Telford and Wrekin Council

Strategic Flood Risk Assessment
Level 2
Final
December 2008

Halcrow Group Limited

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Executive Summary

In February 2008, Telford and Wrekin Council commissioned Halcrow Group Limited to produce a Level 2 Strategic Flood Risk Assessment (SFRA) in accordance with Planning Policy Statement 25 (PPS25) and its Companion Guide, Making Space for Water (2003) and the new Severn Catchment Flood Management Plan (2008). The study comprises two-dimensional (2D) hydraulic modelling of 6 watercourses in the Borough, including: Hurley Brook Tributary, Hurley Brook, Crow Brook, Wall Brook (also cited as Donnington Watercourse), Wesley Brook Tributary and Mad Brook, to produce refined Flood Zone information for Flood Zones 2 (1 in 1000 year), 3a (1 in 100 year), 3a plus climate change (1 in 100 year +20%) and 3b (1 in 20 year).

The study refines and builds upon the work undertaken during the Level 1 SFRA which identified that the resolution of existing Flood Zone data through the Borough is relatively course. This study therefore focuses on improving the Flood Zone information in order to better inform the Sequential Test and site selection process, which the Council will undertake as part of its Local Development Framework (LDF). It also assesses the flood hazard posed by these watercourses as well as the residual risk from partial blockage of selected culverts. Relevant policies for the management of flood risk and appropriate development in these areas are then put forward. The Environment Agency has been consulted throughout the study to ensure that the approach is robust and meets best practice.

The modelling results have shown that in most areas, Flood Zones 2, 3a and 3b are fairly narrow and there is little difference in flood extent between each of these events. In these areas, it will be important that the flood risk affected areas remain as open space. However, the downstream extents of the Hurley Brook Tributary, Hurley Brook, and the entire modelled area of the Wall Brook, is relatively flatter and flood extents are larger. For some development sites in these areas, the flood hazard is sufficiently low that development could go ahead provided the Sequential Test is passed and the guidance for development in Flood Zones, put forward in this report, is followed. Such instances should be very carefully considered and a strong case for development put forward.

Two formal flood storage areas and a number of informal flood storage areas (produced as a result of the presence of railway embankments) have been identified in the modelled study areas. It is important that these areas are safeguarded from future development, and where possible, options to convert informal storage areas to formal storage areas explored. It is established practice that developer contributions are used for this purpose. There are also numerous culverts in the modelled study area, some of which have been shown to have insufficient capacity to convey flood flows (various blockage scenarios therefore typically showed little difference to the results for the 1 in 100 year event). The surcharging effect in some areas significantly affects flood risk downstream. Opportunities to increase the capacity of the culverts, without increasing flood risk elsewhere, should be explored in order to bring flood risk management benefits to the wider community. Again, developer contributions could be sought for this purpose.

A number of policy recommendations are made for the possible development sites along the modelled watercourses, based on detailed hydraulic modelling results from the Level 2 SFRA. Guidance for Development Control and potential developers required to produce site-specific Flood Risk Assessments is also included.

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1 Introduction

1.1 *Project Overview*

Halcrow Group Ltd has been requested by Telford and Wrekin Council to undertake a Level 2 Strategic Flood Risk Assessment (SFRA). The aim of the study is to improve the existing Flood Zone information for six watercourses in Telford and Wrekin, assess the flood hazard posed by these watercourses and assess the residual risk from partial blockage of selected culverts. This study refines and builds upon the work undertaken during the Level 1 SFRA which included a broad scale assessment of flood risk, using existing data, across the whole of the Borough and from all sources.

Telford and Wrekin's drainage has been influenced by human activity and most watercourses rarely follow the original, open course. Watercourses in the Borough are heavily culverted, sometimes re-aligned and often with various flow and flood control structures. The complexity of the watercourses is often not represented in the existing Flood Zone data, which has been derived from JFLOW, a national broadscale model. Therefore as part of the Level 2 assessment, six two dimensional (2D) TUFLOW models have been developed for key watercourses in Telford and Wrekin, including:

- Hurley Brook Tributary (SJ 63809 11944 to SJ 63811 14270)
- Hurley Brook (SJ 65755 10831/SJ 67100 10383/SJ 67303 10251 to SJ 65102 15158)
- Wall Brook (SJ 71188 14078 to SJ 70029 15617)
- Crow Brook (SJ 68592 11510 to SJ 67761 14893)
- Tributary of Wesley Brook (SJ 70391 08259 to SJ 71949 06049)

It has been necessary to improve the Flood Zone information for these watercourses and establish the different levels of flood hazard and residual risk. This will give a truer account of flood risk in the Borough, upon which informed decisions on the allocation of development sites can be made, via the application of the Sequential Test, by the Council.

The flood extents for key return periods (1 in 20, 100, 100 plus climate change and 1000 years to represent Flood Zone 3b, Flood Zone 3a, Flood Zone 3a plus climate change and Flood Zone 2 respectively) were determined and mapped for each watercourse. These can be found in Volume 2. The 2D software TUFLOW has been used to produce peak flood extents, depths and flow velocities, allowing the production of hazard maps for each return period. The refined assessment of flood risk has then been used to inform appropriate flood risk management policies for the areas affected.

This Level 2 SFRA has been prepared in accordance with best practice, Planning Policy Statement 25: Development and Flood Risk (PPS25). The Environment Agency's Development Control and Flood Risk Mapping teams have also been consulted at all stages of the assessment, and both modelling and mapping methodologies have been discussed with the Environment Agency to ensure acceptance of the Level 2 SFRA approach.

1.2 Flood Risk Management Strategies - Environment Agency

The work undertaken and recommendations provided in Level 2 SFRAs should be in accordance with the relevant Catchment Flood Management Plan (CFMP) covering the study area, in this case, the River Severn CFMP. At the time of production of the Level 2 SFRA, the Severn CFMP was being updated and became available in draft form.

Most of Telford and Wrekin falls in the Policy Unit 'Telford and Black County'. The CFMP states that urbanisation of the area and expected development in the future, particularly in Telford, must be managed to ensure flood risk does not increase across the Policy Unit. The CFMP identifies the following opportunities and constraints:

- Opportunities lie in the use of SUDS and using Defra's 'Making Space for Water' campaign to try and mitigate the effects of surface water flooding. Policy 5 [see below] is therefore the preferred policy choice in this area due to the scale of existing flood risks and the anticipated growth of development and flood risk associated with climate change.

- There are opportunities to implement SUDS within urban areas as well as the promotion of PPS25 which will help to reduce risk to new developments.

- The extension of Flood Warning areas within the catchment has potential for allowing many more people at risk of flooding to receive the service.

- The promotion of flood proofing schemes will help to mitigate the affects of flooding where building defence structures is not an option.

- Telford has been identified for urban development in the future.

- Many urban areas in the catchment experience problems in surface water flooding which occurs in addition to the fluvial flooding.

- Standard of Protection of many defences and number of properties they protect is unknown for many defences within the catchment.

The selected Policy Option for the area is to 'take further action to reduce risk (now and/or in the future)'. Identified actions are as follows:

- Through the implementation of PPS25 and primarily SUDS in FRAs and SFRAs the problem of surface water flooding may be addressed.

- Review maintenance plans and identify new areas for trash screens to reduce blockages caused by large woody debris through the use of Strategic Asset Management Plans and Asset Management Plans.

- Maintain defences through the use of Strategic Asset Management Plans and Asset Management Plans.

- Apply the recommendations from the Integrated Urban Drainage project being undertaken for Telford and Wrekin as part of Defra's 'Making Space for Water project'. Close communication between the Environment Agency Development Control and Local Planning Authority.

- Maintain Flood Warnings and promote other emergency plans and flood plans.

The suggested policies contained in this document therefore take strong direction from the recommended actions for Telford identified in the CFMP, as well as the recommendations of PPS25, Making Space for Water and the Water Framework Directive.

1.3 ***Strategic Flood Risk Assessment***

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. Where new development is necessary in such areas, under exceptional circumstances, the policy aims to make the development 'safe' without increasing flood risk elsewhere and, where possible, reducing flood risk overall.

The aim of a 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). Much of this work has been completed as part of the Level 1 assessment with subsequent Level 2 work required to fully guide the planning and development control processes.

Flood Zones are referred to as follows:

- Flood Zone 1 (Low Probability): This zone comprises land assessed as having less than a 1 in 1000 year annual probability of river or sea flooding in any year (>0.1%)

- Flood Zone 2 (Medium Probability): This zone comprises land assessed as having between a 1 in 100 (1%) and 1 in 1000 (0.1%) annual probability of river flooding in any one year.

- Flood Zone 3a (High Probability): This zone comprises land assessed as having a 1 in 100 or greater annual probability of river flooding in any one year.

- Flood Zone 3b (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).

It should be noted, however, that flooding from sources including sewers, surface water, groundwater and impounded water bodies such as reservoirs and canals, can occur in any zone.

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, the SFRA allows the 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 a SFRA will feed directly into the preparation of Local Development Documents (LDDs). To date, the Core Strategy Development Plan Document (DPD) has been adopted (1st December 2007). The Level 2 SFRA will inform the production of the remaining Local Development Framework (LDF) documents, including the updated Proposals Map, which will be amended to conform with the various DPD policies as they are adopted.

Level 2 Strategic Flood Risk Assessment

According to the PPS25 Practice Guide (2008), the principal purpose of a Level 2 SFRA is to facilitate the application of the Sequential and Exception Tests. The Exception Test is applied when there are 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.

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 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.

The increased scope of the Level 2 assessment involves a more detailed review of flood hazard within a Flood Zone (including flood probability, flood depth, flood velocity and the rate of onset of flooding) taking into account the presence of flood risk management measures such as flood defences. This also includes 2D modelling and breach/overtopping analysis for certain locations where the residual risk of failure of existing water retaining structures may impact on future development. It should be noted that there is also a residual risk with SUDS, which may become blocked, fail or have insufficient design capacity, but this risk is minimised by adhering to Ciria's 'Design for Exceedance' and by regular maintenance. There are no formal raised defences in Telford and Wrekin, though there are numerous culverts which can pose a residual risk if they were to become blocked.

This Level 2 SFRA, in conjunction with the Level 1 SFRA, will enable Telford and Wrekin Council to fully apply a Sequential Test approach at the site allocation level (vulnerable uses within the site to be directed to areas at the lowest probability of flooding in the first instance) and will inform policies and practices to ensure that where necessary any development in such areas satisfies the requirements of the Exception Test.

1.4 UK Flood Hazard

In addition to the TUFLOW outputs of depth and velocity, the UK Flood Hazard is also calculated by the model. The output includes a grid of Flood Hazard derived from the flood depth and velocity outputs and a debris factor. The Hazard and its associated classification are calculated within TUFLOW. The UK Flood Hazard is calculated by using the following equation from Defra's Flood Risks to

People – Phase Two Document (FD2321/ TR2) (2006). Hazard is calculated as follows:

Hazard = d x (v + 0.5) + DF

Where **d = depth (m)**

V = velocity (m/s)

DF = debris factor

In this study, the following debris factors have been used:

- If the flood depth is >0.25m, **or** the velocity is >2m/s, DF = 1
- If the flood depth is <0.25m **and** less than <2m/s, DF = 0

Based on the value of the hazard for a given area, a Hazard Classification is then assigned. This can be used to ensure developments are suitably safe up to the 1 in 1000 year event. The Flood Hazard classifications are divided into four classes of risk:

Table 1: Flood Hazard Rating and Associated Category

Flood Hazard Rating	Category
0.0 – 0.75	Low
0.75 – 1.25	Moderate
1.25 – 2.5	Significant
2.5 +	Extreme

These classes of risk then translate into the following Flood Hazard classification (Figure 1):

- Class 1: Danger for some – Flood zone with deep or fast flowing water that presents a hazard for some people (i.e. children)

- Class 2: Danger for most – Flood zone with deep or fast flowing water that presents a hazard for most people

- Class 3: Danger for all – Flood zone with deep or fast flowing water that presents a hazard for all people and emergency services.

For example, if peak water depths are 1.0 m for example, for velocities less than 1.0 m/s, the flooding is considered to present 'Danger for some'. For velocities between 1.0 m/s and 2.0 m/s the flooding is considered to present 'Danger for most'. For velocities greater than 2.0 m/s the flooding is considered to present 'Danger for all'.

Where development is proposed and the flood hazard rating is greater than 0.75 then the development is likely to require the intervention of the emergency services to aid rescue and evacuation. Local Authorities will need to liaise carefully with their Emergency Planners and Emergency Services, as development in areas with this level of risk could lead to an additional burden on the Emergency Services during times of extreme flooding, and at a time when resources are already likely to be stretched dealing with existing problems

Figure 1: Flood Hazard Classification

1.5 Background to the study area

Telford and Wrekin Council covers an area of some 290km² and is bordered by North Shropshire, Shrewsbury and Atcham, Bridgnorth and Stafford. At the heart of the Borough is the 'New Town' of Telford (designated in 1963), which is a regional focus for population and economic growth. The Borough is also composed of several small towns (District Centres) that existed before the designation of the New Town including Wellington, Dawley, Donnington, Madeley and Oakengates. In the south of the area situated on the northern bank of the River Severn is Ironbridge, the birth place of the Industrial Revolution. The

Wrekin, a hill to the south west of Telford, is a prominent and well-known landmark on the border between the boroughs of Shrewsbury and Atcham and Telford and Wrekin. It rises to a height of 407 metres above the Shropshire Plain. The Borough has a significant rural area which is located to the north and west of Telford and covers approximately 72% of the Borough's total area.

The Borough contains a number of designated Main Rivers, including: the River Roden, which cuts across the north west corner of the Borough; the River Meese, which flows across the northern part of the Borough; the River Tern, which flows south through the rural landscape into the Borough of Telford and Wrekin before joining the River Severn; and the River Severn, which flows through the southern tip of the Borough, passing through Ironbridge, Jackfield and Coalport. While some potential development sites lie near these watercourses, the focus of the Level 2 SFRA has been on 6 non-main rivers (Hurley Brook Tributary, Hurley Brook, Wall Brook, Crow Brook and Tributary of Wesley Brook) which flow through areas of identified growth and have not been modelled before.

1.6 *Aims & Objectives*

In September 2007 a Level 1 SFRA was produced by Halcrow for Shropshire County Council and the associated 5 Borough and District Councils, together with the Unitary Authority, Telford and Wrekin, in accordance with PPS25. Following this study the Borough identified the need for a Level 2 SFRA in order to facilitate application of the Sequential and Exception Tests (possible future site allocations were identified in zones of higher flood risk). This study focuses on proposed development along the following watercourses: Crow Brook, Hurley Brook, Hurley Brook Tributary, Mad Brook, Wall Brook and Wesley Brook Tributary. This study therefore has wide spatial coverage of Telford and Wrekin. In addition, all potential site allocations have been assessed on flood risk grounds, the findings and recommendations of which can be found in Appendix A.

Aim

The main aim of this Level 2 SFRA has been to develop 2D hydraulic models to refine the assessment of flood risk from:

- Hurley Brook Tributary (SJ 63809 11944 to SJ 63811 14270)
- Hurley Brook (SJ 65755 10831/SJ 67100 10383/SJ 67303 10251 to SJ 65102 15158)
- Wall Brook (SJ 71188 14078 to SJ 70029 15617)

- Crow Brook (SJ 68592 11510 to SJ 67761 14893)
- Tributary of Wesley Brook (SJ 70391 08259 to SJ 71949 06049)
- Mad Brook (SJ 70022 07039 to SJ 71434 03676)
- A 75% blockage (during the 100 year event) of the following culverts:
    - Hurley Brook: Culvert at SJ 65882 10928 and drop culvert at 66885 11363
    - Crow Brook: Culvert at SJ 68723 11756
    - Wall Brook: Culverts at SJ 71020 14260 and SJ 70420 14890
    - Mad Brook: Culvert at SJ 70488 06475

The location of these watercourses can be viewed in Figure 2. Modelled flood maps can be found in Volume 2.

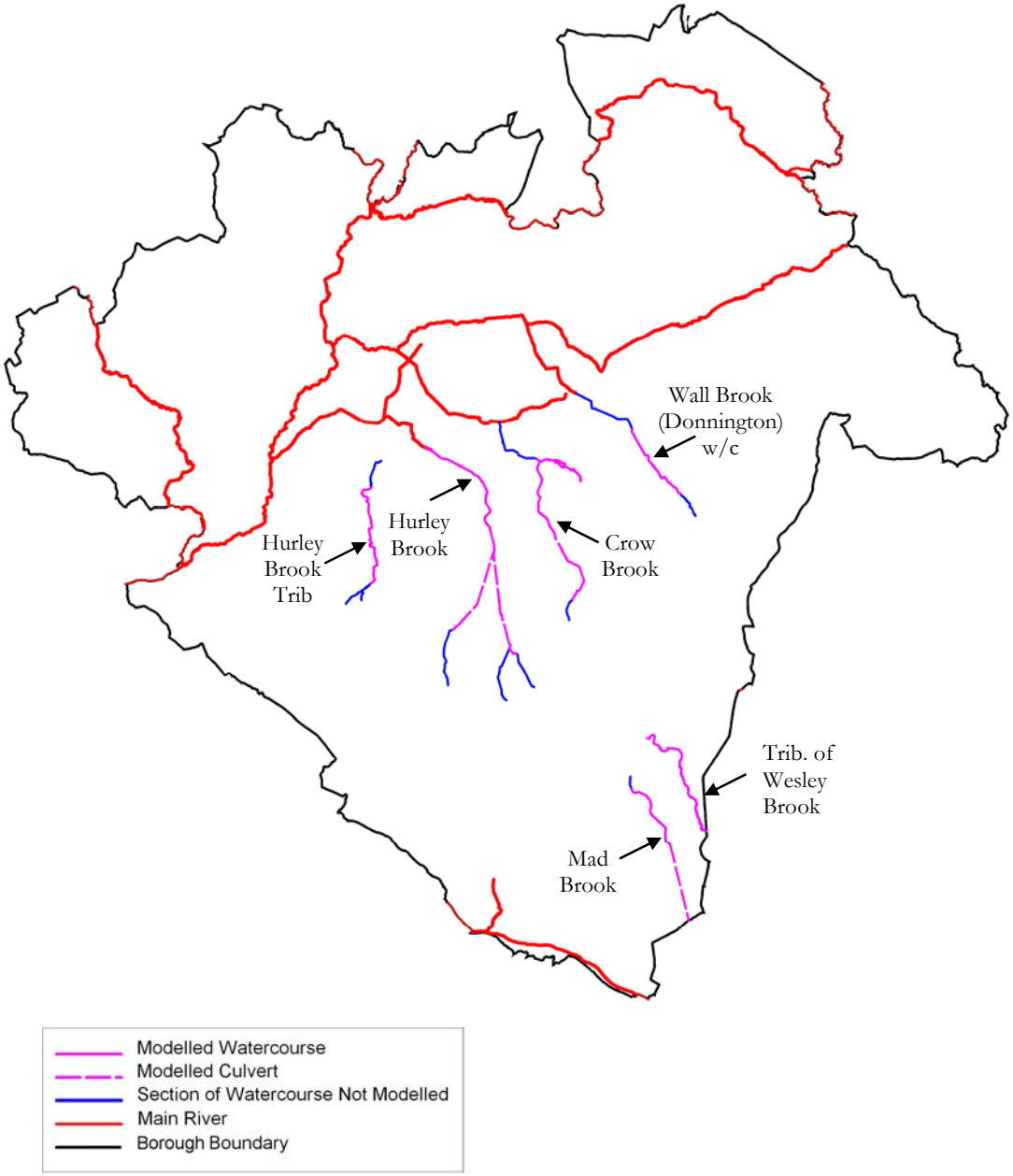

Figure 2: Location of Watercourses Modelled in Level 2 Assessment

Main Tasks

The main tasks of this study are to:

- Develop 2D hydraulic models for the six identified watercourses using Digital Terrain Models (DTM) derived from LiDAR survey data – the 2D aspect of the model allows modelling not only of the flood extent, but also the depth and velocity of out-of-channel flows.
- Identify locations where culvert blockage scenarios should be carried out to identify residual risk areas
- Produce Flood Zones 2, 3a, 3a plus climate change and 3b for each watercourse
- Produce flood maps showing:
  (i) Flood Extent
  (ii) Flood Depth
  (iii) Flood Velocity
  (iv) UK Flood Hazard – derived from flood depth, velocity and UK hazard debris factor.
- Assess flood risk posed to sites and develop appropriate policies for flood affected areas
- Provide appropriate Development Control policies and FRA guidance for developers

2 Planning Context

2.1 *Local Planning Policy*

Telford and Wrekin Council are in the process of preparing the LDF for the Borough, comprising various documents as outlined below, in accordance with the provisions of the Planning and Compulsory Purchase Act 2004. On adoption, the LDF will replace the existing Telford and Wrekin Local Plan (2000) and Joint Shropshire and Telford & Wrekin Structure Plan (JSTWSP, November 2002).

The adopted Telford and Wrekin Local Plan and JSTWSP formally expired on 27th September 2007, however some policies have been 'saved' for a further period until the updated LDF policy is in place, and therefore still form part of the statutory development plan for the Borough, along with the West Midlands Regional Spatial Strategy (RSS). A list of the 88 'saved' Local Plan policies can be found at: http://www.telford.gov.uk/NR/rdonlyres/2A735ED7-66BA-405C-BD93-FDD879A3D8C9/0/WrekinlocalplansavedpolicyschedulefromGOWM.doc Decisions in respect of minerals and waste applications will be determined in accordance with the relevant 'saved' policies of the JSTWSP and the 'saved' policies of the Shropshire and Telford & Wrekin Joint Minerals Local Plan, along with relevant national and regional guidance.

The Local Development Scheme (LDS) for Telford & Wrekin was updated in August 2007, and sets out a timetable for the production of documents. However, due to circumstances and slippage the LDS is in the process of being updated to include more accurate information on the likely timescale for production of the LDF documents and will be finalised later in the year. Based on officer advice, the table below shows the indicative dates for the production of Development Plan Documents (DPDs), subject to confirmation in the revised LDS 2008:

Table 2: Indicative dates for production of LDDs

Development Plan Document (DPD)	Issues & Options	Preferred Options	Submission to Secretary of State	Adoption
Core Strategy	Summer 2004	Autumn 2005	Winter 2006	Winter 2007
Proposals Map	Updated as DPDs are produced – ongoing			
Central Telford AAP	Summer 2004	Autumn 2005 and Winter 2007	Winter 2009	Winter 2010
Land Allocations	Summer 2004	Autumn 2005	Spring 2009	Winter 2010
General Policies (formerly known as Development Control Policies)	Summer 2004	Autumn 2005 and Summer 2009	Winter 2009	Winter 2010
South Telford AAP	Spring 2008	Summer 2009	Spring 2010	Winter 2011

To date, the Core Strategy has been adopted. The Level 2 SFRA will inform the production of the remaining LDF documents, including the updated Proposals Map, which will be amended to conform with the various DPD policies as they are adopted. There is no timetable as yet for the production of the Minerals and Waste Development Framework.

A number of Supplementary Planning Documents will be produced and will form part of the LDF. Some are not site-specific, in that they include general guidance on a particular issue, e.g. design guidance, and therefore may not need to refer to the SFRA's findings. The Level 2 SFRA will inform the production of the remaining un-adopted SPDs where relevant.

Telford & Wrekin Borough Council have also successfully applied to the Government to achieve 'New Growth Point' status. This requires the Borough to provide approximately 20% more housing above existing RSS levels. The higher

levels of development supported by the Borough's Growth Point status will be promoted and tested through the normal LDF procedures, including the Land Allocations DPD, and will therefore have regard to the findings of the Level 2 SFRA where relevant.

In line with PPS25 and the living draft practice guide companion, this SFRA will enable Telford & Wrekin Borough Council to prepare appropriate policies for the management of flood risk within the LDF DPDs and inform the Sustainability Appraisal process in order that flood risk is taken into account when considering development options and the preparation of strategic land use policies.

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3 Site Assessment

3.1 *Overview*

Telford and Wrekin Council are currently appraising in excess of 400 potential housing sites (based on draft Strategic Housing Land Availability Assessment data), some 79 potential employment, education, health and mixed use sites and 4 potential cemetery sites. To assist the Council with this process, this study has included an assessment of the flood risk posed to each of these sites, with associated recommendations. The results of the assessment are tabulated in Appendix A. The location of sites is shown in Figure 3.

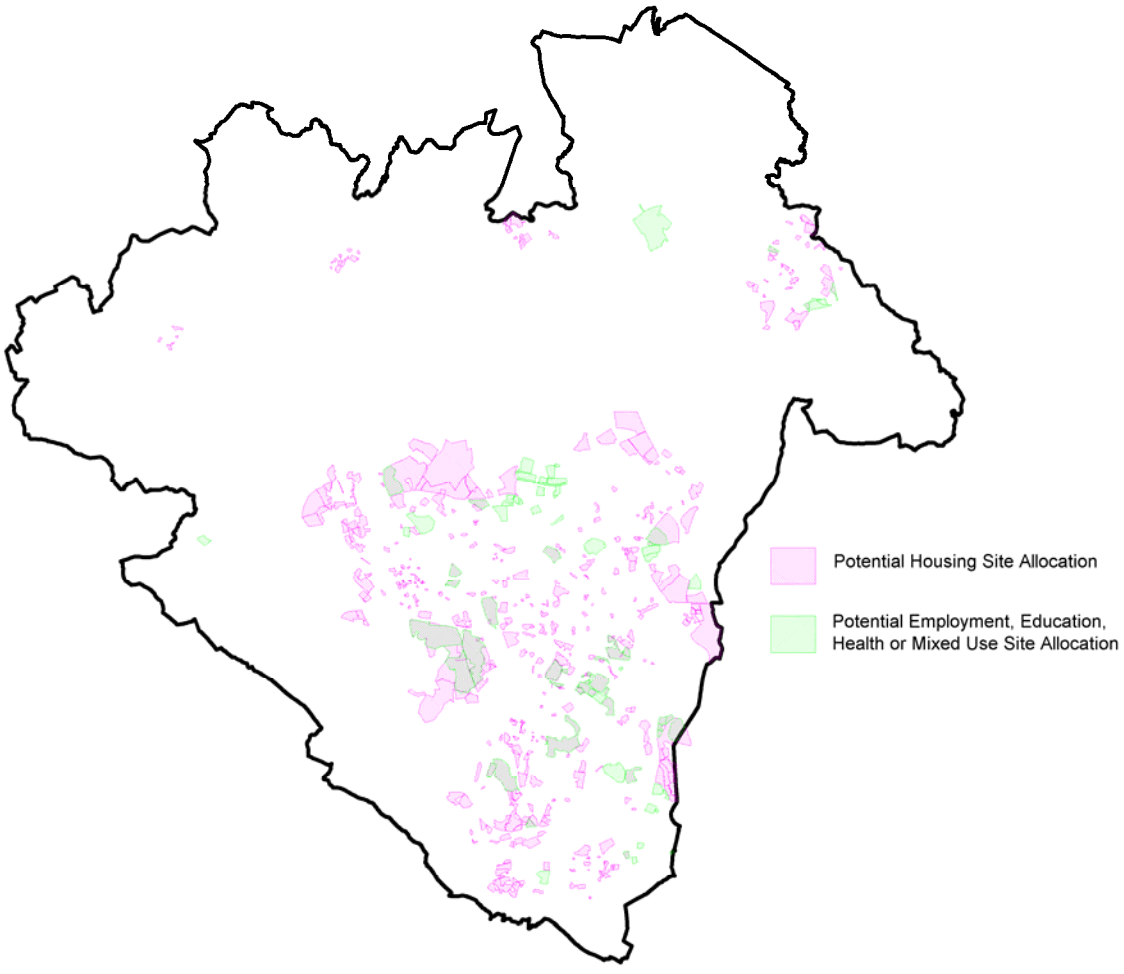

Figure 3: Potential Site Allocations

The site assessment has used the data collected in the Level 1 SFRA, which included mapping the flood risk posed from sources other than fluvial. Recommendations are in accordance with the Level 1 SFRA and relevant guidance including PPS25.

The aim of the site assessment is to assist the Council in gaining a detailed overview of each site, to assist the Sequential Test process. Specific recommendations are given for each site in Appendix A. Section 11.9 gives FRA guidance of the requirements for development of any given site in each Flood Zone, should the Sequential Test be passed (for sites which would need to pass the Exception Test, Appendix A recommends, where applicable, that appropriate alternative in lower risk Flood Zones are developed in preference, though it is possible that the Council may still identify the need to carry out the Exception Test).

Sites which are in the vicinity of the watercourses modelled as part of this study have been assessed, the results of which are presented in Appendix B, as well as Chapters 5, 6, 7, 8, 9 and 10.

3.2 General Points to Note

The site assessment has made use of the DG5 data received from Severn Trent Water, which coarsely illustrates the number of properties within a four-digit postcode polygon (e.g. TF1 6) which have been flooded by either foul, combined or surface water sewers. Figure 3 shows that in general, the majority of Telford and Wrekin's potential site allocations lie in the centre and south of the Borough. In this area, the DG5 data shows that generally, the number of properties flooded by sewers in any given postcode polygon is low to medium (see Figure 4). However, it should be noted that the resolution of data available for this assessment is very coarse and therefore limits its use for spatial planning. It is therefore recommended that the Council considers assessing sewer capacity in more detail through a Water Cycle Strategy (WCS), to further assist the sustainability appraisal of new development areas.

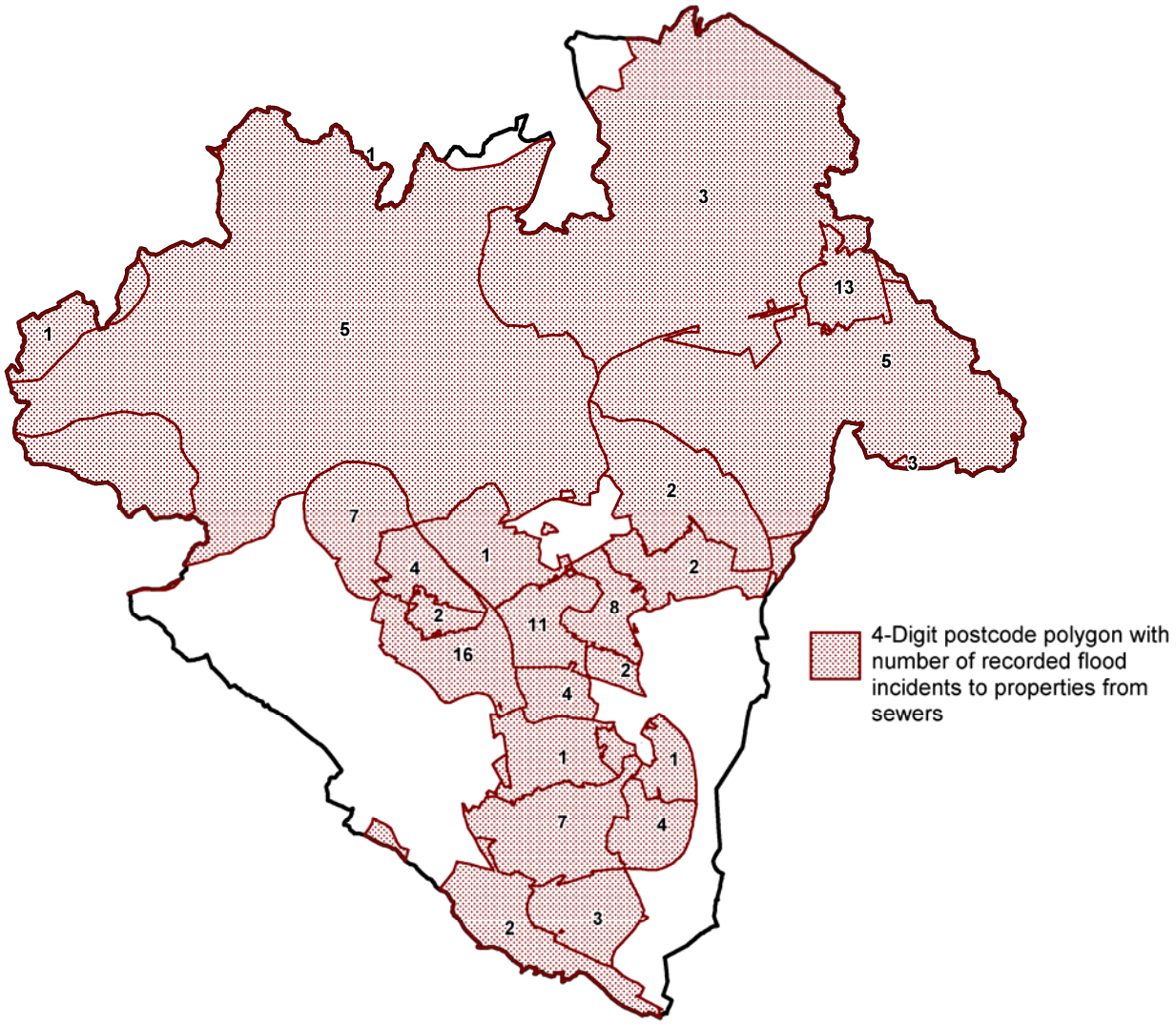

Figure 4: Sewer Flood Risk Data for Telford and Wrekin

3.3 *Site Selection Process*

The Sequential Test Process as advocated by PPS25 (Appendix C) should be carried out for all potential development sites.

The sites identified in Flood Zone 1 are generally suitable for development, as long as the recommendations for development in Flood Zone 1 are followed (Section 11.9). Where only a small proportion of the site is not in Flood Zone 1, development may have some impact on the floodplain through providing new

infrastructure such as access crossings and roads across the floodplain. The Council should try and avoid this happening and consider the options which have the least impact on the floodplain.

Sites which mainly lie in Flood Zone 1, but are affected in some way by Flood Zones 2, 3a and 3b, should only be developed if there are no other suitable sites lying fully in Flood Zone 1. If this can be demonstrated, such sites are generally suitable for development provided that the Council/developer adopts the principle of **avoidance**, ensuring that the area of Flood Zone 2, 3a and 3b remains as undeveloped open space. This is especially important where Flood Zone 3a is shown to affect the site, which has been assumed to equal Flood Zone 3b where no 3b exists to differentiate. The avoidance of flood risk is important in the development of sustainable communities and will deliver a positive reduction in flood risk by reducing the impact that flooding may have on the community (by reducing the number of people within the site that would otherwise be at risk). It can also help the Council to achieve green space targets. This approach is generally appropriate when an area of 10% or less of the site is affected by Flood Zones 2, 3a and 3b.

Provided that the Sequential Test process has been carried out and passed, sites falling in whole or in part in Flood Zones 2, 3a and 3b can be developed **but only in accordance with Table D3 of PPS25** (Table 3). It is important to ensure that sites fully in Flood Zone 1 are considered in preference to the development of sites in higher risk areas, and sites in higher risk areas should only be developed if it can be demonstrated that no alternative site in Flood Zone 1 are suitable.

Where Flood Zones 2, 3a and 3b will be developed after passing the Sequential Test, the Council/developer should **substitute** less vulnerable development types for those incompatible with the degree of flood risk. The land should be developed sequentially; i.e. the layout of the development should be planned so that the development types within each Flood Zone are in accordance with the requirements of Table D3 of PPS25 (Table 3). An example is given in Figure 5.

Table 3: Flood Risk Vulnerability and Flood Zone 'Compatibility' (Table D3 of PPS25)

Flood Risk Vulnerability classification (see Table D2)		Essential Infrastructure	Water compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone (see Table D.1)	Zone 1	✔	✔	✔	✔	✔
	Zone 2	✔	✔	Exception Test required	✔	✔
	Zone 3a	Exception Test required	✔	✗	Exception Test required	✔
	Zone 3b 'Functional Floodplain'	Exception Test required	✔	✗	✗	✗

Key:

✔ Development is appropriate

✗ Development should not be permitted

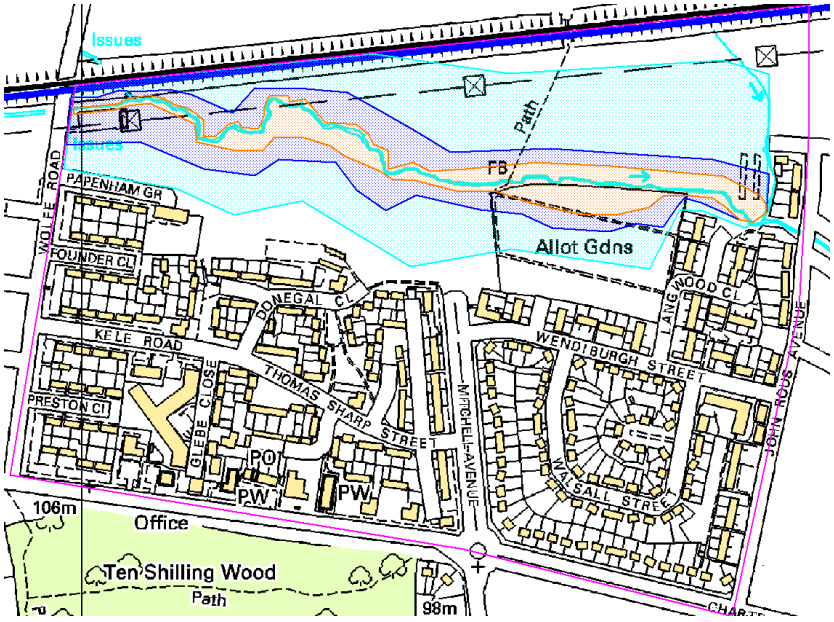

Figure 5: An example of correct master planning of a site affected by Flood risk

Appendix A illustrates that in some cases, potential development sites fall in areas which will be wholly inappropriate for the type of land use proposed. In such instances it has been recommended that alternative sites in lower risk areas are considered in preference.

Section 11.9 includes key requirements for development in Flood Zones 1, 2, 3a and 3b, which should inform developers' FRA requirements and be used to deal with non-allocated 'windfall' sites.

4 Hydrological and Hydraulic Approach

4.1 *Hydrological Approach*

The hydrological inputs to the assessment were derived using the Flood Estimation Handbook (FEH), the current industry standard for flood estimation in the UK. The chosen methodology for the hydrological modelling of each of the six watercourses is the FEH Rainfall-Runoff model. No suitable gauged data was available for any of the catchments therefore estimates are based on catchment descriptors alone, derived from the FEH CD-ROM. Full details of the hydrological approach, as well as peak flows, can be found in Appendix D.

4.2 *Hydraulic Approach*

The 2D modelling software package TUFLOW was used in conjunction with LiDAR data to construct 2D models of the six watercourses. Each of the channels has been represented in the 2D grid and a 'z line' has been used to reinforce the channel and eliminate any localised high points caused by inaccuracies in the LiDAR data. The modelled extents are shown in Table 4.

Table 4: Modelled Extents

Watercourse	**Upstream Modelled Extent**	**Downstream Modelled Extent**
Hurley Brook Tributary	SJ 63809 11944	SJ 63811 14270
Hurley Brook	SJ 65755 10831 SJ 67100 10383 SJ 67303 10251	SJ 65102 15158
Wall Brook	SJ 71188 14078	SJ 70029 15617
Crow Brook	SJ 68592 11510	SJ 67761 14893
Tributary of Wesley Brook	SJ 70391 08259	SJ 71949 06049
Mad Brook	SJ 70022 07039	SJ 71434 03676

The various inflow boundaries for each of the models are detailed in Appendix D. All downstream boundaries are represented by a normal slope calculated using the LiDAR data.

For a Level 2 SFRA the assessment of flood risk should take account of the presence of flood risk management measures, therefore culverts, reservoirs and pools and major flow control structures have been incorporated into the models where they exist (for full details see Appendix E). Culvert dimensions were measured, wherever accessible, during site visits and where measurement was not possible the culvert sizes were estimated. Wherever possible, the level of the culvert (mAOD) was verified using a hand-held GPS system and the data was then used to QA the LiDAR data. A major flow control structure exists on Mad Brook, details of which (dimensions, levels etc.) were obtained from the owner, Severn Trent Water, to assist in the accurate representation of this structure in the model.

A full account of the hydraulic modelling approach can be found in Appendix E. Modelled flood maps can be found in Volume 2.

4.3 Culvert Blockages

There are numerous culverts in the study area, each of which are at risk of complete or partial blockage, or indeed collapse. This poses residual risk to the surrounding area (which might be bigger than the risk area identified by Flood Zones 2 and 3).

A review was undertaken of culverts along the modelled watercourses and their proximity to possible development sites. Where the modelling exercise indicated issues of surcharging (due to insufficient capacity for a given flood event) or where a culvert was located immediately downstream of a development site, an analysis of residual risk was deemed necessary. For the purposes of this study, 75% blockages were modelled using the 1 in 100 year events for the relevant watercourses. The following blockages were modelled:

- Hurley Brook: Culvert at SJ 65882 10928 and drop culvert at 66885 11363
- Crow Brook: Culvert at SJ 68723 11756
- Wall Brook: Culverts at SJ 71020 14260 and SJ 70420 14890
- Mad Brook: Culvert at SJ 70488 06475

5 Hurley Brook Tributary

5.1 *Overview*

The Hurley Brook Tributary lies to the west of the Borough and rises in a principally rural area, flowing northwards. Upon flowing beneath a railway line the watercourse proceeds through mainly residential areas, before flowing into open fields. A full description of the modelled section of the watercourse, including details of structures and photographs, can be found in Appendix F.

5.2 *Proposed Development Areas*

There are a number of sites available for housing development in the vicinity of the Hurley Brook Tributary which has necessitated the need for improved Flood Zone information and a clearer understanding of the flood hazard. These are sites: 16, 68, 81, 166, 179, 181, 182, 183, 184, 380, 381, 395 and 424 (a site plan is shown in Figure 6). A detailed examination of the flood risk posed to these sites is given in this chapter, and in Appendix B.

It should be noted that site 656 has been included in this assessment though this site is affected by Flood Risk from the Hurley Brook (Chapter 6), as its floodwaters flow along the railway line for the 100 year plus climate change and 1000 year events.

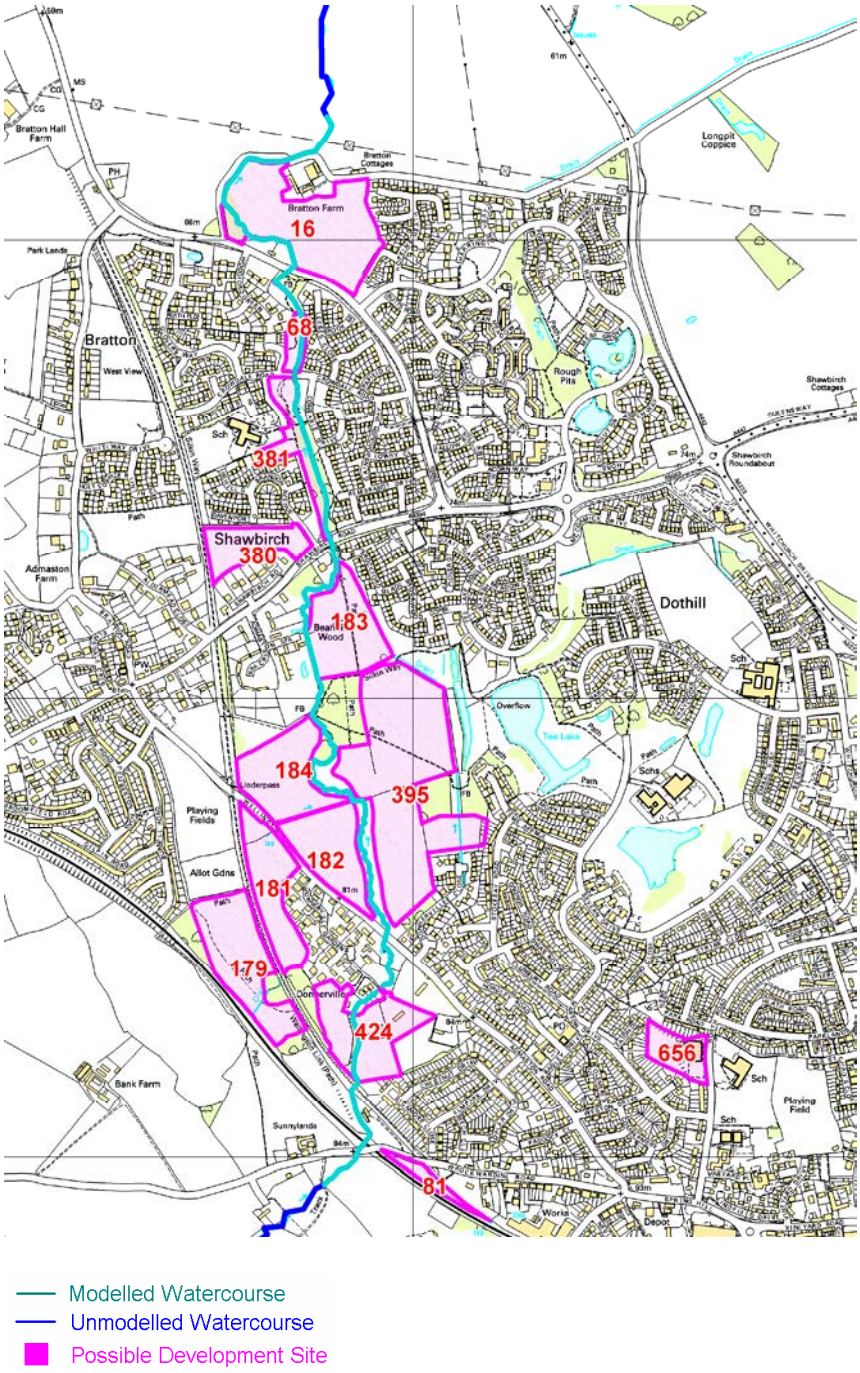

Figure 6: Site Plan of possible development sites along Hurley Brook Tributary

5.3 Model Results

The aim of the hydraulic modelling is to improve the Flood Zone information along the Hurley Brook tributary and assess the flood hazard posed to relevant possible development sites. Therefore, hydraulic modelling results consider flooding from the Hurley Brook Tributary and do not incorporate any other forms of flooding. Appendix B presents the assessment of flood risk and hazard posed to the possible development sites by various return periods along the Hurley Brook Tributary, while this section gives a general overview. Modelled flood maps can be found in Volume 2.

Overall the modelling results show that along this watercourse, the variability in flood extent, depth, velocity and hazard across each of the four modelled scenarios is minimal. The difference between the 100 year and the 100 year plus climate change events is also not significant. This indicates that all flood affected areas, up to and including Flood Zone 2, should remain as open space. For most sites this should be achievable given the size of the development sites. In line with this recommendation, sites **68** and **381** are not deemed suitable for development given the degree of flood risk posed across the sites (though a section of site **381** protrudes into Flood Zone 1 which could be developed if required). It is possible that the flood risk and hazard posed to these sites is higher due to the presence of culverts within the site which may not be able to convey flood flows of higher return periods, hence presenting some residual risk.

Flood risk through the centre of the modelled area, specifically between sites **183** and **424**, is low and flows up to the 1000 year event are generally in bank. This is due to the attenuation effect of the railway upstream, which holds back significant flood flows for all modelled return periods, creating a flood storage area. It should be noted that it has been assumed that there are no openings along the railway line which could allow the passage of water northwards (this should be confirmed prior to the allocation of site **179**). The FRA for site **179** will need to investigate the ability of the railway line to hold back water (see paragraph 7.16 of the PPS25 Practice Guide (2008)) and may require breach analysis. It is recommended that the potential for a formal flood storage area in this area should be investigated in partnership with the Environment Agency. It should also be noted that the removal of the railway embankment would have a significant effect on flood risk downstream, likely to increase the extent of the Flood Zones, as the storage effect would be lost. Prior to the allocation of any sites along the Hurley Tributary, the Council should consult the owner of the railway embankment (Network Rail) to ascertain the status of its maintenance and future use.

It is apparent that the Hurley Brook poses flood risk to some sites in the area, specifically for the 100 year plus climate change and 1000 year events. For the Hurley Brook's 100 year plus climate change event, flood waters flow along the railway and around the Wellington area find their way north westwards, affecting site **656** on the south western side (note that other Wellington sites are assessed in Chapter 6 – Hurley Brook). The situation is similar for the 1000 year event, though flood waters make their way further north, joining a drain along the eastern boundary of sites **395** and **183** and posing low-hazard flood risk. It is recommended that for the sites affected, the areas are left as open space. However, the low flood hazard means this risk could be mitigated in the identified areas, and could be developed for housing if it could be demonstrated that there are no other available sites fully in Flood Zone 1 (i.e. Flood Zone 2 where there is a suitably low hazard).

5.4 Blockage Scenario

Modelling of a 75% blockage (during the 100 year event) at culvert SJ 68552 10928 on the Hurley Brook has indicated development sites **395**, **656**, and **183** are affected by flooding from water that flows along the railway line towards development sites located adjacent to the Hurley Brook Tributary. In general the depth and velocity of flooding is minimal with a flood hazard of 'danger for some.' Modelled flood maps can be found in Volume 2. It is recommended that the parts of the site affected by flooding during a blockage scenario are left as open space.

6 Hurley Brook

6.1 *Overview*

The Hurley Brook lies in the centre of the Borough and rises in a principally rural area at three separate watercourses, the Hurley Brook and two branches of the Ketley Brook. Upon flowing beneath the M54 the watercourses proceed northwards, through various long sections of culverts through a relatively urban area, before meeting around Hadley Castle (SJ 66730 12680) and continuing northwards through open, though engineered, watercourse. At the roundabout on the A442 the watercourse leaves the urban area and enters into open fields, before flowing through Wappenshall and north west, out of the study area. A full description of the modelled section of the watercourse, including details of structures and photographs, can be found in Appendix F.

6.2 *Proposed Development Areas*

There are a number of sites available for housing development, as well as four possible employment, education, health and mixed use developments in the vicinity of the Hurley Brook which have necessitated the need for improved Flood Zone information and a clearer understanding of the flood hazard.

The potential housing development sites are: 69, 74, 93, 138, 189, 190, 191, 192, 193, 225, 228, 290, 361, 382, 414, 432, 441, 443, 460, 493, 519, 530, 609, 611 and 614.

The four employment, education, health and mixed use developments are also possible housing sites and are as follows: EMP2-POR (also housing site 382), 192-SHLAA (also housing site 192), 432-SHLAA (also housing site 432) and 138-SHLAA (also housing site 138). A site plan is shown in Figure 7. A detailed examination of the flood risk posed to these sites is given below.

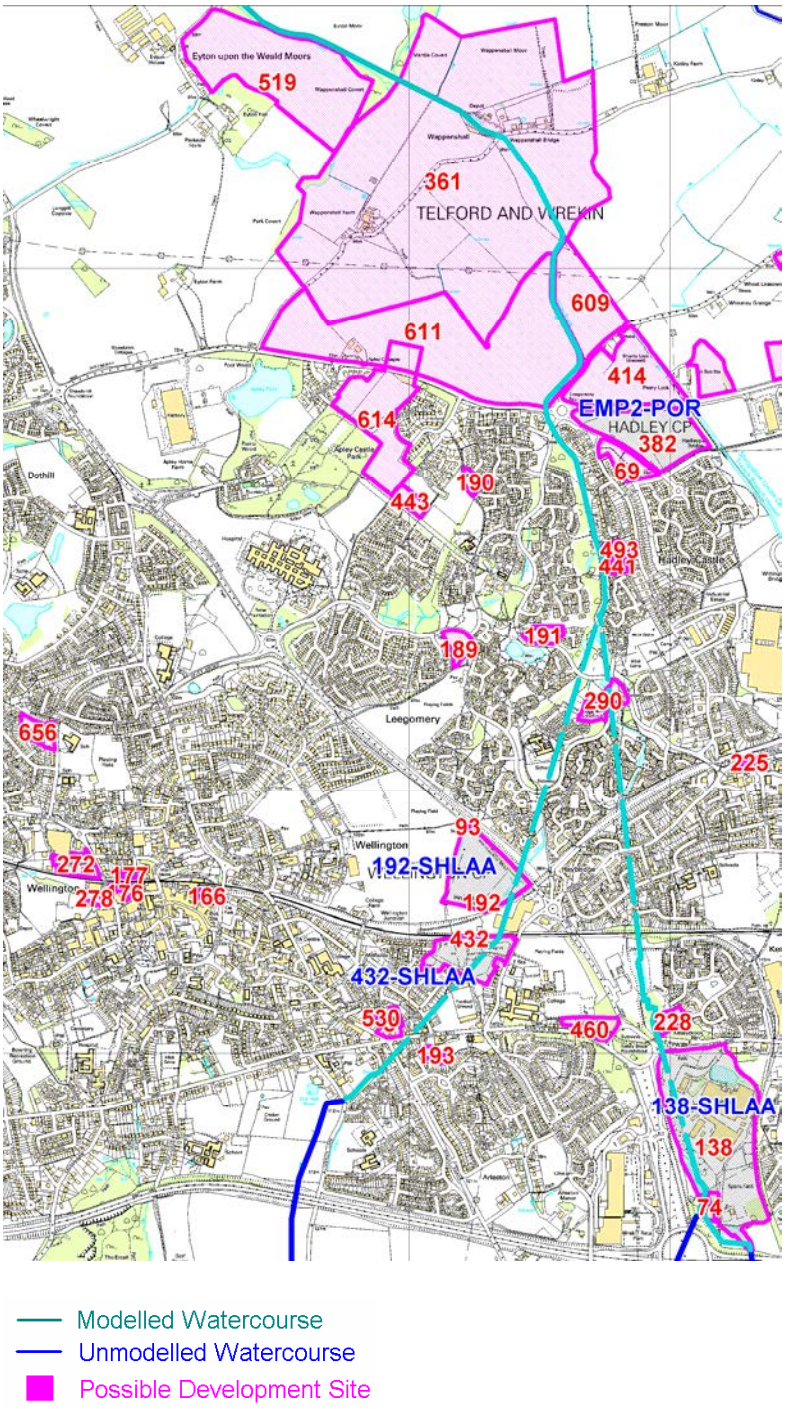

Figure 7: Site Plan of possible development sites along Hurley Brook

6.3 Model Results

The aim of the hydraulic modelling is to improve the Flood Zone information along the Hurley Brook and assess the flood hazard posed to relevant possible development sites. Therefore, hydraulic modelling results consider flooding from the Hurley Brook and do not incorporate any other forms of flooding. Appendix B presents the assessment of flood risk and hazard posed to the possible development sites by various return periods along the Hurley Brook, while this section gives a general overview. Modelled flood maps can be found in Volume 2.

Overall the modelling results show that along this watercourse, the variability in flood extent, depth, velocity and hazard across each of the four modelled scenarios is minimal. The difference between the 100 year and the 100 year plus climate change events is also not significant. This indicates that all flood affected areas, up to and including Flood Zone 2, should remain as open space. For most sites this should be achievable given the size of the development sites. However, in line with this recommendation, sites **74** and **228** on the eastern branch of the Hurley Brook (Ketley Brook), site **432** on the western branch of the Hurley Brook, and site **609** at the downstream extent, are not deemed suitable for development given the degree of flood risk posed across the sites.

The area immediately upstream of the railway line on the eastern branch of the Hurley Brook (Ketley Brook) is acting as a designated flood storage area and is mitigating the risk of flooding downstream. Therefore site **228** is not deemed appropriate for development as it significantly encroaches this storage area. The storage area should continue to be safeguarded from future development, and maintained and operated as such.

Towards the upstream extent of the modelled area between sites **193** and **432** on the western branch of the Hurley Brook, the culvert upstream of Watling Street (SJ 6587 1092) is surcharged for all modelled events, causing flooding downstream. Water flows overland towards the railway line affecting a number of proposed sites. Upstream of the railway line the watercourse emerges for a small section of open channel before being culverted beneath the railway line. Modelling has shown the channel and culvert at this location to be of sufficient capacity to cope with discharge from the upstream culvert (i.e. there is no out-of-bank flow resulting from this location). The out-of-bank flow results only from the lack of culvert capacity upstream of Watling Street. Modelling has shown this flood water to flow along the railway towards Wellington (described below). Increasing the capacity of the culvert upstream of Watling Street, or providing some upstream

storage, may improve the flood risk in this area, and prevent flows along the railway line towards Wellington.

Between Watling Street and the railway line, sites **3** and **432** are marginally affected by the 20 year event, with greater flooding for the 100 year event and 100 year event plus climate change. For the 1000 year event, site **193** is also at risk from flooding. It is recommended that the sections of sites **3** and **193** affected by Flood Zones 3a and 2 are left as open space, while site **432** should ideally not be developed. Site **193** could be developed in full for housing if it can be demonstrated there are no other sites fully in Flood Zone 1, given the low probability and flood hazard, though the housing in this area would need appropriate raised floors (see recommendations for development in Flood Zone 2).

Downstream of the railway line, housing and employment site **192** is at risk from flooding for the 100 year event, 100 year plus climate change and 1000 year event, and should only be considered for development if no other sites fully in Flood Zone 1 are available. If the Sequential Test is passed, Flood Zones 2 and 3a should be left as open space (as the flood hazard within Flood Zone 2 is moderate to significant for large parts of the site). The railway itself is acting as a barrier to flow creating residual risk to the site and the FRA will be required to assess this. The FRA for this site will need to investigate the ability of the railway line to hold back water (see paragraph 7.16 of the PPS25 Practice Guide (2008)) and may require breach analysis. More vulnerable uses should be directed away from the flood affected areas.

The Hurley Brook poses flood risk to sites in the Wellington area, for the 100 year, 100 year plus climate change and 1000 year events. Water flows along the railway towards the Wellington area, marginally affecting site **272** along the southern and western boundaries. Flood waters do not inundate sites **166**, **176**, **177**, and **278** with these sites lying fully in Flood Zone 1. It is recommended for the parts of the site affected, the areas are left as open space. However, modelling has indicated that the flood hazard is low for the 1000 year event, and therefore the risk could be mitigated and could be developed for housing if it could be demonstrated that there are no other available sites fully in Flood Zone 1.

Flood risk at the downstream extent of the modelled area is evident between sites **414** and **519**. A significant area of land is being considered for development in this area. Site **414** consists of three parts with the western most part affected by

flooding from the Hurley Brook. There is little difference between the extent of flooding for the 1 in 100 year and 1 in 1000 year event, and as such, it is recommended that these areas are left as open space. The far western part of site **414** is also affected by the Crow Brook (refer to Section 7). Approximately fifty percent of site **609** is affected by Flood Zone 3a, with almost the entire site affected by Flood Zone 2. The nature of flood risk at this site indicates that development should be discouraged and alternative sites in Flood Zone 1 considered.

Site **361** is affected by Flood Zone 3b, 3a and 2, mainly at the central and northern parts of the site. The Hurley Brook itself runs through the centre of this site effectively splitting the site into two halves. On the right bank over fifty per cent of the site is affected by Flood Zones 3b, 3a and 2, with very little difference in the extent of flooding. Parts of the site located within Flood Zone 1 appear to be cut off by flooding entirely, in particular to the south eastern part of the site. It is therefore recommended that the right-bank part of the site is not developed. It is also recommended that the parts of the site on the left bank of the Hurley Brook affected by Flood Zones 3b, 3a and 2 be kept as open space as again, there is little difference in the extent of the flooding. Parts of the site located within Flood Zone 1 are acceptable for development, provided alternative sites fully in Flood Zone 1 are not available, subject to a detailed FRA. More vulnerable parts of the development (bungalows etc.) should be directed towards the lowest risk part of the site (i.e. well away from Flood Zones 2, 3a and 3b). Site **519** is also substantially affected by Flood Zones 3a and 2. Development would be suitable if sites fully in Flood Zone 1 are not available, and Flood Zones 2 and 3a are left as open space, however as the flood affected areas encroach some 50% of the site, this may not make the development feasible.

6.4 Blockage Scenario

With a 75% blockage (during the 100 year event) applied at culvert SJ 68552 10928 and the drop culvert at 66885 11363 on the Hurley Brook, the extent of flooding to sites **3**, **74**, **138**, **193**, **228** and **432** increases marginally in comparison to the 100 year event. Depths, velocities and flood hazard are also only marginally different across the affected parts of the site. This re-enforces the recommendation to leave parts of the site affected by Flood Zones 3a and 2 as open space within sites **3** and **193**. With a 75% blockage on culvert SJ 68552 10928 on the Hurley Brook, the extent of flooding to housing and employment site **192/ 192-SHLAA** increases by a slightly greater margin, to a similar extent as the 1% AEP (1 in 100 year) plus

climate change event. Modelled flood maps can be found in Volume 2. It is recommended that the affected parts of the site remain as open space.

Flooding to sites to the west of the Hurley Brook is also experienced when a blockage is applied to the culvert at SJ 68552 10928.

7 Crow Brook

7.1 *Overview*

The Crow Brook lies to the east of the Borough emerging from a culvert into a natural channel by Oakengates (SJ 68590 11510) and flowing on a north easterly direction towards Trench. At its upstream extent, the watercourse is conveyed through a series of culverts before emerging at Trench Pool, a large raised reservoir. From here, water overflows at the western end of the pool before the channel diverts from its original path and is culverted before emerging to the west of Queensway. This differs from the route of the channel shown by the previous JFLOW outlines which suggested that the watercourse followed a route directly north through Hortonwood before emerging downstream of Horton Lane (SJ 6879 1437). From Queensway, the watercourse is culverted once again beneath Hadley Park Roundabout before continuing in a predominantly north westerly direction. A full description of the modelled section of the watercourse, including details of structures and photographs, can be found in Appendix F.

7.2 *Proposed Development Areas*

Three possible sites available for housing development and nineteen employment, education, health and mixed use developments are proposed in the vicinity of the Crow Brook which have necessitated the need for improved Flood Zone information and a clearer understanding of the flood hazard.

The potential housing development sites are: 164, 195 and 471. Site 471 has also been proposed as an employment site (471-SHLAA). The potential employment, education, health and mixed use development sites are: EMP4-POR (9 individual sites), EMP3-POR (7 sites), 100-SHLAA and 383-SHLAA. A site plan is shown in Figure 8 with a detailed examination of the flood risk posed to these sites outlined below.

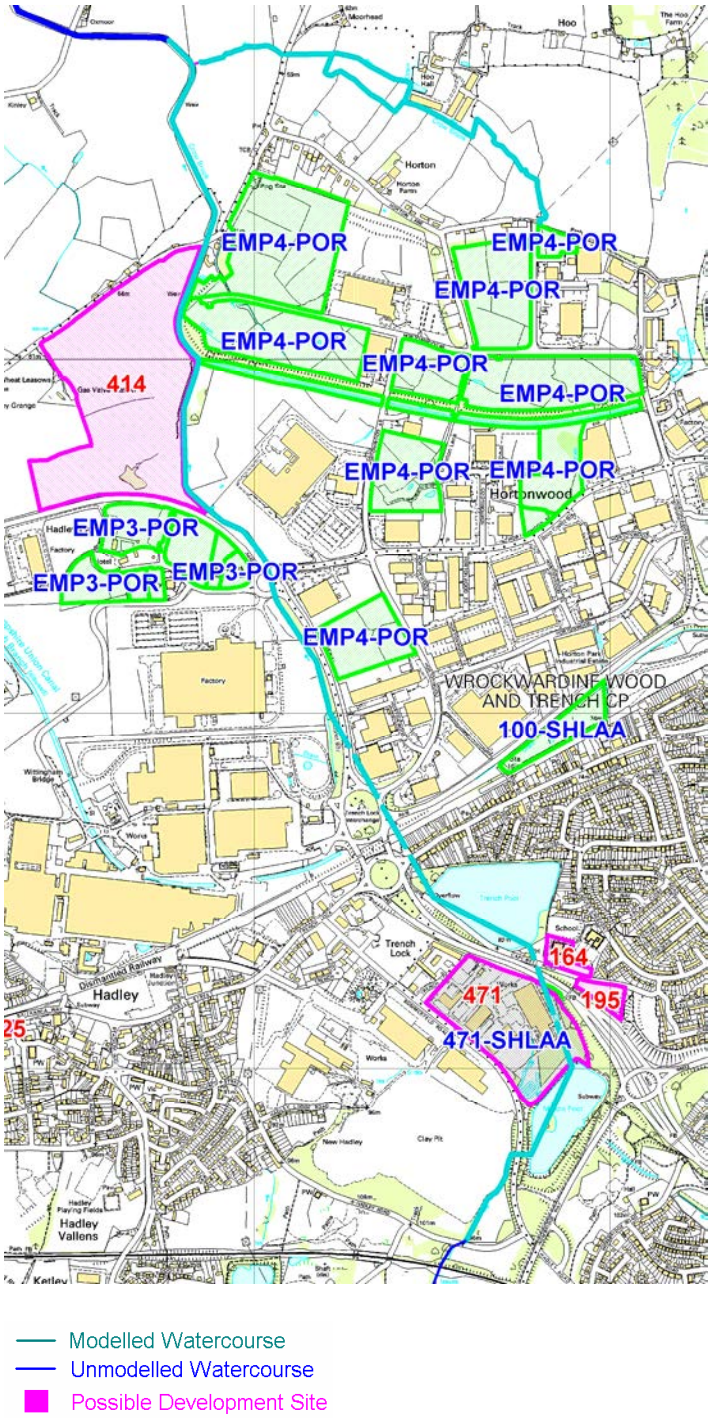

Figure 8: Site Plan of possible development sites along Crow Brook

7.3 Model Results

The aim of the hydraulic modelling is to improve the Flood Zone information along the Crow Brook and assess the flood hazard posed to relevant possible development sites. Therefore, hydraulic modelling results consider flooding from the Crow Brook and do not incorporate any other forms of flooding. Appendix B presents the assessment of flood risk and hazard posed to the possible development sites by various return periods along the Crow Brook, while this section gives a general overview. Modelled flood maps can be found in Volume 2.

Overall the flood risk posed to the majority of sites adjacent to the Crow Brook is minimal, with the majority of proposed sites located within Flood Zone 1. The Flood Zones based on the updated modelling differ significantly from the previous JFLOW outlines. The previous JFLOW outlines showed the watercourse to follow a path through Hortonwood, to the east of the actual path of the watercourse. Sites **100-SHLAA** and five areas of the **EMP4-POR** site were previously shown to lie within Flood Zones 3a and 2. The updated modelling has removed these sites from the floodplain, now placing them fully in Flood Zone 1, as the work undertaken as part of this Level 2 SFRA has confirmed that the watercourse is actually culverted from Trench Pool before emerging to the west of Queensway at SJ 6821 1300. For each of these sites, however, a detailed FRA will be required to confirm the site's placement in Flood Zone 1.

It is apparent that surcharging of culverts at the upstream extent of the Crow Brook poses flood risk to sites at downstream locations, in particular housing/employment site **471/471-SHLAA.** At this location, there is residual risk from the culvert, which surcharges, causing water to flow down Sommerfeld Road, entering the site on the western boundary. In addition, many of the surrounding roads flood, which may present access issues to the site. Although the whole site is not affected, large parts are shown to be inundated towards the centre and western extent, with additional drains/channels located towards the south eastern corner of the site. There are slight differences in the extent of flooding between the 1 in 20 year event and 1 in 100 year event; with greater differences between the 1 in 100 year event and the 1 in 1000 year event. There are also minimal variations in the depth, velocity and hazard posed to this site, however, given the extent of the flooding, alternative sites in lower risk Flood Zones, preferably Flood Zone 1, should be developed in preference to this site.

Towards the downstream extent of the modelled watercourse, a number of sites are shown to be at risk of flooding from the Crow Brook including seven

employment sites **EMP3-POR** and one residential site (**414**). It should be noted that site **414** consists of three parts, with the part located furthest east affected by the Crow Brook. The remainder of the site further west are affected by the Hurley Brook (refer to Section 6). Modelled results have shown the 1 in 20 year and 1 in 100 year events to be contained within the Crow Brook channel at this location. However, there is flood risk from the 1 in 100 year plus climate change event and the 1 in 1000 year event where modelling has shown flood water to follow a route along the roads adjacent to the sites. The part of the site shown to be affected by Flood Zone 2 should ideally be kept as open space, however, given the low flood hazard posed during the 1000 year event, development here may be acceptable provided it can be demonstrated that the Sequential Test has been passed and therefore are no other sites available fully in Flood Zone 1. However, the most vulnerable elements of the development must be placed in the lowest risk Flood Zone (1).

Employment sites **EMP3-POR** (7 sites) are located on the left bank of the Crow Brook. Flood Zone 2 extends into five of the sites; however, the associated flood hazard is low with shallow depths and slow velocities across most of the sites. Flood waters flow along the roads currently surrounding the sites with two appearing to be cut off by floodwaters. It is recommended that areas affected by Flood Zone 2 be left as open space. However, employment development may be acceptable provided it can be demonstrated that the Sequential Test has been passed and therefore are no other sites available fully in Flood Zone 1. However, the most vulnerable elements of the development must be placed in the lowest risk Flood Zone (1).

7.4 Blockage Scenario

With a 75% blockage (during the 100 year event) applied at culvert SJ 68723 11756 the extent, depth and velocity of flooding within site **471** (also housing site **471-SHLAA**) is similar to the 100 year event. Modelled flood maps can be found in Volume 2. It is recommended that the parts of the site affected are left as open space.

8 Wall Brook (Donnington Watercourse)

8.1 *Overview*

The Wall Brook (also cited as Donnington Watercourse) lies to the east of the Borough by Donnington and flows through a predominantly urban area. The watercourse emerges from a culvert under Fieldhouse Drive, proceeding in a north westerly direction and passing beneath a number of culverts between Brookside and New Trench Road. Once emerging downstream of New Trench Road, the watercourse then proceeds in a northerly direction parallel to Donnington Drive before reaching the downstream extent of the model. The general area is very flat, resulting in extensive flood risk areas. A full description of the modelled section of the watercourse, including details of structures and photographs, can be found in Appendix F.

8.2 *Proposed Development Areas*

There are a number of sites available for housing development in the vicinity of the Wall Brook which has necessitated the need for improved Flood Zone information and a clearer understanding of the flood hazard. These are sites: 144, 336, 350, 482, 504 and 508 (a site plan is shown in Figure 9). A detailed examination of the flood risk posed to these sites is given below.

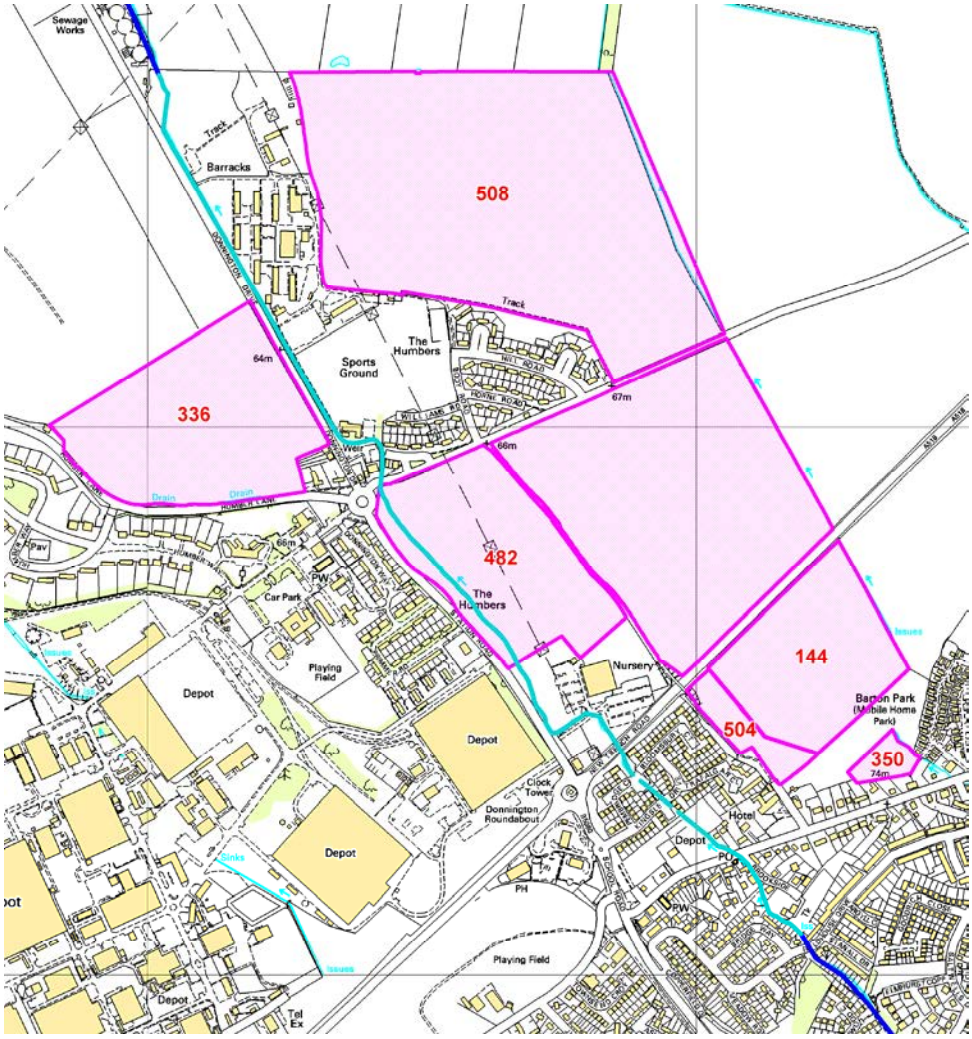

Figure 9: Site Plan of possible development sites along Wall Brook

8.3 ***Model Results***

The aim of the hydraulic modelling is to improve the Flood Zone information along the Wall Brook and assess the flood hazard posed to relevant possible development sites. Therefore, hydraulic modelling results consider flooding from the Wall Brook and do not incorporate any other forms of flooding. Appendix B

presents the assessment of flood risk and hazard posed to the possible development sites by various return periods along the Wall Brook, while this section gives a general overview. Modelled flood maps can be found in Volume 2.

Overall, the modelling results show that along this watercourse, the variability in flood extent, depth, velocity and hazard across each of the four modelled scenarios is minimal. This is predominantly due to the flat nature of the surrounding topography. The difference between the 100 year and the 100 year plus climate change events is also not significant. This indicates that all flood affected areas, up to and including Flood Zone 2, should remain as open space. For most sites this should be achievable given the size of the development sites. The exception to this is site **482** which is not deemed suitable for development given the degree of flood risk posed across the site.

Flood risk to some sites may be higher due to the presence of culverts along the watercourse which may not be able to convey flood flows, hence presenting some residual risk. Modelling results have indicated that parts of sites **144 and 508** are affected by flooding across the range of modelled return periods with flood waters from the surcharged culvert at New Trench Road flowing towards the sites. Access to these sites should also be considered, as all return periods appear to affect the surrounding roads to these sites.

It is recommended that for the sites affected by Flood Zones 2, 3a and 3b, the areas are left as open space. However, the low flood hazard means this risk could be mitigated in the identified areas, and could be developed if it could be demonstrated that there are no other available sites fully in Flood Zone 1.

8.4 Blockage Scenarios

Blockage scenarios were modelled at two locations along the Wall Brook: SJ 71020 14260 and SJ 70420 14890. These were run separately to see the effect a blockage on each culvert would have on flood risk. Results from both blockage scenarios showed the extent, depth, and velocity of flooding to be similar to that of the 100 year event. Modelled flood maps can be found in Volume 2. It is recommended that the parts of the sites affected are left as open space, in accordance with original recommendations outlined above.

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9 Tributary of Wesley Brook

9.1 *Overview*

The Wesley Brook Tributary lies to the south east of the Borough. The watercourse emerges at Hollinswood and proceeds in an easterly direction. After passing beneath Queen Elizabeth Avenue, the watercourse flows through Randlay Wood until it meets a drain running alongside Queensway (A442). The Wesley Brook Tributary then passes under Queensway, emerging to the south west of Nedge Hill, before continuing in a south easterly direction to the downstream extent of the modelled area. A full description of the modelled section of the watercourse, including details of structures and photographs, can be found in Appendix F.

9.2 *Proposed Development Areas*

There are a number of sites available for housing development and employment, education, health and mixed use development sites proposed in the vicinity of the Wesley Brook Tributary which have necessitated the need for improved Flood Zone information and a clearer understanding of the flood hazard. The proposed housing sites are: 111, 112, 155, 156, 221, 229, 379, 605, 606, 607, 608 and 612. There are also three potential employment, education, health and mixed use development sites: EMP8-POR (30010, 60050 and 60060). A site plan is shown in Figure 10 with a detailed examination of the flood risk posed to these sites outlined below.

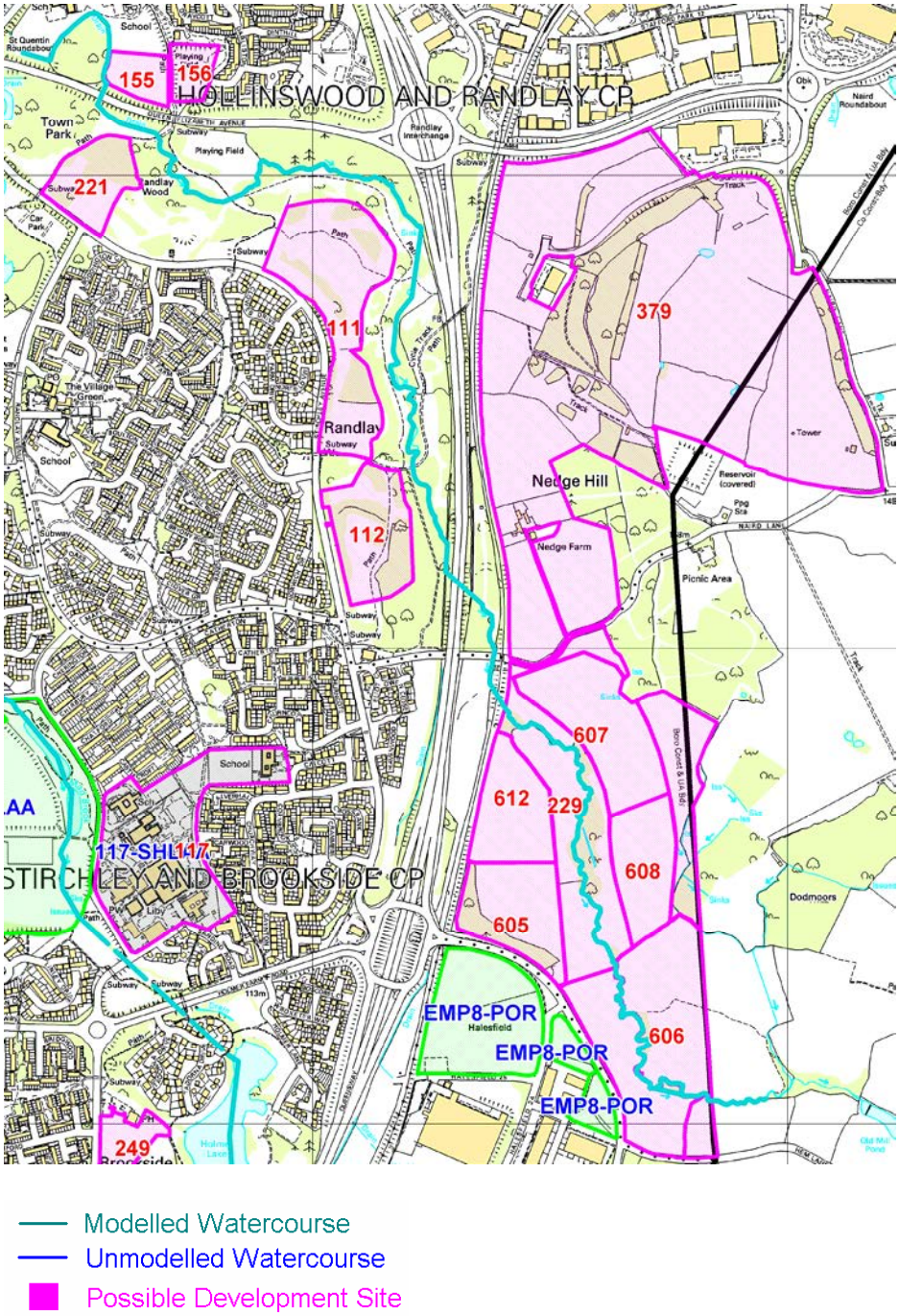

Figure 10: Site Plan of possible development sites along Wesley Brook Tributary

9.3 Model Results

The aim of the hydraulic modelling is to improve the Flood Zone information along the Wesley Brook Tributary and assess the flood hazard posed to relevant possible development sites. Therefore, hydraulic modelling results consider flooding from the Wesley Brook Tributary and do not incorporate any other forms of flooding. Appendix B presents the assessment of flood risk and hazard posed to the possible development sites by various return periods along the Wesley Brook Tributary, while this section gives a general overview. Modelled flood maps can be found in Volume 2.

Overall the modelling results show that along this watercourse, the variability in flood extent, depth, velocity and hazard across each of the four modelled scenarios is minimal. The difference between the 100 year and the 100 year plus climate change events is also not significant. This indicates that all flood affected areas, up to and including Flood Zone 2, should remain as open space. For most sites this should be achievable given the size of the development sites.

Towards the upstream extent of the watercourse, modelled results have shown site **155** to lie entirely within Flood Zone 3b. The watercourse itself is culverted beneath Queen Elizabeth Avenue, which surcharges during all modelled events. Flood water is stored in the area upstream of the culvert and is contained by a series of embankments, with some flood waters flowing through a pedestrian subway located beneath Queen Elizabeth Way to the east. Consequently the velocity of water is high as it is conveyed through the subway. Similarly, the water is deep at this location as it is contained behind the embankments. Given the degree of flood risk posed, this site should not be developed and alternative site in lower risk Flood Zones, preferably Zone 1, should be developed in preference to this site.

Site **156** lies to the east of site **155**. Although the majority of this site lies within Flood Zone 1, it is evident that there is a residual risk to this site as a series of embankments located around the edge of the site are holding back flood water. There may also be flooding issues behind the embankment due to overland flooding. The FRA will require a detailed assessment of the embankments ability to hold back water, in line with the requirements set out in paragraph 7.16 of the PPS25 Practice Guide (2008), and should confirm the flood extents and levels which are shown the affect the sites.

Downstream of Queensway, the Wesley Brook Tributary continues in a south easterly direction with the majority of development sites adjacent to the watercourse located within Flood Zone 1. Towards the downstream extent of the modelled section, the watercourse flows through the centre of sites **229** and **606**. The extent of flooding is similar between the modelled return periods and therefore the parts of the site affected by flood risk should remain as open space. This restricts the area available for development, particularly within site **229**. It is therefore recommended that alternative sites in Flood Zone 1 are developed in preference to site **229**.

Model results have indicated that the three potential employment, education, health and mixed use development sites: EMP8-POR (30010, 60050 and 60060) are located entirely within Flood Zone 1.

10 Mad Brook

10.1 *Overview*

The Mad Brook lies to the south east of the Borough and rises just upstream of Grange Farm Pond, flowing in a south easterly direction towards Stirchley. Downstream of the pond, there is an overflow into a culvert with the watercourse emerging downstream of Stirchley Road. From here, the watercourse flows under a footbridge and through two successive pools before being culverted once again at the southern end of Stirchley playing fields. At the downstream end of the playing fields there is a flood relief culvert, which passes under Grange Avenue and the watercourse emerges downstream of Holmer Farm Road before flowing into Holmer Lake. Water flows out of Holmer Lake via an overflow and is culverted beneath Queensway (A442) emerging downstream of Halesfield Industrial Estate during low flow conditions before continuing in a southerly direction towards the downstream extent of the model. At the downstream end of the Queensway culvert there is an overflow for high flow conditions with water flowing along the overflow and through another culvert under the railway. Downstream of the railway there is a flood storage area and a series of overflow culverts convey water to the storage area. A full description of the modelled section of the watercourse, including details of structures and photographs, can be found in Appendix F.

10.2 *Proposed Development Areas*

There are a number of potential residential housing developments proposed and employment, education, health and mixed use development sites proposed in the vicinity of the Mad Brook which have necessitated the need for improved Flood Zone information and a clearer understanding of the flood hazard. The proposed housing sites are: 117 (also employment), 249, 250 and 368. There are also four potential employment, education, health and mixed use development sites: EMP8-POR (60090 and 60200), 141-SHLAA and 117-SHLAA (also housing). A site plan is shown in Figure 11 with a detailed examination of the flood risk posed to these sites outlined below.

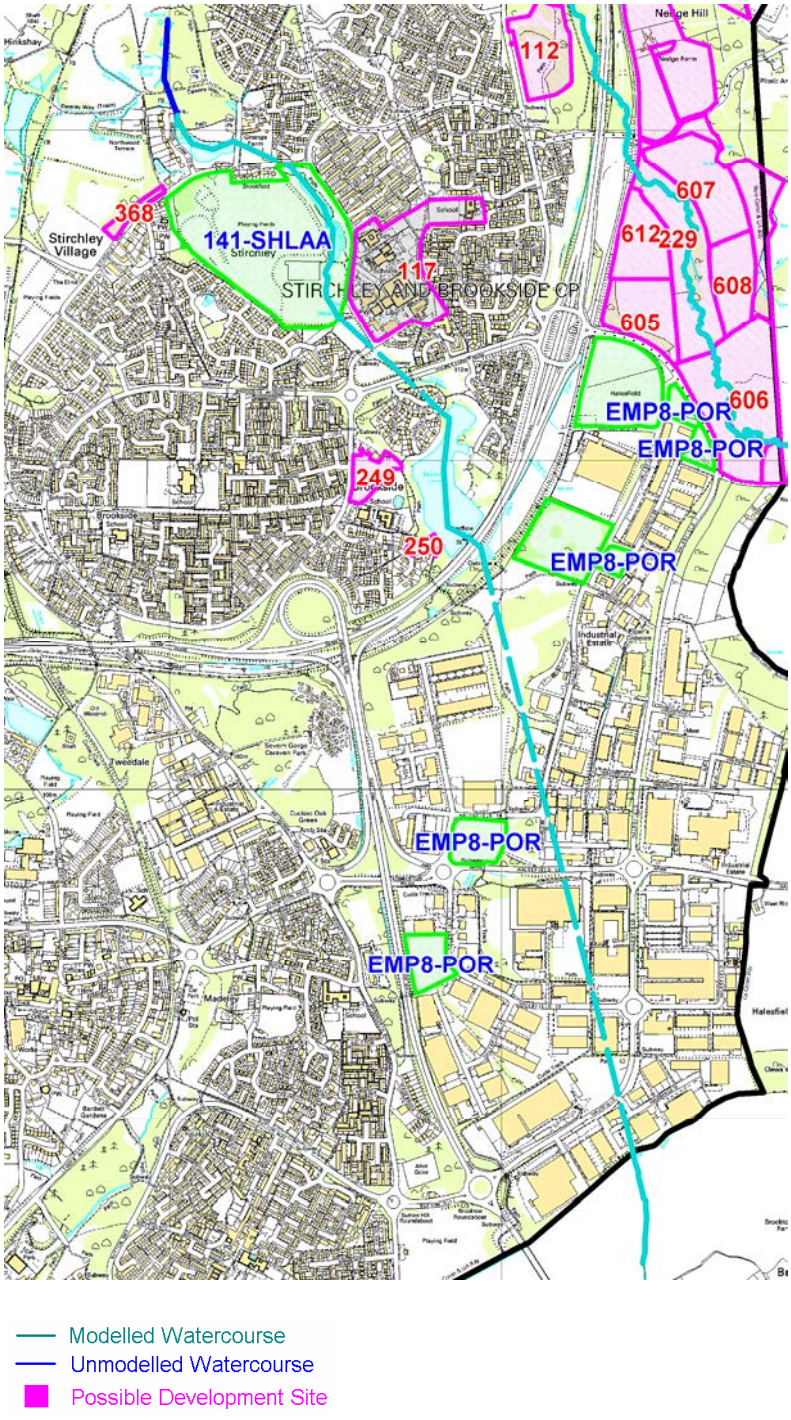

Figure 11: Site Plan of possible development sites along Mad Brook

10.3 Model Results

The aim of the hydraulic modelling is to improve the Flood Zone information along the Mad Brook and assess the flood hazard posed to relevant possible development sites. Therefore, hydraulic modelling results consider flooding from the Mad Brook, though an element of surface water flooding is considered above the downstream culverted section. Appendix B presents the assessment of flood risk and hazard posed to the possible development sites by various return periods along the Mad Brook, while this section gives a general overview. Modelled flood maps can be found in Volume 2.

Overall the modelling results show that along this watercourse, the variability in flood extent, depth, velocity and hazard across each of the four modelled scenarios is minimal. The difference between the 100 year and the 100 year plus climate change events is also not significant. This indicates that all flood affected areas, up to and including Flood Zone 2, should remain as open space. For most sites this should be achievable given the size of the development sites.

The exception to this is sites **EMP8-POR** (**60200** and **60220**) where modelling has shown that the flood risk posed to these sites is a consequence of surface water runoff following a flow route across the industrial estate (the actual watercourse is culverted in this location). The flood hazard is low for each of these sites, but mitigation is still required to ensure the development is safe. Providing the Sequential Test can be passed (i.e. it can be demonstrated that sites fully in Flood Zone 1 are not available), these sites could be developed in accordance with Table D3 of PPS25.

Downstream of Queensway and the railway, employment site EMP8-POR (Halesfield 24) is shown to be affected by Flood Zones 3b, 3a and 2. It is strongly recommended that alternative sites are considered in preference to this site as the area is acting as a purpose built storage area. This, in addition to residual risk from the presence of the railway line across the western boundary of the site mean that the flood risk posed to the site is high. The storage area should continue to be safeguarded from future development, and maintained and operated as such.

10.4 Blockage Scenarios

With a 75% blockage (during the 100 year event) applied at culvert SJ 70488 06475 the extent, depth and velocity of flooding within sites **141-SHLAA**, **177**, and **250** is similar to the 100 year event. Modelled flood maps can be found in Volume 2. It

is recommended that the parts of the site affected are left as open space as recommended previously.

11 Policy Recommendations

11.1 *Overview*

This chapter provides recommendations to enhance the existing flood risk management policies outlined in the Level 1 SFRA report. The recommended policies provided from Section 11.2 to 11.7 are intended to be locationally specific, and do not reproduce policies at the regional and national level.

This chapter also provides Development Control policies and provides guidance for development in different Flood Zones, which can be used by potential developers required to produce site-specific FRAs, and to help the Council deal with non-allocated 'windfall' sites should they arise.

The following recommendations are in line with PPS25 and are in accordance with the broad objectives of the 'Telford and Black County' Policy Unit from the River Severn CFMP.

11.2 *Hurley Brook Tributary*

Planning Recommendations for the Development Areas

Prior to the allocation of any development sites along the Hurley Brook Tributary, the Council should liaise with Network Rail to ascertain the future maintenance and use of the railway embankment, which provides an informal defence and is shown to hold back flood water, creating an informal storage area which appears to mitigate flood risk downstream.

The Council should liaise with the Environment Agency to discuss opportunities to create a formal flood storage area upstream of the railway embankment, which will provide flood risk mitigation downstream. Developer contributions could be sought for this purpose.

The area currently shown to be acting as an informal flood storage area should be safeguarded from development, and maintained and operated as such (by the Council).

Provided the future maintenance and use of the railway line is ascertained and the nature of the railway line is shown not to change in the future (which may increase flood risk downstream) development downstream would be acceptable, only in line

with the recommendations in the Level 2 SFRA (Appendix B). The FRA for site **179** will require a detailed assessment of the embankment's ability to hold back water, in line with the requirements set out in paragraph 7.16 of the PPS25 Practice Guide (2008).

The culvert upstream of Watling Street (on the Hurley Brook) is shown to have insufficient capacity to adequately convey the 100 year, 100 year plus climate change and 1000 year events, causing it to surcharge. The lie of the land causes much of this flood water to flow onto the railway line and north through Wellington towards development sites along the Hurley Brook Tributary. Options to increase the capacity of this culvert, or provide an upstream storage area, should be explored where the opportunity arises, in order to mitigate flood risk downstream. Developer contributions could be sought for this purpose.

Sites **68** and **381** are not deemed suitable for development given the degree of flood risk posed across the sites (though a section of site **381** protrudes into Flood Zone 1 which could be developed if the Sequential Test is passed).

All other sites along the Hurley Brook Tributary which are shown to be marginally affected by flood risk, should only be developed if the Sequential Test is passed and it can be demonstrated that there are no other available sites lying fully in Flood Zone 1.

Where such sites are allocated for development, the Council should adopt the principle of **avoidance** by ensuring that areas affected by Flood Zones 2, 3a and 3b remain as open space. The avoidance of flood risk is important in the development of sustainable communities and will deliver a positive reduction in flood risk by reducing the impact that flooding may have on the community (by reducing the number of people within the site that would otherwise be at risk). It can also help the Council to achieve green space targets.

The exception to this applies to sites **656, 395** and **183** which are shown to be affected by the 1000 year event from the Hurley Brook. As the flood hazard in these areas from the 1000 year event is shown to be low, these sites could be developed in their entirety in accordance with Table D3 of PPS25, provided the Sequential Test is passed (i.e. it can be demonstrated that there are no other alternative sites fully in Flood Zone 1). If so, the development could proceed provided the requirements for development in Flood Zone 2 are followed (Section 11.9) and the developer aims to reduce flood risk. Following these

recommendations are especially important as these areas of the sites are shown to be at residual risk of a blockage of the culvert on Hurley Brook, during a 1 in 100 year event.

All sites will require application of the sequential approach at the site level (sequential design) to ensure that the more vulnerable housing development (e.g. bungalows) is located well away from Flood Zones 2 and 3. The vulnerability from other sources of flooding should be considered as well as the effect of the new development on surface water runoff (see below).

Developments should seek 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 on the 'use' proposed for future developments within the Low Probability Flood Zone 1, although the vulnerability from other sources of flooding should be considered as well as the effect of the new development on surface water runoff. An FRA 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 the Telford and Wrekin Sustainable Drainage Systems Review document, Halcrow (2008) for further details on appropriate SUDS techniques for the Telford and Wrekin area). For all sites, the post development runoff volumes and peak flow rates should be attenuated (1 in 100 year + climate change) to the Greenfield (pre-development) condition with a minimum reduction of 20%, and mimic the surface water flows arising from the site prior to the proposed development.

11.3 ***Hurley Brook***

Planning Recommendations for the Development Areas

Prior to the allocation of any development downstream of the railway line, the Council should liaise with Network Rail to ascertain the future maintenance and use of the railway embankment, which provides an informal defence and is shown to hold back flood water in two areas, creating both formal and informal storage areas which appear to mitigate flood risk downstream.

Along the western branch of the upstream section of the Hurley Brook, the culvert upstream of Watling Street is shown to have insufficient capacity to adequately convey the 100 year, 100 year plus climate change and 1000 year events, causing it to surcharge. The lie of the land causes much of this flood water to flow north east through some existing development and onto the railway line, which then

flows north through Wellington towards development sites along the Hurley Brook Tributary. Options to increase the capacity of this culvert, or provide a formal upstream storage area, should be explored where the opportunity arises, in order to mitigate flood risk both in the existing residential area, and downstream. Developer contributions could be sought for this purpose.

The area currently shown to be acting as a formal flood storage area on the eastern branch of the Hurley Brook (Ketley Brook) immediately upstream of the railway line should be safeguarded from development, and maintained and operated as such (by the Council). This discounts the feasibility of site **228** for development.

Provided the future maintenance and use of the railway line is ascertained and the nature of the railway line is shown not to change in the future (which may increase flood risk downstream) development downstream would be acceptable, only in line with the recommendations in the Level 2 SFRA (Appendix B). The FRA for site **192 (1920-SHLAA)** will require a detailed assessment of the embankments ability to hold back water, in line with the requirements set out in paragraph 7.16 of the PPS25 Practice Guide (2008), and should confirm the flood extents and levels which are shown the affect the site.

Sites **74** and **228** on the eastern branch of the Hurley Brook (Ketley Brook), site **432** on the western branch if the Hurley Brook, and site **609** at the downstream extent, are not deemed suitable for development given the degree of flood risk posed across the sites.

Site **361** is very large and there are large areas which lie in Flood Zone 1. However, there are also considerable flood risk affected areas. Development in Flood Zone 1, the south western side of the site, would be suitable for development provided alternative sites fully in Flood Zone 1 are not available, subject to a detailed FRA. The north eastern side of the site appears to have complex flood risks, which should be carefully considered and only developed in accordance with Table D3 of PPS25 if the Sequential Test is passed. More vulnerable parts of the development (bungalows etc.) should be directed towards the lowest risk part of the site (i.e. well away from Flood Zones 2, 3a and 3b).

All other sites along the Hurley Brook which are shown to be marginally affected by flood risk, should only be developed if the Sequential Test is passed and it can be demonstrated that there are no other available sites lying fully in Flood Zone 1.

Where such sites are allocated for development, the Council should adopt the principle of **avoidance** by ensuring that areas affected by Flood Zones 2, 3a and 3b remain as open space. The avoidance of flood risk is important in the development of sustainable communities and will deliver a positive reduction in flood risk by reducing the impact that flooding may have on the community (by reducing the number of people within the site that would otherwise be at risk). It can also help the Council to achieve green space targets.

The exception to this applies to sites **193**, **290 and 272,** which are shown to be marginally affected by the 1000 year event (with 272 also marginally affected by the 100 year event). As the flood hazard in these areas is shown to be low, these sites could be developed in their entirety in accordance with Table D3 of PPS25, provided the Sequential Test is passed (i.e. it can be demonstrated that there are no other alternative sites fully in Flood Zone 1). If so, the development could proceed provided the requirements for development in Flood Zone 2 (Section 11.9) are followed.

All sites will require application of the sequential approach at the site level (sequential design) to ensure that the more vulnerable housing development (e.g. bungalows) is located well away from Flood Zones 2 and 3. The vulnerability from other sources of flooding should be considered as well as the effect of the new development on surface water runoff (see below).

Developments should seek 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 on the 'use' proposed for future developments within the Low Probability Flood Zone 1, although the vulnerability from other sources of flooding should be considered as well as the effect of the new development on surface water runoff. An FRA 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 the Telford and Wrekin Sustainable Drainage Systems Review document, Halcrow (2008) for further details on appropriate SUDS techniques for the Telford and Wrekin area). For all sites, the post development runoff volumes and peak flow rates should be attenuated (1 in 100 year + climate change) to the Greenfield (pre-development) condition with a minimum reduction of 20%, and mimic the surface water flows arising from the site prior to the proposed development.

Options for de-culverting along the Hurley Brook should be explored wherever possible. In the event that this is not possible, an assessment of the structural integrity of the culverts should be carried out prior to any development in the vicinity. Any remedial works to ensure the culverts' longevity (commensurate with the lifetime of the development) should be carried out. Developer contributions should be sought for this purpose.

The Council should develop a culvert maintenance schedule, to periodically clear culverts (maintained by/on land owned by Telford and Wrekin Council) of debris, which will reduce the risk of blockage during flood events. For culverts on privately owned land, land owners should be encouraged by the Council to also maintain and periodically clear culverts of debris to reduce the risk of blockage during flood events.

11.4 Crow Brook

Planning Recommendations for the Development Areas

The culvert upstream of Middle Pool has insufficient capacity to convey all modelled events, which causes site **471** to be subject to flood risk from all events, as well as major roads in the area. Options to increase the capacity of this culvert, or provide a formal upstream storage area, should be explored where the opportunity arises, in order to mitigate flood risk to site **471**. If this can be achieved, without increasing flood risk elsewhere, then the development of site **471** may become feasible. Developer contributions could be sought for this purpose.

Middle Pool is shown to overtop at the north eastern corner for the 1 in 1000 year event, contributing to flood risk along the A442. Prior to the allocation of Site **471,** this risk should be investigated further (through a detailed FRA) and mitigating actions to reduce this risk identified and carried out.

The eastern, western and southern sides of Trench Pool are at ground level and do not pose a breach risk to surrounding development sites. However, along the northern side, Trench Pool is shown to be raised some 3-4m above the surrounding residential houses. Although a potential breach is unlikely to affect any of the potential development sites, breach analysis should be requested for any future development immediately north of Trench Pool. It may be prudent to carry out this exercise to inform emergency plans for the residential area to the north.

The previous JFLOW outlines showed site **100-SHLAA** and the **EMP4 POR** sites (**61900, 62060** and **62070**) to be at risk of flooding from the 100 and 1000 year

events. The updated modelling has included the diverted channel, and confirms that these sites are fully in Flood Zone 1. These sites will be suitable for development, however, a detailed FRA will be required to confirm the sites' placement in Flood Zone 1.

All other sites along the Crow Brook which are shown to be marginally affected by flood risk, should only be developed if the Sequential Test is passed and it can be demonstrated that there are no other available sites lying fully in Flood Zone 1.

Where such sites are allocated for development, the Council should adopt the principle of **avoidance** by ensuring that areas affected by Flood Zones 2, 3a and 3b remain as open space. The avoidance of flood risk is important in the development of sustainable communities and will deliver a positive reduction in flood risk by reducing the impact that flooding may have on the community (by reducing the number of people within the site that would otherwise be at risk). It can also help the Council to achieve green space targets.

The exception to this applies to site **414** and Employment sites **EMP3-POR** (5 sites). For these sites, the 1000 year event is shown to have a low flood hazard. These sites could therefore be developed including Flood Zone 2, in accordance with Table D3 of PPS25, provided the Sequential Test is passed (i.e. it can be demonstrated that there are no other alternative sites fully in Flood Zone 1). If so, the development could proceed provided the requirements for development in Flood Zone 2 (Section 11.9) are followed.

All sites will require application of the sequential approach at the site level (sequential design) to ensure that the more vulnerable housing development (e.g. bungalows) is located well away from Flood Zones 2 and 3. The vulnerability from other sources of flooding should be considered as well as the effect of the new development on surface water runoff (see below).

Developments should seek 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 on the 'use' proposed for future developments within the Low Probability Flood Zone 1, although the vulnerability from other sources of flooding should be considered as well as the effect of the new development on surface water runoff. An FRA 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 the Telford and Wrekin Sustainable Drainage Systems Review document, Halcrow (2008) for further details on appropriate SUDS techniques for the Telford and Wrekin area). For all sites, the post development runoff volumes and peak flow rates should be attenuated (1 in 100 year + climate change) to the Greenfield (pre-development) condition with a minimum reduction of 20%, and mimic the surface water flows arising from the site prior to the proposed development.

Options for de-culverting along the Crow Brook should be explored wherever possible. In the event that this is not possible, an assessment of the structural integrity of the culverts should be carried out prior to any development in the vicinity. Any remedial works to ensure the culverts' longevity (commensurate with the lifetime of the development) should be carried out. Developer contributions should be sought for this purpose.

The Council should develop a culvert maintenance schedule, to periodically clear culverts (maintained by/on land owned by Telford and Wrekin Council) of debris, which will reduce the risk of blockage during flood events. For culverts on privately owned land, land owners should be encouraged by the Council to also maintain and periodically clear culverts of debris to reduce the risk of blockage during flood events.

11.5 ***Wall Brook***

Planning Recommendations for the Development Areas

It is clear that flood risk along the Wall Brook (also cited as Donnington Watercourse) is exacerbated by a series of culverts which have insufficient capacity to convey flood flows for all return periods up to and including the 1 in 1000 year event, hence presenting residual risk. Options to increase the capacity of the culverts, or provide an upstream storage area, should be explored where the opportunities arise, in order to mitigate flood risk downstream. If this can be achieved, without increasing flood risk elsewhere, then the development of site **482** may become feasible. Developer contributions could be sought for this purpose. If flood risk is not mitigated, site **482** is not deemed suitable for development given the degree of flood risk currently posed across the site.

All sites along the Wall Brook which are shown to be marginally affected by flood risk should only be developed if the Sequential Test is passed and it can be demonstrated that there are no other available sites lying fully in Flood Zone 1.

Where such sites are allocated for development, the Council should adopt the principle of **avoidance** by ensuring that areas affected by Flood Zones 2, 3a and 3b remain as open space. The avoidance of flood risk is important in the development of sustainable communities and will deliver a positive reduction in flood risk by reducing the impact that flooding may have on the community (by reducing the number of people within the site that would otherwise be at risk). It can also help the Council to achieve green space targets.

All sites will require application of the sequential approach at the site level (sequential design) to ensure that the more vulnerable housing development (e.g. bungalows) is located well away from Flood Zones 2 and 3. The vulnerability from other sources of flooding should be considered as well as the effect of the new development on surface water runoff (see below).

Developments should seek 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 on the 'use' proposed for future developments within the Low Probability Flood Zone 1, although the vulnerability from other sources of flooding should be considered as well as the effect of the new development on surface water runoff. An FRA 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 the Telford and Wrekin Sustainable Drainage Systems Review document, Halcrow (2008) for further details on appropriate SUDS techniques for the Telford and Wrekin area). For all sites, the post development runoff volumes and peak flow rates should be attenuated (1 in 100 year + climate change) to the Greenfield (pre-development) condition with a minimum reduction of 20%, and mimic the surface water flows arising from the site prior to the proposed development.

Options for de-culverting along the Wall Brook should be explored wherever possible. In the event that this is not possible, an assessment of the structural integrity of the culverts should be carried out prior to any development in the vicinity. Any remedial works to ensure the culverts' longevity (commensurate with the lifetime of the development) should be carried out. Developer contributions should be sought for this purpose.

The Council should develop a culvert maintenance schedule, to periodically clear culverts (maintained by/on land owned by Telford and Wrekin Council) of debris,

which will reduce the risk of blockage during flood events. For culverts on privately owned land, land owners should be encouraged by the Council to also maintain and periodically clear culverts of debris to reduce the risk of blockage during flood events.

11.6 ***Wesley Brook Tributary***

Planning Recommendations for the Development Areas

The area currently shown to be acting as an informal flood storage area at the upstream modelled extent (north of Queen Elizabeth Avenue) should be safeguarded from development, and maintained and operated as such (by the Council). This discounts the feasibility of site **155** for development.

Residual risk is posed to site **156** as a series of embankments located around the edge of the site are shown to hold back flood water for all modelled return periods. The FRA will require a detailed assessment of the embankments ability to hold back water, in line with the requirements set out in paragraph 7.16 of the PPS25 Practice Guide (2008), and should confirm the flood extents and levels which are shown the affect the sites.

Prior to the allocation of any development downstream of the railway line, the Council should liaise with Network Rail to ascertain the future maintenance and use of the railway embankment, which provides an informal defence and is shown to hold back flood water, creating an informal storage area.

Provided the future maintenance and use of the railway line is ascertained and the nature of the railway line is shown not to change in the future (which may increase flood risk downstream) development downstream would be acceptable, only in line with the recommendations in the Level 2 SFRA (Appendix B). The FRA for sites **229** and **607** will require a detailed assessment of the embankments ability to hold back water, in line with the requirements set out in paragraph 7.16 of the PPS25 Practice Guide (2008), and should confirm the flood extents and levels which are shown the affect the sites.

The extent of flood affected areas on site **229** restricts the area available for development. It is therefore recommended that alternative sites in Flood Zone 1 are developed in preference to site **229**.

All other sites along the Wesley Brook Tributary which are shown to be marginally affected by flood risk should only be developed if the Sequential Test is passed and

it can be demonstrated that there are no other available sites lying fully in Flood Zone 1.

Where such sites are allocated for development, the Council should adopt the principle of **avoidance** by ensuring that areas affected by Flood Zones 2, 3a and 3b remain as open space. The avoidance of flood risk is important in the development of sustainable communities and will deliver a positive reduction in flood risk by reducing the impact that flooding may have on the community (by reducing the number of people within the site that would otherwise be at risk). It can also help the Council to achieve green space targets.

All sites will require application of the sequential approach at the site level (sequential design) to ensure that the more vulnerable housing development (e.g. bungalows) is located well away from Flood Zones 2 and 3. The vulnerability from other sources of flooding should be considered as well as the effect of the new development on surface water runoff (see below).

Developments should seek 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 on the 'use' proposed for future developments within the Low Probability Flood Zone 1, although the vulnerability from other sources of flooding should be considered as well as the effect of the new development on surface water runoff. An FRA 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 the Telford and Wrekin Sustainable Drainage Systems Review document, Halcrow (2008) for further details on appropriate SUDS techniques for the Telford and Wrekin area). For all sites, the post development runoff volumes and peak flow rates should be attenuated (1 in 100 year + climate change) to the Greenfield (pre-development) condition with a minimum reduction of 20%, and mimic the surface water flows arising from the site prior to the proposed development.

11.7 ***Mad Brook***

Planning Recommendations for the Development Areas

A formal flood storage area exists downstream of Holmer Lake. This area should be safeguarded from development, and maintained and operated as such (by the Council). This discounts the feasibility of site **EMP8-POR (Halesfield 24, also Cemetery site 2)** for development.

All other sites along the Mad Brook which are shown to be marginally affected by flood risk should only be developed if the Sequential Test is passed and it can be demonstrated that there are no other available sites lying fully in Flood Zone 1.

Where such sites are allocated for development, the Council should adopt the principle of **avoidance** by ensuring that areas affected by Flood Zones 2, 3a and 3b remain as open space. The avoidance of flood risk is important in the development of sustainable communities and will deliver a positive reduction in flood risk by reducing the impact that flooding may have on the community (by reducing the number of people within the site that would otherwise be at risk). It can also help the Council to achieve green space targets.

The exception to this is sites **EMP8-POR** (**60200** and **60220**) where modelling has shown that the flood risk posed to these sites is a consequence of surface water runoff following a flow route across the industrial estate (the actual watercourse is culverted in this location). The flood hazard is low for each of these sites. Providing the Sequential Test can be passed (i.e. it can be demonstrated that sites fully in Flood Zone 1 are not available), these sites could be developed in accordance with Table D3 of PPS25 and using the guidance for development in Flood Zones 2 and 3a (Section 11.9).

All sites will require application of the sequential approach at the site level (sequential design) to ensure that the more vulnerable housing development (e.g. bungalows) is located well away from Flood Zones 2 and 3. The vulnerability from other sources of flooding should be considered as well as the effect of the new development on surface water runoff (see below).

Developments should seek 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 on the 'use' proposed for future developments within the Low Probability Flood Zone 1, although the vulnerability from other sources of flooding should be considered as well as the effect of the new development on surface water runoff. An FRA 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 the Telford and Wrekin Sustainable Drainage Systems Review document, Halcrow (2008) for further details on appropriate SUDS techniques for the Telford and Wrekin area). For all sites, the post development runoff volumes and peak flow rates should be attenuated (1 in 100 year + climate

change) to the Greenfield (pre-development) condition with a minimum reduction of 20%, and mimic the surface water flows arising from the site prior to the proposed development.

Options for de-culverting along the Mad Brook should be explored wherever possible. In the event that this is not possible, an assessment of the structural integrity of the culverts should be carried out prior to any development in the vicinity. Any remedial works to ensure the culverts' longevity (commensurate with the lifetime of the development) should be carried out. Developer contributions should be sought for this purpose.

The Council should develop a culvert maintenance schedule, to periodically clear culverts (maintained by/on land owned by Telford and Wrekin Council) of debris, which will reduce the risk of blockage during flood events. For culverts on privately owned land, land owners should be encouraged by the Council to also maintain and periodically clear culverts of debris to reduce the risk of blockage during flood events.

11.8 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 for both allocated and non-allocated 'windfall' sites. The following policy objectives are recommended for all sites in Telford and Wrekin Council:

- **Application of the Sequential Test** - Use the Sequential Test to locate all new development (site allocations) in least risky areas, giving highest priority to Flood Zone 1. Where the Sequential Test alone cannot deliver acceptable sites, the Exception Test will need to be applied.

- **Protect the functional floodplain (in Greenfield and previously developed areas) –** Avoid development in the Greenfield functional floodplain in the first instance. Identify opportunities for making space for water on previously developed areas by reinstating the functional floodplain.

- **Site Layout** - apply the sequential approach within the development site by locating the most vulnerable elements of a development in the lowest flood risk areas in the first instance. The use of flood risk areas (i.e. Flood Zones 2, 3a and 3b) 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.

- **Enhance and restore the river corridor** - identify opportunities to undertake river restoration and enhancement as part of a development to make space for water.

- **De-culvert wherever possible.** Where this is not possible, an assessment of the structural integrity of the culvert, with any required remedial work, should be carried out prior to the development. A maintenance schedule should be developed for all culverts to ensure regular clearance.

- **Set development back from watercourses -** any riverside developments should leave a minimum 8 metre wide as undeveloped buffer strip, maintaining the river and its floodplain as an enhancement feature and allowing for routine maintenance.

- **Reduce surface water runoff from new developments –** any development must ensure that post development runoff volumes and peak flow rates are attenuated to the Greenfield (pre-development) condition with a minimum reduction of 20%. SUDS should also be a requirement for all new development and space should be specifically set-aside for SUDS and used to inform the overall site layout. Hardstanding areas should be kept to a minimum and infiltration techniques and re-use of water should be considered before attenuation devices in accordance with the SUDS hierarchy. SUDS will need to have a maintenance strategy to ensure they are maintained and working efficiently.

- **Sequential approach to the release of development land** - Brownfield land should be developed in advance of Greenfield sites (NB. In the first instance, the sequential test should be applied prior to considering the release of land to determine which type of land is the safer option in terms of flood risk).

- **Maintenance of existing flood storage areas, both formal and informal** – existing storage areas should be maintained and safeguarded from development.

- **Maintenance of water channels –** New developments adjacent to watercourses should have a maintenance strategy for clearing and maintaining the channel, in particular structures such as trash screens and bridges.

- **Ensure a development is 'Safe' -** For residential developments to be classed as 'safe', dry pedestrian access should be provided to and from the development without crossing through the 1 in 100 year plus climate change floodplain.

In addition, the following guidance should be followed:

11.9 ***Requirements for Flood Risk Assessments and Guidance for Dealing with Windfall Sites***

The following reflects the minimum requirements under PPS25 for a Flood Risk Assessment (reference should be made to Tables D.1-D.3 in PPS25). Appendices A and B outlines FRA requirements for specific development sites, which should also be considered. This guidance could also be used to help the Council to deal with non-allocated 'windfall' sites.

Sites in Flood Zone 1

The majority of sites fall entirely in Flood Zone 1, with no known local flood risk issues. In many cases sites fall in Flood Zone 1 but have a small drain flowing through it, with no associated Flood Zone information. This section details the requirements for development in Flood Zone 1. Some sites may have specific recommendations, in addition to those put forward here, which are detailed in Appendices A and B.

- In accordance with Table D3 of PPS25, any type of development can be located in Low Probability Flood Zone 1.

- The vulnerability of the development from other sources of flooding should be considered as well as the effect of the new development on surface water runoff. The Level 1 SFRA, Telford and Wrekin Council SUDS Report and proposed Water Cycle Strategy provide information on other sources of flooding.

- The potential to increase flood risk elsewhere through the addition of hard surfaces and the effect of the new development on surface water runoff, with appropriate mitigating action, should be incorporated in a Flood Risk Assessment (FRA) for the site. This should take the form of a Drainage

Impact Assessment (DIA), required to demonstrate that runoff from the site is the same as in the predevelopment case, thereby ensuring flood risk is not increased (though wherever possible, betterment should be achieved). This will involve the use of SUDS techniques which should take into account the local geological and groundwater conditions. Where possible these should be strategic SUDS. Space should also be set-aside for SUDS at the master planning stage. The Council/developer should refer to the Telford and Wrekin Sustainable Drainage Systems Review document, Halcrow (2008) for further details on appropriate SUDS techniques for the Telford and Wrekin area.

- Reference should be made to the Telford Integrated Urban Drainage (IUD) Project for specific information on surface water issues.

- Where a small watercourse or drain, with no Flood Zone information, either runs through the site or follows the boundary of the site, a development easement from the top of bank should be applied. The exact distance of the easement should be discussed with the Environment Agency, but should typically be 8m, to allow appropriate access for routine maintenance and emergency clearance.

Sites in Flood Zone 2

The majority of sites which are affected by Flood Zone 2 are only affected in a minor way, for example, Flood Zone 2 might encroach a small part of a site (details of how this should be dealt with are given below). Where sites are substantially affected by Flood Zone 2, alternative sites in Flood Zone 1 should be considered in preference as part of the Sequential Test process. Specific recommendations for each affected site are given in Appendices A and B.

- In accordance with Table D3 of PPS25, land use within Medium Probability Flood Zone 2 should be restricted to the 'essential infrastructure', 'water compatible', 'less vulnerable' and 'more vulnerable' categories. Only if the Sequential Test process has been carried out and passed should such development occur in Flood Zone 2.

- 'Highly vulnerable' uses in Flood Zone 2 will have to pass the Exception Test.

- An FRA will be required, which should confirm flood extents and levels.

- Floor levels should be situated above the 100 year plus climate change predicted maximum level plus a minimum freeboard of 600mm.

- Dry pedestrian access to and from the development should be possible above the 1 in 100 year plus climate change flood level.

- The development should be safe, meaning that: people (including those with restricted mobility) should be able to remain safe inside the new development up to a 1 in 1000 year event; and rescue and evacuation of people from a development (including those with restricted mobility) to a place of safety is practicable up to a 1 in 1000 year event.

- The development should incorporate flood resistance and resilience measures.

- 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.

- SUDS should be implemented to ensure that runoff from the site (post development) is reduced. Space should be set-aside for SUDS at the master planning stage. The Council/developer should refer to the Telford and Wrekin Sustainable Drainage Systems Review document, Halcrow (2008) for further details on appropriate SUDS techniques for the Telford and Wrekin area.

- Reference should be made to the Telford Integrated Urban Drainage (IUD) Project for specific information on surface water issues.

- Residents should be made aware that they live in a flood risk area, and should be encouraged to sign up to Floodline Warnings Direct, should a Flood Warning system exist (as indicated by the Level 1 SFRA).

- Car parking needs to be safe, especially in terms of flood warning and overnight parking areas.

Sites in Flood Zone 3a

There are only a few sites which are substantially affected by Flood Zone 3a, in which case it has been recommended that alternative sites in lower risk areas are considered. For most watercourses in the Borough, Flood Zone 3b has not been modelled. Therefore when carrying out the Sequential Test the Council should

assume that where Flood Zone 3b has not been modelled, its extent would be equal to Flood Zone 3a, unless, or until, an FRA can demonstrate otherwise.

Therefore wherever possible, development in Flood Zone 3a should be avoided, due to the reduction in flood storage that can result and the increased flood risk which can occur as a result of climate change. However, for the sake of completion and for future reference, the following recommendations are put forward for development of Flood Zone 3a:

- Land use with High Probability Flood Zone 3a should be restricted to the 'less vulnerable' and 'water compatible' uses to satisfy the requirements of the Sequential Test.
- 'More vulnerable' uses in Flood Zone 3a will have to pass the Exception Test.
- An FRA should be prepared for the site, which should confirm flood extents and levels.
- 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 (though it should be noted that no raised defences currently exist in the Borough). The nature of any breach failure analysis should be agreed with the Environment Agency. For breaches of canals, British Waterways should be consulted.
- The development should not increase flood risk elsewhere, and opportunities should be taken to decrease overall flood risk.
- Floor levels should be situated above the 100 year plus climate change predicted maximum level plus a minimum freeboard of 600mm.
- Dry pedestrian access to and from the development should be possible above the 1 in 100 year plus climate change flood level.
- The development should be safe, meaning that: people (including those with restricted mobility) should be able to remain safe inside the new development up to a 1 in 1000 year event; and rescue and evacuation of people from a development (including those with restricted mobility) to a place of safety is practicable up to a 1 in 1000 year event.
- The development should incorporate flood resistance and resilience measures.

- 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 600 mm above the 1 in 100 year flood level plus climate change.

- An evacuation plan should be prepared in consultation with the Council's Emergency Planning team.

- Residents should be made aware that they live in a flood risk area, and should be encouraged to sign up to Floodline Warnings Direct, should a Flood Warning system exist (as indicated by the Level 1 SFRA).

- 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.

- SUDS should be implemented to ensure that runoff from the site (post development) is reduced. Space should be set-aside for SUDS at the master planning stage. The Council/developer should refer to the Telford and Wrekin Sustainable Drainage Systems Review document, Halcrow (2008) for further details on appropriate SUDS techniques for the Telford and Wrekin area.

- Reference should be made to the Telford Integrated Urban Drainage (IUD) Project for specific information on surface water issues.

Sites in Flood Zone 3b

Where a modelled outline for Flood Zone 3b has not been produced, its extent is equal to Flood Zone 3a. Therefore for any development site falling in Flood Zone 3a with no 3b available, this section should be used to understand the requirements of development.

- Development in High Probability Flood Zone 3b should be restricted to 'water-compatible uses' only.

- PPS25 dictates that 'essential infrastructure' can be located in Flood Zone 3b if the Exception test is passed. However, appropriate judgement should be exercised when attempting the Exception Test for essential infrastructure in Flood Zone 3b. Essential infrastructure includes: 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. Essential transport infrastructure may be appropriate if designed in such a way that flood flow routes and flood storage areas are not affected (e.g. designing a bridge to cross the flood risk area). However, utility infrastructure may be less appropriate due to the potential consequences that may occur should the utility site become flooded (as demonstrated by the flooding of Mythe Treatment Works and near-flooding of the power station in Gloucestershire during the summer 2007 flood events).

- 'Essential infrastructure' in this zone must be designed and constructed to remain operational in times of flood and not impede water flow.

11.10 ***Guidance on the use of Level 2 SFRA Flood Zone Data***

The modelling approach adopted by the Level 2 SFRA follows the Environment Agency SFRA guidance, but it should be noted that this method varies somewhat to the Environment agency's own flood mapping approach.

The Environment Agency's original Flood Zone philosophy uses a quasi 2D hydraulic modelling package in conjunction with a digital terrain model (DTM). The DTM is filtered to remove flood defences as well as defacto defences (man-made barriers to flow) to create 'undefended' flood maps. This is a key difference to Level 2 SFRA modelling, which, in accordance with PPS25 guidance, states that the presence of flood risk management measures should be taken into account in modelling exercises (thereby producing 'defended' flood maps). The Environment Agency's approach is precautionary and in many instances derives a hypothetical flood regime. Since publication of the flood maps in 2004 there have been many challenges to the original philosophy, in particular with regard to the presence of defacto defences. The Environment Agency's position now on the status of defacto defences within their flood mapping is to generate a combination map showing a worst case scenario of the undefended and defended situation. This approach aims to highlight the risks of both the current situation merged with some possible future scenario where a defence has failed or been removed.

The Environment Agency agrees that the new Flood Zone outputs generated within the Level 2 SFRA (Volume 2) will provide very useful information upon which informed decisions on the location and layout of future development. The Environment Agency notes, however, that the new Flood Zone information should be used in conjunction with the existing zone mapping; in particular, the Environment Agency's flood mapping and development control teams will look to

use it as a complimentary dataset. The new Level 2 SFRA Flood Zone information should be used by the Council to carry out the Sequential and Exception tests. This would be supported where appropriate with a detailed FRA from the developer.

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12 Glossary

1) Breach Hazard/Analysis – Hazard attributed to flooding caused by the constructional failure of a flood defences or other structure that is acting as a flood defence.

2) CFMP – Catchment Flood Management Plan. A CFMP is a high-level strategic plan through which the Environment Agency seeks to work with other key-decision makers within a river catchment to identify and agree long-term policies for sustainable flood risk management.

3) 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.

4) Culvert - A closed conduit used for the conveyance of surface drainage water under a roadway, railroad, canal, or other impediment

5) Defra - Department of Environment, Food and Rural Affairs Development

6) DG5 Register - A register of properties at risk from sewer flooding maintained by UK water companies.

7) DPD - Development Plan Document. A DPD is 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.

8) Dry pedestrian egress - Routes to and from buildings that will remain dry and allow pedestrian/wheelchair evacuation to dry land in times of flood.

9) DTM – Digital Terrain Model.

10) Environment Agency - The leading public body for protecting and improving the environment in England and Wales.

11) 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. PPS25 sets out strict requirements for the application of the Test.

12) Flood Estimation Handbook (FEH) - The latest hydrological approach for the estimate of flood flows in UK.

13) Flood Defence – Natural or man-made infrastructure used to reduce the risk of flooding

14) Flood Risk – Flood risk is a combination of two components: the chance (or probability) of a particular flood event and the impact (or consequence) that the event would cause if it occurred

15) FRA – Flood Risk Assessment. Assessment of flood risk posed to a defined area (usually a new development site) as defined above.

16) Flood Risk Management – Flood risk management can reduce the probability of occurrence through the management of land, river systems and flood defences and reduce the impact through influencing development on flood risk areas, flood warning and emergency response.

17) Flood Risk Vulnerability - PPS25 provides a vulnerability classification to assess which uses of land maybe appropriate in each flood risk zone.

18) Flood Warning – A system maintained by the Environment Agency to enable warning messages to be sent to homeowners and businesses over the telephone network when floods are likely.

19) Formal Flood Defence - A structure built and maintained specifically for flood defence purposes.

20) Flood Zones - Nationally consistent delineation of 'high' and 'medium' flood risk, published on a quarterly basis by the Environment Agency.

21) Functional Floodplain Zone 3b - Defined as areas at risk of flooding in the 5% AEP (1 in 20 year) design event. In any one year the chance of a 5% AEP (1 in 20 year) event occurring is 5%.

22) GIS – Geographic Information System. GIS is any system which stores geographical data, such as elevations, location of buildings and extent of flood outlines.

23) High probability Zone 3a - Defined as areas at risk of flooding in the 1% AEP (1 in 100 year) design event. In any one year the chance of a 1% AEP (1 in 100 year) event occurring is 1%.

24) 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).

25) Integrated urban drainage – An integrated approach to surface water management

26) JFLOW - A computer river model based on routeing 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.

27) LDD – Local Development Documents

28) 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.

29) LDF - Local Development Framework. The LDF consists of a number of documents which together form the spatial strategy for development and the use of land.

30) LDS – Local Development Scheme. A schedule and timetable for production of LDF documents.

31) Low Probability Zone 1 – The area outside Zone 2. Defined as an area with less that 0.1% AEP (1 in 1000 year) chance of flooding. In any one year the chance of a 1% AEP (1 in 100 year) event occurring is less than 0.1%.

32) LPA – Local Planning Authority

33) Main River – All watercourses shown on the statutory main river maps held by the Environment Agency and the Department for Environment, Food and Rural Affairs. This can include any structure or appliance for controlling or regulating the flow of water into, in or out of the channel. The Environment Agency has permissive power to carry out works of maintenance and improvement on these rivers.

34) '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.

35) Medium probability Zone 2 - Defined as an area at risk of flooding from flood events that are greater than the 1% AEP(1 in 100 year), and less than the 0.1% AEP (1 in 1000 year) design event. The probability of flooding occurring in this area in any one year is between 1% and 0.1%.

36) Minor River - Every river, stream, ditch, drain, cut, dyke, sluice, sewer (other than a public sewer) and passage through which water flows and which does not form part of a main river. The local authority or Internal Drainage Board (IDB) where relevant, has powers for ordinary watercourses.

37) mAOD – Metres Above Ordnance Datum

38) NGR – National Grid Reference

39) OS - Ordnance Survey

40) Ordinary Watercourse (non-main river, minor watercourse) – Any section of watercourse not designated as a Main River.

41) PPS - Planning Policy Statements. The Government has updated its planning advice contained within Planning Policy Guidance Notes with the publication of new style Planning Policy Statements.

42) PPS 25 - Planning Policy Statement 25: Development and Flood Risk. PPS 25 reflects the general direction set out in 'Making Space for Water'.

43) 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.

44) Residual Risk - The risk which remains after all risk avoidance, reduction and mitigation measures have been implemented.

45) Return Period – The probability of a flood of a given magnitude occurring within any one year e.g. a 1% AEP (1 in 100 year) event has a probability of occurring once in 100 years, or a 1% chance in any one year. However, a 1% AEP (1 in 100 year) event could occur twice or more within 100 years, or not at all.

46) RSS - Regional Spatial Strategy. The RSS for Telford and Wrekin is the West Midlands RRS, a regional planning policy providing the overarching framework for the preparation of LDFs. It provides a broad development strategy for the West Midlands region up to 2026.

47) SA - Sustainability Appraisal. An SA is an appraisal of plans, strategies and proposals to test them against broad sustainability objectives.

48) SAAR – Standard-period Annual Average Rainfall.

49) 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.

50) SEA - Strategic Environmental Assessment.

51) SFRA - Strategic Flood Risk Assessment. An SFRA 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.

52) SPD - Supplementary Planning Document. An 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.

53) SPRHOST – Standard percentage runoff from the Hydrology of Soil Types classification.

54) SoP – Standard of Protection. The return period against which a defence offers protection.

55) SFRM – Strategic Flood Risk Management. An Environment Agency framework typically used to carry out flood mapping and CFMP studies.

56) SUDS – Sustainable Urban Drainage Systems. SUDS are drainage systems which are designed to reduce the impact of urbanisation on the hydrology of a river system.

57) 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)

58) TUFLOW – A 2D hydraulic modelling package

59) UK Flood Hazard – a measure of hazard of a given flood event, calculated by using the following equation from Defra's Flood Risks to People – Phase Two Document (FD2321/ TR2) (2006). Hazard is calculated as follows:

Hazard = d x (v + 0.5) + DF

Where **d = depth (m)**

V = velocity (m/s)

DF = debris factor

60) URBEXT – Urban Extent. A measure of the urban extent in a given catchment.

Appendix A

Assessment of all possible allocations

See separate document

Appendix B

Assessment of all possible allocations in the vicinity of modelled areas

See separate document

Appendix C

Sequential Test and Exception Test Process

Appendix D

Hydrological Approach Technical Note

Appendix E

Hydraulic Approach Technical Note

Appendix F

Site Visit Technical Notes x2

Appendix G

Environment Agency Sign-off Letter