

Flood Risk & Water Management

Belle Vue Flood Risk Assessment July 2014



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Capita Property and Infrastructure was commissioned by Barnsley College to undertake a Flood Risk Assessment (FRA) for the proposed development of residential properties, including sports pitches and access, at Belle Vue, Barnsley (SE 34197 07154)

The site is 1.8 ha in size and lies within the Environment Agency's (EA) Flood Zone 1 and is therefore not considered to be at risk from fluvial flooding in extreme events.

More Vulnerable and Water Compatible development located in Flood Zone 1. The consequences of flooding can be managed and the development will not increase flood risk elsewhere.

Flood risk to the site from all sources is considered to be low. However, surface water flooding is considered to be the more prominent source of flood risk in the area.

The overall flood risk to the site from surface water is deemed to be very low although it is noted that an area just outside the eastern site boundary is highlighted as having a risk of surface water flooding.

The new development is considered to be a 'More Vulnerable' and 'water compatible' development, because of the residential elements and sports fields respectively. Both of these development classifications are considered appropriate. Because the development is proposed in a Flood Zone 1 area there can be no areas of lower risk and so the site is expected to pass the Sequential Test.

The site is currently used by Barnsley College with a number of hard standing areas already existing for car parks, building roofs and so on. The proposed development of the site will see a minor increase in impermeable area. In line with the recommendations of the Barnsley Metropolitan Borough Council SFRA, NPPF and the Barnsley Local Development Framework Core strategy the development will need to ensure that runoff rates from the development are limited to 70% of the existing runoff rate.

The site will need to provide attenuation within the site for flows above this rate for all events up to and including the 1% AEP storm plus an allowance for climate change. Attenuation can be provided by use of Soakaways, underground storage with runoff rates further controlled using permeable paving. Rainwater harvesting may also be utilised by residences.

The development proposal has considered flood risk throughout the development of the scheme and flood risk constraints have been taken into account within the design such that the master plan reflects the flood risk constraints and the need to manage, and where possible reduces, flood risk in compliance with the guidance in the NPPF and the SFRA.

This FRA demonstrates that the proposed development is not in an area with a high risk of flooding. The development proposes measures to manage surface water in line with the relevant policies. The development will not increase the risk of flooding to others.

Site Name	Belle Vue
Location	Barnsley
Client	Barnsley College
Grid Reference	SE 34197 07154
Area (ha)	1.8
EA Flood Zone Classification	Flood Zone 1
SFRA	Barnsley SFRA Level 1
Current Site Use	Car parking, open green space, buildings.
Description of proposed development	The proposed development will see the construction of a number of residential properties and football pitches.
Vulnerability Classification	More Vulnerable/water compatible
History of Flooding	None known
Flood Defences	None present
Summary of Risks	Risk from all sources 'Low'
Safe Access and Egress	Access and egress not expected to be an issue
Summary of Surface Water Runoff	Surface water runoff is expected to increase as a result of the proposed development. Measures to control this have been recommended
Drainage and SuDS Techniques employed	Soakaway (if applicable), Underground storage, permeable paving and rainwater harvesting

1. Introduction

1.1 Scope of Assessment

- 1.1.1 Capita Property and Infrastructure has been commissioned by Barnsley College to undertake a Flood Risk Assessment (FRA) to support a planning application for a proposed 1.8 ha development at Belle Vue, Barnsley (SE 34197 07154). The proposals include the construction of a number of residences as well as two new football pitches. The site lies in Flood Zone 1, outside of the Environment Agency's currently defined Flood Zones 2 and 3, meaning the area has a low fluvial flood risk.
- 1.1.2 The contents of this FRA describe the assessment undertaken of the flood risk to the proposed development and the implications of the proposed development on flood risk. The FRA has been prepared following guidance provided in the National Planning Policy Framework (NPPF) (March 2012) and the Planning Practice Guidance.
- 1.1.3 An outline planning application is being submitted and this assessment seeks to provide the level of detail necessary to demonstrate that the potential effects of the proposal with respect to flood risk have been addressed by:
- Identifying the source and probability of flooding to the application site, including effects of climate change;
 - Determining the consequences of flooding to and from the proposed development proposal and advising on how this will be managed, if necessary; and
 - Demonstrating that the flood risk issues described in this assessment are compliant with the relevant guidance.
- 1.1.4 The scope of data available is summarised in this report and in the associated plans (attached within appendices). An assessment of areas potentially at risk from flooding has been undertaken and the redevelopment proposals have been examined in relation to their potential to increase flood risk both on and off site. The final layout for the site has been developed considering flood risk at all stages throughout the process. The final development layout reflects the flood risk constraints and the need to manage, and where possible reduce, flood risk in accordance with national guidance.
- 1.1.5 This FRA accompanies the planning application for the proposed redevelopment to demonstrate that flood risk has been given material consideration throughout the development planning process and redevelopment should not be restricted at this site due to flood risk.

1.2 Responsibility

- 1.2.1 Barnsley College are promoting the site for redevelopment. The designers are Capita Property and Infrastructure who are responsible for the formulation of the design layout and drawings. Capita Property and Infrastructure are responsible for assessing the scheme with respect to its flood risk impact. The assessment is based on the scheme design and site data provided by the designers and developers.

2. Policy and Guidance

2.1 Flood and Water Management Act, 2010

2.1.1 Combined with the Flood Risk Regulations 2009, (which enact the EU Floods Directive in England and Wales) the Act places significantly greater responsibility on Local Authorities to manage and lead on local flooding issues. The Act and The Regulations together raise the requirements and targets Local Authorities need to meet, including:

- Playing an active role leading Flood Risk Management;
- Development of Surface Water Management Plans (SWMP);
- Implementing requirements of Flood and Water Management legislation;
- Preparation of preliminary flood risk assessments and flood risk management plans;
- Development and implementation of drainage and flooding management strategies; and
- Responsibility for first approval, then adopting, management and maintenance of Sustainable Urban Drainage System (SuDS).

2.1.2 The Flood and Water Management Act also clarifies three key areas that influence development:

1. *Sustainable drainage (SuDS)* - the Act makes provision for a national standard to be prepared on SuDS, and developers will be required to obtain local authority approval for SuDS in accordance with the standards, likely with conditions. Supporting this, the Act requires local authorities to adopt and maintain SuDS, removing any ongoing responsibility for developers to maintain SuDS if they are designed and constructed robustly.
2. *Flood risk management structures* - the Act enables the EA and local authorities to designate structures such as flood defences or embankments owned by third parties for protection if they affect flooding or coastal erosion. A developer or landowner will not be able to alter, remove or replace a designated structure or feature without first obtaining consent.
3. *Permitted flooding of third party land* - The EA and local authorities have the power to carry out work which may cause flooding to third party land where the works are deemed to be in the interest of nature conservation, the preservation of cultural heritage or people's enjoyment of the environment or of cultural heritage.

2.2 National Planning Policy Framework, 2012

2.2.1 The National Planning Policy Framework (NPPF) was issued in March 2012 and outlines the national development policy including with respect to flood risk. This replaced with immediate effect national policy including Planning Policy Statement 25 – Development and Flood Risk.

- 2.2.2 The NPPF requires Local Plans to be supported by a Strategic Flood Risk Assessment (SFRA) and to develop policies to manage flood risk from all sources. The advice of the Environment Agency and other relevant flood risk management bodies, such as Lead Local Flood Authorities (LLFAs) and Internal Drainage Boards (IDBs), as well as from within a local authority's own internal drainage and emergency planning functions should be sought when developing a Strategic Flood Risk Assessment. Barnsley Metropolitan Borough Council is the LLFA. In developing policies, Local Plans should apply a sequential, risk-based approach to the location of development in order to avoid flood risk to people and property, to manage any residual risk, and to take account of the impacts of climate change.
- 2.2.3 In general, these requirements will be met by:
- Applying the Sequential Test and, where appropriate and necessary, the Exception Test;
 - Safeguarding land from development that is required for current and future flood risk management;
 - Using opportunities offered by new development to reduce the causes and impacts of flooding; and
 - Seeking opportunities to facilitate the relocation of development, including housing, to more sustainable locations where climate change is expected to increase flood risk to existing development.
- 2.2.4 Development should not be allocated or permitted if there are reasonably available sites appropriate for the proposed development in areas with a lower probability of flooding. The SFRA will be the basis for applying the Sequential Test and a sequential approach should be used in areas known to be at risk from any form of flooding.
- 2.2.5 Following application of the Sequential Test, if it is not possible for the development to be located in zones with a lower probability of flooding, the Exception Test should be applied. It should only be applied if appropriate to the type of development and flood zone and if consistent with wider sustainability objectives.
- 2.2.6 For the Exception Test to be passed it must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk, informed by a SFRA. It must also be demonstrated within a site-specific FRA that the development will be safe for its lifetime without increasing flood risk elsewhere, and where possible reducing flood risk.
- 2.2.7 When determining planning applications, Local Planning Authorities should ensure that flood risk is not increased elsewhere and should only consider development in areas at risk from flooding where it can be demonstrated that a sequential approach has been taken, that the development is appropriately flood resilient, that residual risks can be managed and that priority is given to the use of SuDS.

2.3 National Planning Policy Framework (NPPF) Planning Practice Guidance: Flood Risk and Coastal Change, 2014

2.3.1 The Planning Practice Guidance (PPG) to the National Planning Policy Framework (NPPF) provides additional guidance to Local Planning Authorities and developers to ensure the effective implementation of the planning policy set out in the National Planning Policy Framework on development in areas at risk of flooding and to provide guidance on the contents of flood risk assessments. The guidance retains key elements of the now superseded Technical Guidance to the NPPF and its previous incarnation the PPS 25 Practice Guide.

2.3.2 The document provides supporting information on:

- The definition of Flood Zones;
- Flood risk vulnerability of different land uses;
- The application of the sequential approach and Sequential and Exception Tests;
- Flood risk assessment at the strategic and site level; and
- Climate change and managing residual risks.

2.3.3 The PPG clarifies that the objectives of a site-specific FRA are to establish:

- Whether a proposed development is likely to be affected by current or future flooding from any source;
- Whether it will increase flood risk elsewhere;
- Whether the measures proposed to deal with these effects and risks are appropriate;
- The evidence for the local planning authority to apply (if necessary) the Sequential Test, and;
- Whether the development will be safe and pass the Exception Test, if applicable.

2.4 The Don Catchment Flood Management Plan (CFMP)

2.4.1 The Don CFMP is the Environment Agency's plan for flood risk management covering the entire River Don Catchment. Beyond this the River Trent flows into the Humber Estuary. The CFMP area includes all of the River Trent's tributaries, covering an area of 10,452 km². The CFMP area is sub-divided into ten distinct sub areas. Each sub area is formed of areas which have similar physical characteristics, sources of flooding and levels of risk.

2.4.2 The proposed development falls within sub area 5: Barnsley and Mexborough. This particular sub-area falls within policy option 6: areas of low to moderate flood risk where action will be taken with others to store water or manage run-off in locations that provide overall flood risk reduction or environmental benefits. This policy will tend to be applied where there may be opportunities in some locations to reduce flood risk locally or more widely in a catchment by storing water or managing run-off. The policy has been applied to an area (where the potential to apply the policy exists), but would only be implemented in specific locations within the area, after more detailed appraisal and consultation.

2.4.3 The long term visions for the Barnsley and Mexborough sub area are to identify the requirements for reducing flood risk at key locations. This includes;

- Better use of washlands in a more natural system to provide localised improvements to risk;
- A need for rigorous development control in accordance with the principles outlined in the now superseded PPS25 which will see the production of policies to safeguard vital functional floodplain from development; and
- Understanding more about the risk of flooding from surface water and flooding from sewer systems.

2.5 Barnsley Local Development Framework (LDF) Core Strategy

2.5.1 Within the Core Strategy, Policy CSP 1 – Climate Change (Section 9), states that the council will take action to adapt to climate change by locating and designing development to reduce the risk of flooding and promote the use of sustainable drainage systems (SuDS). The use of SuDS is covered by Policy CSP 3 – Sustainable Drainage Systems (Section 9) which states that all development, except where it can be demonstrated that all types of SuDS are impractical, will be expected to use SuDS. Planning applications must include an assessment to show that SuDS will work and be maintained. Measures should be taken to avoid water contamination and safeguard groundwater supply. Developers will be required to contribute to the maintenance of SuDS.

2.5.2 Within the Core Strategy, Policy CSP 4 – Flood Risk (Section 9) states that the extent and impact of flooding will be reduced by:

- Not permitting new development where it would be at an unacceptable risk of flooding or would give rise to flooding elsewhere;
- Requiring developers with proposals in Flood Zone 2 and 3 to provide evidence of the sequential test and exception test where appropriate;
- Requiring site-specific Flood Risk Assessments (FRAs) for proposals over 1 hectare in Flood Zone 1 and all proposals in Flood Zones 2 and 3;
- Expecting proposals over 1000 m² floor space or 0.4 hectares in Flood Zone 1 to demonstrate how the proposal will make a positive contribution to reducing or managing flood risk;
- Expecting all development proposals on brownfield sites to reduce surface water run-off by at least 30% and development on Greenfield sites to maintain or reduce existing run-off rates;
- Requiring development proposals to use Sustainable Drainage Systems (SuDS) in accordance with policy CSP 3;
- Not culverting or building over watercourses and encouraging the removal of existing culverts wherever practicable; and
- Using flood resilient design in areas of high flood risk.

- 2.5.3 In accordance with national policy to discourage development in areas at risk of flooding the council will adopt the sequential approach to new development. This means there will be a general presumption against development within areas of high flood risk unless there are no reasonably available sites in areas of lower flood risk (Flood Zone 1) and, in cases where it is appropriate for the exception test to be applied, the benefits of the development outweigh the risks from flooding.
- 2.5.4 Developers required to submit a site specific Flood Risk Assessment (FRA) must demonstrate the following:
- Whether the development is likely to be affected by flooding (from all sources: rivers, land, groundwater, sewers, reservoirs, canals and other artificial sources) now or in the future, taking climate change into account;
 - That the development is safe and where possible reduces flood risk;
 - Whether the development will increase flood risk elsewhere;
 - That measures can be incorporated to mitigate the effects and risks of flooding; and
 - That an assessment of surface water and drainage has been incorporated.

2.6 Barnsley Level 1 Strategic Flood Risk Assessment (SFRA) 2010

- 2.6.1 The most recent SFRA for the Barnsley area was produced in September 2010. The primary objective of the SFRA is to inform the revision of flooding policies, including the allocation of land for future development, within the emerging Local Development Framework (LDF). The SFRA has a broader purpose however, and in providing a robust depiction of flood risk across the area, it can:
- Inform the development/developer of Council policy that will underpin decision making within the Borough, particularly within the areas that are affected by (and/or may adversely impact upon) flooding;
 - Assist the development control process by providing a more informed response to development proposals affected by flooding, influencing the design of future development within the Borough;
 - Help to identify and implement strategic solutions to flood risk, providing the basis for possible future flood attenuation works;
 - Support and inform the Councils emergency planning response to flooding;
 - Identify what further investigations may be required in flood risk assessments for specific development proposals; and
 - Provide flood information that supports sustainability appraisals of the local development framework.
- 2.6.2 The guidance set out in the SFRA seeks to achieve the following:
- Reduce the probability of flooding to a development and consequently reduce the associated hazard;
 - Minimise the impact and damage that flood water may cause to a development and thus enable a faster recovery following a flood event;

- Ensure no adverse impacts resulting in increased flood risk to neighbouring sites;
- Wherever possible seek to provide an overall benefit to flood risk for neighbouring sites; and
- Be adaptable to future climate change scenarios.

2.6.3 For sites in Flood Zone 1 – Low Probability, the SFRA states that from a flood risk perspective all land uses are acceptable within Flood Zone 1. Flood risk is not considered to be a significant constraint to development and all land uses listed below are appropriate in this zone:

- Essential infrastructure;
- Highly vulnerable;
- More vulnerable;
- Less vulnerable; and
- Water compatible development.

2.6.4 A detailed Flood Risk Assessment will not usually be required for development in this zone unless there are for example, historical records of localised flooding or site specific considerations that necessitate further investigation. However, due to their potential impact on the local flood risk, a Flood Risk Assessment will be required for all developments greater than 1ha in size. This will include further consideration of surface water drainage and on-site mitigation measures that may be required, particularly where the capacity of the surface water sewer or receiving watercourse is limited. This assessment will be undertaken by the developer of the site and should be appropriate to the scale, nature and location of the development. The Environment Agency will be able to advise potential developers as to their specific requirements on a site by site basis.

2.6.5 Table 2-1 provides a summary of the potential risks identified within the SFRA to the site.

Table 2-1: SFRA Summary of potential flood risks

Flood Zone	Flood Zone 1
Hazard Level	n/a
Actual Risk	
Tidal	n/a
Fluvial	Flood Zone 1
Climate Change	n/a
Residual Risk	
Breach	n/a
Extreme Event	n/a
Surface Water	Eastern edge of site is at risk from 100 year pluvial flooding
Groundwater	n/a
Historic Flooding	None recorded for the site

Bedrock permeability		n/a
Potential Sources of Overland Flow		n/a
Sewer Flooding	Within 250m	No site specific data made available
	Within 500m	
	Within 750m	
	Within 1km	

2.6.6 A number of conclusions and recommendations were drawn from the SFRA, despite the fact that the flood extents within the SFRA indicate that the site is in Flood Zone 1 the following conclusions and guidance recommendations for general surface water drainage are considered the most appropriate to this FRA:

- Surface water flows from all sites should be restricted to the Greenfield runoff rate up to the 1 in 100 year event;
- The FRA should consider whether a “Greenfield runoff approach” to the assessment of source control is appropriate. This method is generally satisfactory in the cases where the development is relatively small, isolated from other planned sites and the runoff processes are fully understood;
- SuDS must be investigated and any obstacles to the use of SuDS will need to be clearly justified within the FRA; and
- The FRA should conclude with an assessment of the scale of the impact, and the recommended approach to controlling surface water discharge from a proposed development.

2.7 The SuDS Manual, CIRIA (2007)

2.7.1 This guidance provides best practice on planning, design, construction, operation and maintenance of Sustainable Drainage Systems (SuDS) to facilitate their effective implementation within developments.

2.7.2 The guidance supersedes previous general guidance on SuDS and addresses landscaping, biodiversity issues, public perception and community integration as well as water quality treatment and sustainable flood risk management. The output is based on results contained in the Environment Agency R&D Report SCO20114/2.

2.7.3 The SuDS Manual aims to provide comprehensive advice on the implementation of sustainable drainage techniques in the UK. It provides guidance on:

- Initial planning;
- Design through to construction;
- The management of SuDS in the context of the current regulatory framework; and
- Advice on landscaping, waste management, cost, and community engagement.

2.7.4 The SuDS Manual has been used to provide the necessary design guidance for the surface water drainage strategy incorporated into the Masterplan.

2.8 Designing for Exceedance in Urban Drainage: Good Practice, CIRIA (2006)

- 2.8.1 The good practice guide aims to provide best practice advice to designers and managers of urban sewerage and drainage systems to reduce the issues arising from exceedance in urban drainage systems. The guide also provides council on risk assessment procedures and planning that can reduce the impact of exceedance events to those at risk.
- 2.8.2 The guide has been used to provide direction on the design of urban drainage systems capable of coping with extreme events and within an assessment of the likelihood and impact of exceedance.

2.9 Sewers for Adoption 7th Edition (2012)

- 2.9.1 This document is the definitive guide for those planning, designing and constructing sewers and pumping stations for subsequent adoption by water companies in England and Wales under Section 104 of the Water Industry Act.
- 2.9.2 This guidance provides best practice on planning, design, construction, operation and maintenance of sewers to facilitate their effective implementation within developments and expands on earlier versions by giving more consideration to the use of SuDS.

2.10 UK Climate Impact Programme 2009 (UKCIP09)

- 2.10.1 In June 2009 the UK Climate Impact Programme released new guidance with respect to climate change predictions. The predictions have moved from a deterministic approach (i.e. one range of outcomes) to a probabilistic approach (i.e. a range of possible outcomes based on a range of climate change scenarios).
- 2.10.2 The results indicate that based on a central estimate of likely outcomes (i.e. 50 percentile), increases in rainfall are expected to remain similar to those predicted by UKCP02 (i.e. those used in this FRA). A high estimate of likely outcomes (i.e. 95 percentile) could result in significantly more intense rainfall than at present.
- 2.10.3 At present Defra and the Department for Communities and Local Government (CLG) have advised to continue using the existing climate change guidance (NPPF).

3. Development Site Planning Considerations

3.1 Development Description and Location

- 3.1.1 The proposed development is located at Belle Vue (SE 34197 07154) in Barnsley. The red-line boundary for the development site occupies an area of approximately 1.8 Ha. The River Dearn lies approximately 600 m to the north of the site.
- 3.1.2 The proposed development is for new residential properties and football pitches to be constructed to the west of the Barnsley College. Refer to 0 for a site layout plan.

3.2 Vulnerability Classification

- 3.2.1 The site lies within the Environment Agency's Flood Zone 1, which is described within the NPPF's supporting Planning Practice Guidance (PPG) Table 1, as having a 'Low Probability' of flooding. Flood Zone 1 is defined as "*having a less than 1 in 1000 annual probability of river or sea flooding (<0.1% AEP)*". The Environment Agency's Flood Zone Map is shown in Appendix B.
- 3.2.2 With reference to Table 2 of the PPG, the Flood Risk Vulnerability Classification of the proposed developments are considered to be a mix of 'more vulnerable' and 'water compatible' developments. The PPG 'Flood Risk Vulnerability and Flood Zone Compatibility' is reproduced below (Table 3-1), and shows that '*All uses of land are appropriate in [Flood Zone 1]*'. Development in this flood zone is therefore deemed appropriate, subject to passing the Sequential Test. No application of the Exception Test would be required for the proposed scheme.

Table 3-1: Flood Risk Vulnerability and Flood Zone Compatibility, NPPF

Flood Risk Vulnerability classification	Essential Infrastructure	Water compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	✓	Exception Test Required	✓	✓
Zone 3a	Exception Test Required	✓	✗	Exception Test Required	✗
Zone 3b	Exception Test Required	✓	✗	✗	✗

3.3 Sequential Test

- 3.3.1 The risk-based Sequential Test should be applied at all stages of the planning process. Its aim is to steer new development to areas at the lowest probability of flooding. The Sequential Test is applied on the basis of the EA Flood Zone Map and Tables 1 and 2 in the PPG.

3.3.2 As indicated above, the site location is within Flood Zone 1, which comprises '*land assessed as having less than 1 in 1,000 annual probability of river or sea flooding in any year (<0.1%)*'. As the site location is in Flood Zone 1, there can be no alternative viable sites with a lower flood risk that are capable of delivering the objectives of the development.

3.3.3 These reasons should demonstrate that the site passes the risk-based Sequential Test.

3.4 Exception Test

3.4.1 Application of the Exception Test is not required for this combination of flood risk zone and type of development.

4. Flood Probability and Hazard

4.1 Catchment Context

- 4.1.1 In order to assess the risk of flooding to the proposed development site, it is important to understand the existing catchment characteristics, flow patterns and historical flooding.
- 4.1.2 Flooding in the Dearn catchment occurs as a result of fairly natural flood responses.

4.2 Historic Flooding

- 4.2.1 Information provided in correspondence with Yorkshire Water included in Appendix D states that there are no properties on the sewer flooding register and there is no record of sewer flooding in the area.
- 4.2.2 Information provided in correspondence with the Environment Agency included in Appendix D states that there is not known to be any risk affecting the site associated with historic flooding.
- 4.2.3 The Barnsley Level 1 SFRA indicates that the River Dearn has a history of flooding but this has not been known to affect the site.

4.3 Local Geology

- 4.3.1 A description of the geology beneath the site is provided from the British Geological Society (BGS) 1:50 000 scale mapping. The bedrock in the area is described as being of the “Kent’s Rock Sandstone” group, which is a sedimentary bedrock. The permeable nature of sandstone would ensure that there would be free drainage through the bedrock. No details are provided on the overlying drift geology.

4.4 Soil Classification

- 4.4.1 The National Soil Resources Institute Soilscales mapping shows that the whole site is underpinned by “slowly permeable seasonally wet acid loamy and clayey soils”. These soils typically exhibit impeded drainage where sustained periods of heavy rainfall are likely to induce water-logging. Overland flow is likely to be witnessed following periods of prolonged, heavy precipitation.
- 4.4.2 The soil information generally supports a conclusion of limited permeability across the site suggesting there may be constraints in the use of SuDS in these areas. It is recommended that any detailed drainage strategy be developed in conjunction with soakaway tests at proposed SuDS locations to confirm the infiltration rates available.

4.5 Site Topography

- 4.5.1 A topographic survey was undertaken by First Point Surveys, covering the proposed site (0). The elevations vary between approximately 114m AOD and 96 m AOD, generally falling away from west to east. The lowest elevations are located along the North eastern corner of the site located approximately along the access road from Honeywell Lane.

4.6 Flood Zones

- 4.6.1 Flood Zones describe the extent of flooding that would occur on the basis that no flood defences were in existence. Where flooding information is available that includes the effect of defences then they can also describe the extent to which the land under scrutiny is afforded protection by the presence of those defences. The definition of Flood Zones is provided in Table 1 of the PPG.
- 4.6.2 A review of the Flood Zone Map provided by the Environment Agency has identified that the site is located within Flood Zone 1, which is described within the PPG Table 1 as having a having a 'Low Probability' of flooding. Flood Zone 1 is defined as "having a less than 1 in 1000 annual probability of river or sea flooding (<0.1% AEP)". **Error! Reference source not found.** in Appendix B shows the Environment Agency Flood Zones.

4.7 Flood Risk Management Infrastructure

- 4.7.1 Correspondence with the EA (Appendix D) has revealed that there are no formal flood defences helping to reduce flood risk to the site.

4.8 Sources and Mechanisms of Flooding

- 4.8.1 This section provides a review of flooding from land, sewers, groundwater and artificial sources in addition to rivers and the sea.

Fluvial Flood Risk

- 4.8.2 Fluvial flooding occurs when the amount of water within a river channel exceeds the flow capacity of the river channel. Most rivers have a natural floodplain into which the water spills in times of flood. Based on information provided by the Environment Agency the site is not susceptible to fluvial flooding.
- 4.8.3 In summary, the site is at not considered at risk of fluvial flooding.

Tidal Flood Risk

- 4.8.4 Tidal flooding occurs when a high astronomical tide and storm (tidal surge) exceeds the level of coastal land or coastal flood defences. Tidal flooding can also be caused by 'tide locking' of rivers or estuaries. Tide locking prevents a river from discharging into the sea, causing 'backing up' and resulting in tidal/fluvial flooding.

- 4.8.5 There is no risk of tidal flooding or associated impacts within the proposed development site or surrounding area.

Flood Risk from Land, Surface Water and Sewers

- 4.8.6 Flooding from land can be caused by rainfall being unable to infiltrate into the natural ground or to enter the drainage systems due to blockage, or flows being above design capacity of gullies and drains. This can then result in (temporary) localised ponding and flooding. The natural topography and location of buildings/structures can influence the direction and depth of water flowing off impermeable and permeable surfaces.
- 4.8.7 High intensity storms (often with a short duration) are often unable to percolate into the ground or be drained by formal drainage systems since the capacity of the collection systems is not sufficient to convey runoff to underground pipe systems (that might themselves be surcharged). The pathway for surface water flooding can include blockage and overflows of the drainage system and failure of sluice outfalls and pump systems.
- 4.8.8 As the development site is underlain by soils with impeded drainage characteristics the rate of infiltration is expected to be slow and may exacerbate small scale localised surface water flooding.
- 4.8.9 The Barnsley Level 1 SFRA indicates that there have been no incidences of widespread of major surface water flooding and only small, dispersed areas suffer from surface water flooding. The SFRA also confirms confidence in the EA Flood Map for Surface Water, which shows that very small areas outside of the site boundary near Barnsley College are shown to have low to high risk of surface water flooding, but overall the site is at very low risk of surface water flooding. (Appendix B).
- 4.8.10 Flooding can also result when sewers, typically combined foul and surface water, are overwhelmed and surcharge water into the nearby environment. The Barnsley SFRA highlights that the incidences of external sewer flooding are not widespread or particularly frequent. Yorkshire Water states that there are no properties on the sewer flooding register and there is no record of sewer flooding in the area.
- 4.8.11 Drainage plans for the existing site area are included in Appendix C. These show that a surface water drain runs along Huddersfield Road outside the western boundary of the site. The connection point for the site to the existing sewer network is not known.
- 4.8.12 In conclusion, the information available on surface water and sewer flooding suggests that the flood risk from land, surface water, and sewers is low. It is also concluded that the drainage system includes systems to manage runoff from within the site and to restrict flows downstream.

Groundwater Flood Risk

- 4.8.13 Groundwater flooding occurs when water levels in the ground rise above surface elevations. It is most likely to occur in low-lying areas underlain by permeable rocks. Flooding from this source may result in ponding in low lying basins and overland flow in areas where water may normally flow during heavy rain events. Flooding of this nature may, however, last for longer periods of time because of the typically slower response of groundwater units to changes in rainfall.
- 4.8.14 A review of the SFRA indicates that the site is not considered likely to be affected by groundwater flooding. The aquifer information available from the Environment Agency indicates that the site is situated in an area considered to be underlain by a Secondary A Aquifer in a high groundwater vulnerability zone.
- 4.8.15 Based on the information available, groundwater flooding affecting the site is considered a low probability occurrence.

Flood Risk from Artificial Sources

- 4.8.16 Artificial sources of flooding include reservoirs and canals.
- 4.8.17 The Environment Agency Risk of Flooding from Reservoir Inundation Flood Map (Appendix B) shows that the site is not at risk of flooding from this source.
- 4.8.18 The Barnsley Canal is situated approximately 750m to the south-west of the site but does not pose any risk of flooding to the site.
- 4.8.19 Based on this information it is concluded that under normal circumstances the risk of flooding from artificial sources is low.

4.9 Flood Hazard

- 4.9.1 The low risk of flooding from any source at this site implies that there is a very low flood hazard from any source and therefore this is not discussed in any further detail.

5. Flood Risk Management

5.1 Principles of Flood Risk Management

- 5.1.1 Current National guidance requires a precautionary approach to be undertaken when making land use planning decisions regarding flood risk. This is partly due to the considerable uncertainty surrounding flooding mechanisms and how flooding may respond to climate change. It is also due to the potentially devastating consequences of flooding to the people and property affected.
- 5.1.2 Flood risk is a combination of the probability of flooding and the consequences of flooding. Hence 'managing flood risk' involves managing either, the probability of flooding or the consequences of flooding, or both.
- 5.1.3 The NPPF requires flooding from all sources to be considered. The flood risk management measures discussed in this section are based on the sources of flooding discussed in Section 4. It was identified that the site is at low risk of fluvial flooding, surface water flooding, groundwater flooding and all artificial sources.
- 5.1.4 Despite the low risks, the following sections outline measures that could be considered to ensure that the development is resistant to flooding.

5.2 Avoidance and Substitution – The Sequential Approach

- 5.2.1 The location of the development outside of an area at fluvial risk indicates that further measures are not required to avoid the risk from this source. The assessment concludes that the development does not lie in areas at risk from other sources; therefore further avoidance of these sources is also unwarranted.
- 5.2.2 Section 3 considers the application of the Sequential Test and it concludes that the development would be acceptable based on its location in Flood Zone 1 and on the proposed type of development. No substitution of the proposed type of development for one that has a lower vulnerability will be required.

5.3 Management (Control and Mitigation) of Flood Risk

- 5.3.1 The assessment concluded that there was a low risk of flooding from all sources, including surface water and groundwater.
- 5.3.2 Building Regulations set out in BS 8102:2009 Code of practice for protection of below ground structures against water from the ground require that threshold levels are raised above surrounding ground levels to ensure that surface water cannot enter a building from surrounding levels and this will be sufficient to mitigate any risk of surface water flooding at this site.
- 5.3.3 Management of surface water runoff generated within the site is discussed in Section 6.

5.4 Flood Warning and Evacuation plan

- 5.4.1 When conditions suggest that floods are likely, the Environment Agency issue flood warnings to the Police, Fire and Rescue Service, to relevant local authorities, to the public and to flood wardens. It is the responsibility of individuals in the community to receive flood warnings via Flood Warnings Direct (FWD) which passes messages over the telephone network.
- 5.4.2 The site is not covered by a Flood Warning Area. There is no requirement for this site to sign up for flood warning and because of the low risk no evacuation plan is necessary to specifically deal with the risk of flooding.

5.5 Residual Flood Risk

- 5.5.1 Residual risks are those that remain after a risk has been managed or mitigated and may relate to risks such as the failure of flood defences or the blockage of structures.
- 5.5.2 Given the low risk of flooding from any source at the site, there are no specific residual risks that have been identified and which would require specific management over and above the measures discussed in this section or in Section 6.

6. Surface Water Management

6.1 General Principles

6.1.1 The calculation of existing and post-development surface water runoff from the site has used two industry standard methods – Ioh124, for calculating runoff rates from permeable ('Greenfield') areas, and the Modified Rational Method for calculating rates and volumes of runoff from impermeable (hard standing) areas. The two methodologies are described in Appendix E along with the full surface water calculations.

6.1.2 The Barnsley Level 1 Strategic Flood Risk Assessment (SFRA) 2010 sets out 'General Surface Water Drainage Guidance' in chapter 8, Section 8.4, detailed below:

- Opportunities for developing an Integrated Water or Drainage Management Strategy across development site boundaries should be explored, and a catchment led approach should be adopted.
- Integrated drainage systems may be considered suitable for catchments where other development is being planned or constructed, and where on-site measures are set in isolation of the systems and processes downstream.
- Surface water drainage assessments are required where proposed development may be susceptible to flooding from surface water drainage systems. The potential impact upon areas downstream of the development, including the impact on a receiving watercourse, also needs careful consideration.
- Local drainage issues, together with the specific requirements for surface water drainage systems, will need to be discussed with the Environment Agency, the appropriate Water Utility Company, Local Authority Drainage Engineers and Internal Drainage Board Engineers.
- Consideration should be given to whether a 'Greenfield runoff approach' to the assessment of source control is appropriate.
- The FRA should conclude with an assessment of the scale of the impact, and the recommended approach to controlling surface water discharge from a proposed development.

6.1.3 The local authority drainage engineers have been consulted as part of this FRA and the following principles are noted from this correspondence:

- There should be no increase in surface water runoff from the new development. The management of flood risk is not simply restricted to floodplains and that a catchment-wide approach should be employed.
- There is a combined public sewer within this site. The developer should contact Yorkshire Water if they wish to discharge to these sewers to discuss allowable discharge rates.
- Any balancing facility should be designed to accommodate a 1 in 30 year flow from the site below ground and a 1 in 100 year flow retained within the site (including an allowance of 30% for climate change), without causing any flooding to buildings.

6.1.4 The Barnsley Local Development Framework (LDF) core strategy also sets out general principles for managing surface water. This is discussed in section 2.5 and should be referred to, however, the key principles relative to the management of surface water within the development are as follows:

- All development proposals on Brownfield sites should reduce surface water run-off by at least 30% and development on Greenfield sites should maintain or reduce existing run-off rates;
- Development proposals should use Sustainable Drainage Systems (SuDS) in accordance with policy CSP 3;

6.2 Site Constraints for Drainage

6.2.1 The development of the Belle Vue site is representative of a 'Brownfield' development. In line with the Barnsley LDF core strategy the development will therefore need to ensure that surface water run-off rates are reduced by at least 30% of the existing run-off rate.

6.2.2 The plans are multi-dimensional and include the re-development of a car park into residences to the west of the site, provision of two football pitches on the fields to the east of the site and the provision of car parking space to the south east of the site. For a detailed layout of the proposal refer to Appendix A.2. On balance, it is unlikely that the proportion of impermeable and permeable areas are to change significantly, however localised drainage regimes are likely to be affected and this should be considered when assessing SuDS measures.

6.2.3 Topographic Survey of the site shows that the majority of the site drains to the east of the development (see Appendix A.3). The nearest surface water pipes are to the west and north of the site (See Appendix C). On this basis it is unlikely that areas to the east of the site including the car park and access road near Barnsley College will discharge to the same public sewer network as the residential developments. As such, the re-development of areas relating to access from Honeywell Lane and associated car parking should be assessed separately in considering drainage strategies.

6.2.4 Yorkshire Water (YW) have been consulted in order to determine the constraints for drainage in place for the development. It has been noted that only curtilage surface water will be accepted by Yorkshire water and as such, recommendations on how much water can be discharged must represent water from the proposed housing developments and hard standing areas alone. Separate measures to reduce surface water run-off will be required in assessing the sports fields to the east of the site.

6.2.5 For this reason the analysis has been split into the following parts:

- **Area 1:** 0.73 ha Residential development consisting of 12 semi-detached houses, access road, gardens, car parks and green space associated with existing developments.
- **Area 2:** 0.76 ha sports field development consisting of two football pitches and open green space.

- **Area 3:** 0.35 ha site consisting of an access road to the site from Honeywell Lane and small car park in the south east corner of the site.

6.2.6 Figure 6-1 below provides a visualisation of the various development areas which will each be analysed.



Figure 6-1: Proposed Drainage Analysis – Area 1 (red), Area 2 (Blue), Area 3 (green)

Area Specific Drainage Constraints – Area 1

6.2.7 Details of the existing drainage network at the site are not available; however, it is assumed that surface water from area 1 of the existing development site discharges to the nearest connection point to the North West of site which sits 2.18m below ground level. This would suggest that areas to the east of area 1 are set below the invert level of this connection and would not drain by gravity. The existing site appears to use drainage channels to direct water to discharge points in the west of the site where ground levels are more conducive to gravity drainage. It is assumed therefore that the proposed development drainage strategy will implement a similar strategy using the same connection point and similar points of discharge to ensure positive drainage is possible. This will need to be demonstrated at the detailed design stage.

- 6.2.8 The plans involve the re-development of a car park into residences which will see a shift from impervious hard standing areas into a combination of impervious and permeable areas. Table 6-1 below presents the existing land use against proposed land use and subsequent proportions of hard standing and permeable areas.

Table 6-1: Land Use Existing against Proposed

Land Use/Type	Areas in Existing Site (ha)	Areas in Proposed Site (ha)
Open Space (Greenfield)	0.36	0.3
Roofs (Hard Standing)	0.05	0.13
Paths/Roads/Paving (Hard Standing)	0.32	0.3

Area Specific Drainage Constraints – Area 2

- 6.2.9 Development in area 2 will not be permitted to discharge to the public sewer network and so it is assumed that infiltration and discharge to ground will be the drainage strategy adopted for this area. All development taking place within this area is considered to be permeable.
- 6.2.10 The topography of the site shows that surface water would most likely drain to the east towards low lying areas around the Barnsley College. It is assumed that the current flow paths will be maintained following the development of the site.
- 6.2.11 An important constraint on drainage for development area 2 will be the permeability of the underlying geology. At present, the information available suggests infiltration rates will be fairly slow with local geology prone to impeded drainage. This will need to be confirmed via a ground investigation.

Area Specific Drainage Constraints – Area 3

- 6.2.12 Development in area 3 will involve the construction of a car park for the sport fields and the construction of an access road. The majority of this area is already hard standing however; construction of the car park will increase the impermeable areas and subsequently increase runoff rates in this development area. Table 6-2 below presents the existing land use against proposed land use and subsequent proportions of hard standing and permeable areas.

Table 6-2: Land Use Existing against Proposed

Land Use/Type	Areas in Existing Site (ha)	Areas in Proposed Site (ha)
Open Space (Greenfield)	0.08	0.00
Paths/Roads/Paving (Hard Standing)	0.27	0.35

- 6.2.13 The topographic survey collected for this FRA does not cover the entirety of development area 3, however, it is safely assumed that ground levels in this area are much lower than those in development area 1 and so a different public sewer would be required to manage surface water from this area. Satellite images of the site appear to suggest that a drainage network exists along the proposed access road which would most likely be utilised for managing surface water in this area.
- 6.2.14 In order to comply with the requirements outlined by Yorkshire Water, runoff from the site will be limited to 70% of the existing run off rate. However, it is recommended that details of the existing drainage network are attained at the detailed design phase to ensure that this is an appropriate design assumption.

6.3 SuDS Selection Process – the ‘Management Train’

- 6.3.1 Paragraph 103 of the NPPF gives priority to the use of SuDS in new development and they should be incorporated into the development proposal where possible. Such systems have the potential to reduce peak runoff rates and volumes and can improve the amenity and biodiversity of the development.
- 6.3.2 The management train concept promotes division of a development to be drained into sub-catchments with different drainage characteristics and land uses, each with its own drainage strategy. Dealing with the water locally not only reduces the quantity that has to be managed at any one point, but also reduces the need for conveying the water off the site.
- 6.3.3 A key concept of Sustainable Drainage Systems (SuDS) is of the "treatment train", whereby features are constructed at different stages on the source-pathway-receptor model (Figure 6.1 overleaf) and combine to attenuate, settle and treat surface water. Retention, bioretention basins and wetlands are the principal treatment facilities while ponds, detention basins, treatment swales and infiltration systems are also major forms of site control. Figure 6.2 outlines this concept.

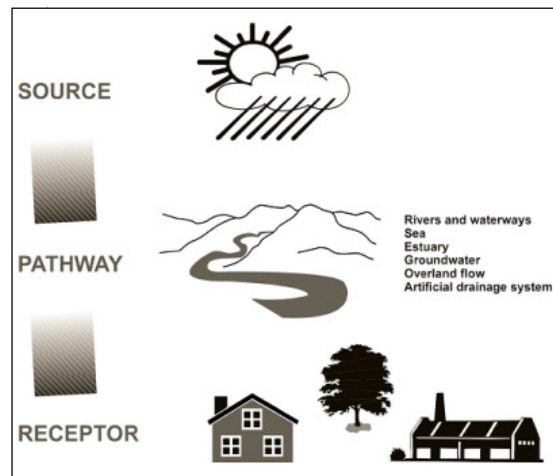


Figure 6-2: Source-Pathway-Receptor Model¹

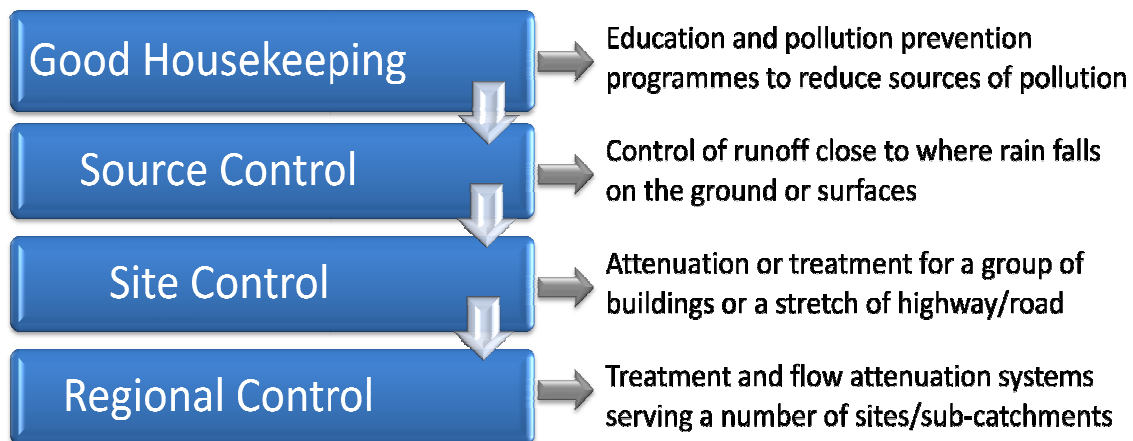


Figure 6-3: Sustainable drainage treatment train²

- 6.3.4 It is generally recommended that the use of SuDS within any master plan is included at the beginning of the master plan formulation so that the most appropriate measures can be included within the site design and not just added as an afterthought at the end of the process.
- 6.3.5 Below is a detailed description of possible sustainable drainage techniques that could be used in formulating the detailed drainage design. It is recommended that infiltration testing is carried out to determine the suitability of infiltration techniques and to determine infiltration rates to inform the design. Section 6.4 discusses the preferred options for the site.

Regional Control (Attenuation) SuDS

¹ Source: CIRIA (2004) – *Development and Flood Risk Guidance for the Construction Industry (C624)*

² Adopted from CIRIA C697: SUDS Manual

Dry Detention Basins (Dry Ponds)

- 6.3.6 These areas are typically purpose built basins or depressed open space/landscape areas that allow surface water runoff to be attenuated during rainfall events. These devices drain via a specifically designed outlet structure that ensures the device fully drains between storm events. Only depressed landscaped areas are viable in this site and they should be no deeper than 300mm. This protects the public who might venture into these areas when they are wet. As large portions of detention basins will remain dry for much of the year they can also be used as public open space.



Figure 6-4: Large basin (Left) and micro storage basin (right)

Infiltration Basins

- 6.3.7 These are vegetated depressions designed to store runoff and infiltrate gradually. The Environment Agency should be consulted to determine what restrictions apply to the site based on the proposal being located within a source protection zone (SPZ). Linear features are more likely to be appropriate given the confined nature of the site and its existing uses.

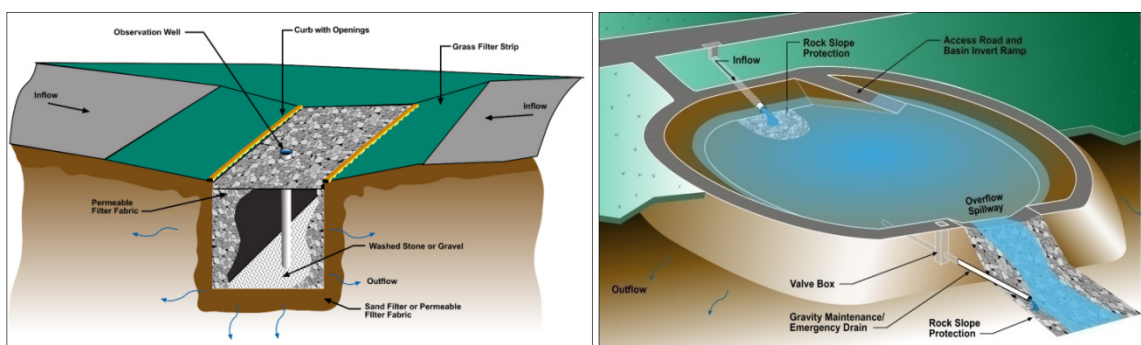
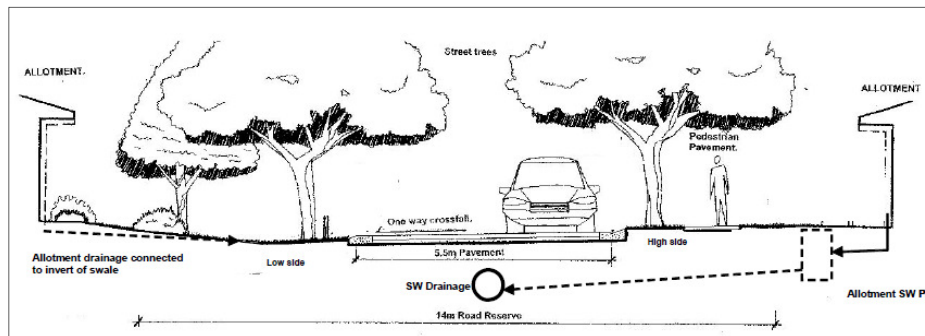


Figure 6-5: Linear infiltration trench (Left) and infiltration basin (right)³**Site Control SuDS***Grassed Swale*

- 6.3.8 Swales are vegetated channels which convey or store surface water. Low water speeds allow settlement of suspended particles. The base of these features can be designed to allow infiltration and can be used to place conventional pipe drainage. The final detailed drainage design should promote their use throughout the final development layout.

**Figure 6-6:** Indicative one way cross fall design (left) and constructed vegetated swale (right)*Permeable Paving*

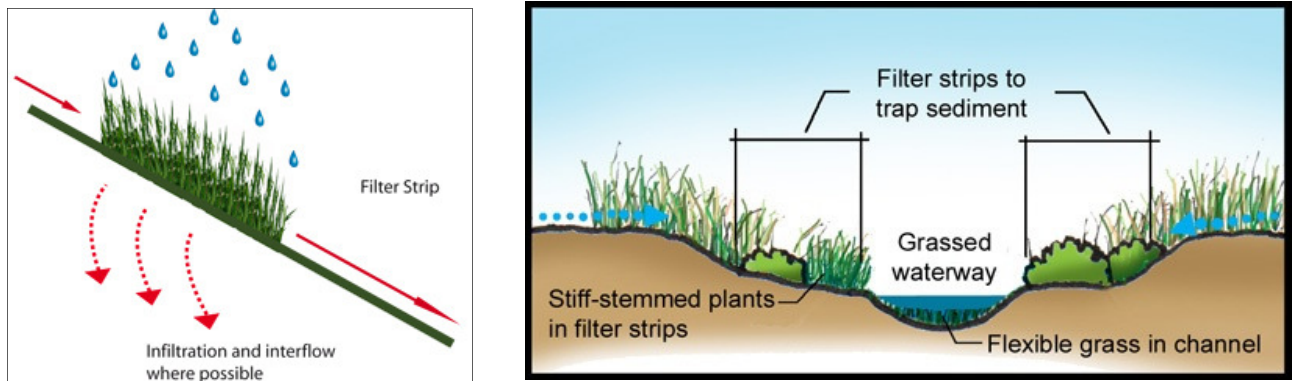
- 6.3.9 Permeable paving is an option within some hard standing road and car parking surfaces. These devices can be designed to incorporate a sub surface drain within the sub base to allow for adequate drainage in areas where infiltration cannot occur. These devices require regular maintenance to ensure that the voided areas are not compromised by sediments. Permeable pavement should be used within the site at appropriate locations (such as car parks, public squares and courtyards) identified through detailed design and reserved matters planning application process.



³ <http://keneulie.files.wordpress.com/2010/02/feb-infiltratintrench.jpg>

Figure 6-7: Various permeable paving surfaces*Filter Strips*

- 6.3.10 Filter strips are vegetated strips of land designed to accept runoff as overland flow from upstream development. These should be incorporated wherever appropriate adjacent to receiving swales and ditches so that drainage fits in with the overall structural landscape of proposed development.

**Figure 6-8:** Illustration of filter strip function (left) cross section adjacent to swale (right)⁴*Bioretention*

- 6.3.11 Bioretention devices are landscaped depressions which are typically under drained and rely on engineered soils and enhanced vegetation. The use of bioretention devices is feasible within the site depending on the location and adequate free drainage from the devices sub surface drain.

⁴ http://www.unl.edu/nac/bufferguidelines/guidelines/3_productive_soils/4.html

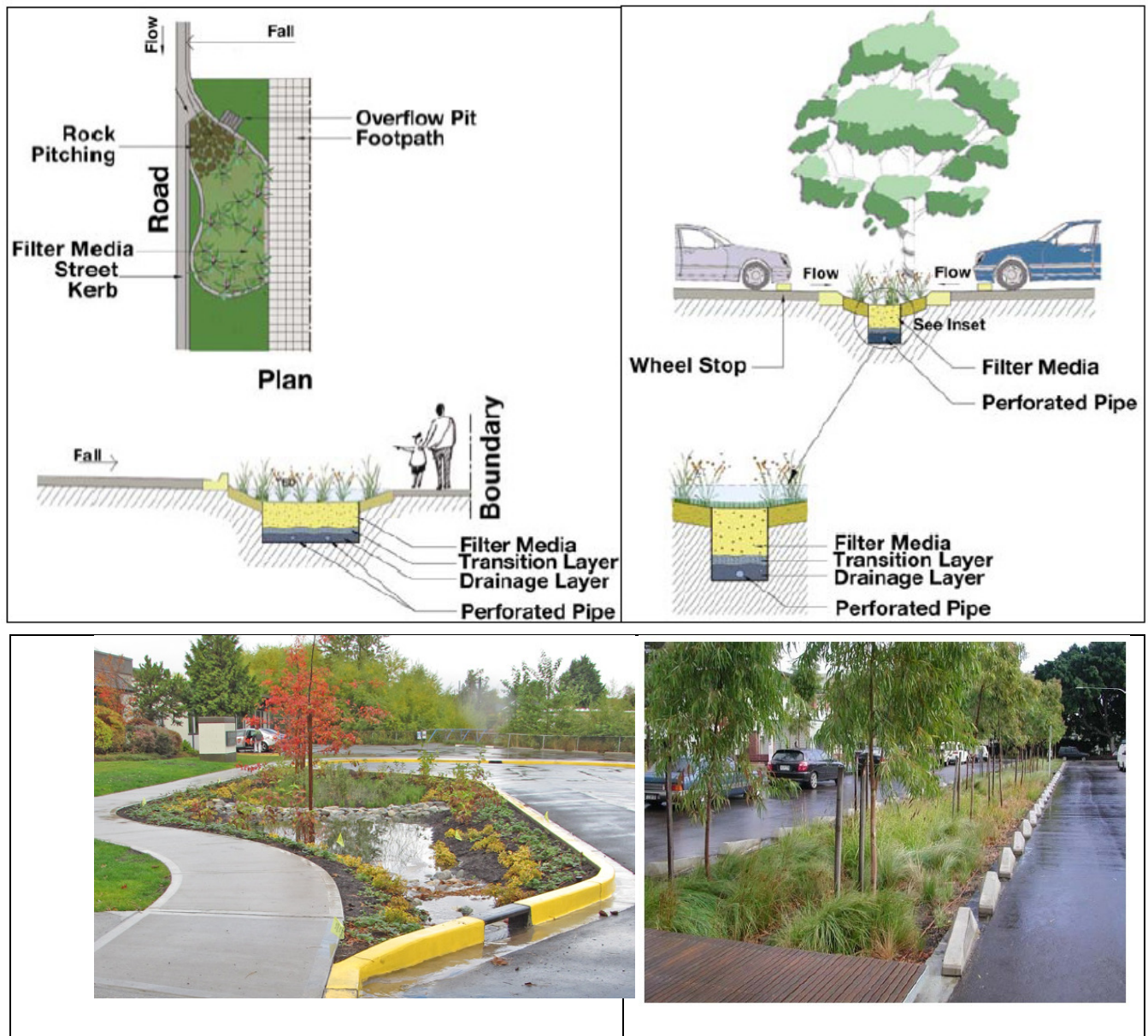


Figure 6-9: Minor 'rain garden' (left) and a linear bioretention feature (right)⁵

Trenches

- 6.3.12 These are shallow excavations filled with rubble to create temporary storage or infiltration of runoff.

⁵ <http://gravel-lok.blogspot.com/2009/10/french-drain-system-with-gravel-lok.html>

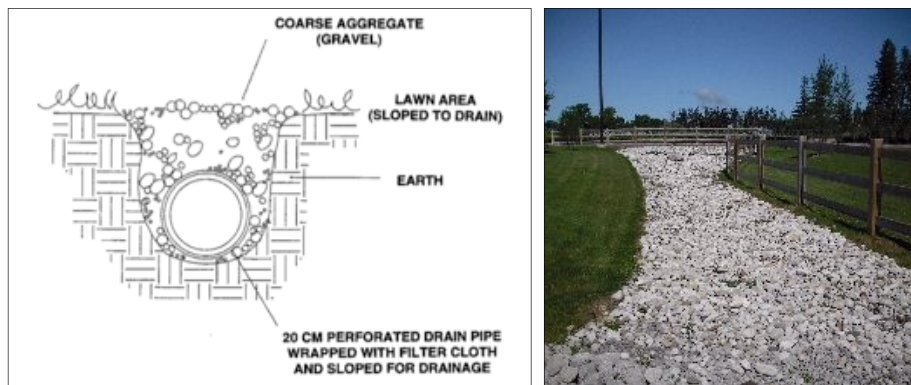


Figure 6-10: Indicative cross section through a trench (left) constructed trench/'French Drain' (right)⁶

Source Control SuDS

6.3.13 These measures can be used to reduce the peak rates and volumes of runoff 'at the source', before it reaches downstream attenuation SuDS. These SuDS techniques have been assessed as suitable, and should be considered as part of the detailed design process.

Green Roofs

6.3.14 Vegetated roof areas can assist in reducing the runoff amount, provide some treatment of water quality within the soil media and plant uptake and provide additional habitat for fauna, without requiring additional space. They can require (depending on the proposed roof configuration) regular maintenance so can be difficult to ensure they work correctly on individual properties where the owner is responsible. They also require additional structural roof strength and may not be suitable to typical residential building constructions – final building designs can determine if they can be implemented.



Figure 6-11: Grassed green roof (left) green roof with intensive landscaping (right)

⁶ <http://gravel-lok.blogspot.com/2009/10/french-drain-system-with-gravel-lok.html>

Water Butts/Rainwater Harvesting

- 6.3.15 The incorporation of rainwater harvesting tanks within the development can have benefits for both the reduction of surface water runoff and a reduction of the demand from potable resources. When utilising the rainwater tank for attenuation purposes the device should be viewed as two distinct cells/tanks one purely for harvesting and one for runoff attenuation which will include a controlled release device (overflow pipe) to ensure the cell/tank can drain after a rain event.
- 6.3.16 It is recommended that their use on residential and larger buildings is investigated at the detailed design stage.
- 6.3.17 These devices would not reduce the required downstream attenuation, as adopting a precautionary approach they would be assumed as full when a large storm event occurred, however they are an important aspect of sustainable drainage.

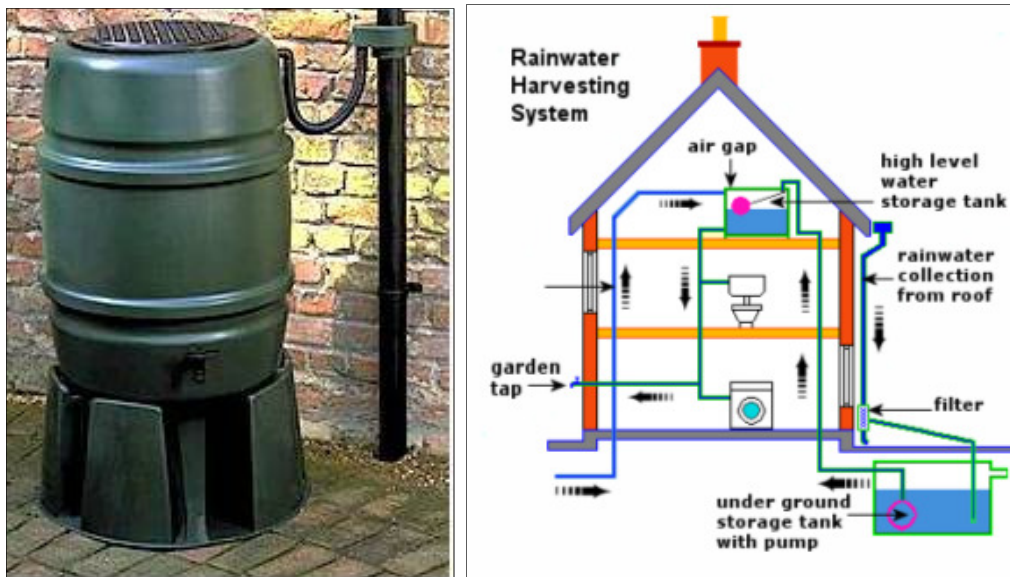


Figure 6-12: Water butt feature (left) and indicative property scale rainwater harvesting scheme (right)¹

6.4 Preferred SuDS Options

- 6.4.1 Where possible the use of Sustainable Drainage Systems (SuDS) should be incorporated into the development proposal. Such systems have the potential to reduce the peak runoff flows and volumes further and can improve the amenity and biodiversity of the development.
- 6.4.2 Table 6-3 provides a review of sustainable drainage options identified in the CIRIA SUDS Manual in order to identify techniques appropriate for the site and proposed development. For each technique a short justification is provided for their use, or otherwise.

Table 6-3: SuDS Technique Justification

Management Train approach	Technique	Proposed for Use	Justification
Source Control	Green roofs	x	Unlikely to be Possible as site will largely be formed of residential properties with pitched roofs.
	Rainwater harvesting	✓/x	Potentially applicable, if appropriate space is available for harvesting infrastructure e.g. pipe work and tanks etc).
	Permeable pavement	✓	Appropriate for areas of paving within the site. Although it is noted that this will be more applicable to public paved areas such as the car park in the south east corner of the site and less applicable near the residential developments.
Ponds/ Wetlands/ Detention Basins	Pond/Wetland	x/✓	There is potential for small ponds/wetlands to be incorporated into these areas. However, the applicability of this as a SuDS measure will be dependent on the volume of storage required. In addition the developer will need to consider whether creating ponds/wetland in the green space available is appropriate for the development.
	Detention Basin	x/✓	There is potential for detention basins to be incorporated into these areas. However, the applicability of this as a SuDS measure will be dependent on the volume of storage required.
Infiltration	Infiltration trenches/basins	x/✓	Local ground conditions would need to be tested to confirm suitability
	Soakaways	x/✓	Local ground conditions would need to be tested to confirm suitability
	Bioretention/filter strips	x/✓	Potentially applicable, if appropriate space is available
Open channels	Swales	✓/x	Potentially appropriate.
Retention	Underground storage/oversize pipes	✓	This measure would be appropriate; however, it is not truly a system that mimics natural drainage patterns.

6.5 Potential options for detailed design

Development Area 1 and 3

6.5.1 Based on the scale of the development and type of land uses could, subject to detailed design, utilise:

- Permeable paving – this reduces runoff volumes and can drain into underground porous or cellular storage in appropriate areas around the proposed building. Applicable to any adjacent areas that may be resurfaced as part of the development.
- Underground storage – located within network connecting the drainage from the new building to the existing network providing the necessary attenuation.
- Rainwater harvesting – If there is suitable space to implement rainwater harvesting then this can reduce water use as well as contribute towards the attenuation of runoff.

Development Area 2

6.5.2 The proposals for development area 2 include the provision of two sports fields 1000m² and 2000m² in size. It is presumed at this stage that the proposals will include localised improvements to land drainage to ensure that surface water is managed effectively. It is assumed that surface water flow paths from the site will be maintained post development.

6.5.3 It is recommended that for development area 2 ground investigations are carried out to assess the permeability of the land. SuDS measures that could be implemented for the fields include:

- Infiltration basins
- Soakaways

6.6 Surface Water Runoff Calculations

Calculation Inputs

6.6.1 As previously discussed, the analysis for the development site has looked at three development areas. The following section presents the calculations carried out for development areas 1 and 3.

6.6.2 Calculations have been undertaken to determine the existing runoff rates from the site, which have adopted the Modified Rational Method for runoff from hard standing areas, as per the guidance in the SuDS Manual. The existing area is a mixture of hard standing and permeable areas, and therefore the Greenfield Runoff loH124 method has been used to calculate existing surface water runoff rates from permeable areas.

6.6.3 To calculate the runoff from impermeable areas a runoff co-efficient of 0.85 was used for all building roofs, which are likely to be pitched and therefore will not retain rainfall, and 0.8 was used for all other hard standing areas such as parking bays, pavements and roads.

Development Area 1 Calculations

- 6.6.4 As shown in Appendix E.1, the existing site is calculated as providing 0.36 ha of green open space with 0.37 ha of hard standing making up the rest of the site.
- 6.6.5 The proposed developed represents an increase in the amount of impervious hard standing area with an additional 0.09 ha of impervious areas, in other words 0.43 ha of hard standing and 0.3 ha of permeable areas
- 6.6.6 Table 6-4 shows the pre and post development runoff rates for the 15-minute duration storm event, which produced the highest runoff rates.

Table 6-4: Pre- and Post Development Runoff Rates for the site

Return Period (years)	Existing Runoff Rate (l/s) – IH124 + Mod. Rational Method	Post-Development Runoff Rate (l/s) –IH124 + Mod. Rational Method
1	17	20
2	31	37
10	59	68
30	86	100
100	127	149
100 + CC	166	194

- 6.6.7 The results above indicate that there is a 14.0 – 16.2% increase in post development runoff, as a result of the increased hard standing impervious areas.
- 6.6.8 As discussed in Section 6.1, developments on Brownfield sites should reduce surface water run-off by at least 30%. It is recommended that runoff rates from the developed site are limited to 70% of the existing runoff rate for the 1 in 2yr event (22 l/s).
- 6.6.9 Restriction of runoff rates from the site to existing runoff rates for the 1 in 2yr storm will result in the following storage requirements within the site:

Table 6-5: Surface Water Attenuation Requirements

Return Period (years)	70% of the 1 in 2yr Existing runoff rate	Maximum Storage Volume (m ³) required	Critical Storm Duration (mins)
1	22	-6	15
2	22	6	15
10	22	28	15
30	22	49	30
100	22	85	30
100 + CC	22	123	30

- 6.6.10 The development at Belle Vue will need to provide a minimum of 123m³ of storage in order to attenuate surface water and restrict runoff rates to the permitted rates (see Table 6-5). As the development is on 'Brownfield' land this could easily be done through the provision of underground storage. Underground storage could either be provided beneath the parking spaces for each development, assuming that each parking space is 12m², a 1m deep tank beneath each house would be sufficient to provide the necessary storage for the site.
- 6.6.11 It is recommended that local ground conditions be investigated to determine the applicability of Soakaways as this would be the preferred approach. Further SuDS measures such as permeable paving could be implemented across the sites hard standing areas which could discharge directly to the storage.

Development Area 3 Calculations

- 6.6.12 As shown in Appendix E.2, the existing site is calculated as providing 0.08 ha of green open space with 0.27 ha of hard standing making up the rest of the site.
- 6.6.13 The proposed developed represents an increase in the amount of impervious hard standing area with an addition 0.08 ha of impervious areas, in other words 0.35 ha of hard standing with no permeable areas
- 6.6.14 Table 6-2Table 6-6 shows the pre and post development runoff rates for the 15-minute duration storm event, which produced the highest runoff rates.

Table 6-6: Pre- and Post Development Runoff Rates for the site

Return Period (years)	Existing Runoff Rate (l/s) – IH124 + Mod. Rational Method	Post-Development Runoff Rate (l/s) –IH124 + Mod. Rational Method
1	12	15
2	22	29
10	42	54
30	61	79
100	91	118
100 + CC	119	153

- 6.6.15 The results above indicate that there is a 20.0 – 24.1% increase in post development runoff, as a result of the increased hard standing impervious areas.
- 6.6.16 As discussed in Section 6.1, developments on Brownfield sites should reduce surface water run-off by at least 30%. It is recommended that runoff rates from the developed site are limited to 70% of the existing runoff rate for the 1 in 2yr event (16 l/s).
- 6.6.17 Restriction of runoff rates from the site to existing runoff rates for the 1 in 2yr storm will result in the following storage requirements within the site:

Table 6-7: Surface Water Attenuation Requirements

Return Period (years)	70% of the 1 in 2yr Existing runoff rate	Maximum Storage Volume (m ³) required	Critical Storm Duration (mins)
1	16	-3	15
2	16	6	15
10	16	23	15
30	16	40	15
100	16	69	30
100 + CC	16	99	30

- 6.6.18 The development at Belle Vue will need to provide a minimum of 99m³ of storage in order to attenuate surface water and restrict runoff rates to the permitted rates (see Table 6-7). This could be achieved through the provision of underground storage or oversized pipes. However, it is recommended that local ground conditions be investigated to determine the applicability of Soakaways as this would be the preferred approach. Further SuDS measures such as permeable paving could be implemented across the sites hard standing areas which could discharge directly to the storage.

6.7 Residual risks from failure or exceedence

- 6.7.1 The calculations presented in this section have been designed to ensure that flows up to the 100 year plus climate change event are stored on site without flooding occurring within the site itself whilst also ensuring flood risk elsewhere is not increased. Should a rainfall event of greater magnitude occur and the system is exceeded it is assumed that runoff will tend towards the current drainage paths present in the existing site i.e. flows will be directed towards the east of the site.
- 6.7.2 To ensure that this excess flow does not contribute to flooding within the development, or increase risk to Barnsley College to east, it is recommended that kerb heights be raised along access roads in development area 1 to direct flow away from housing and into the existing surface water drainage as and when capacity is restored.
- 6.7.3 In development area 3 it is recommended that flow paths are maintained along the roads to ensure that water is directed away from the Barnsley College and towards the existing surface water drainage network.
- 6.7.4 In development area 2 it is recommended that flow paths are maintained so as not to increase flooding elsewhere.

6.8 Maintenance and Adoption

- 6.8.1 It is expected that the developer will set up a management company to provide the necessary maintenance of the SuDS and any other elements of the development that won't be adopted by either highways or the Local Authority through its adoption of public open spaces.

- 6.8.2 Unlike conventional drainage systems, SuDS features should be visible and their function should be easily understood by those responsible for maintenance. When problems occur, they are generally obvious and can be remedied simply, using standard landscaping practice. If systems are properly monitored and maintained, any deterioration in performance can often be managed out.
- 6.8.3 It is recommended that a SuDS owner's manual is provided to the site owners. This should include the following:
- Location of all SuDS on site;
 - Brief summary of how the SuDS work;
 - Maintenance requirements (a maintenance plan) and a maintenance record;
 - Explanation of the consequences of not carrying out the maintenance that is specified;
 - Identification of areas where certain activities are prohibited (for example stockpiling materials on pervious surfaces);
 - An action plan for dealing with accidental spillages; and
 - Advice on what to do if alterations are to be made to a development, if service companies undertake excavations or other similar works carried out that could affect the SuDS.
- 6.8.4 Maintenance requirements will be determined by the type of SuDS. Cellular storage areas will require maintenance that should include:
- Monthly for 3 months, then six monthly inspection and identification of any areas that are not operating correctly;
 - Monthly debris removal from catchment surface;
 - Monthly, and following significant storm events, checks of filter surface for blockage by silt, algae or other matter;
 - Removal and replacement of surface infiltration medium as necessary;
 - Removal annually, or as required of sediment from pre-treatment structures;
 - Repair/rehabilitation as required of inlets, outlet, overflows and vents; and
 - Inspection annually, and following significant storm events, of all inlets, outlets, vents and overflows to ensure that they are in good condition and operating as designed.
- 6.8.5 Soakaways will require maintenance that should include:
- Annual removal of sediment and debris from pre-treatment devices and floor of inspection tube or chamber;
 - Annual cleaning of gutters and any filters on downpipes;
 - Annual trimming of any roots that may be causing blockages;
 - Annual check of soakaway to ensure emptying is occurring;
 - Reconstruction of soakaway and/or replacement or cleaning of void fill, if performance deteriorates or failure occurs;
 - Replacement of clogged geotextile as required;
 - Monthly inspection of silt traps.

7. Conclusion

- 7.1.1 Capita Property and Infrastructure has been commissioned by Barnsley College to undertake a Flood Risk Assessment for the proposed development of the Belle Vue site.
- 7.1.2 The site is approximately 1.8 ha in size and the application site is located within Flood Zone 1 on the Environment Agency's Flood Zone Maps. The proposed development is classified as 'More Vulnerable' according to the National Planning Policy Framework (NPPF). More Vulnerable development is acceptable in Flood Zone 1 subject to the passing of the Sequential Test.
- 7.1.3 This FRA provides information to show that the development should pass the Sequential Test, as it is not located within a high risk area and there are no other areas with lower risk suitable for purpose. Alternative sites are unlikely to be able to meet the project objectives.
- 7.1.4 The fluvial flood risk to the site is low as it lies outside of the Environment Agency Flood Zones 2 and 3. No mitigation measures would be required to manage the risk of fluvial flooding.
- 7.1.5 The risk from other sources, including surface water, sewers and artificial sources is also low and the development requires no measures to manage these risks.
- 7.1.6 There will be an overall increase in impermeable areas resulting from development of the site which will lead to an increase in runoff coefficients. The development is on Brownfield land and so should aim to reduce the existing runoff rate by at least 30% from in accordance to guidelines set out in the Barnsley MBC SFRA, NPPF and the Barnsley Local Development Framework (LDF) core strategy. Attenuation can be provided within the site for runoff above this rate for all events up to the 1% AEP plus climate change storm. Attenuation could be provided through underground storage with runoff rates reduced by the provision of permeable paving discharging directly the storage unit. It may also be appropriate to incorporate Soakaways into the SuDS drainage strategy although this will be subject to local ground investigations. It has been calculated that a combined Storage volume up to 222m³ will be required.
- 7.1.7 The development proposal has considered flood risk throughout the development of the scheme and reflects the flood risk constraints and the need to manage, and where possible reduce, flood risk in compliance with the guidance in the NPPF and the local SFRA. This FRA demonstrates that the proposed development is not at risk of flooding. The development will not increase the risk of flooding to others. Surface water runoff can be managed within the site.

Appendix A – Figures

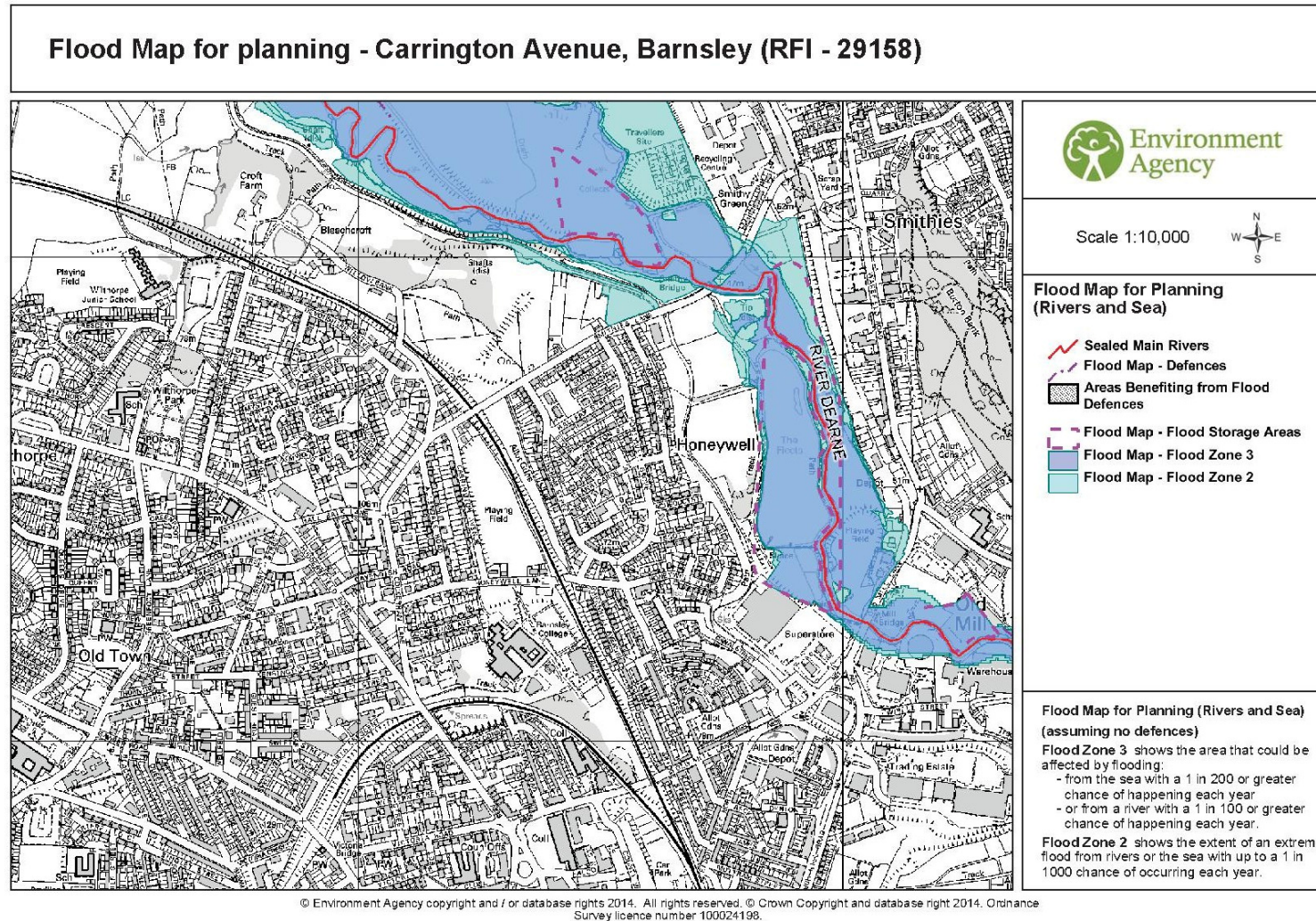
A.1 Site Layout Plan

A.2 Proposed Development Plan

A.3 Topographic Survey

Appendix B – Flood Zone Maps

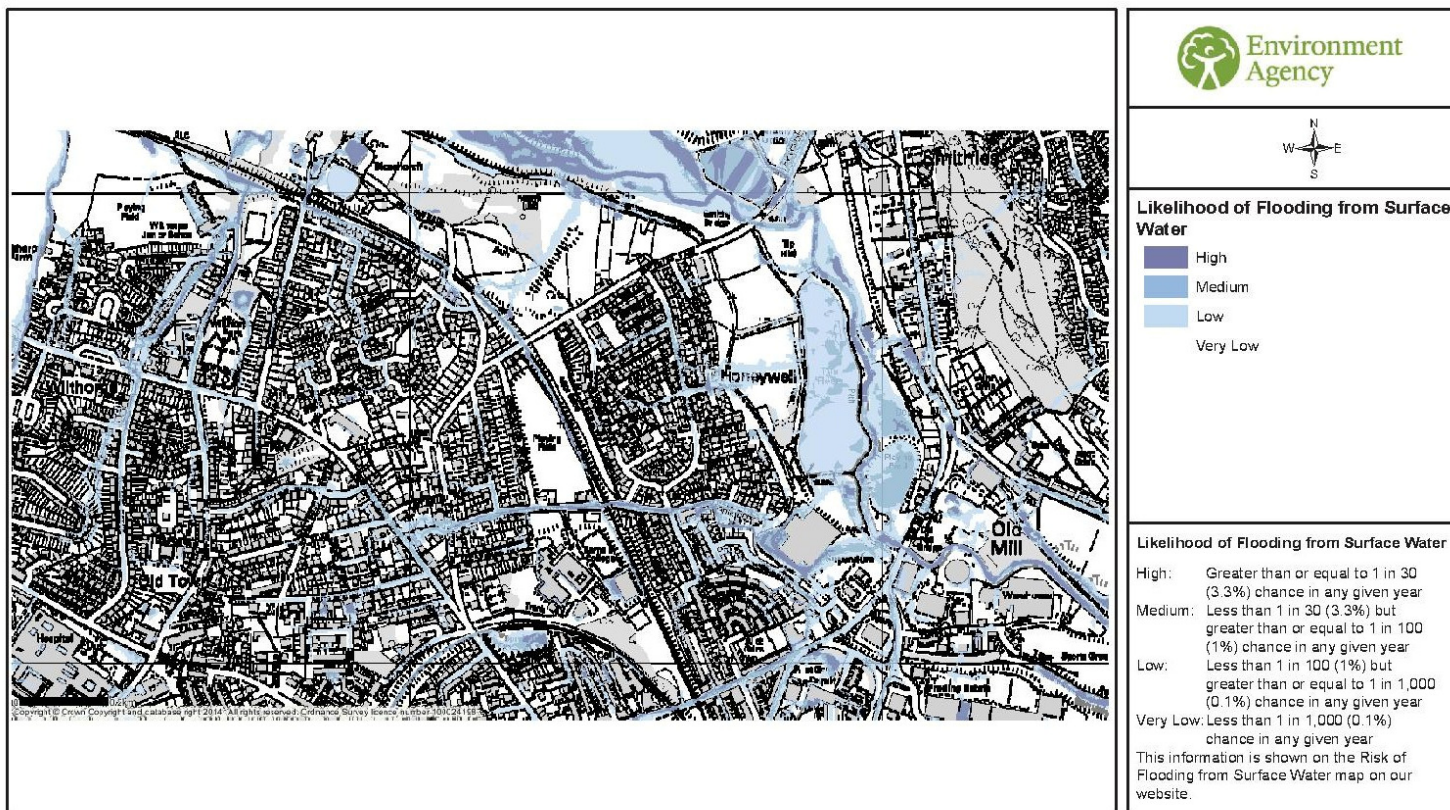
B.1 Environment Agency Flood Zone Maps



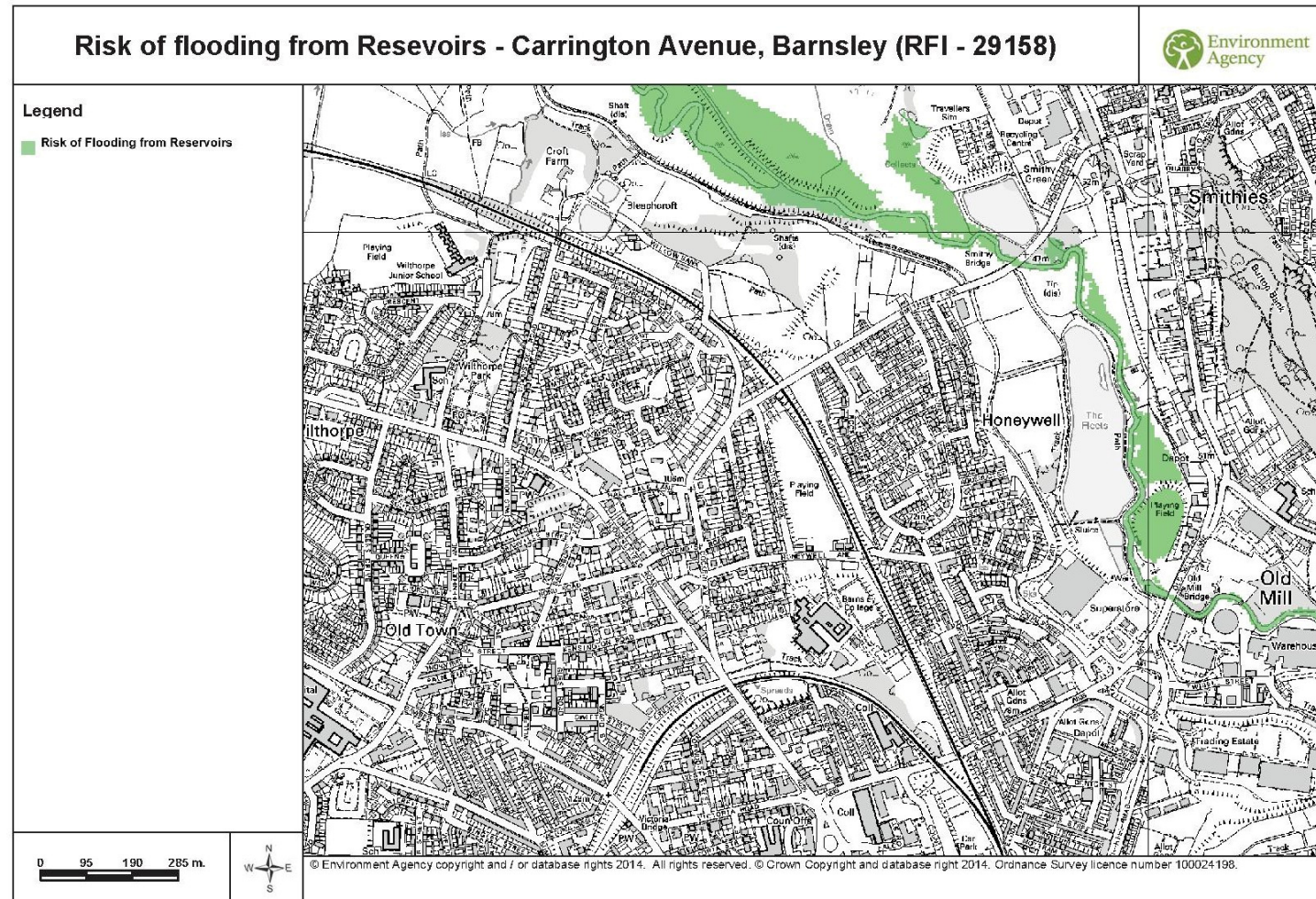
Contact Us: National Customer Contact Centre, PO Box 544, Rotherham, S60 1BY. Tel: 03708 506 506 (Mon-Fri 8-6). Email: enquiries@environment-agency.gov.uk

B.2 Surface Water Flood Map

Risk of flooding from Surface Water – Carrington Avenue, Barnsley- RFI no: 29158 – Date 21 May 2014

Contact Us: National Customer Contact Centre, PO Box 544, Rotherham, S60 1BY. Tel: 03708 506 506 (Mon-Fri 8-6). Email: enquiries@environment-agency.gov.uk

B.3 Reservoir Inundation Flood Map



Appendix C – Drainage Strategy

C.1 Existing Drainage Network

Appendix D – Correspondence

Appendix E - Drainage Strategy

E.1 Surface Water Runoff Methodology

Runoff from Impermeable Areas

The estimated runoff rate and volume from the proposed layout has been calculated using the Modified Rational (Wallingford) Method. This method allows estimation of the amount of runoff that is likely to be generated from an urban area. Rainfall depths for the various return periods were produced using the FEH CD-ROM DDF (Depth-duration-frequency) modelling function have been used to calculate rainfall intensities for specified return periods.

The Modified Rational method uses the following equation to calculate peak runoff rate from an area:

$$Q_o = 2.78 C_v CR i A$$

Where:

C_v = Volumetric Runoff Coefficient

CR = 1.3 (Routing Coefficient)

i = Rainfall Intensity (mm/h)

A = Area (ha)

2.78 = Coefficient which accounts for the differences in units used for the inputs and the outputs of the equation.

The variable C_v is a co-efficient that describes the proportion of rainfall appearing in the surface water drainage system. CR is a routing co-efficient added to the Rational Method to represent runoff characteristics of a particular site or area in a more accurate manner.

The following spreadsheets have been used to calculate runoff rates and volumes using the above methodologies, as reported in Section 6 of this FRA.

E.2 Surface Water Runoff Calculations

