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Flood Risk Assessment

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Report Date: 1st March 2012

TABLE OF CONTENTS

1.0 INTRODUCTION 1
1.1 Objectives 1
1.2 The Site 1
1.2.1 The Existing Site 1
1.2.2 Development Proposals 1
1.3 Requirements for a Flood Risk Assessment 2
1.3.1 PPS25 2
1.3.2 Environment Agency Guidance 2
1.4 Previous Communication with the LPA 3
1.5 Report Structure 4
2.0 FLOOD RISK 5
2.1 Fluvial Flood Maps 5
2.1.1 Flood Alleviation Measures 5
2.1.2 Historical Flooding 5
2.1.3 Estimated Flood Levels 6
2.2 Other Sources of Flooding 6
2.3 Implications for the Proposed Development 8
2.3.1 Floor Levels 8
2.3.2 Speed and Duration of Flooding 8
2.3.3 Safe Escape 8
2.3.4 Volume of Displacement 8
2.3.5 Flood Defences 9
2.3.6 Flood Resilience and Resistance 9
3.0 SITE RUNOFF AND SUDS 10
3.1 Existing Site Runoff 10
3.1.1 Drainage Areas and Runoff 10
3.1.2 Design Storms 10
3.2.3 Peak Flows and Volumes 10
3.2 Post Development Runoff 11
3.2.1 Land Use Changes 11
3.2.2 Peak Flows and Volumes 11
3.3 Sustainable Urban Drainage Systems 12
3.3.1 Principles of Sustainable Urban Drainage Systems 12
3.3.2 Source Control Techniques 12
3.3.3 Permeable Conveyance Systems 14
3.3.4 Passive Treatment Systems 14
3.3.5 Preferred Option 16
4.0 PLANNING POLICY GUIDANCE 16
4.1 Appropriate Development 16
4.2 The Sequential Test 16
4.3 Exception Test 17

FIGURES

Figure 1.1 Location Plan
Figure 1.2 Aerial Photograph of Existing Site
Figure 1.3 Topographical Survey
Figure 1.4 Existing and Proposed Site Plan
Figure 1.5 Flood Map
Figure 3.1 Bed Rock Geology
Figure 3.3 Hydrographs
Figure 3.4 Hydrographs

1.0 INTRODUCTION

1.1 Objectives

The proposals, the subject of this Flood Risk Assessment (FRA) report, are for the demolition and rebuild of the property known as Whitehaven. This FRA report is designed to provide the necessary flood risk evidence to support the planning application.

1.2 The Site

1.2.1 The Existing Site

The proposed development site is located at Whitehaven on the south side of Brook Lane (Figure 1.1) located in a mainly rural area south of Botley. The existing site comprises a detached dwelling with an adjacent garage and outbuilding (Figure 1.2) with car parking and an access driveway onto Brook Lane to the north and a large rear garden to the south.

The total site covers an area of 1,629m^2 (0.163 ha) of which the buildings and other impermeable hard-standing areas cover 415m^2 or 25.5% of the site area (Table 1.1). The remaining 1,214m^2 is covered by gardens and landscaped areas.

Table 1.1 Existing Site Components

Component	Impermeable Areas (m^2)	Permeable Areas (m^2)	Total Area (m^2)
House	161		
Garage	24		
Outbuilding	22		
Drive	208		
Gardens		1214	
Total	**415**	**1214**	**1629**

A topographical survey of the site (Figure 1.3) indicates that ground elevations fall from 11.45m OD on the northern part of the site to 9.82m OD adjacent to a watercourse at the southern and eastern ends of the garden. The existing building ground floor level is at 11.50m OD and the access driveway onto Brook Lane falls from 11.35m to 10.97m OD.

1.2.2 Development Proposals

The proposals are for the demolition of the existing buildings and the construction of a new detached dwelling (Figure 1.4) with integral garage. The property will be a chalet bungalow with roof space accommodation and a large patio area to the rear. The impermeable ground cover will increase from 415m^2 to 603m^2 once developed with a reduced permeable ground cover from 1214m^2 to 1026m^2 (Table 1.2).

Table 1.2 Proposed Development Components

Component	Impermeable Areas (m^2)	Permeable Areas (m^2)	Total Area (m^2)
House/Garage	316		
Patio	79		
Outbuilding	-		
Drive	208		
Gardens		1026	
Total	**603**	**1026**	**1629**

1.3 Requirements for a Flood Risk Assessment

As part of the planning application a Flood Risk Assessment (FRA) is required, the content of which is detailed by "Planning Policy Statement 25" (PPS25) and the specific requirements of the Environment Agency.

1.3.1 PPS25

PPS25 requires that a FRA should be submitted with a planning application to determine the risk of flooding at a development site and the likely impact on neighbouring sites. The FRA should address the requirements given in Appendix E of PPS25 and consider the vulnerability to flooding over the lifetime of the development (from fluvial, tidal and other sources) and show that the residual risks of flooding after flood management and/or mitigation measures are taken into account are acceptable. A FRA should also consider the potential increased surface water run-off from the addition of hard surfaces, and measures to reduce any impact on the site and to adjacent or surrounding properties.

1.3.2 Environment Agency Guidance

In addition the Environment Agency have produced Standing Advice which simplifies the requirements for a FRA according to the nature of the development and its location in relation to the flood zones - Zone 1 areas have a low risk, Zone 2 a medium risk and Zone 3 areas a high risk of flooding of greater than 1% a year.

The development site is located adjacent to a small watercourse and according to the Environment Agency's flood map part of the site lies in Flood Zone 2 and 3 with a medium to high probability of flooding (Figure 1.5). The EAs standing advice on flood risk indicates that for a site less than 1 ha in Flood Zone 3 a FRA should consider the EAs Guidance Note 3. This requires:

- A location plan (Figure 1.1).
- Existing and developed site plan (Figure 1.3).
- Topographical survey giving site levels to OD (Figure 1.4).

- Consideration of whether site falls in Zone 3b, the functional flood plain (Section 2.1).
- Flood alleviation measures, their state of maintenance and performance (Section 2.1).
- Information about all potential sources of flooding that may affect the site (Section 2.2).
- The impact of flooding on a site including: the likely rate or speed of flooding (Section 2.3).
- Safe access and exit can be provided for routine and emergency access (Section 2.34).
- An assessment of how the layout and form of development can be used to reduce or minimise flood risk (Section 2.3)
- The likely impact of any displaced water on third parties caused by alterations to ground levels or raising flood embankments (Section 2.3).
- The potential impact on form and structure of rivers or coastal areas, and the likely longer-term stability and sustainability of existing defences (Section 2.3).
- The remaining (known as residual) risks to the site after the construction of any necessary defences and the means of managing those (Section 2.3).
- Consideration of the proposal relative to any existing Strategic Flood Risk Assessment carried out by the local authority (Section 2.3).
- An assessment of the capacity of any drains or sewers, existing or proposed, on the site during various flood events (Section 3.1).
- An assessment of the volume of surface water run-off likely to be generated from the proposed development. (Section 3.2).
- Estimates should be made of how climate change could affect the probability and intensity of flood events (Section 3.2).
- Proposals for surface water management according to sustainable drainage principles, with the aim of not increasing, and where practicable, reducing the rate of runoff from the site as a result of the development (Section 3.3).
- Demonstrate that development meets the vulnerability criteria of PPS25 (Section 4).
- Consider whether the Exception Test and Sequential Test are required (Section 4).

1.4 Previous Communication with the LPA

A pre-planning enquiry was lodged with Eastleigh Borough Council on 27 January 2011. The Environment Agency's response, dated 13 February 2012 (Ref HA/2012/112658/01-L01), indicated they would object to this application and recommend refusal of planning permission as the application site lies within Flood Zone 2 and 3, defined by PPS25 as having a high risk of flooding. In the absence of a FRA the flood risks resulting from and to the proposed development are unknown and this is sufficient reason for a refusal of planning permission. This objection will be maintained until an adequate FRA has been submitted.

The Agency response is also on the understanding that the LPA is satisfied that the Sequential Test has been adequately demonstrated. This requires the LPA to consider whether the applicant has demonstrated there are no alternative sites available in a lower flood risk zone, in accordance with paragraph 17 of PPS25.

Under the Water Resources Act 1991, and the Southern Region Land Drainage and Sea Defence Byelaws, the prior written consent of the Environment Agency is required for any proposed works or structures, in, under, over or within 8 metres of the top of the bank of a main river or any proposed works or structures within 15 metres of a sea defence. This permission is separate from planning permission.

1.5 Report Structure

For this FRA details of the local hydrology and flooding history, fluvial and other sources, are given in Section 2 together with the implication of flood levels on the proposed development and consideration of a safe escape route. The calculation of the existing and developed site runoff and the use of sustainable urban drainage systems (SUDS) is given in Section 3. An interpretation of Planning Policy, detailing the Sequential and Exception Tests, is given in Section 4.

2.0 FLOOD RISK

2.1 Fluvial Flood Maps

PPS25 requires identification of all watercourses and water bodies that could influence local hydrology and hydraulics in times of flooding. The main potential source of flooding of the site is the nearby watercourse which runs in a west to east direction along the south and eastern boundary of the site (Figure 1.5). The overtopping of the banks of this watercourse could potentially lead to inundation of parts of the site during the extreme 100 year and 1000 year flood events.

2.1.1 Flood Alleviation Measures

The site is protected from this watercourse by being on raised ground above the top of the river banks. Otherwise there are no formal flood defences or walls to provide protection.

2.1.2 Historical Flooding

(I) Water Level Records

In terms of measured water levels and flows the Environment Agency operate no gauging stations in this small catchment. The nearest gauge is on the River Hamble at Frogmill (CEH Ref: 42011) which lies 2km north east of Botley. The extent of available flow data, based on the Environment Agency's latest Hiflows database, indicates this gauge has 37 years of record).

The available flow records provide a useful indication of the date and magnitude of major flood events in the area and the largest floods in the period of record occurred in November 2000 and February 1990 (Table 2.1). There are no known records of flooding of the development site on these dates.

Table 2.1 Largest Floods at Frogmill Gauging Station

Rank	Date	Flow (m^3/s)	Flow (m^3/s)
1	05 Nov 2000	12.938	1.307
2	03 Feb 1990	12.761	1.304
3	08 Dec 1994	11.765	1.284
4	24 Dec 1999	11.512	1.276
5	05 Jan 1998	10.806	1.253

(II) Historical Flood Events

The British Hydrological Society's "Chronology of British Hydrological Events" can also provide details of historic flooding but there is no evidence of flood events in the Botley area.

On the basis of the above there is therefore no direct, measured, historical, photographic or any other evidence of flooding of the development site, including the 1947 event which was the largest flood in the area in recent history.

2.1.3 Estimated Flood Levels

According to the EA flood map (Figure 1.5) the lower parts of the site lie in Flood Zone 3 with an annual probability of flooding of 1% per year (inside the 100 year flood level) and Flood Zone 2 inside the 0.1% extent (1000 year event).

Comparison of these flood extents with the topographic survey (Figure 1.3) indicates the 100 year flood level is around 11.0m OD and the 1000 year 11.20m which would flood the garden to the south and east. Only a small part of the existing garage would be flooded but with floor levels at 11.50m OD water would not enter the existing building. The site does not appear to fall within Zone 3b, the 20 year functional flood plain.

2.2 Other Sources of Flooding

PPS25 emphasises the need to consider other sources of flooding when planning a development and the SFRA has been referred to. For this site these other potential sources of flooding may include:

- Storm Water Flooding. This can occur when excess water runs off the surface of the land particularly during short but intense storms. Flooding occurs because the ground is unable to absorb the high volume of rain water or because the amount of water is greater than the capacity of the drainage system to take it away. This can also occur under wet antecedent conditions or on developed sites impermeable concrete and tarmac can be responsible for reduced infiltration and high runoff. The greenfield parts of the site have a low permeability, as reflected in the SPRHOST of 46.5%, and hence and the risk of flooding from this source is considered to be moderate. The proposals will include a new storm water drainage system over the developed parts of the site which will be designed to handle extreme storm events and so the risk of flooding form this source will be managed. In addition the proposed new buildings will have floor levels raised above local ground levels to prevent storm water ponding entering the building. The EA holds no records suggesting the site has been previously affected by surface water flooding and on the basis of the above the risk to the site from surface water flooding is considered to be low.

- Highway flooding can occur from intense rain storms on road surfaces when the amount of water arriving on the road is greater than the capacity of the drainage facilities that take it away. Exceptional rainfall, a road being in a low lying area, changes in runoff from adjacent fields and rivers overflowing are some situations that can lead to the road flooding or being waterlogged even when drains are in good working order. Material carried into the drains by floods can also lead to them becoming blocked when materials like mud are deposited on the road or when there is a heavy fall of leaves. Brook Lane is at a lower elevation than the proposed development site and the risk of flooding from this source is therefore considered to be low.

- Sewer flooding. This can occur when storm sewer or combined sewer networks become overwhelmed and the maximum capacity is reached. Higher flows are likely to occur during periods of prolonged rainfall, the autumn and winter months, when the capacity of the sewer systems is most likely to be reached. During summer periods sewers can become susceptible to blockage as the low flows are unable to transport solids which leads to the gradual build-up of solid debris. The Water Companies maintain a register of properties/areas which are at risk of flooding from the public sewerage system, shown on the DG5 Flood Register. There are no records of sewer flooding in this area. Brook Lane is at a lower elevation than the proposed development site and the risk of flooding from this source is considered to be low. There are no records of incidents of flooding as a result of surcharging of public sewers in the vicinity of the site. The risk of flooding from overflowing surface and/or foul water sewers is considered to be low.

- Flooding from Impounded Water Bodies. There are no impounded water bodies near the site and the risk of flooding from this source is considered to be low.

- The impact of rising sea levels at this site is considered to be minimal as it is far inland and at an elevation of 11m OD and above. This site is therefore not considered to be at risk of tidal flooding.

- Groundwater flooding is most likely in low-lying areas underlain by permeable rocks (e.g. Chalk or Sandstone) and occurs as water rises up through the underlying rocks or from water flowing from abnormal springs. This tends to occur after long periods of sustained high rainfall which can cause the water table to rise above normal levels and particularly in lower lying areas. The EA has no records indicating the site and surrounding area has flooded in the past from groundwater flooding. As the proposed development will not include basements, and that solid concrete ground floors will be used that are raised above local ground levels, the risk to the site from groundwater flooding is considered to be low.

Information about all potential sources of flooding that may affect the site have therefore been included in this FRA as required by the EAs Guidance Note 3.

2.3 Implications for the Proposed Development

2.3.1 Floor Levels

The existing development has a ground floor level at 11.5m OD which is 500mm above the 100yr flood level of 11.0m OD and 300mm above the 100 year flood level of 11.2m OD. If the ground floor levels of the new buildings are maintained as existing this 300mm freeboard will prevent these properties from being inundated during this extreme flood-events. These raised floor levels will also prevent ponding of rain water entering any building. The site layout and form of development will therefore reduce or minimise flood risk as required by the Agency's Guidance Note 3.

2.3.2 Speed and Duration of Flooding

PPS25 requires an assessment of the likely rate or speed with which flooding might occur, the order in which various parts of the location or site might flood and the likely duration of any flood events. As detailed above, it is anticipated that the development site will not flood during the present day 100 year event. For the more extreme 100 year event with climate change, as any flooding will be towards the top of the fluvial cycle it is likely that the speed of water entering the lower parts of the site, will be slow.

2.3.3 Safe Escape

The escape route from the site in the event of the 100 year plus climate change flood inundating the site is along Brook Lane which is above the 100 year flood level. This route will provide a dry means of escape to Zone 1 area through flood water not more than 200mm deep. From here escape would be made further along Brook Lane and from there to Zone 1 areas where services and facilities exist. Safe access and exit can therefore be provided for routine and emergency access as required by the Agency's Guidance Note 3.

2.3.4 Volume of Displacement

The volume of water which would be displaced from the site, before and after development, is usually compared to determine the need for compensatory storage. As the proposed development site lies above the 100 year flood level there is no requirement for compensatory storage. There will therefore be no loss of flood plain storage, no additional displaced water and no change in the flooding potential for upstream and downstream sites. There will be no impact of any displaced water on third parties caused by alterations to ground levels or raising flood embankments.

2.3.5 Flood Defences

There will be no impact on form and structure of rivers or coastal areas or on long-term stability and sustainability of existing defences as no works nears any defences are proposed. There are therefore no residual risks to the site as there will no construction of any defences.

2.3.6 Flood Resilience and Resistance

Flood risk can also be managed either by reducing the probability of flood water entering a site or building (flood resistance) or reducing the consequences when a site or building is flooded (flood resilience). The preferred approach depends on the predicted water depths and with flood depths of less than 0.3m, and for short duration floods, the preferred strategy is to adopt a 'flood resistant' approach and try to keep water out of any building. This can include ramps and rims at site entrances, raised floor levels, building walls and floors with low permeability materials to reduce the rate of water ingress into a property, with minimal (or no) damage or deformation.

For this site these flood resistance measures aim to prevent flood water from entering the property and damaging its fabric. The ground floor levels will be set 500mm above the 100 year flood level of 11.0m OD at 11.5m OD.

The requirements of the EAs Guidance Note 3 have therefore been considered.

3.0 SITE RUNOFF AND SUDS

As part of the FRA the run-off from the existing site and that likely to be generated once the development has been completed are compared based on rainfall data provided in the Flood Estimation Handbook (FEH). For previously developed areas the Agency require no increase in peak flows and for these to be maintained at the existing rate. The existing site and developed site peak flows and volumes are considered below and the use of Sustainable Urban Drainage Systems (SUDS) to reduce the developed site flows to the existing rate detailed in Section 4.

3.1 Existing Site Runoff

The Rational Method can also be used to provide peak flows for the existing site based on the drainage area, the percentage runoff and rainfall intensity for an appropriate storm duration.

3.1.1 Drainage Areas and Runoff

The site plans and topographical survey (Figure 1.3) suggest the area can be considered as a single sub-catchment which currently drains to a storm sewer network and the local watercourse. The catchment boundary is assumed to be provided by the site boundary with a site area of 1629m^2.

The percentage runoff is taken from the FEH SPRHOST value of 46.5%. However the existing site is partly covered by impermeable ground which will have a percentage runoff of 75%. It is assumed once the site is developed that the permeable garden areas will drain as existing hence it is only the impermeable fractions which are compared since these are the areas which will require a drainage strategy. This impermeable area is 415m^2 for the existing site compared to 603m^2 for the developed site.

3.1.2 Design Storms

Rainfall intensities for various return period storms and durations are derived from the Flood Estimation Handbook (FEH)[1]. (Table 3.1) based on point rainfall data provided by FEH at the nearest 1km grid point to the site (SU513125).

Table 3.1 FEH Point Rainfall Totals (mm) at Botley

Return Period (yrs)	Storm Duration			
	30 min	1 hour	3 hour	6 hour
100	31.6	39.1	54.8	67.8

3.2.3 Peak Flows and Volumes

The peak flows and volumes using the Rational method, based on the impermeable drainage areas, a percentage runoff of 75% and FEH rainfall are given below (Table 3.2).

[1] Flood Estimation Handbook, Centre for Ecology and Hydrology 1999

Table 3.2 Existing Site Peak Flows and Volumes

Return Period (years)	30 min		1 hr		3 hr		6 hr	
	Peak Flow (l/s)	Volume (m^3)	Peak Flow (l/s)	Volume (m^3)	Peak Flow (l/s)	Volume (m^3)	Peak Flow (l/s)	Volume (m^3)
100	5.5	9.8	3.4	12.2	1.6	17.1	1.0	21.1

This suggests the 100 year 30 minute storm would provide a peak flow of 5.5 l/s and a volume of 10m^3 whilst the 100 year 6 hour storm a peak flow of 1.0 l/s and a volume of 21m^3. The 30 minute 100 year storm provides a higher peak flow than the longer 6 hour storm because although rainfall totals are larger the rainfall intensity is less. The volumes obviously increase with storm duration and return period.

3.2 Post Development Runoff

3.2.1 Land Use Changes

The proposed development is based on the construction of a larger detached residential property with the same access roads and car parking areas. The impermeable land cover is assumed to be 603m^2 and a 75% percentage runoff is assumed. The post development peak flows and volumes include an allowance for increased rainfall due to climate change over the lifetime of the development which for residential properties is taken as 100 years. The latest guidance suggests that peak rainfall is expected to increase by 30% up to 2110 and hence the rainfall totals in Table 3.1 are increased by 30%.

3.2.2 Peak Flows and Volumes

The developed site peak flows and volumes (Table 3.3) suggests the 100 year 30 minute storm would provide a peak flow of 10 l/s and a volume of 19m^3 whilst the 100 year 6 hour storm a peak flow of 1.8 l/s and a volume of 40m^3.

Table 3.3 Developed Site Peak Flows and Volumes

Return Period (years)	30 min		1 hr		3 hr		6 hr	
	Peak Flow (l/s)	Volume (m^3)	Peak Flow (l/s)	Volume (m^3)	Peak Flow (l/s)	Volume (m^3)	Peak Flow (l/s)	Volume (m^3)
100	10.3	18.6	6.4	23.0	3.0	32.2	1.8	39.9

The 90% increase in peak flows and volumes is a function of the 30% increase in rainfall totals due to climate change and the increase in the developed site impermeable area compared to the existing site, a 188m^2 increase from 415m^2 to 603m^2.

The use of Sustainable Urban Drainage Systems to reduce these flows to the existing rate are considered in Section 3.3.

3.3 Sustainable Urban Drainage Systems

3.3.1 Principles of Sustainable Urban Drainage Systems

To reduce storm runoff from impermeable drainage areas a range of techniques known as Sustainable Urban Drainage Systems (SUDS) can be utilised. SUDS are physical structures and fall into three broad groups;

- Source Control Techniques. These aim to reduce the quantity of runoff at source and include porous pavements, soakaways, rainwater harvesting or green roofs;

- Permeable Conveyance Systems which slow the velocity of the runoff to allow settlement filtering and infiltration between the source and a disposal point such as a stream or other watercourse and include infiltration trenches and swales; and

- Passive Treatment Systems which are end of pipe systems and provide storage and attenuation of collected surface water before discharge into a watercourse and include basins, ponds, tanks and/or wetlands.

The usual approach in a FRA is to consider the "SUDS train" where each of the above are considered in turn until a suitable solution is found. Thus source control techniques such as soakaways or trenches, if suitable on site, are considered preferable to permeable conveyance and passive treatment systems such as tanks or ponds. The options are considered below.

3.3.2 Source Control Techniques

(I) Soakaways

Soakaways can often be considered for buildings, car parking areas or road margins where surface runoff can be directed. These are usually lined pits or holes filled with rubble or stone and hence have a high storage volume which provides attenuation of the flows and allows gradual infiltration into the surrounding soil. They require relatively permeable strata below a site to allow percolation into the ground and the reduction in runoff is achieved by both the rate of percolation and the available storage volume. The outline designs therefore require details of the characteristics of the sub-soils and the geology to confirm the infiltration rate or vertical permeability.

The British Geological Survey (BGS) 1:50,000 geological map for the area indicates that the site lies over the impermeable Oldhaven, Blackheath, Woolwich, and Reading and Thanet beds (Figure 3.1) with no drift deposits and this is reflected in the high

SPRHOST of 46.5%. The low permeability of these strata suggest that infiltration techniques such as soakaways would not provide a suitable SUDS option at this site.

(II) Permeable Pavements

Permeable pavements are often considered for car parking areas and driveways as long as there is no heavy traffic loading which could damage the pavement infrastructure. Pavements have a high installation cost and due to the low permeability of the strata other SUDS methods detailed below may be more appropriate.

(III) Rainwater Harvesting

The reuse of water from roofed areas to provide grey (non-potable) water for flushing WCs or process water can reduce storm runoff from new dwellings without the need for treatment or oil separators since the risk of spillage or contamination is low. This would require rain water to be held in off-line storage tanks at or about roof level from where a gravity feed is used to supplement the standard water supply or ground level water butts for garden irrigation. Over the course of a year a grey water system will reduce the volume of water entering the storm water disposal system. This does not include the hard standing areas at ground level such as roads and car parking areas which would require a pump system to return water to the roof level, and this is considered impractical.

A grey water system would require one or more large tanks and under optimum conditions these would be kept as near as full as possible to ensure a reliable water supply. For the purposes of a worst case design scenario it is assumed that such a storage system would be full at the start of an extreme rainfall event and hence all storm rainfall would enter the surface water drainage disposal system rather than grey water storage. Whilst there may be merit in including such a scheme in the overall designs, such as water butts for garden irrigation, these are not considered in the SUDS assessment.

(IV) Green Roofs

A green roof is a multi-layered system that covers the top of a building with vegetation, which will provide a degree of rain storm attenuation and a reduction in site runoff. These can either be extensive roofs which are low maintenance with a 25-125 mm soil layer in which a variety of hardy drought tolerant low plants are grown, or intensive roofs with trees and planters which impose a greater load on the roof structure but are more suitable in certain circumstances. Green roofs can be used to reduce the volume and rate of runoff so that other SUDS techniques in the scheme can be significantly reduced in size. The roof of the dwelling will be pitched and hence green roofs are not considered a practical option.

3.3.3 Permeable Conveyance Systems

Permeable conveyance can take the form of infiltration trenches or swales at road margins where surface runoff from roads, car parking areas and also possibly roof drainage can be directed. As detailed above, as the site is underlain by the relatively impermeable strata and infiltration trenches and swales are unlikely to provide a suitable solution.

3.3.4 Passive Treatment Systems

If infiltration systems, whether source control or conveyance, cannot provide suitable solutions then passive treatment systems based on storage and attenuation are considered. For large sites this can include a pond, wetland, basin or an underground tank located on the lower parts of the site. For smaller areas and single dwellings sub-surface attenuation structures such as Storm cells or Metro cells or an oversized drainage network are preferred. Due to the low permeability of the soils a storage and flow attenuation facility will provide the only practical SUDS solution for this site and this option is therefore considered in outline below.

(I) Tanks or Ponds

Preliminary routing calculations have been undertaken to assess the required size of such a storage facility based on maintaining the maximum runoff at the existing rate and assuming any excess water is taken into storage. This suggests (Table 3.4) that a storage facility of 4.6m^3 would be required for the 1 hour storm and 7.9m^3 for the 6 hour storm.

Table 3.4 Storage Required to Maintain Existing Runoff Rates - 100 year storm

Storm Duration (hrs)	Peak Flow (l/s)		Volume (m^3)		Storage Volume (m^3)
	Existing	Developed	Existing	Developed	
1	3.4	6.4	12.2	23.0	4.6
3	1.6	3.0	17.1	32.2	6.4
6	1.0	1.8	21.1	39.9	7.9

The flood routing hydrographs for these three storm durations (Figures 3.2 to 3.4) show that the required storage volume is less than the difference in the total runoff volumes due to attenuation within such a storage facility. This storage volume requirement arises due to the 30% increase in rainfall due to climate change and the increased impermeable area.

An 8m^3 surface water feature may be difficult to achieve as a 1m deep pond would have to be approximately 2m by 4m and would cover a large part of the small site. This would require a drainage system to convey water from the impermeable parts of the site to this storage area and from there to the disposal water course with flows limited to the Greenfield rate.

(II) Drainage Network

An oversized drainage network, rather than a tank or pond, could provide some of the required storage volume. For example, a drainage system provided by 20m of 150mm storm water pipes will give a total storage volume of 0.35m^3 (Table 4.5) and increasing this to 50m of 300mm diameter pipe provides 3.53m^3 of storage. On this site there may not be sufficient room to provide a long length of storm water pipe and this will not be sufficient to offset the total site runoff storage requirements of 7.9m^3 (Table 3.4). However this option could be used to allow the other SUDS elements detailed above to be reduced in size based on the combination of pipe sizes and lengths provided (Table 3.5).

Table 3.5 Volume of Storage Afforded by Different Drainage Networks

Diameter (m)	Length (m)					
	10	20	30	40	50	60
0.15	0.18	0.35	0.53	0.71	0.88	1.06
0.20	0.31	0.63	0.94	1.26	1.57	1.88
0.25	0.49	0.98	1.47	1.96	2.45	2.94
0.30	0.71	1.41	2.12	2.83	3.53	4.24
0.35	0.96	1.92	2.89	3.85	4.81	5.77

(III) Storm Cells

Sub-surface structures such as Storm-Cells or Metro-Cells could be used to provide the required attenuation and storage in garden areas or below car parking areas. A Storm-cell can provide 1.42m^3 of storage and to maintain runoff at the existing rate for the 1 hour storm would then require 4 storm cells over an area of 11.5m^2 or for the 6 hour storm 6 cells over an area of 17.3m^2 (Table 3.6). The parking areas to the front of the property would provide sufficient room to install a storm cell system and hence provide the storage volume required but this number could be reduced if used in combination with other measures detailed above.

Table 3.6 Number and Surface Area Required for Storm Cells

Storm Duration (hrs)	To Maintain Greenfield Runoff		
	Storage Reqd (m^3)	No Reqd	Surface Area (m^2)
1	4.6	4	11.5
3	6.4	5	14.4
6	7.9	6	17.3

This will require a new drainage network to divert flow from the impermeable buildings and roads to this area with an overflow arrangement to the existing receiving watercourse.

3.3.5 Preferred Option

In terms of the suitability of SUDS techniques at this site due to the low permeability of the underlying soils it is likely that storage and attenuation techniques will provide the most suitable solution, whether as a surface water feature such as a pond or a subsurface tank, storm cell or an oversized drainage network.

The adopted SUDS strategy will require a drainage system to convey water from the impermeable parts of the site to the propose disposal option with the inclusion of an overflow feature in the event that a design event is exceeded. Long term maintenance and management of the preferred SUDS options will also be considered as part of the detailed design.

These preliminary considerations are based on the development scheme provided and hence the results are intended to indicate the magnitude and direction of any change in storm runoff rather than for design purposes. The detailed drainage scheme designs are usually covered by a planning condition and subject to approval by the EA or LPA

4.0 PLANNING POLICY GUIDANCE

4.1 Appropriate Development

Under PPS25, the proposed new residential property is classified as “more vulnerable” development. The EAs flood maps indicates the site lies in Flood Zone 2 and partly in Zone 3 and in terms of planning and development control Table D1 of PPS25 suggests that "more vulnerable" residential uses are appropriate in Zones 1 and 2 and would have to consider the Exception Test in Zone 3. The Sequential Test is normally considered prior to the Exception Test and both are detailed below.

4.2 The Sequential Test

As part of the FRA it is required to consider the flood risk Sequential Test (PPS25 paragraphs 16 and 17 and Annex D) and confirm this has been applied. This requires consideration of alternative sites on the LPA area which are at lower flood risk and on which the development could take place instead.

However the PPS25 Practice Guide indicates (Para 4.40) that where an individual proposes to redevelop their property in an existing flood risk area the consideration of alternative sites is not likely to be a realistic option. If the site is large enough there may be an option to relocate the development to parts of the site at lower risk but this is not considered practical. However, the applicant has shown that the development can be made safe through design and flood resistant and resilient construction and that it does not increase flood risk elsewhere. The proposed bungalow will have living accommodation on the ground and first floor which are above predicted flood levels and this will reduce the risk to the residents. The application of the Sequential Test is therefore not a requirement for this site.

4.3 Exception Test

According to Table 5.1 the Exception Test should be considered for "more vulnerable" uses in Flood Zone 3a. The application of the Exception Test requires consideration of three issues

a) it must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk. With raised floor level the flood risk is considered to be low hence this part of the Exception test is considered to be passed.

b) the development is on developable previously-developed land; and

c) This FRA demonstrates that the development will be safe, without increasing flood risk elsewhere, and will reduce flood risk overall.

Is it therefore considered that the requirements of the Exception test have been met.

Figures

Figure 1.1 Location Plan



Figure 1.2 Aerial Photograph of Existing Site



Figure 1.3 Topographical Survey

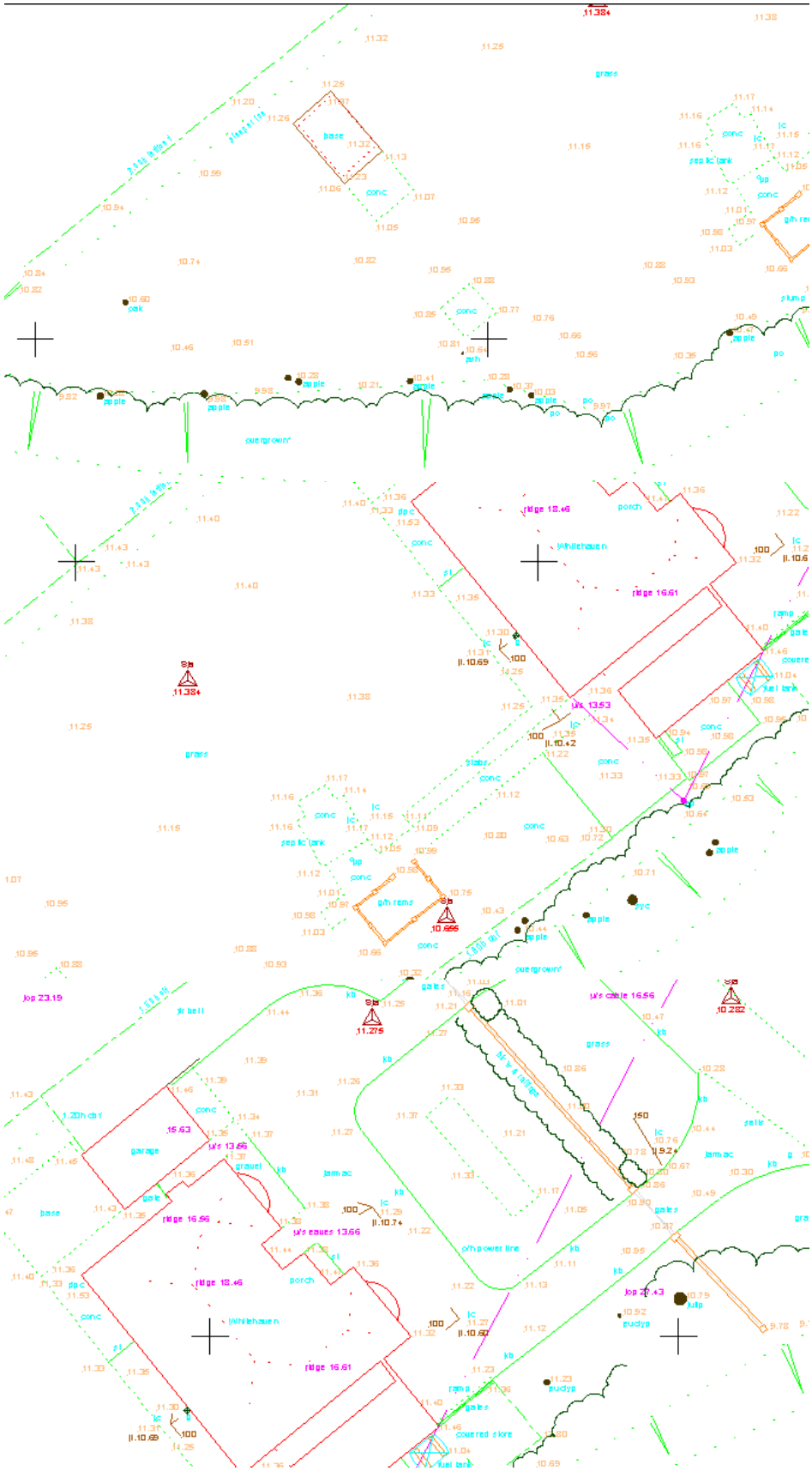

Figure 1.4 Existing and Proposed Site Plan

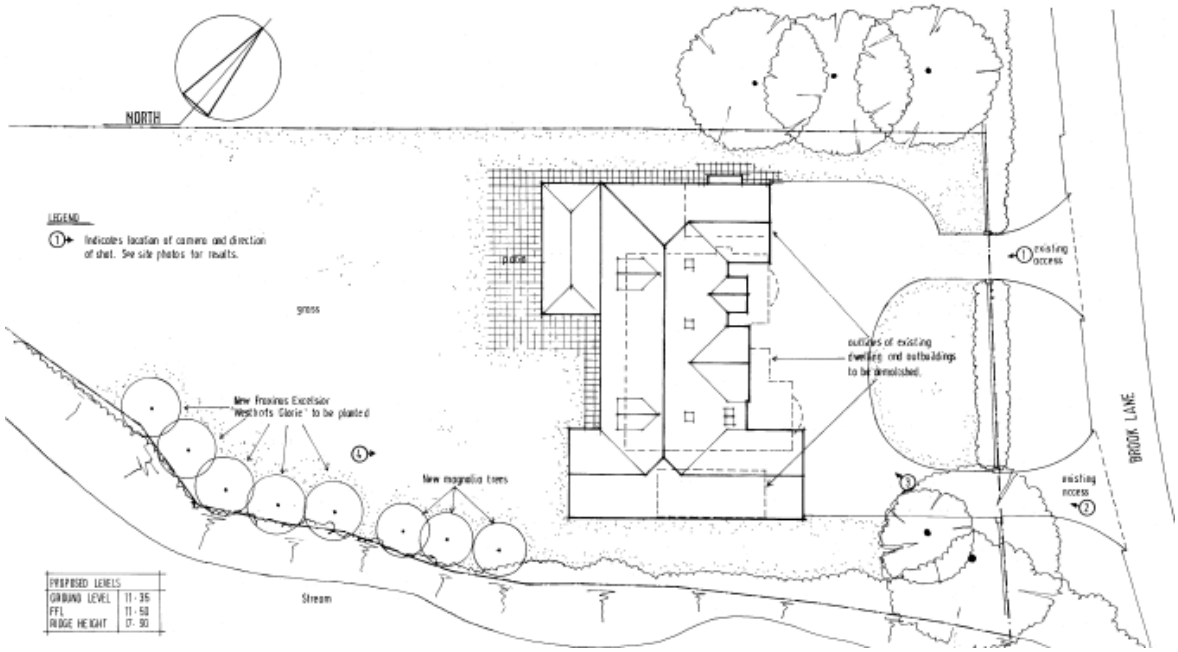

Figure 1.5 Flood Map



Figure 3.1 Bed Rock Geology

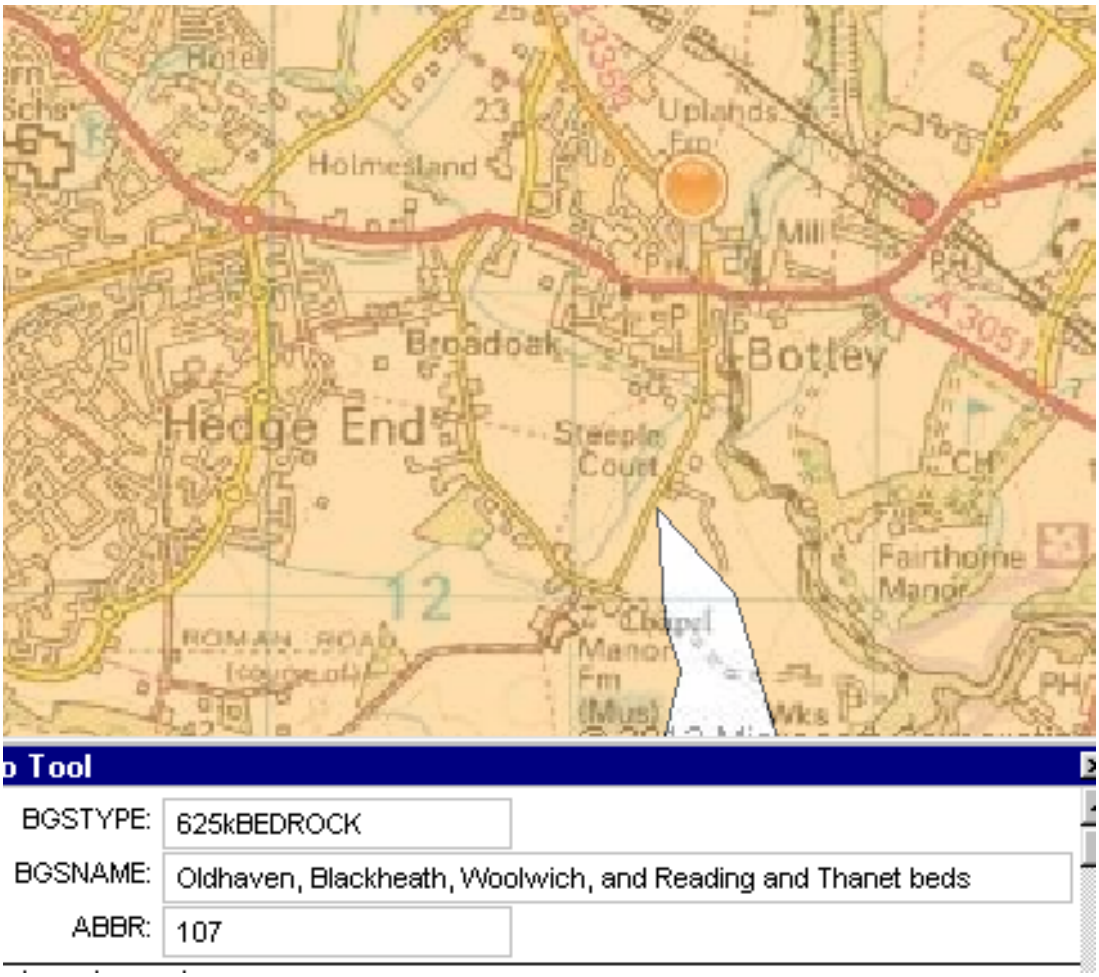

Figure 3.2 Hydrographs - 1 hour storm

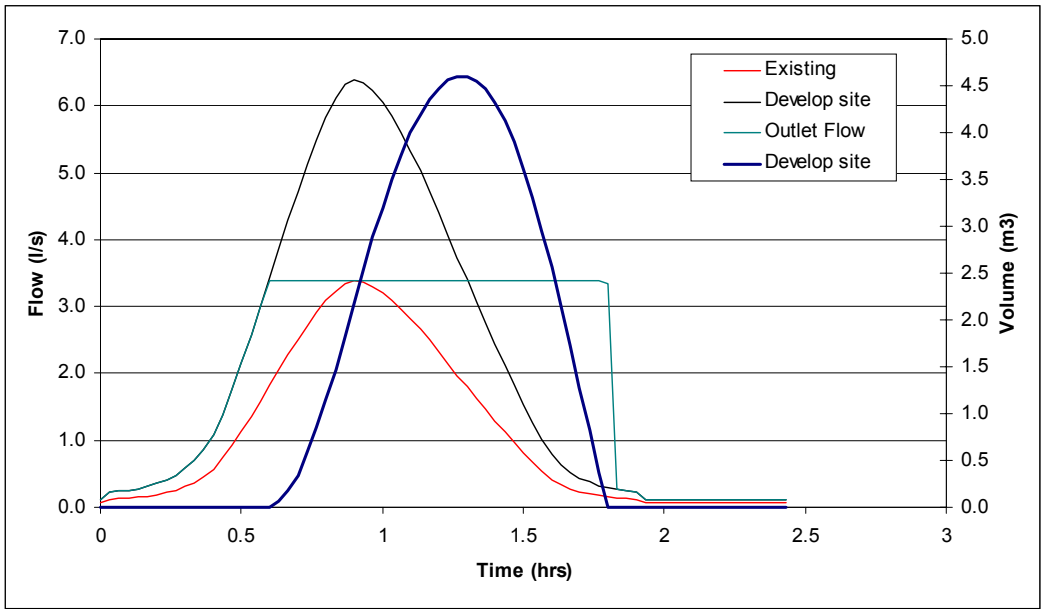

Figure 3.3 Hydrographs - 3 hour storm

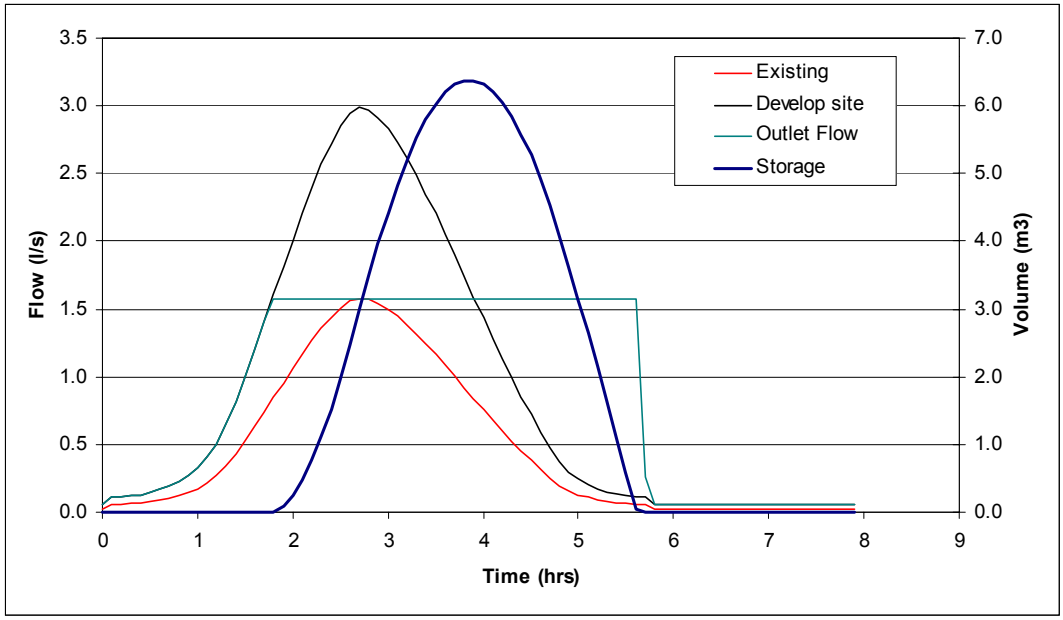

Figure 3.4 Hydrographs - 6 hour storm

