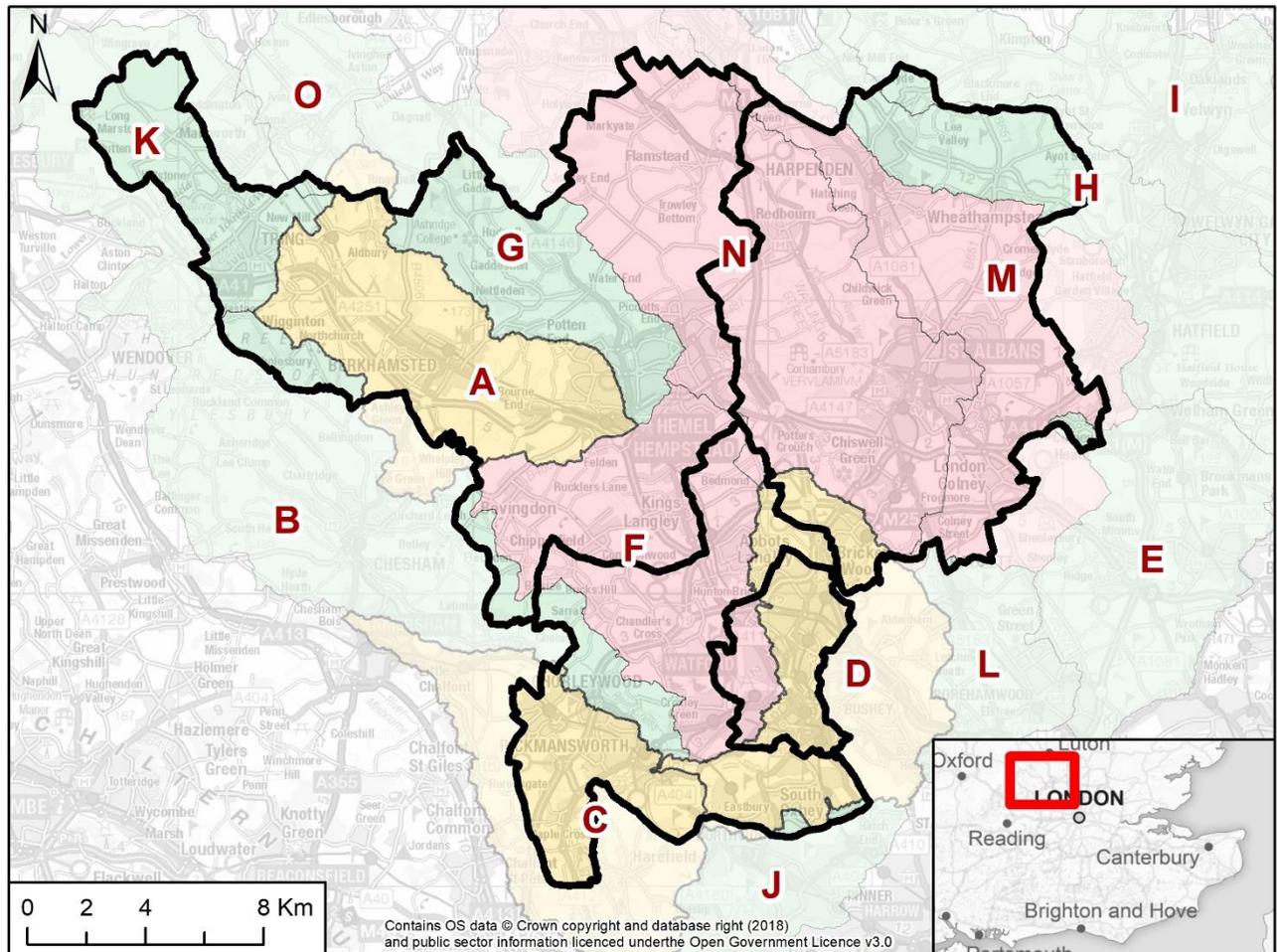
The highest ranked catchments overall are:

- Gade (Bulbourne to Chess) (Dacorum, Three Rivers, Watford)
- Upper Colne and Ellen Brooke (St. Albans)
- Ver (Dacorum, St. Albans)

An inspection of flood incidents and SWMP hotspots in the catchments also identified the following catchments as areas with existing flood risk issues, where management of development may help to manage flood risk:

- Colne (from Confluence with Ver to Gade) (St. Albans, Three Rivers, Watford)
- Thames upstream of Aylesbury (Dacorum)

Figure 0-2: Red Amber Green scoring of catchments within South West Hertfordshire, based on a combined score of potential development pressure and flood risk within each catchment.



**South West Hertfordshire
Level 1 Strategic Flood
Risk Assessment**

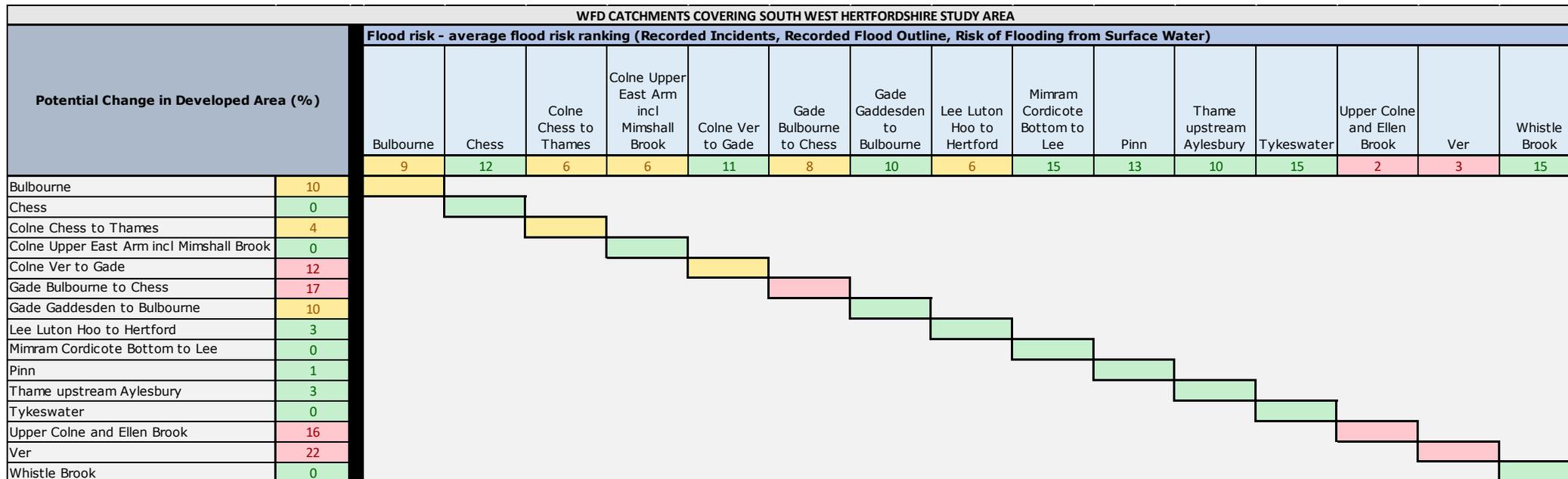
Legend
 South West Hertfordshire
River Catchments in South West Hertfordshire

Cumulative Impacts Score (RAG)

- Amber
- Green
- Red

- A = Bulbourne
- B = Chess
- C = Colne Chess to Thames
- D = Colne Ver to Gade
- E = Colne Upper East Arm incl. Mimshall Brook
- F = Gade Bulbourne to Chess
- G = Gade Gaddesden to Bulbourne
- H = Lee Luton Hoo to Hertford
- I = Mimram Cordicote Bottom to Lee
- J = Pinn
- K = Thames upstream Aylesbury
- L = Tykeswater
- M = Upper Colne and Ellen Brook
- N = Ver
- O = Whistle Brook

Figure 0-3: Relative risk of cumulative development on catchments covering South West Hertfordshire, based on potential future development pressure and historic/predicted flood risk ranking.



1.3.1 Planning Policy Considerations for Catchments

Planning policy considerations have been identified for the catchments where cumulative development is likely to have the greatest impact on flood risk to communities.

The overall analysis provides a context for further appropriate consideration of catchment-scale flood risk issues, once the Local Plans reach Pre-Submission (draft site allocation) stage.

In addition to assessment at a SFRA level, it is recommended that site-specific FRAs are required to include consideration of the cumulative effects of the proposed development. It should be demonstrated that flood risk downstream will not be made worse by the combination of effects from more than one development allocation.

River Gade (Bulbourne to Chess) (Dacorum, Three Rivers, Watford)

The catchment forms the lower extent of the River Gade, extending from the confluence with the River Bulbourne in Hemel Hempstead, to the confluence with the River Chess at Rickmansworth.

The catchment is urbanised to the east and south, covering east Hemel Hempstead, west Watford and Croxley Green, whereas the western area is more rural, with Bovington forming the largest settlement.

Significant surface water flow paths flow towards the River Gade, following the natural topography. This is reflected in the high number of surface water flooding incidents reported in Bovington, Frogmore End in Hemel Hempstead and Croxley Green, which have been identified, alongside west Watford, as SWMP hotspots.

As rural areas fringe the major towns, areas at the edge of these towns will be considered for development, within the Gade (Bulbourne to Chess) catchment. If left unattenuated, the developments have the potential to worsen surface water flooding issues in the catchment towns, as well as increasing river flows in the Lower Gade and the River Colne downstream at Rickmansworth.

Opportunities should be taken to implement SuDS schemes which reduce runoff to greenfield runoff rates or less, and hold back surface water during storm events. A catchment-based approach could also be taken, to manage surface water, particularly in the northwest of the catchment, by creating storage areas and interrupting known surface water flow paths.

Upper Colne and Ellen Brook (St. Albans)

The Upper Colne and Ellen Brook Catchment extends from Luton in the north to the confluence with the River Ver in southern St. Albans. It is a largely rural catchment, however incorporates the settlements of Harpenden, eastern St. Albans and London Colney.

Fluvial flood risk in Harpenden, London Colney and southern St. Albans is confined to a relatively narrow floodplain, due to the steeper topography. However, significant surface water flow paths form in the east of the catchment, with several flood incidents recorded in Harpenden and the Jersey Farm area of St. Albans. Surface water flow paths which have contributed to flooding issues are identified within the SWMP hotspots in Harpenden and east St. Albans.

Without appropriate management of surface water, development within Harpenden, London Colney, and the northern and eastern periphery of St. Albans has the potential to lead to an increase flooding to these areas. Due to the large surrounding rural areas, catchment-scale approaches could be used to slow and hold back the flow of surface water pathways by creating storage areas, particularly upstream of key settlements and SWMP hotspots.

River Ver (Dacorum, St. Albans)

The Ver catchment extends from southeast Luton to southern St. Albans, where it forms a confluence with the Upper Colne. The upper Ver catchment is relatively rural, however it becomes increasingly urbanised downstream, incorporating the settlements of Markyate, Redbourn, eastern Hemel Hempstead and western St. Albans.

With the exception of Markyate, fluvial flood risk is largely concentrated in rural areas. However, the Ver is a comparatively narrow and steep catchment within South West Hertfordshire, which has the potential to convey surface water runoff quickly downstream. This is supported by surface water flood incidents and SWMP hotspots located in Markyate, Redbourn, St. Albans and eastern Hemel Hempstead. As a tributary of the River Colne, flows from the Ver may impact the downstream flood risk associated with the Colne, particularly within the nearest settlements of eastern Watford and Oxhey.

Development in the catchment may well be wide-ranging, with the potential for larger allocations in rural areas and suburban peripheries, and smaller infill sites within existing built up areas. Providing appropriate storage for surface water in the sites upstream of the key settlements could help to alleviate existing surface water flooding issues. For brownfield and infill sites, which could have a large collective impact on surface water, opportunities should be taken to improve existing runoff rates and minimise runoff through implementation of SuDS.

As a groundwater-fed watercourse, the River Ver catchment may be also sensitive to increases in impermeable area, as the ability of rainfall drain into the ground and maintain groundwater levels may be restricted. Maintaining Green Infrastructure within the catchment, and using these spaces to accommodate above-ground, landscaped SuDS is likely to be appropriate in both managing surface water runoff, and encouraging recharge of the groundwater-fed watercourse.

River Colne (from Confluence with Ver to Gade) (St. Albans, Three Rivers, Watford)

The urbanised catchment extends from Abbots Langley in the north, to eastern Watford, Carpenders Park, Oxhey and South Oxhey. Within the catchment, there is significant flood risk from the River Colne, Hartsbourne Stream and Oxhey Brook, as well as surface water flow paths which follow the topography and are impeded by embankments for major transport infrastructure.

Due to the more urbanised nature of the catchment, development sites are likely to involve redevelopment or infill, on comparatively smaller sites than elsewhere in South West Hertfordshire. Taken individually these sites may not require a FRA or drainage strategy. However taken collectively, their cumulative impact could significantly increase the volume of surface water runoff within the catchment, increasing flood risk to existing properties. Development of these sites should strive to limit discharge rates and volumes to greenfield, in line with Hertfordshire County Council policy.

To provide wider flood risk benefits to the mid-Colne catchment, development sites in the upper catchment, such as north of Watford and around Abbots Langley, should consider the provision of long-term storage. This would control the release of surface water volumes from the site during and immediately after storm events, help to reduce and delay the peak flows on the River Colne reaching south Watford and Oxhey.

Development within Flood Zone 3a should provide suitable flood compensation storage to avoid a net loss in floodplain.

River Thame upstream of Aylesbury (Dacorum)

Should development be proposed around Tring, it would lie within the headwaters of the Upper Thame catchment. Surface water flooding issues have been identified within Tring itself, as well as at Long Marston, to the north. The major settlement of Aylesbury, located downstream on the River Thame, also experiences fluvial flooding.

Providing longer-term storage of surface water within such development sites at Tring could provide some attenuation of flows in the upper Thame catchment, reducing the flood peak on the River Thame where it enters Aylesbury. In addition, it may help to manage surface water flooding issues both within the town and at Long Marston, further downstream.