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 NPPF[1], 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). These cumulative impacts may be negative, i.e. development leading to an increase in the existing level of flood risk within the catchment, or positive i.e. surface water management within a development helping to alleviate existing flooding issues within a catchment.

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

1.2.1 Cumulative impact of development: Assessing existing and future development scenarios

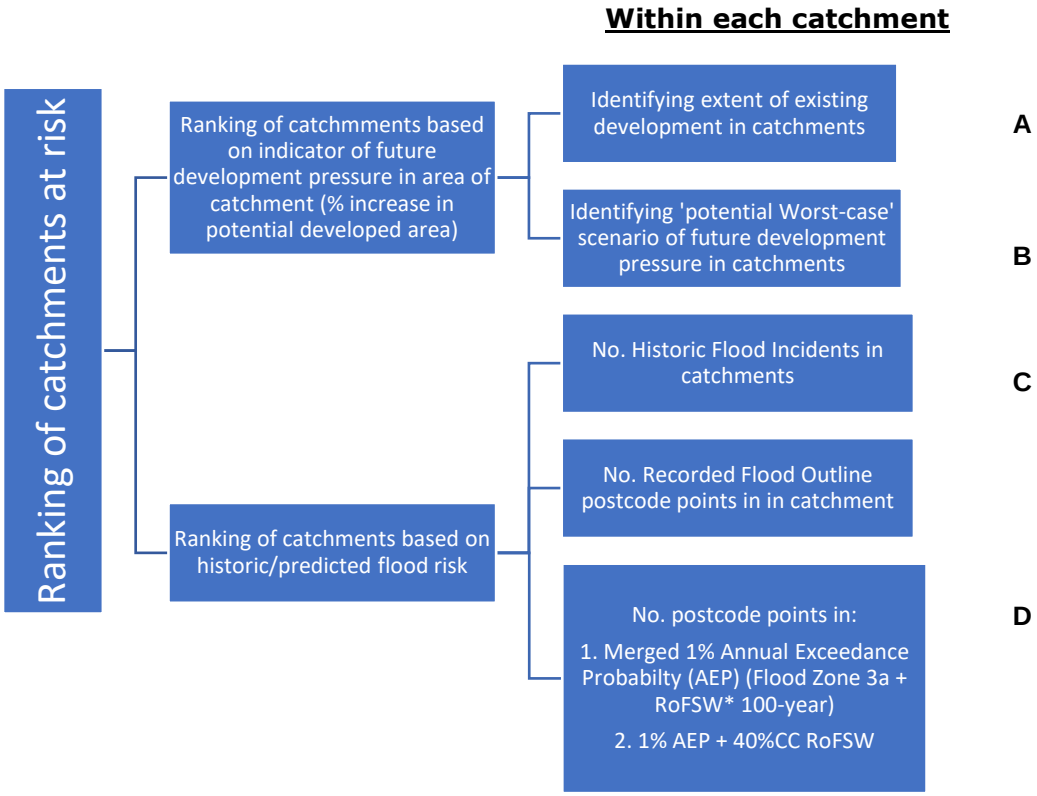
To ensure that the strategic policies of the Local Plan consider the impact of any future development on areas susceptible to flooding, the potential development pressures during the Local Plan period need to be considered.

This has been assessed by establishing the 'baseline' scenario, of development already committed prior to the Local Plan, as well as the potential future development pressures.

It should be noted that the inclusion of potential future development pressures makes the scoring method sensitive to future change, should any larger sites be removed, or additional sites come forward. However, it provides the best possible indication of development pressure across all four Councils at the time of 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

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



**Risk of Flooding from Surface Water (RoFSW)*

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

Dataset	Cover age	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 Register, Spatial Policy Areas etc.)	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
Data used to rank catchments by flood risk			
Merged 1 in 100-year flood extent (Flood Zone 3a and 1 in 100-year RoFSW extent)	SW Hertfordshire Study Area	Environment Agency (EA)	Potential fluvial flood risk
Merged 1 in 100-year + climate change (CC) flood extent (Flood Zone 3a + 70%CC and RoFSW + 40%CC change)	SW Hertfordshire Study Area	Environment Agency (EA) – re-run for latest CC allowances for L1 SFRA	Potential future fluvial 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

Dataset	Cover age	Source of data	Use of data
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 Cumulative impact of flood risk: 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

- Merged fluvial and surface water 1 in 100-year flood extent - Flood Zone 3a and RoFSW 100-year (number of postcode points at risk within catchment).
- Merged fluvial and surface water 1 in 100-year flood extent plus climate change extent - Flood Zone 3a + 70%CC and RoFSW 100-year + 40%CC (number of postcode points at risk within catchment).

  - These layers were intersected with postcode points, to approximate the number of people predicted to be affected by fluvial and surface water flooding.

  - The datasets were merged to prevent double counting of properties at risk where fluvial and surface water flood risks overlap.

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 1-2.

Table 1-2: Assumptions and limitations of the assessment

Assessment aspect	Assumption made	Details of limitation in method	Justification of method used
Development pressure	*Inclusion of all sites received by Councils during the Local Plan process*	The study assessed the potential impact of all sites received during the Local Plan process. 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.	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. 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.
	Assumption of housing density and impermeable areas	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.	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, but is the best available indicator.

Assessment aspect	Assumption made	Details of limitation in method	Justification of method used
Flood risk	*Overlap between fluvial and surface water flood extents*	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. To address this overlap, the fluvial and surface water mapping layers were merged, creating a composite flood risk layer.	To prevent double counting, the Flood Zone and Risk of Flooding from Surface Water dataset were merged, with any overlapping areas dissolved. Significant localised surface water flood risk was also identified by the SWMP hotspots and recorded flood incidents.
	Use of postcode point data to represent people and properties affected by historic /predicted flood risk	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 1-3 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 1-3: 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 1-4 and

Figure *1-2* provide an overview of the results from the cumulative impacts assessment.

Table 1-4: 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 *Dacorum, St. Albans, Three Rivers*	Colne Ver to Gade *St. Albans, Three Rivers, Watford*
2	Upper Colne and Ellen Brook *St. Albans*	Upper Colne and Ellen Brook *St. Albans*
3	Gade (Bulbourne to Chess) *Dacorum, Three Rivers, Watford*	Lee Luton Hoo to Hertford *St. Albans*
4	Colne Ver to Gade *St. Albans, Three Rivers, Watford*	Ver *Dacorum, St. Albans, Three Rivers*
5	Bulbourne *Dacorum*	Colne (Chess to Thames) *Three Rivers*

The highest ranked catchments overall are:

- Colne (from Confluence with Ver to Gade) (St. Albans, Three Rivers, Watford)
- 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 catchment as an area with existing flood risk issues, where management of development may help to manage flood risk:

- Thame upstream of Aylesbury (Dacorum)

Figure 1-2: Sensitivity to cumulative impacts scoring of catchments within South West Hertfordshire, based on a combined score of potential development pressure and flood risk within each catchment.

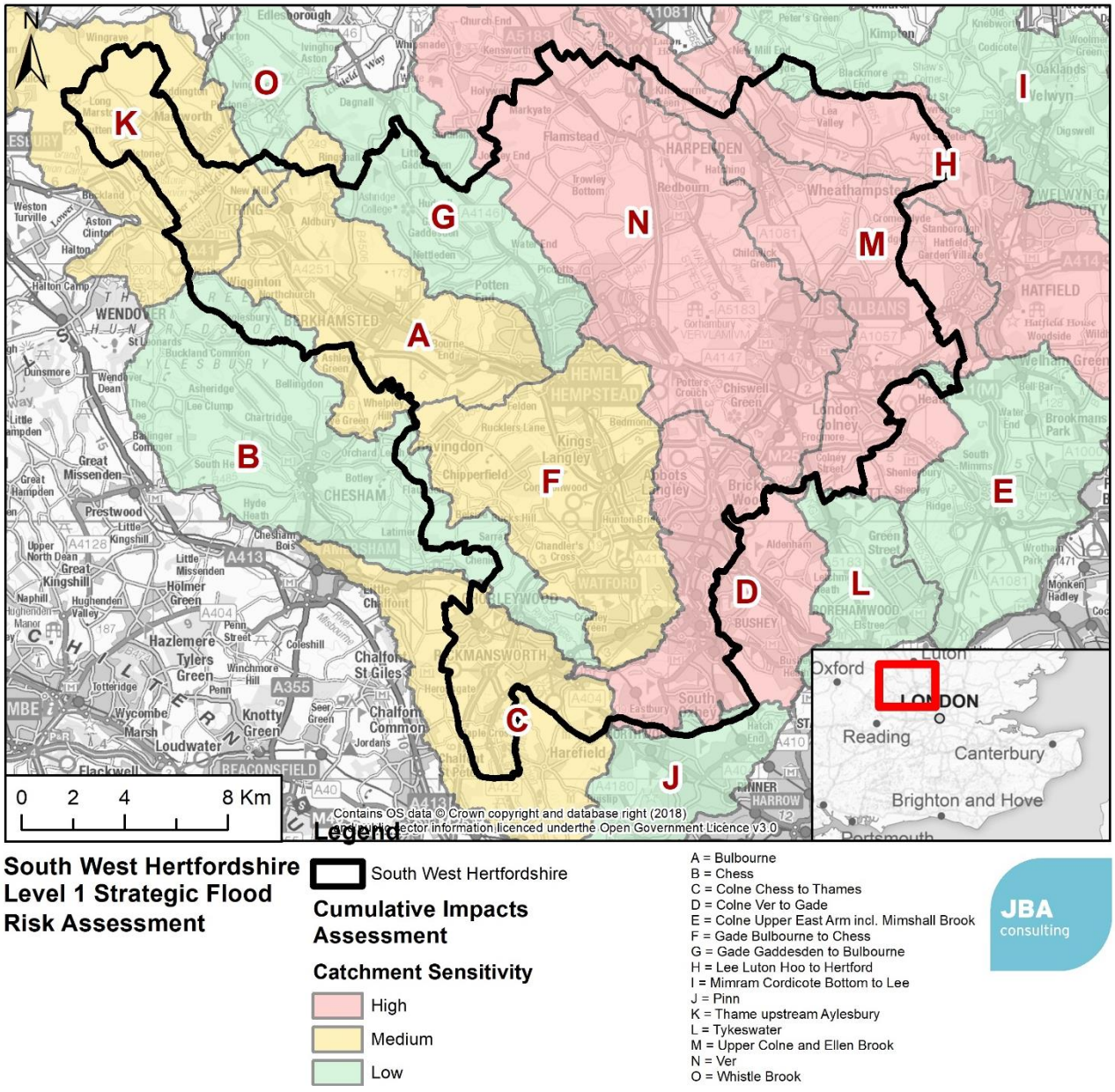


Figure 1-3: Relative risk of cumulative development on catchments covering South West Hertfordshire, based on potential future development pressure and historic/predicted flood risk ranking.

WFD CATCHMENTS COVERING SOUTH WEST HERTFORDSHIRE STUDY AREA																
Potential Change in Developed Area (%)		**Flood risk - average flood risk ranking (Recorded Incidents, Recorded Flood Outline, 1 in 100-year and 1 in 100-year + CC merged flood extents**														
		Bulbourne	Chess	Colne Chess to Thames	Colne Upper East Arm incl Mimshall Brook	Colne Ver to Gade	Gade Bulbourne to Chess	Gade Gaddesden to Bulbourne	Lee Luton Hoo to Hertford	Mimram Cordicote Bottom to Lee	Pinn	Thame upstream Aylesbury	Tykeswater	Upper Colne and Ellen Brook	Ver	Whistle Brook
		9.8	10.5	7.2	10.3	2.8	9.7	11.7	3.8	14.3	11.3	9.5	11.3	3.7	4.3	15.0
Bulbourne	10															
Chess	0															
Colne Chess to Thames	4															
Colne Upper East Arm incl Mimshall Brook	0															
Colne Ver to Gade	12															
Gade Bulbourne to Chess	17															
Gade Gaddesden to Bulbourne	10															
Lee Luton Hoo to Hertford	3															
Mimram Cordicote Bottom to Lee	0															
Pinn	1															
Thame upstream Aylesbury	3															
Tykeswater	0															
Upper Colne and Ellen Brook	16															
Ver	22															
Whistle Brook	0															

1.3.1 Planning Policy Considerations for Catchments

Planning Considerations for low to medium risk catchments

As flood risks are present within all of the South West Hertfordshire catchments, there are opportunities for development to deliver a positive cumulative impact on flood risk.

Developments should seek betterment of existing flood risks both within the site and in surrounding areas. As a minimum, developments must meet national and local standards for Flood Risk Assessments and surface water drainage strategies. By looking at flood risks beyond the site boundary, developers should be encouraged to implement sustainable solutions which manage flood risk.

In upland and rural areas of the catchments, Natural Flood Management (NFM) techniques, such as woodland planting and earth bunds, can be used to slow down and store flood waters upstream of settlements. In urban and suburban locations, Sustainable Drainage Systems (SuDS) should be integrated into the site design, to manage the existing surface water flow paths on the site and to help mitigate the flood risks to downstream communities.

Successive minor developments have the potential to significantly impact on existing surface water and flood risk issues, particularly as the LLFA is not consulted on these applications. Therefore, planning policy for minor developments should support existing Hertfordshire County Council policy on the reduction of existing runoff rates, through the use of SuDS.

Any development within the floodplain (i.e. Flood Zones 3b, 3a and 2) should provide suitable flood compensation storage, in consultation with the Environment Agency, to avoid a net loss in floodplain.

Planning Considerations for highest risk catchments

Catchment-specific 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 Bovingdon 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 Bovingdon, Frogmore End in Hemel Hempstead and Croxley Green, which have been identified, alongside west Watford, as SWMP hotspots.

As rural land fringes the major towns, areas at the edge of these towns will be considered for development within the Gade (Bulbourne to Chess) catchment. Under current legislation, there is greater potential to influence the runoff rates and volumes from these types of development, with opportunities for larger, more strategic surface water management solutions, which could improve surface water flooding issues in the catchment towns, as well as delaying peak river flows from reaching the Lower Gade and the River Colne downstream at Rickmansworth. However, the suitability of larger development areas must be viewed in light of the other objectives for sustainable development.

Opportunities should be taken to implement SuDS schemes which reduce runoff to greenfield runoff rates or less, and hold back surface water for longer periods during storm events. A strategic, catchment-based approach to managing surface water should also be taken, particularly in the northwest of the catchment, by interrupting known surface water flow paths and creating ponds or basins to store water.

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. Within the large surrounding rural areas, catchment-scale Natural Flood Risk Management (NFM) approaches, such as woody debris dams and new wetlands, could be used to slow, hold back and store 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, and minor development where the LLFA is not consulted, however which could have a large collective impact on surface water, planning policy should support the reduction of existing runoff rates and minimise runoff, through implementation of SuDS.

As well as managing water at times of flood, there are also opportunities for development to improve the availability of water during drier periods. As a groundwater-fed watercourse, the River Ver catchment may be also sensitive to increases in impermeable area, as the ability of rainfall to drain into the ground and maintain groundwater levels may be restricted. Maintaining Green Infrastructure within the catchment, and incorporating infiltration SuDS features will encourage recharge of the groundwater, while also managing surface water runoff. However, this does not preclude the use of above-ground, landscaped SuDS, which contribute to Green Infrastructure and a variety of other benefits.

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. As the LLFA may not be consulted on minor development sites, planning policy should ensure that these sites limit discharge rates and volumes to greenfield, in line with Hertfordshire County Council policy for major development sites.

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.

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.