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FLOOD RISK ASSESSMENT AND SURFACE WATER MANAGEMENT STRATEGY

FOR PROPOSED DEVELOPMENT

at

WILTHORPE ROAD, BARNSLEY

Prepared for

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1 INTRODUCTION

1.1 iD Civils Ltd (iD), have been appointed by Persimmon Homes West Yorkshire (PHWY) to prepare a Flood Risk Assessment (FRA) and surface water drainage management strategy report for the proposed residential development at Wilthorpe Road, Barnsley.

1.2 The report will be undertaken in accordance with Environment Agency (EA), Barnsley Metropolitan Borough Council (BMBC) and Yorkshire Water (YW) development control policy, and will focus on:

Site Use and Current Drainage regime, Flooding History, Ground Conditions and use of SUDS, Impact of development and proposed drainage strategy, flash flooding routes and the overall impact of development on the site and surrounds.

1.3 The report is for the sole use of PHWY and presents comments and conclusions based on information available at the time of writing. iD Civils reserve the right to amend conclusions if further information is made available.

2 BACKGROUND

2.1 PHWY is seeking detailed planning permission to develop a greenfield site to the north of Wilthorpe Road and east of Redbrook Business Park in Barnsley. The gross area of the development site is 12.90 Ha, which includes substantial areas of open space and buffer landscaping. A location plan for the site is included in Appendix A.

2.2 This Flood Risk Assessment has been undertaken with reference to the following reports, documents and plans:

- Environment Agency Flood Zone maps (EA website and SFRA)
- Barnsley Metropolitan Borough Council Strategic Flood Risk Assessment (JBA, 2010)
- Barnsley Metropolitan Borough Council Preliminary Flood Risk Assessment.
- Phase 1 (desk top) Site Investigation (Sirius)
- Topographical Survey (Persimmon)
- Sewer Record Plans (Yorkshire Water)
- National Planning Policy Framework (NPPF)
- CIRIA C697 – SUDS Manual
- CIRIA C624 Development and Flood Risk

- Defra – Draft National Standards for Sustainable Drainage Systems
- Yorkshire Water Development Control Standards

In addition, iD Civils has undertaken a walkover survey of the site. Commercially available aerial photographs and historic ordnance survey maps of the area have also been used during the preparation of the report.

2.3 **Site Walkover:** A site visit was undertaken in September 2013. During the site walkover overland flood routes onto and from the site were inspected in order to assess the risk of flooding from external sources.

3 REGULATORY GUIDANCE

3.1 National Planning Policy Framework (NPPF), along with the technical guidance to NPPF provides the regulatory framework and guidance for planning authorities in relation to Flood Issues for new developments. Any application submitted to a local planning authority will be considered in conjunction with this guidance, and dependant on the nature and location of the application, the planning authority may request a site specific Flood Risk Assessment as part of the planning application documents.

3.2 The Environment Agency is a statutory consultee to the local Planning Authority in relation to flood risk issues. The EA have responsibility for the management of Main Rivers.

3.3 BMBC is the Lead Local Flood Authority (LLFA) with respect to the area, and has responsibility for control and management (but not maintenance) of ordinary watercourses. The Land Drainage Act 1991 provides a regulatory framework for this issue.

3.4 The watercourses downstream of the area are administered by the Dearne and Dove Internal Drainage Board which are part of the Shire Group of drainage boards. The board utilises Jeremy Benn Associates to deliver their obligations.

3.5 BMBC appointed Jeremy Benn Associates (JBA) to prepare a Level 1 Strategic flood Risk Assessment (SFRA) which was published in 2010.

3.6 Under the Flood Risk Regulations 2009 the LLFA has a duty to prepare a Preliminary Flood Risk Assessment (PFRA). The PFRA is a high level risk assessment based on existing information where available. The process led to the publication of the BMBC PFRA in June 2011 which highlighted local areas at significant risk of flooding.

3.7 The EA has produced a matrix for local planning authorities, which provides advice in terms of the requirements for risk assessment. 'Environment Agency Standing Advice – Development and Flood Risk' dated February 2009 tabulates the requirements relative to the scale of the development and the applicable Flood Zone. The assessment is required for all sites larger than 1 Ha in flood Zone 1 and all sites regardless of size in Flood Zones 2 and 3.

3.8 The Environment Agency have undertaken a national study of flood risk across England and published flood maps covering the country. The maps can be viewed on the agency web site at **www.environment-agency.gov.uk**. Specific locations can be studied by searching either using postcode or address.

3.9 The EA flood maps identify 3 zones.

Flood Zone 1: This zone comprises land with a less than 1 in 1000 annual probability of river or sea flooding in any one year (<0.1%)

Flood Zone 2: This zone comprises land assessed as having between a 1 in 100 and 1 in 1000 annual probability of river flooding (1%-0.1%) or between a 1 in 200 and 1 in 1000 annual probability of sea flooding (0.5%-0.1%) in any year.

Flood zone 3: The zone comprises land assessed as having a 1 in 100 year or greater annual probability of river flooding (>1%) or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year.

Flood risk should be assessed from the following sources; tidal and river, surface water and flooding from land, groundwater, sewers and artificial sources e.g. canals and reservoirs.

Flood zone plans reflect the undefended flood scenario for a particular area. Many flood areas are defended with flood defences of varying types and design life. Areas benefiting from flood protection are shown hatched on the EA plans.

3.10 The level of detail and complexity of a Flood Risk Assessment can vary considerably, dependant on the scale, nature and location of the planned development. EA guidance sets out the criteria for the level of information which should be included within the FRA.

3.11 The application site is within EA **Flood Zone 1** in accordance with the published EA flood zone plans. An extract of the flood risk plan is presented in appendix B.

3.12 The Practice Guide to NPPF refers to vulnerability classifications, which are based on the sensitivity of different forms of development. In accordance with the guidance (table 2), the intended end use planned for this development is classed as 'More Vulnerable' (residential).

3.13 Table 3 in the NPPF technical guidance provides information in relation to the appropriate vulnerability classes within each of the flood risk zones. The table is presented below and based on the table residential development is appropriate to the flood zone setting of the site.

Table 4015.1 – Flood risk vulnerability and Flood Zone compatibility

Flood Risk Vulnerability Classification (Table 2 NPPF)	Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Zone 1	√	√	√	√	√
Zone 2	√	√	Exception Test Required	√	√
Zone 3a	Exception Test Required	√	x	Exception Test Required	√
Zone 3b	Exception Test Required	√	x	x	x

3.14 **The Sequential Test:** In accordance with NPPF, LPA's allocating land for development should apply the Sequential test, to demonstrate that there are no available sites in the area with a lower risk of flooding. The site is within Flood Zone 1 therefore there are no sites of a lower risk in the area.

3.15 **The Exception Test:** The exception test is relevant if, following the application of the sequential test; it is not possible for the development to be allocated in zones of lower probability of flooding. The exception test criteria are detailed in The Technical practice guide of PPS25. The test provides a method of managing flood risk while still allowing necessary development to occur.

The sequential and exception test are not relevant in this particular instance.

3.16 BMBC Local Development Framework, Core Strategy Publication (Policy CSP4 – Flood Risk) 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 site specific flood risk assessment for development proposals over 1 Ha in Flood zone 1.
- Requiring all development proposals on Brownfield sites to reduce surface water run-off by 30% and development on Greenfield Sites to maintain existing run-off rates.
- Requiring development sites to use Sustainable Drainage Systems in accordance with policy CSP3

3.17 Yorkshire Water work within the framework of 'Sewers for Adoption- 6th edition', which sets the standard for adoptable surface water and foul waters sewers. They also apply development control standards which are consistent with current best practice and Building Regulations.

3.18 Developers are encouraged to make 'pre development' enquiries to YW to ensure that there is sufficient time for the company to fully assess the capacity of their network and treatment works. This process also ensures that drainage strategies are acceptable in principle, prior to planning permission and helps avoid any objections from YW during the planning process. iD submitted a pre development enquiry in May 2013. A copy of YW's response is enclosed in appendix F.

3.19 The emerging 'Flood and Water Management Act 2010' will fundamentally change the way developers and local authorities approach the design and adoption of SuDS drainage. New SuDS Approving Bodies (SAB) will be formed to ensure adequate consideration is given to SuDS methods of drainage and the SAB will act to approve SuDS designs and adopt the constructed SuDs features. As LLFA, BMBC is expected to be appointed as the SuDS Approval Body for this area.

3.20 There are currently no mandatory SuDS design standards. Draft standards have been circulated and the mandatory standards are awaited prior to the formation of the SAB's. The 7th edition of 'Sewers for Adoption' has been published, but will not be enforced by YW until the SuDS standards are adopted and the Flood and Water Management Act comes into force. The timetable for the Act coming into force is currently October 2014.

3.21 The principles identified in the consultation SuDS standards have been considered in developing the strategy outlined in this report, on the assumption that the strategy will be consistent with best practice and that ultimately the site will come forward after the SAB's are in place. Some of the principles with respect to the treatment of water are not possible to implement due to the current adoption policies of the local authority.

4 SITE DESCRIPTION AND HISTORY

4.1 A site location plan is included within Appendix A of this report. Site details are summarised in the Table below.

Table 4015.2 - Site Location Summary

Detail	Remarks
Location	Approx. 3KM NE of Barnsley Centre.
NGR	SE 332 080
Area	12.90 Ha (gross)
Current Use	Arable Farmland

4.2 **Topography:** The topographical survey and walkover survey indicate that the site is steeply sloping and forms a valley feature, falling to the watercourse which runs through the site flowing in a northerly direction. The majority of the development is west of the watercourse and this area falls steeply to the north east where the watercourse flows under a railway line in a culvert. The eastern parcel is mainly open space and play area but contains a small amount of development. This area falls mainly to the north west but the eastern area falls to the north east corner adjacent to the railway line.

4.3 The new site access is from Wilthorpe Road. There is currently a drop in levels of cc 1-2m from Wilthorpe Road into the site. The highest point of the site is adjacent to Wilthorpe Road with an elevation of cc 93m AOD. The lowest point of the area west of the watercourse is approx. 66.5m AOD. The western part of the site falls at typical gradients of approximately 1:8 to 1:15. The western side of the site falls from a level of approx. 80m AOD to 65m AOD with the lowest point of the site being adjacent to the watercourse.

4.4 The northern boundary of the site is adjacent to a railway line which is mainly in cut below the site but partially in embankment for a short section. There is an existing bridge over the railway from the western parcel to land to the north. At this point to line is in approximately 5m of cut below the site.

4.5 Boundaries to the site are a mixture of stone walls, fences and hedges as shown on the topographical survey.

4.6 **Adjacent Land use:** The site is bounded by the following features:

Table 4015.3 -Adjacent Land Uses

North	Railway line and embankments.
South	Wilthorpe Road, The Crescent with residential dwellings and Tennis Club.
East	Wilthorpe Avenue and Wilthorpe Farm, Playing Fields to Wilthorpe Junior School.
West	Redbook Business Park

4,7 **Previous Development:** iD Civils have reviewed the Phase 1 desk top study undertaken by Sirius. The report indicates that there has been no previous 'development' use on the site.

4.8 **Existing Hard standing:** The site does not contain any areas of hard standing or drained roofs.

4.9 **Hydrology:** There is an open watercourse running within a steep valley crossing the site flowing from south to north. The watercourse emerges out of culvert below Wilthorpe Road and runs in open cut across the site, returning to culvert below the railway line to the northern boundary. The watercourse is an unnamed tributary of the River Dearne. The watercourse is well defined and in a 1.5 – 2.5m deep channel set substantially lower than the site. Sections of the watercourse are lined with concrete slabs. The watercourse generally falls at gradients of between 1 in 8 and 1 in 12.

4.10 There is a canal, the Barnsley Canal (disused) approximately 250m to the north of the railway line.

4.11 The Sirius report confirms that the site is not within a source protection zone and there are no water abstractions within the vicinity. There have been no pollution incidents relevant to this site.

4.12 The site is located on a Secondary A aquifer.

5 EXISTING SITE DRAINAGE

5.1 iD has obtained a copy of the Yorkshire Water Sewerage Record plans for the area. A summary is presented below and the plans are enclosed within appendix F:

Table 4015.4 – Existing Sewers Summary

Sewer Type	Comment
Surface Water	There are no surface water sewers crossing the site. The nearest surface water sewer is within Wilthorpe Avenue to the east of the watercourse. The system here discharges into the watercourse.
Foul Water	There are no foul sewers crossing. The nearest foul sewer is within The Crescent flowing west to connect to the combined system in Wilthorpe Road.
Combined Sewers	There are no combined sewers crossing the site. The nearest combined sewer is within rear gardens to Wilthorpe Avenue. This sewer crosses Wilthorpe Road which forms the southern boundary of the site. The sewer is 300mm diameter and at the point it crosses the road is cc 2.4m deep.
Highway Drains	iD Civils has no records of highway drainage in the area.
Culverted Watercourse	There are no recorded culverted watercourses crossing the site.
Land drainage	There are no records of land drainage crossing the site; however signs of land drainage entering the watercourse from land to the east were noticed on the site walkover.

5.2 There may be land drainage within the proposed site. Care should be taken to avoid damage to land drainage systems during site earthworks. Land drainage systems should be maintained or diverted around proposed new development wherever possible to avoid changing the natural drainage patterns.

5.3 Pre development liaison with BMBC indicates that:

'The watercourse is an ordinary watercourse for the purpose of the Land Drainage Act 1991, and is in riparian ownership.'

5.4 **Greenfield Run-off:** The assessment of Greenfield runoff is a complex issue, which can be influenced by many site specific factors. There are a number of methodologies which can be used to derive Greenfield flow rates. IoH 124 which is the approved method prescribed by the EA provides a robust assessment tool, but cannot factor in site specific influences which may be relevant to a particular development and setting within the flood zone. IoH124 has been developed following a study of 71 small rural catchments. The tool is based on rainfall hydrographs and soil types for a particular location. It does not consider site specific gradients, connectivity with the receiving watercourse, or any other site related constraint.

5.5 Using IoH 124 method, the developed area of the site (8.15Ha) produces the following Greenfield run-off rates:

Table 4015.5 – Greenfield Run-off using IoH 124

Return Period	Flow rate (litres/sec)
1 year (rural)	31.9
30 year	65.3
100 year	77.2

5.6 ADAS 345 was developed as a design tool for the assessment of field drainage design. This methodology, whilst not based on as many catchment studies as IoH124, does allow for the input of catchment lengths, gradients and soil types and may be more accurate where sites have a close relationship with the receiving watercourse.

5.7 An assessment in accordance with ADAS 345 has been undertaken and provided the following Greenfield run-off rates:

Table 4015.6 – Greenfield Run-off using ADAS 345

Return Period	Flow rate (litres/sec)
1 year	33.4
30 year	68.3
100 year	80.8

5.8 BMBC development control policy specifies a borough wide 1 in 1 year greenfield rate of 5.0 l/s/ha. The Greenfield rate from the 8.15 Ha site in accordance with development control policy would therefore be 40.75 l/s.

5.9 Given the varying greenfield rates derived from each method, the normal BMBC development control rate has been adopted for the purposes of this assessment.

6 PROPOSED DEVELOPMENT

6.1 PHWY is promoting a detailed application for 312 residential dwellings. The site will be accessed from Wilthorpe Road to the south via a new protected right turning lane junction. There will be an internal loop system within the site to ensure satisfactory highway arrangement for a development of this size.

6.2 New dwellings provide a range of accommodation and styles from small terraced units to large family homes with private front and rear gardens.

6.3 Due to the retaining wall which separates the site from Wilthorpe Road, it is anticipated that the initial section of highway access will be elevated above the ground levels within the site by cc 1.0m. The majority of the site is likely to be +/- 0.50m from current ground levels.

6.4 The net developable area of the site (excluding open space and landscape buffers) is estimated as 8.15 Ha.

6.5 It is estimated (from experience of similar types of development) that the overall site may produce an impermeable fraction of around 55% of the gross site area. The total anticipated impermeable area of the proposed development is estimated as 4.48 Ha (roofs, driveways and highways). Flows from the development if unattenuated would be in the order of 625 l/s in the 1 in 1 year event, and 935 l/s in the 1 in 30 year event.

6.6 Highways within the site will be offered for adoption with Barnsley Metropolitan Borough Council, via a section 38 agreement. Main sewers within the site will be offered for adoption to Yorkshire Water via a section 104 agreement. Adopting authorities will maintain the roads and sewers in perpetuity.

6.7 There are substantial landscape buffer to the north of the site and also buffers adjacent to the watercourse.

7 FLOOD HISTORY AND SITE VULNERABILITY

7.1 Flooding can occur from a variety of sources, including tidal, rivers, watercourses, overland run-off, groundwater, sewers and culverts. NPPF and BMBC guidance requires flood risk from all sources to be evaluated and suitable mitigation provided.

7.2 Inspection of the EA flood map indicates that the site falls within Flood Zone 1 and has a low risk of flooding from fluvial and tidal sources. A copy of the Flood Zone Plans included within Appendix B.

7.3 **Preliminary Flood Risk Assessment:** BMBC has published the PFRA in 2011. The PFRA was based on a review of historical flood information from a range of sources. Within the PRFA there are a number of plans which present details of significant areas of flood risk. There are no plans of this area and it is assumed therefore that this area does not suffer significant flooding.

7.4 A request for detailed historical flood records has been issued to BMBC. The response from BMBC, which was part of a wider scale planning pre consultation response, did not highlight any significant flood issues with respect to the site.

7.5 A request for historical flooding information was also made to the Dearne and Dove Internal Drainage Board. As the site is actually outside their area, no records of flooding were held by the board.

7.6 The EA has recently published a series of Surface Water Flood Maps(SWFM) recently which cover the whole country. Review of the SWFM indicates that a small part of the site is affected by potential overland surface water flooding which is discussed in section 8.2. A copy of the plan is enclosed within appendix D.

7.7 **Flood Vulnerability and Climate Change:** NPPF provides guidance with respect to the implications of climate change and suggests appropriate additional allowances for climate change with respect to rainfall intensities. It also recommends the following precautionary sensitivity ranges are applied to rainfall intensities for the design life of the development:

Table 4015.7 – Climate Change Allowances

Parameter	1990-2025	2025-2055	2055-2085	2085-2115
Peak Rainfall Intensity	+5%	+10%	+20%	**+30%**
Peak river Flow	+10%	+20%		

7.8 The Practice guide to NPPF states that for residential development a 100 year design life should be assumed. Therefore in accordance with the above table a climate change factor of 30% should be built in to all designs where applicable to protect against future increases in rainfall.

8 FLOOD IMPACT AND MITIGATION MEASURES

8.1 NPPF guidance requires the risk from a range of potential sources to be evaluated, as follows:

8.2 **Overland Flooding:** Based on the site walkover survey, review of the topographical survey, and review of the EA surface water flooding maps, the risk of flooding onto the site for the majority of its area from adjacent land is low due to the relative levels between the site and its surroundings. There is a **low risk** of overland flows flowing onto the site to the north of Wilthorpe Farm as shown on the EA maps due to a low spot in Wilthorpe Avenue and land falls towards the watercourse. Risks are considered in further detail below:

8.3 **South:** Wilthorpe Road forms part of the southern boundary and is elevated above the site. The carriageway and footway of the road are separated from the site by a stone wall so there is currently no risk of overland flows entering the site at present.

Mitigation: There will be a widening of the road and creation of a new access to the site. Road drainage should be considered as part of this improvement scheme and additional gullies should be placed on the access bellmouth to ensure that run-off from the higher sections of Wilthorpe Road do not flow into the site.

8.4 **South:** The residential dwellings on the Crescent and the Tennis Club are higher than the site and have the potential to create overland flows onto the site. Due to the size of the catchment flows generated are not considered to be significant and unlikely to create a significant risk to the site.

Mitigation: None required.

8.5 **North:** The railway line to the north of the site is below the level of the site for the majority of the northern boundary, so there is no risk of overland flows entering the site. The short section of the line where it is elevated above the site is close to the watercourse and any flows entering the site from the raised embankment will be drained via the watercourse culvert below the line to the north.

8.6 **East:** The adjacent Business Park to the east is below the site and will not create overland flows towards the site.

8.7 **West:** The land to the west (Wilthorpe Avenue) is above the site. Wilthorpe Avenue has a low spot adjacent to 25/27 which will create a low risk of overland flows towards the site as land falls towards the site from the rear of 25/27.

This route is indicated on the EA surface water plans as a 'Low' risk. Low risk routes are classed as flood routes which may occur in a return period of 100-1000 years.

Mitigation: The layout indicates new dwellings in the area of the flood route. Plots 283-287 are potentially at risk from this route and mitigation measures will be required to protect these plots. It is recommended that the boundary of plots 286/287 is designed to feature a low wall of a height of cc 450mm with a overland flood route towards the driveway of plots 283-286, which will create a route for potential flood water towards the existing watercourse and new road.

8.8 The most significant risk of overland flooding is from flows generated within the site flowing to the low points of the site to the north. At present when ground becomes saturated, or during periods of intense rainfall when the ground is hard, water will flow down the site across the surface and drain into the watercourse which runs through the centre of the site. The percentage of water running off the site to the watercourse is approximately equal to the SPR value of the soil type. SPR values are given in the Flood Studies Report (FSR) or the Flood Estimation Handbook (FEH), SPR values are given in five categories (1-5) with impermeable clays being rated as 5 and granular soils 1. The SPR values are as follows:

Table 4012.8 - SPR Values

Category	SPR
1	0.10
2	0.30
3	0.37
4	0.47
5	0.53

8.9 Based on an assumed SPR value for the site of 0.37, and a catchment area of cc 8 Ha draining towards the watercourse, the potential overland flows from a 1 in 100 year event to the watercourse will be cc 740 litres/second.

8.10 **Flooding from Rivers/Watercourses or the Sea:** The risk of flooding from the sea is low by virtue of the inland location of the site. Flood risk from fluvial sources (River or watercourses) is low due to relative levels from the site to the watercourse which is set in a valley feature crossing the site.

8.11 **Flooding from Culverts or field drains:** iD Civils are not aware of any existing culverts or land drains within the site.

8.12 **Flooding from Sewers:** There are no surface water sewers within the site. The nearest surface water sewer is within the estate to the east and the total catchment of the system is small.

8.13 **Flooding from artificial sources:** The YW mains records do not indicate any substantial water mains within the site or adjacent to the site. The nearest water main which could pose a risk to the site is within Wilthorpe Road. The main at this point is 160mm diameter. If the main should leak or bust water from the main would be trapped in the roadside gullies and drained by the adopted drainage system or highway drain.

EA flood maps published on the web site do not show the area as at risk from reservoir breach.

8.14 **Groundwater Flooding:** The PFRA and SFRA do not highlight this site as an area at risk from groundwater flooding.

8.15 **Downstream Sensitivity:** The immediate area downstream of the site is sensitive to flooding and it is essential that flows from the development are controlled to pre development levels so as not to increase flooding through the culvert or in the downstream River. It is important that the surface water management strategy reflects the sensitivity of the downstream receptor and mitigates against increases in run-off from the site as required in development control standards and BMBC policies.

8.16 **Development Levels:** Dwelling floor levels should be carefully considered in any low lying areas of the site, or areas which are potentially at risk from overland flows generated within the site. Dwellings at risk should be designed 300mm above the natural ground level, or be designed to produce an overland flood route around the dwelling to mitigate against the risk of internal flooding.

9 SUDS

9.1 Building Regulations (Part H), NPPF, YW and BMBC development control policies and Environment Agency advice notes, require the consideration of sustainable drainage techniques for new developments. This existing legislation is to be reinforced by the emerging Flood Water Management Act which will provide a formal structure for the adoption of SuDS drainage and further encourage their use.

9.2 Surface Water drainage should be considered in accordance with a prescribed hierarchy aimed at minimising the impact of development. Surface Water flows should be designed to discharge to:

1. Infiltration based or sustainable drainage systems
2. Watercourses
3. Surface water Sewers
4. Combined water sewers

Designers should evaluate drainage options in accordance with this hierarchy. Developer's rights to connect surface water into the drainage system under section 106 of the Water act will be withdrawn as part of the new act until it can be proven to the SAB that methods of drainage further up the hierarchy cannot be reasonably achieved.

9.3 Guidance on SUDS techniques can be found in the SUDS Manual (Ciria 2007). There are various forms of technique available as summarised below:

Table 4015.9 – Forms of SuDS Drainage

Technique	Description
Trenches	Shallow excavations filled with rubble or stone that create temporary storage and either filter into the ground or convey water to an outlet. Known as 'French drains'
Swales	Shallow linear vegetated drain ditches which can either convey flows to an outlet or infiltrate via a granular sub base to the sub strata.
Pervious Pavements	Material which allows water to permeate into underlying sub strata – best utilised on flat sites with permeable sub strata. Permeable paving can be used on clay sub strata but will require a piped drainage outlet from the sub base to a positive system.
Geocellular Systems/Tank systems	Modular plastic geocellular systems which have a high void ratio and allow water to be storage below ground. Large diameter pipework or purpose designed tanks to allow below ground storage.
Infiltration Basins	Vegetated depressions which allow water storage and slow infiltration into the ground
Detention Basins	Surface water storage basins which remain dry when not in use and allow flood water to collect and discharge to a design flow rate
Ponds	Ponds can provide both attenuation and treatment features, together with landscape and ecology value. Run off through storms is attenuated in an upper level above ambient pond depths. Many councils have published design standards if a developer intends to offer ponds for adoption. Design standards within WMDC area are covered later in this report.

9.4 The use of SUDS techniques is designed to mitigate the impact of development on receiving watercourses or sewers by mimicking pre development conditions as far as possible. New development should not worsen flooding downstream and should attempt to improve flooding wherever practical.

9.5 Sustainable Drainage can take many forms dependant on site use, layout, ground conditions and topography. In terms of the hierarchy of sustainable options, infiltration based systems should be considered in the first instance i.e. soakaways/infiltration swales/basins etc. The use of infiltration systems will be subject to the infiltration characteristics of the natural ground below the site. In areas with cohesive sub soils it is unlikely that sufficient percolation can be provided to allow the implementation of infiltration techniques.

9.6 A detailed intrusive site investigation report should be undertaken to accurately determine the nature of strata below the site and the infiltration properties. The Sirius desk top study confirms that the site is likely to be underlain by shallow bedrock (Mudstone), or thin weathered bedrock deposits. Drainage options covering the use of soakaways and also in the event that they cannot be used are covered in the drainage strategy section of this report.

9.7 Sustainable Drainage in areas of cohesive sub soils can be provided by a range of flow attenuation devices to suit the proposed development, policies of adopting authorities and planning authority requirements. Attenuation ponds and swales can provide ecological benefits by the creation of wetland habitats. Ponds can be designed to contain a permanent body of water with a freeboard capacity to attenuate peak storm events up to the 1 in 100 year plus climate change event. The detailed design and location of ponds with a permanent body of water will need to be agreed with the planning authority. Whilst many local authorities do adopt ponds, there is no legal requirement for local authorities to adopt ponds prior to the formation of the SAB's. In terms of BMBC policy it is understood that they will not adopt ponds at the present time.

9.8 Due to the sloping topography of the site, the provision of a formal pond/basin feature to attenuate surface water flows may prove difficult due to the shallow batter slope requirements which would require significant earthworks.

9.9 Provision of attenuation storage volume by underground tanks or oversize sewers is also an acceptable form of SUDS drainage and in many cases may provide the most practical solution to meet the requirements of guidance due to the availability of land or other constraints, particularly in small infill or sloping sites. In order to achieve adoption requirements the 1 in 30 year flows should be stored within tanks however flows between 1 in 30 years and 1 in 100 year can be stored above ground provided that there is no risk to property or downstream flooding. This would be an option on this site.

10 PROPOSED DRAINAGE STRATEGY

10.1 The development of the site will require a new drainage system designed to suit the final approved layout, and in compliance with current Building Regulations and Sewers for Adoption. The system will be adopted by YW under a section 104 agreement.

10.2 A drainage strategy can be determined based on the available information and regulator liaison to date. This strategy is illustrated on the plan within appendix H. A summary is provided below:

10.3 **Foul Drainage:** iD Civils has undertaken a 'pre-development enquiry' with YW. The response to our enquiry is contained within appendix D.

Yorkshire Water confirms that:

'Foul water domestic flows should discharge to the 300mm diameter public combined sewer recorded crossing Wilthorpe Road, at a point south east of the site.

From the information supplied it is not possible to determine if the whole site will drain by gravity to the public sewer network. If the site, or part of it, will not drain by gravity, then it is likely that a sewage pumping station will be required to facilitate connection to the public sewer network. If sewage pumping is required foul water discharge must not exceed 8 litres/second.'

Discussion: The combined sewer crossing Wilthorpe Road is 2.4m deep. Due to the site topography it will be necessary to pump flows from the site up to this sewer. The final flow rates for the site need to be agreed with YW as the rate of 8 l/s will be exceeded under the normal flow calculations required by Sewers for Adoption. Given the size of the receiving pipe an increase in the 8 l/s stated is considered to be likely.

10.4 **Surface Water and SuDS Hierarchy:** In accordance with the hierarchy contained within Part H of the building regulations, NPPF and the emerging SuDS standards, the surface water strategy should be considered in order of the sustainable hierarchy. The hierarchy and ability of the site to support the particular elements of the hierarchy are discussed below:

10.5 **Discharge to infiltration drainage/soakaway:** The ability of any development to discharge to infiltration drainage is wholly reliant on the ground conditions across the site. The desk top study site investigation indicates that drainage via infiltration methods is unlikely to be an option due to the presence of shallow mudstone bedrock. A detailed site investigation should e undertaken to verify this desk based assumption.

10.6 **Discharge to Watercourse:** The site is crossed by a watercourse and a connection to this watercourse is the favoured and most sustainable options for the new development. The site is within the catchment of the River Dearne and the maintenance of a Greenfield run off rate for the new development will not exacerbate flooding downstream.

10.7 **Discharge to Surface Water Sewer:** There are no suitable surface water sewers which could be utilised to discharge the site into. As a method of surface water disposal higher up the hierarchy has been identified there is not reason to propose a discharge to sewer.

10.9 **Discharge Rate:** The pre development Greenfield rate for the area in accordance with BMBC development control policy is 5 l/sec/Ha. Assuming only areas which are developed (8.15 Ha); the total equivalent Greenfield discharge rate for the site is 40.75 l/sec. Guidance states that the equivalent greenfield rate between the 1 in 1 year event and up to the 1 in 100 year event should not be exceeded. The 1 in 100 year event according to IoH124 is 77.2 l/s, therefore the site could in theory discharge 40.75 l/s up to 77 l/s across the storm events.

10.10 Given that it is normal for storage systems to feature a single flow control device, the lower parameter of the 1 in 1 year storm discharge rate should be utilised. This effectively means that during a 100 year storm event the existing greenfield rate will be reduced to approximately 55% of the corresponding rate prior to development resulting in considerable betterment over the current situation.

10.11 Maximum discharge rates should be maintained between the 1 in 1 year and 1 in 100 year events. An allowance of 30% to any storage requirements should be made for climate change factors for the 1 in 100 year event as prescribed in the technical guide to NPPF.

10.12 **Storage:** New drainage should be designed to provide attenuation storage to flows in excess of the design discharge rate of 40.75 l/s. Storage capacity should allow for flows to be retained within the network from the 1 in 30 year event without flooding. Flood water from the 1 in 100 year (plus climate change) event should be stored on site without increasing flood risk elsewhere, or if that is not possible due to site constraints, stored within the network.

10.13 Due to the watercourse running across the site effectively splitting the drainage systems, there will need to be two separate outfalls to the watercourse from the development. The majority of the development is west of the watercourse and the rate of the discharge from this western area is proposed as 30.75 l/s. The eastern area is much smaller and a rate of 10 l/s is proposed.

West: The storage volume required for the 1 in 30 year event is 1290m^3. The storage volume for the 1 in 100 year event is 2523m^3. Due to the topography and stored volumes required between the two events it will be impractical to store the water from the 1 in 30 to 1 in 100 years events above ground, and it is therefore proposed that the whole of the required storage is placed below ground in the open space along the northern boundary. To achieve this within the special constraints a tank will be required.

East: The smaller eastern catchment requires a substantially lower stored volume. The volume required in the 1 in 30 year event is 114m^3. The volume required for the 1 in 100 year event is 235m^3. This area of the site is flatter than the western area so there is an opportunity to store water above ground by creating a bunded adjacent to the storage tank.

10.14 The use of filter strips and permeable paving will only be partially effective due to the underlying bedrock and the steep slopes. It is not recommended that such features are used on this site. The use of swales to provide water treatment will also not be possible as BMBC will currently not adopt such features in advance of the statutory requirements being enacted.

10.15 The plan in appendix H illustrates the likely position of underground storage for each area of the site. This plan should be verified as detailed design is progressed.

11 IMPACT OF DEVELOPMENT AND RESIDUAL RISK

11.1 A detailed Flood Risk Assessment and drainage management plan has been undertaken with respect to the planned development at Wilthorpe Road, Barnsley. The FRA has been undertaken in accordance with EA, YW and BMBC development control guidance, and considers the setting of the development and likely impact on surrounding areas. A drainage strategy has been outlined in the report.

11.2 The development site has been identified as within EA flood zone 1. Residential development is **appropriate** within Flood Zone 1.

11.3 A small section of the eastern side of the development has been identified as at low risk of overland flooding in accordance with EA Surface Water Flood Maps.

11.4 The assessment has identified the current site drainage characteristics in accordance with BMBC development control policy, and also established the current level of risk from flooding. A summary of the risks and mitigation identified is presented below:

Table 4015.10 - Summary of Main Issues

Issue	Summary	Residual Risk
Flood zone	Flood Zone 1 Development proposed is compatible to the flood setting in accordance with NPPF.	**Low**
Fluvial flooding	Low risk of flooding from Fluvial and Tidal sources	**Low**
Pluvial flooding	Low risk of pluvial flooding noted.	**Low**
Overland Flooding	Low risk of overland flooding from land to the east of the site from Wilthorpe Avenue affects a small area of the site. Mitigation specified to reduce the risk. Plots in low lying areas within the site and ends of cul de-sacs to be designed to provide flood routing. In areas of low spots additional road gullies to be provided to intercept water more efficiently.	**Low**
Artificial Sources	No significant artificial sources known	**Low**
Surface Water Management	Infiltration drainage unlikely to be appropriate given soil conditions. Connection of surface water flows to watercourse recommended. Pre development greenfield rate for the 1 in 1 year event calculated and adopted as design flow rate to watercourse for all events to the 100 year plus climate change event. Storage to be in underground storage tanks or piped storage. Western half of site may have some of the storm water stored above ground if levels permit.	**Low**

11.5 On the basis of the above report it is considered that the site can be designed to comply with relevant legislation, good practice and development control policy.