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Technical note

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This technical note outlines the general approach adopted for the hydrological assessment (using the Flood Estimation Handbook) in the Level 2 SFRA Dacorum study.

1 Hydrological Assessment

1.1 Catchment Description

The River Gade is a dip slope stream draining the Chiltern Hills (from Dagnell to Hemel Hempstead) with a predominantly rural catchment area of approximately 48km² (derived from the Flood Estimation Handbook software and verified by inspection of the Ordnance Survey 1:25000 map) (see Figure 1.1). The catchment forms part of the River Colne which drains into the River Thames at Staines. Immediately downstream of Hemel Hempstead the River Gade flows into the Grand Union Canal (note: there are spills from the Canal into the River Bullbourne to the south forming part of a water transfer system).

The underlying geology is Chalk with some tertiary deposits and extensive boulder clay cover, and as a result the catchment is considered relatively permeable. Whilst the response of the river is relatively slow with characteristically low peaks, the artificial influence of urban runoff can have a significant effect on flood peaks.

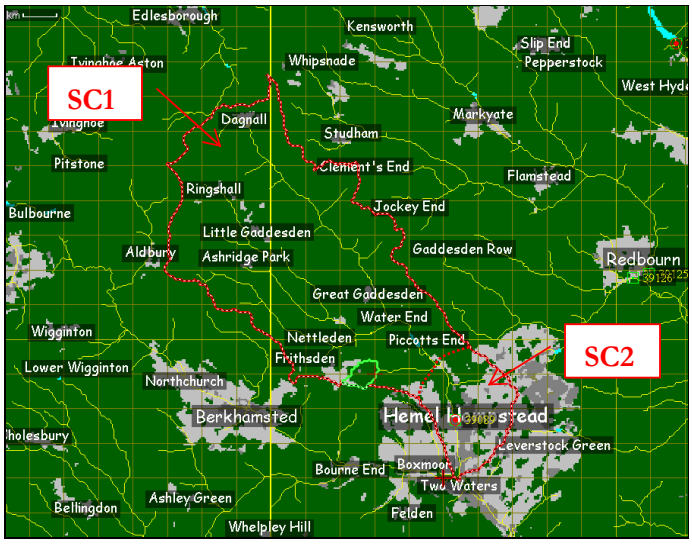

Figure 1-1 ***Catchment Boundary (shown as a dotted line and derived from the FEHCD-ROM)***

1.2 General Approach for Assessment

The background to the general approach adopted for the hydrological assessment is given in Flood Estimation Handbook (FEH) (Volume 3 & 4).

The Gade catchment is gauged with the station located at the former site of Bury Mill upstream of the subject site (Station Number: 39089, Gade at Hemel Hempstead). The gauging station is located in a rectangular flume with side contractions installed by Hemel Hempstead Development Corporation in the mid 1960s. This station was selected as a donor site given that it is very close (upstream) to the subject site (See figure 1-1) and there is a broad similarity between the FEH catchment descriptors (See Table 1-1).

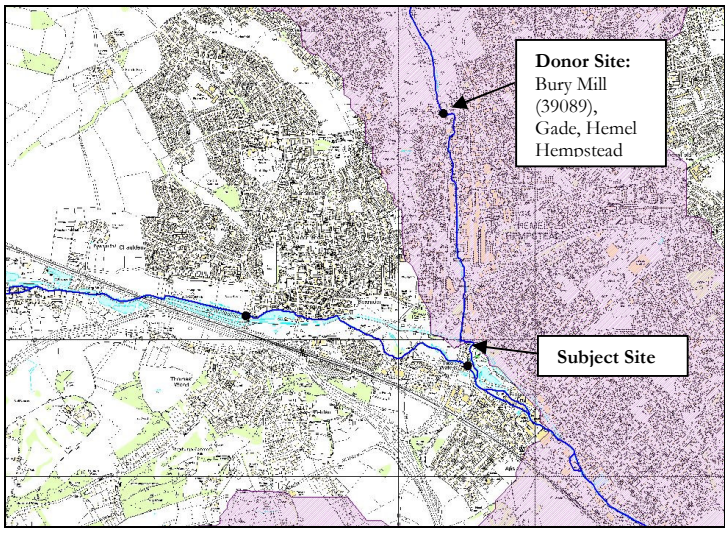

Figure 1-2 ***Location of donor and subject sites***

	AREA	SPRHOST	SAAR	BFIHOST	URBEXT
Subject site	49.80km²	28.95	722mm	0.704	0.0826
Gade - Hemel Hempstead (Bury Mill)	44.74km²	29.48	724mm	0.700	0.0333

Table 1-1 Comparison between the FEH catchment descriptors for the subject site and the donor site

The catchment has been schematised into two sub-catchments representing the two types of flow responses experienced through the catchment. Sub-catchment 1 (SC1) represents the baseflow component from the upstream rural catchment area, a relatively slow response with

characteristically low peaks. Sub-catchment 2 (SC2) represents the quickflow component from urban catchment area through the centre of Hemel Hempstead representing the artificial influence of urban runoff, a relatively quick response with characteristically high peaks. Design flow estimates at the gauging station (donor) and the sub catchments (SC1 and SC2) were undertaken following standard FEH procedures, including statistical analysis, rainfall-runoff modelling and appropriate reconciliation between the two estimates. The following was undertaken during assessment:

- FEH single site analysis using catchment descriptors and an updated AMAX series for the Bury Mill Gauging Station (donor site)
- FEH pooling group analysis using catchment descriptors for the sub-catchments (SC1 and SC2) and application of adjustment factor (derived from factorial difference between QMed from catchment descriptors and QMed from the AMAX series)
- FEH rainfall-runoff method (RF/RO) applied for each sub-catchment (SC1 and SC2) using catchment descriptors.
- Reconciliation of the RF/RO method to the Flood Frequency Curve derived from the adjusted pooling group analysis for each the sub-catchments (SC1 and SC2) and application of factorial adjustment to SC1 and SC2 (downscaling approach).

1.3 Analysis

(a) Statistical Method

FEH single site analysis was undertaken using catchment descriptors and an updated AMAX series for the Bury Mill Gauging Station (donor site). The single site is based on a continuous record of 33 years and is considered long enough to allow a reasonable estimate of Qmed estimated as 0.971m^3/s. Qmed estimated from catchment descriptors is 3.780m^3/s suggesting a factorial overestimation of 0.26.

FEH pooling group analysis was undertaken using catchment descriptors for the sub-catchments (SC1 and SC2). For SC1 a 200 year pooling group was constructed to represent the main design return periods (Figure 1-2).

Figure 1-3 ***SC1 pooling group***

The peak flow estimates for SC1 are detailed in Table 1-2 (Qmed 3.4m^3/s). Following application of the adjustment factor (0.26) the peak flow estimates for SC1 are detailed in Table 1-3 below (Qmed 0.9m^3/s).

Return Period (yrs)	2	5	10	20	50	100	200	1000
Peak flow (m^3/s)	3.4	4.9	5.9	7.0	8.6	9.9	11.4	15.8

Table 1-2 ***SC1: Peak flow estimates from pooling group analysis using catchment descriptors***

Return Period (yrs)	2	5	10	20	50	100	200	1000
Peak flow (m^3/s)	**0.9**	1.2	1.5	1.8	2.2	2.5	2.9	4.1

Table 1-3 ***SC1: Peak flow estimates from pooling group analysis using catchment descriptors and application of the adjustment factor***

For SC2 a 200 year pooling group was constructed to represent the main design return periods (Figure 1-3).

It is important to note that the pooling group was derived for both SC1 and SC2 (Total catchment) as it was not possible to define SC2 using the FEH-CDROM. Re-calculation of the FEH CD-ROM catchment descriptors by area-weighting (FEH Vol 4, Appx C & Vol 5, Ch 7) was undertaken to separate SC2 from the total catchment (SC1 and SC2).

Figure 1-4 ***SC2 pooling group***

The peak flows for SC2 are detailed in Table 1-4 (Qmed 4.1m³/s). Following application of the adjustment factor (2.6) the peak flows for SC1 are detailed in Table 1-5 below (Qmed 1.0m³/s).

Return Period (yrs)	2	5	10	20	50	100	200	1000
Peak flow (m3/s)	**4.1**	5.8	6.9	8.1	9.9	11.4	13.1	18.0

Table 1-4 ***SC2: Peak flow estimates from pooling group analysis using catchment descriptors***

Return Period (yrs)	2	5	10	20	50	100	200	1000
Peak flow (m³/s)	**1.0**	1.5	1.8	2.1	2.5	2.9	3.4	4.6

Table 1-5 ***SC2: Peak flow estimates from pooling group analysis using catchment descriptors and application of the adjustment factor***

(b) Rainfall-Runoff Method

The rainfall-runoff method was used to derive design flow estimates for each sub-catchment using catchment descriptors (See Tables 1-6 and 1-7)

Return Period (yrs)	20	100	1000
Peak flow (m³/s)	19.7	32.6	68.1

Table 1-6 ***SC1: Peak flow estimates from rainfall-runoff method using catchment descriptors***

Return Period (yrs)	20	100	1000
Peak flow (m³/s)	6.2	10.1	20.1

Table 1-7 ***SC2: Peak flow estimates from rainfall-runoff method using catchment descriptors***

(c) Reconciliation

There is a significant disparity in the flood estimate for the 1 in 100 year event derived from the statistical analysis and the rainfall-runoff method. For SC1, Q100 is estimated as 32.6m³/s and 2.5m³/ for the rainfall-runoff method and statistical analysis

respectively. For SC2, Q100 is estimated as 10m³/s and 2.9m³/ for the rainfall-runoff method and statistical analysis respectively. The lower peak flow derived from the pooling group analysis is thought to be more representative of the flows in the River Gade. This is also supported by the evidence below:

- Historical flooding – the Level 1 SFRA showed no observations of flooding within Hemel Hempstead town centre either from the River Gade or as a result of pluvial events (i.e. exceedance of the surface water drainage system capacity).

- Bury Mill Amax Series: The lack of observed fluvial flooding is supported by the Annual Maxima (AMAX) series which spans 30 years in total from Water Year 1969 to 2002 (not continuous, Water Years 1970 – 1973 are missing) where the maximum peak flow recorded is 1.270m³/s in 1979.

Based on this evidence and our knowledge of the Gade catchment reconciliation of the flood estimates from the rainfall-runoff method to the statistical was undertaken. The process of reconciliation involves applying a factorial adjustment to the design hydrographs to fit the flood frequency curve from the statistical analysis for both sub-catchments.

1.4 Summary

Overall the statistical method (pooling group analysis) was selected rather than the rainfall-runoff method. Table 1-8 and Figure 1-5 shows the design flow estimates and the flood frequency curve for SC1. Table 1-9 and Figure 1-6 shows the design flow estimates and the flood frequency curve for SC2. A comparison of the flood frequency curves for the two methods revealed very low peak flows for the pooling analysis in comparison with those for the rainfall runoff method. Following application of the downscale factors to the rainfall runoff estimates the scaled flood frequency curve to that derived from the pooling group analysis (adjusted). A series of hydrographs and return period flows are available for both the sub-catchments to be input into the ISIS model. The inflows will be routed through the ISIS model to derive the Critical Storm Duration and if required the hydrological inflows will be updated. In addition climate change will be taken into account in the modelling phase by increasing the peak flows estimates by 20% in accordance with PPS25.

Return Period (yrs)	2	5	10	20	50	100	200	1000
Pooling Group Analysis (Adj) (m^3/s)	0.9	1.2	1.5	1.8	2.2	2.5	2.9	4.1
Rainfall Runoff (m^3/s)	8.0	10.5	13.3	16.6	22.2	27.6	34.3	57.7
Downscale factor applied	0.112	0.114	0.112	0.108	0.099	0.090	0.084	0.071
Rainfall Runoff (m^3/s) (scaled)	0.9	1.1	1.4	1.8	2.2	2.4	2.8	4.1

Table 1-8 ***SC1: Peak flow estimates from rainfall-runoff method using catchment descriptors***

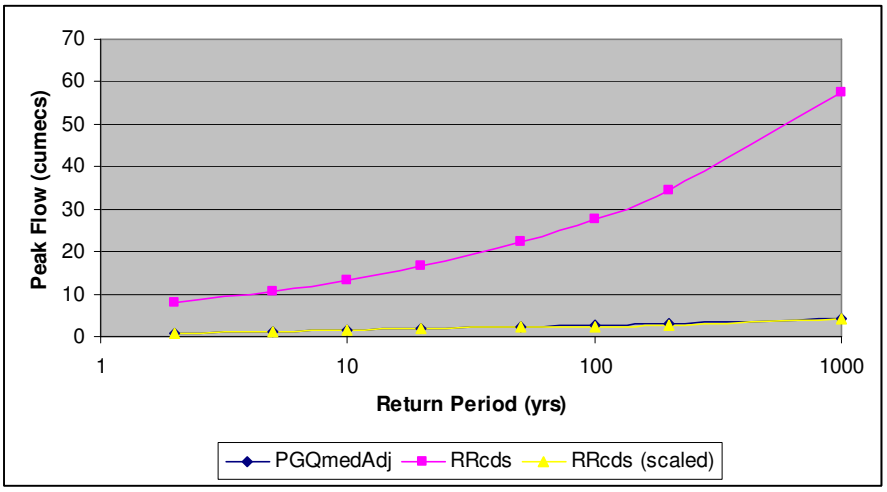

Figure 1-5 SC1 flood frequency curve

Return Period (yrs)	2	5	10	20	50	100	200	1000
Pooling Group Analysis (Adj) (m^3/s)	1.0	1.5	1.8	2.1	2.5	2.9	3.4	4.6
Rainfall Runoff (m^3/s)	3.0	4.0	5.0	6.2	8.2	10.1	12.4	20.1
Downscale factor	0.333	0.375	0.36	0.338	0.304	0.287	0.274	0.228
Rainfall Runoff (m^3/s) (scaled)	1.0	1.5	1.8	2.1	2.5	2.8	3.4	4.5

Table 1-9 SC2: Peak flow estimates from rainfall-runoff method using catchment descriptors

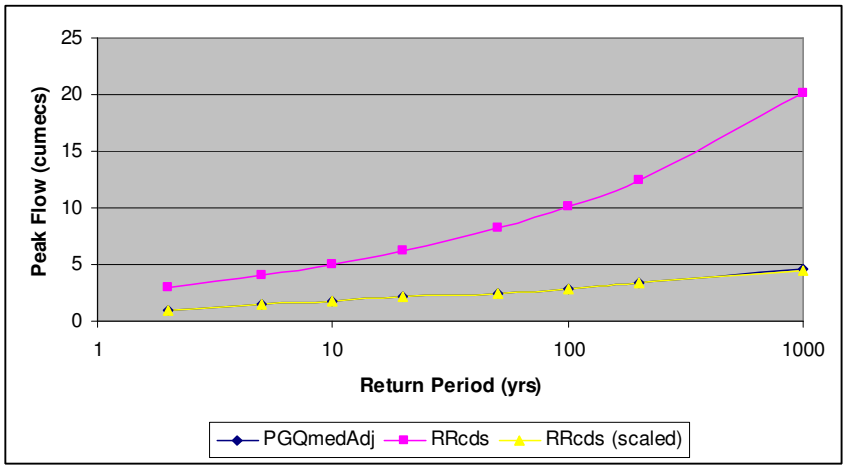

Figure 1-6 SC2 flood frequency curve