APPENDIX 13.1
FLOOD RISK ASSESSMENT

vectos.

FLOOD RISK ASSESSMENT & SURFACE WATER DRAINAGE STRATEGY

Firethorn Developments Limited

Land at North West Bicester

April 2021

Flood Risk Assessment
Surface Water Drainage Strategy

Report control

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1 Introduction

Authorisation

1.1 Vectos has been appointed by Firethorn Developments Limited to prepare a Flood Risk Assessment (FRA) and conceptual surface water drainage strategy to support the outline planning application at Land at North West Bicester.

Background

1.2 The site is located within the allocated strategic extensions to Bicester, known as North West Bicester Eco-Town Development, which will provide up to 6,000 dwellings over 154 hectares (ha).

1.3 The application site consists of two parcels of agricultural land of approximately 22.2 ha located 2 km to the north-west of Bicester (see Figure 1).

1.4 According to the Environment Agency (EA) Flood Map for Planning, the site is predominately in Flood Zone 1. This is defined as land having a less than 1 in 1,000 annual probability of river or sea flooding and is therefore considered to be a low risk from these sources. There is a small portion of the site, alongside the east boundary that is designated as Flood Zone 3 (i.e. high risk; land having a 1 in 100 or greater annual probability of river flooding) and Flood Zone 2 (i.e. low risk; land having between a 1 in 100 and 1 in 1,000 annual probability of river flooding). Given this flood zone status of the site, an FRA is required by the National Planning Policy Framework (NPPF).

1.5 This FRA has been developed in accordance with the guidelines set out in the NPPF and informed by regional and local planning policy, as well as through consultation with key stakeholders.

Development Proposal

1.6 Outline planning application for residential development (within Use Class C3), open space provision, access, drainage and all associated works and operations including but not limited to demolition, earthworks, and engineering operations, with the details of appearance, landscaping, layout and scale reserved for later determination. The outline planning application will consist of up to 530 dwellings.

1.7 It is also proposed to provide green infrastructure including a nature reserve, Sustainable Drainage Systems (SuDS) and buffers along the key watercourses within the site.

1.8 The proposed Land Use Parameters Plans, Framework Plan and Illustrative Masterplan are enclosed in Appendix A.

Aims and Objectives

1.9 The aim of this FRA is to demonstrate that the site can be developed safely for residential purposes, without exposing it to an unacceptable degree of flood risk and/or increasing the flood risk to third parties. The objectives of this FRA are to:

i) Review the relevant planning policy documents to ensure that the development proposals are in accordance with this and other regional and local guidance.

ii) Summarise relevant stakeholder consultation used to inform this FRA.

iii) Undertake a desk-based review of the available flood risk information to assess past, current and future flood risk issues, taking into consideration the anticipated impacts of climate change.

iv) Identify flood mitigation requirements, if any, to ensure the development is safe from flooding, without impacting third parties.

v) Assess whether the development will result in an increase of surface water runoff and how this can be mitigated through the incorporation of SuDS into the proposed development, which are informed through Lead Local Flood Authority (LLFA) guidance and consultation.

vi) Summarise the above into an FRA report including a plan showing the proposed SuDS features associated with the conceptual surface water drainage strategy.

Limitations

1.10 The general limitations of this assessment are that:

i) A number of sources have been used to compile this document, whilst we believe them to be trustworthy; Vectos is unable to guarantee the accuracy of the information that has been provided by others.

ii) This report is based on information available at the time of preparing the FRA. Consequently, there is potential for further information to become available or variations to the development proposals to be made. These changes may lead to future alteration to the conclusions or calculations in this report.

2 Consultation

2.1 Consultation has been undertaken with all key stakeholders, details of which are summarised below.

Environment Agency (EA)

2.2 Consultation with the EA has been undertaken as part of the FRA to obtain flood data associated with the watercourses present on site. This is provided in Appendix B and includes a Product 4 dataset. The Product 4 dataset identified that the Flood Zone 3 and Flood Zone 2 on the east site boundary were derived by the EA using the national generalised JFLOW methodology. This methodology was developed to prepare flood mapping across the country. It is a broad-brush flood modelling technique, which tends to overestimate the extent of flooding and ignores the impact of hydraulic structures such as culverts and bridges.

2.3 Consultation with the EA was also sought as part of the Environmental Impact Assessment (EIA) scoping process. The EA's response to the EIA scoping report gave general guidance with respect to the FRA. It required that the FRA should consider the potential impacts of the proposed development on off-site flooding, with mitigation to be proposed where necessary to ensure that no adverse effects occur as a result of the development.

2.4 The EA advised that a 'sequential location' approach should be applied to ensure that development is steered outside of Flood Zone 3 (with appropriate allowance made for climate change) and that no development should be located in areas at risk of flooding (in accordance with Local Plan Policy Bicester 1 – North West Bicester Eco-Town).

Lead Local Flood Authority (LLFA)

2.5 The Flood Risk Management team of Oxfordshire County Council (OCC) are the LLFA. Their website includes a toolkit with information needed to accompany a major planning application. This includes a local standards and guidance document, which has been used to inform the FRA.

2.6 A formal pre-application process was undertaken and an early version of the Framework Plan was submitted, which presented the location of a series of swales and attenuation basins across the site. A meeting followed, with various stakeholders, including the LLFA, and the wider project team. Subsequent comments made by the LLFA and the key points are outlined below:

i) Some parts of the proposed development (to the east) lie within Flood Zones 2 and 3. The proposed development also falls within areas of medium to high risk of flooding from surface water.

ii) Source control techniques, alongside regional-based SuDS, are required to be integrated into the development.

iii) Detailed BRE365 infiltration testing and long-term groundwater monitoring is required. However, as the development is located within an area of high groundwater vulnerability, infiltration is unlikely to be feasible, unless adequately mitigated.

iv) Surface water should be managed in a number of small catchments with attenuation features provided throughout the development.

v) As the estimated greenfield runoff rate is low, a higher soil type may be used to estimate greenfield runoff rates provided this is supported by a detailed ground investigation report.

vi) Space must be made for shallow conveyance features throughout the development and existing drainage features and flood flow routes should be retained.

vii) A detailed surface water management strategy must be submitted in accordance with the Local Standards and Guidance for Surface Water Drainage on Major Development in Oxfordshire.

2.7 Following receipt of these general comments, changes were made to the conceptual surface water drainage strategy. The LLFA acknowledged that it is difficult to determine the detail of source control attenuation and conveyance features at the outline stage. Therefore, the largest change to meet with the LLFA general requirements at this stage was to integrate a greater number of attenuation features across the site.

2.8 A detailed summary of the surface water drainage principles was outlined to the LLFA and a technical meeting followed. The LLFA appeared satisfied with the changes made and offered some advice for integration into the final strategy. A summary of these were emailed to the LLFA and are enclosed in Appendix C. Reference to these are made throughout Section 6 of this FRA.

Local Planning Authority (LPA)

2.9 Following the pre-application, comments on drainage were also received from Cherwell District Council (CDC). Their comments supported the LLFA response and were repetitive.

3 Site Description

Site Location and Description

3.1 The site is located on land to the north west of Bicester and is centred at approximate grid reference of SP576252. The site comprises two parcels (western and eastern) of land covering a total area of approximately 22.2 ha and is shown in Figure 1.

3.2 The site is bound by the B4100 along part of the north eastern boundary. A residential development lies to the north, south and between the two parcels of land that make up the site. Part of this is currently under construction. Home Farm lies to the east of the site, with the reminder of the surrounding area occupied by agricultural fields.

Figure 1: Site Location Plan

Site Topography

3.3 A topographical survey of the site is enclosed in Appendix D. It shows that the western parcel slopes in a south easterly direction towards a stream along the south boundary. The exception to this is in the north west corner of the western parcel, where the ground slopes in a north easterly direction towards a ditch on the site's northern boundary. The highest elevation in the western parcel is approximately 92 m above ordinance datum (AOD) towards the north, with the lowest elevation at approximately 85 m AOD in the south east.

3.4 The eastern parcel slopes in a south easterly direction towards Town Brook, with ground levels falling from approximately 91 m AOD to approximately 83 m AOD.

Geology and Hydrogeology

Geology

3.5 The 1 in 50,000 scale British Geological Survey (BGS) online mapping indicates that the bedrock underlaying most of the site is the Cornbrash Formation – Limestone. The areas adjacent to the watercourses within the site comprise of Forest Marble Formation – Limestone and Mudstone, interbedded.

3.6 Most of the site has no superficial deposits recorded. However, there are some areas where the bedrock is overlain by Alluvium – Clay, Silt, Sand and Gravel, associated with the watercourses within the site.

3.7 The Cranfield University Soilscapes website identifies the soil across the site as being freely draining loamy soils.

3.8 A site-specific ground investigation was undertaken by Hydrock in September 2020 (extracts are enclosed in Appendix E). This concluded that the geology was generally consistent with that identified on the BGS mapping. Infiltration testing was performed in accordance with BRE365 using 30 trial pits distributed across the site, with 19 of the pits sufficiently draining to enable infiltration rates to be determined, suggesting that in certain parts of the site that infiltration may be possible. However, infiltration was found to be highly sporadic, with side-by-side pits indicating very different results. Furthermore, groundwater was encountered across the site and was shallow in places. In the west part of the site, groundwater was marginally below the ground surface for part of the monitoring period.

3.9 Therefore, given the presence of shallow groundwater and the highly sporadic nature of infiltration rates across the site, an infiltration led surface water drainage strategy was not recommended by Hydrock.

3.10 In total the ground investigation included approximately 100 trial pits across the site. These identified a clay topsoil. This would indicate that the freely draining nature of the topsoil identified by Cranfield University Soilscapes website may not be an accurate portrayal of the characteristics on site. This is discussed further in Section 6.

Hydrogeology

3.11 The superficial deposits associated with the watercourse along the site's eastern (Town Brook) and southern boundary, are classed as a Secondary A aquifer, defined as "permeable layers capable of supporting water supplies at a local rather than a strategic scale, and in some cases forming an important source of base flow to rivers".

3.12 The bedrock geology across the whole site is also classified as a Secondary A aquifer.

3.13 Although the Hydrock ground investigation reports that the deeper geology beneath the site consists of White Limestone Formation which is classified as a Principal Aquifer, no White Limestone Formation was observed at the depths excavated. Furthermore, the Hydrock report states that the Forest Marble Formation acts as an impermeable barrier between the White Limestone Formation and Cornbrash Formation layers.

3.14 The site is not within a groundwater Source Protection Zone (SPZ) or drinking water safeguard zone. However, the site is in a high groundwater vulnerability area.

Hydrology

3.15 A manmade field ditch runs along the northern boundary of the western parcel, draining the northern part of the western parcel. The ditch drains to the north and is culverted beneath the B4100 where it discharges into a tributary of the Town Brook (see Figure 2).

3.16 Town Brook flows around Caversfield House and eventually flows alongside the site's eastern boundary.

3.17 There is an unnamed watercourse which lies along part of the site's southern boundary in the western parcel and forms a confluence with Town Brook at the south east corner of the site.

3.18 Beyond the site, Town Brook continues in a south westerly direction towards the A4095 and Bicester Town centre. Town Brook eventually drains to the Gagle Brook (via Langford Brook) approximately 5 km south of the site.

Figure 2: Local Streams and Ditches

Existing Drainage

3.19 The site is believed to rely on natural processes whereby the rainfall that is unable to infiltrate into the ground will runoff as overland flow following the topography and into the existing watercourses.

4 Planning Policy and Guidance

National Planning Policy Framework

4.1 The NPPF sets out the Government's national policies for flood risk management in a land use planning context within England and how these are expected to be applied. It states that developers and local authorities should try to locate development to land in zones with the lowest probability of flooding.

4.2 The aim is to steer new development to Flood Zone 1 (areas with a low probability of river or sea flooding). Where there are no reasonably available sites in Flood Zone 1, local planning authorities in their decision making should take into account the flood risk vulnerability of land uses and consider reasonably available sites in Flood Zone 2 (areas with a medium probability of river or sea flooding), applying the Exception Test if required. Only where there are no reasonably available sites in Flood Zone 3 (areas with a high probability of river or sea flooding) be considered, taking into account the flood risk vulnerability of land uses and applying the Exception Test if required.

4.3 This sequential risk-based approach to determining the suitability of land for development in flood risk areas is central to the policy statement and should be applied at all levels in the planning process.

4.4 The Planning Practice Guidance (PPG) outlines the approaches that should be taken to meet with the NPPF. In accordance with Table 2 of the PPG, the proposed development (i.e. residential) is classified as More Vulnerable.

4.5 Table 3 of the PPG sets out the 'compatibility' of the vulnerability classification with the identified flood zones. All proposed buildings and SuDS will be located within Flood Zone 1 and application of the Sequential or Exception Test is therefore not required.

The Cherwell Local Plan 2011 -2031

4.6 The Cherwell Local Plan sets out the long term spatial vision up to 2031 for the District and contains policies to help deliver that vision. It should be noted that CDC are in the process of reviewing the current local plan and are at the consultation stage with the Local Plan 2040 document. In addition, the six Oxfordshire councils (including CDC) have committed to producing a joint plan known as the Oxfordshire Plan 2050 which will set out a strategic vision for sustainable growth across the district. This is anticipated to be submitted to the Planning Inspectorate in January 2022. The policies relevant to flood risk, SuDS and the site itself are discussed in more detail below:

Policy ESD 6: Sustainable Flood Risk Management

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The Council will manage and reduce flood risk in the District through using a sequential approach to development; locating vulnerable developments in areas at lower risk of flooding. Development proposals will be assessed according to the sequential approach and where necessary the exceptions test as set out in the NPPF and NPPG. Development will only be permitted in areas of flood risk when there are no reasonably available sites in areas of lower flood risk and the benefits of the development outweigh the risks from flooding.

In addition to safeguarding floodplains from development, opportunities will be sought to restore natural river flows and floodplains, increasing their amenity and biodiversity value. Building over or culverting of watercourses should be avoided and the removal of existing culverts will be encouraged.

Existing flood defences will be protected from damaging development and where development is considered appropriate in areas protected by such defences it must allow for the maintenance and management of the defences and be designed to be resilient to flooding.

Site specific flood risk assessments will be required to accompany development proposals in the following situations:

- **All development proposals located in flood zones 2 or 3**
- **Development proposals of 1 hectare or more located in flood zone 1**
- **Development sites located in an area known to have experienced flooding problems**
- **Development sites located within 9m of any watercourses.**

Flood risk assessments should assess all sources of flood risk and demonstrate that:

- **There will be no increase in surface water discharge rates or volumes during storm events up to and including the 1 in 100 year storm event with an allowance for climate change (the design storm event)**
- **Developments will not flood from surface water up to and including the design storm event or any surface water flooding beyond the 1 in 30 year storm event, up to and including the design storm event will be safely contained on site.**

Development should be safe and remain operational (where necessary) and proposals should demonstrate that surface water will be managed effectively on site and that the development will not increase flood risk elsewhere, including sewer flooding.

Policy ESD 7: Sustainable Drainage Systems (SuDS)

Policy ESD 7: Sustainable Drainage Systems (SuDS)

All development will be required to use sustainable drainage systems (SuDS) for the management of surface water run-off.

Where site specific Flood Risk Assessments are required in association with development proposals, they should be used to determine how SuDS can be used on particular sites and to design appropriate systems.

In considering SuDS solutions, the need to protect ground water quality must be taken into account, especially where infiltration techniques are proposed. Where possible, SuDS should seek to reduce flood risk, reduce pollution and provide landscape and wildlife benefits. SuDS will require the approval of Oxfordshire County Council as LLFA and SuDS Approval Body, and proposals must include an agreement on the future management, maintenance and replacement of the SuDS features.

Policy Bicester 1: North West Bicester Eco-Town

4.7 Policy Bicester 1: North West Bicester Eco-Town directly relates to the wider development and this is further supplemented by the North West Bicester Supplementary Planning Document.

North West Bicester Supplementary Planning Document February 2016

4.8 The Supplementary Planning Document (SPD) expands upon Policy Bicester 1 of the Cherwell Local Plan. The SPD provides further detail to the policy and means of implementing the strategic allocation.

4.9 When fully delivered, North West Bicester will provide:

i) 6,000 homes;

ii) Employment land and opportunities providing at least 4,600 new jobs;

iii) Up to four primary schools and a secondary school;

iv) Forty percent green space, half of which will be public open space;

v) Pedestrian and cycle routes;

vi) New links under the railway line and to the existing town;

vii) Local centres to serve the new and existing communities;

viii) Integration with existing communities.

4.10 Development Principle 11 of the SPD refers to Flood Risk Management and requires that new developments should minimise flood risk by ensuring that surface water runoff rates and volumes from the development are no greater than existing conditions in accordance with the NPPF. It requires that surface water drainage strategies for proposed residential developments (with an assumed lifetime of 100 years) should include a 30% allowance for climate change.

4.11 As part of the approach to flood risk management and climate change adaptation, the SPD refers to the requirement of providing site-wide SuDS which should be integrated into the wider landscape and ecology strategy to help manage and prevent surface water flooding.

4.12 Development Principle 9 (c) refers to retaining and reinforcing existing stream corridors. The development requirement is the establishment of a minimum 60 m corridor to the watercourse (30 m each side of the centre of the watercourse).

Cherwell Level 1 Strategic Flood Risk Assessment (SFRA) May 2017

4.13 The Cherwell SFRA determines the flood risk issues from rivers, surface water, groundwater, sewers and other artificial sources for the District. Recommendations for strategic policies and requirements for site specific FRAs are also included.

4.14 The SFRA refers to the inclusion of SuDS within developments which should seek to reduce flood risk, reduce pollution, and provide landscape and wildlife benefits.

LLFA SuDS Guidance

4.15 The LLFA are a statutory consultee to the planning process to assess major planning applications for their surface water drainage implications. The LLFA published their guidance for major developments in November 2018 with the document: Local Standards and Guidance for Surface Water Drainage on Major development in Oxfordshire, which is available online.

4.16 The guide is intended to assist developers in the design of surface water drainage systems, providing specific information on the planning, design and delivery of surface water drainage, designed to reduce the risk of flooding and maximise environmental gain, including water quality, water resources, biodiversity, landscape and amenity. The guide also aims to ensure that all new developments and redevelopments are designed to mitigate the effects of climate change.

4.17 The guide has been used when considering the surface water drainage strategy discussed in Section 6.

The SuDS Manual (CIRIA C753) 2015

4.18 The SuDS Manual provides comprehensive guidance for the design and incorporation of SuDS. The manual sets out the process by which appropriate SuDS options may be selected for a site.

4.19 The guidance within the CIRIA SuDS Manual (2015) will be used for the planning, design, operation and maintenance of the proposed SuDS.

Policy Conclusions

4.20 The development proposals are consistent with the policies within the NPPF, Local Plan and supporting national, regional and local guidance documents. This is primarily because a 30 m corridor has been established alongside the two key streams, all built development will be steered into Flood Zone 1 and because surface water will be managed using SuDS. This is discussed in the following sections.

5 Assessment of Flood Risk

Flood Map for Planning

5.1 The Flood Map for Planning locates the majority of the site in Flood Zone 1. There is a small area, alongside the east boundary of the site that is designated as Flood Zone 3 and Flood Zone 2. These flood extents were downloaded and is presented in Figure 3.

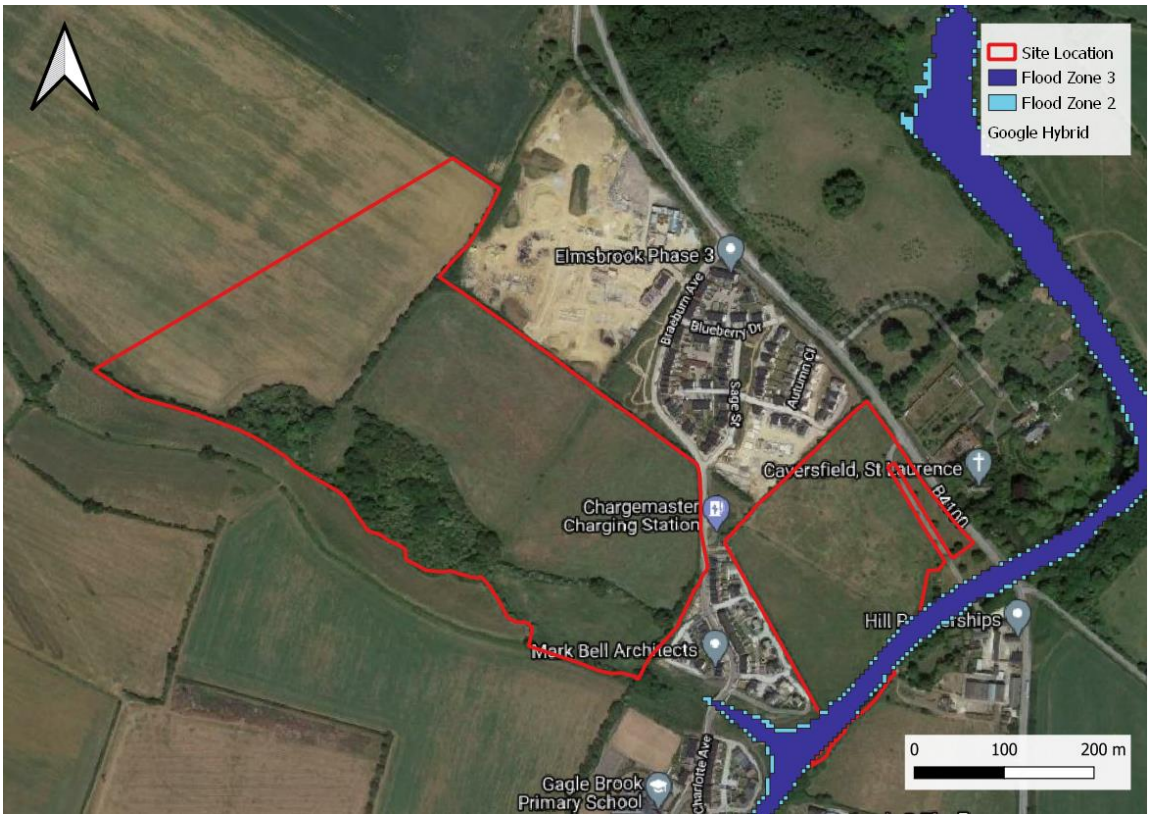


Figure 3: Environment Agency Flood Map for Planning

Coastal/Tidal Flood Risk

5.2 The site is inland and is elevated at least 83 m AOD, therefore, the site is not at risk of coastal/tidal flooding.

Fluvial Flood Risk

5.3 The flood extents at the site on the Flood Map for Planning relate to fluvial flooding. Part of the site is located within Flood Zone 3 and Flood Zone 2. This flooding is associated with the watercourse located on the eastern boundary (Town Brook).

5.4 Flood level data was obtained from the EA and is enclosed in Appendix B, which was available from the JFLOW methodology. Whilst these JFLOW model results were not intended for this purpose, they represent the best available data at this location in terms of fluvial flood levels. Table 1 presents these flood levels in the proximity of the site.

Table 1: Fluvial Flood Levels

Return Period	Flood Point 1	Flood Point 2	Flood Point 3
1 in 100	84.39	84.42	84.69
1 in 100 + 20%CC	84.45	84.46	84.72

5.5 The climate change allowances as required by the NPPF have been revised since the preparation of the JFLOW model. The latest climate change allowance on fluvial flooding in the proximity of the site is 35%. This was extrapolated using the data in Table 1, with the resultant flood levels presented in Table 2.

Table 2: Extrapolated Fluvial Flood Levels

Return Period	Flood Point 1	Flood Point 2	Flood Point 3
1 in 100 + 35%CC	84.50	84.49	84.74

5.6 The extrapolated flood levels were used to derive a 1 in 100 year plus 35% climate change flood extent. This is presented in Appendix F and was used to inform the Land Use Parameters Plans etc. All proposed buildings and SuDS have been steered out of the climate change flood extent and into Flood Zone 1. The site is therefore not susceptible to fluvial flooding and this source of flood risk is therefore assessed to be low.

Risk from Surface Water Flooding

5.7 Surface water flooding is a result of overland flow and ponding of water that can follow a rainfall event, from local catchment areas, hillsides and associated with minor ditches or streams. The Risk of Flooding from Surface Water map is available online and the data for the site has been downloaded and is shown in Figure 4.

5.8 The Risk of Flooding from Surface Water map shows that most of the site is at a very low risk of surface water flooding (defined as an area with less than 1 in 1000 chance of flooding each year), with parts of the site at a low risk (defined as an area with between 1 in 1000 and 1 in 100 chance of flooding each year) to high risk (defined as an area with a greater than 1 in 30 chance of flooding each year) of flooding.

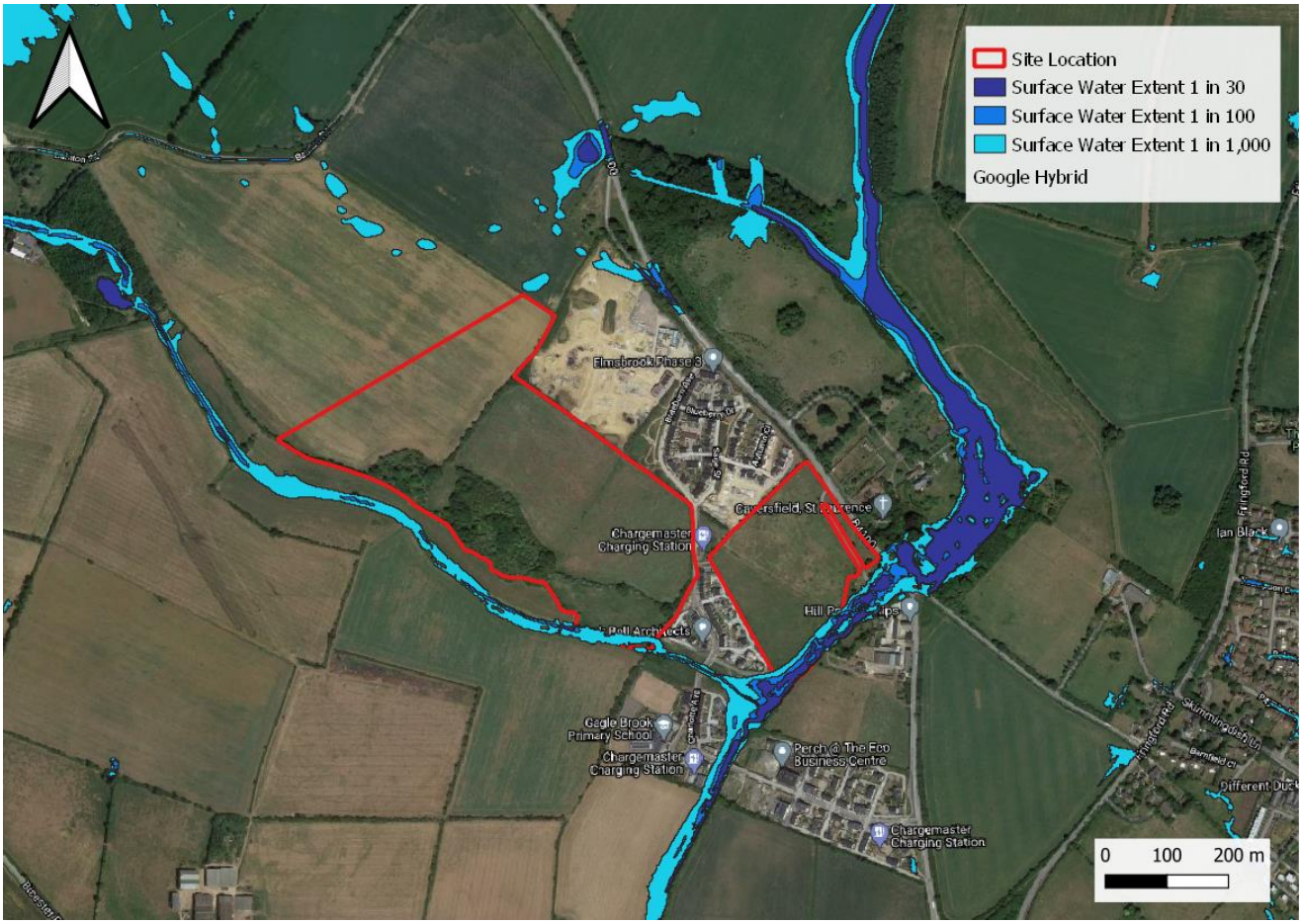


Figure 4: Risk of Flooding from Surface Water Map

5.9 On the east site boundary, the surface water flood extents are broadly consistent with the fluvial flood extents. However, the Risk of Flooding from Surface Water data also picks up the unnamed watercourse to the south, which is shown to be at a low flood risk.

5.10 Given that all proposed buildings, including SuDS, will be steered outside of the surface water flood zone, this source of flood risk is not considered to be a constraint.

Groundwater Flooding

5.11 Groundwater flooding typically occurs in low-lying areas, close to hills which are underlain by permeable rocks. This source of flooding generally only becomes a problem in these areas after long periods of extensive and significant rainfall, resulting in a rise in groundwater level.

5.12 The SFRA includes a map of areas susceptible to groundwater flooding, based on information provided by the Environment Agency. The map shows the site to be located in an area with a <25% susceptibility to groundwater flooding, defined as a low risk.

5.13 A Site Solutions report was compiled by Argyll Environmental and presented groundwater flood risk data prepared by GeoSmart Information Ltd and is presented in Appendix G. This showed that most of the site is at negligible risk of groundwater flooding with a probability of groundwater flooding of less than 1 in 100. In the western parcel, a small portion is at a low risk from groundwater flooding,

located in the south east corner. Low risk is classed as having a 1 in 100 probability of groundwater flooding.

5.14 Groundwater monitoring has identified shallow groundwater in parts of the site. During the preparation of this report, groundwater monitoring was ongoing, but perched groundwater body was found to be 0.1 m below ground level in an isolated areas towards the west part of the site.

5.15 The source of groundwater flood risk relates to a perched body of groundwater, rather than the water table. If the groundwater were therefore to rise above the surface, the impact is unlikely to be significant but may result in waterlogged conditions during parts of the winter season. Mitigation to address this is outlined towards the end of this chapter.

Drainage and Infrastructure Flooding

5.16 Drainage and infrastructure flooding occurs when sewerage systems are overwhelmed and result in flooding, which may occur alone or be combined with other flood sources (e.g. fluvial or surface water).

5.17 Asset maps were obtained from Thames Water which are given in Appendix H. They show that there are no public sewers within the site. There is a public foul sewer network that serves the adjacent residential development. Given that this is still partially under construction, it is assumed that the asset maps will be updated to reflect the full extent of adoptable sewers in the future.

5.18 It is understood that surface water in the adjacent residential development is accommodated by private soakaways and swales. Therefore, no public surface water sewers are identified on the asset maps.

5.19 The local foul sewer network is new and will be designed to modern standards. Furthermore, the network is small and presents a negligible flood risk to the site.

Other Sources of Flooding

5.20 The site is not shown to be at flood risk from reservoirs and there are no canals within the vicinity of the site that could pose a potential flood risk.

5.21 A lake is located upstream of the site associated with Town Brook. It is understood that the water level within the lake is controlled by a sluice gate and weir. Whilst any hydraulic controls on the lake are unlikely to have been considered as part of the EA Flood Map for Planning, it is not anticipated that the lake will introduce an additional source of flood risk.

Flood Mitigation

5.22 Whilst the various potential sources of flood risk at the site are not considered to represent a development constraint, some shallow ground water was encountered following the winter season. Finished Floor Levels (FFL) of the dwellings should be elevated above the surrounding ground levels by at least 150 mm in accordance with building regulations to protect against the possibility of saturated ground and shallow ponding of water.

5.23 Furthermore, all buildings and SuDS will be located outside of areas of fluvial and surface water flood risk.

6 Surface Water Management

Overview

6.1 It is well understood that one of the effects of development is typically to reduce the permeability of a site and consequently change its response to rainfall. Therefore, a drainage strategy is required to ensure that the surface water runoff regime is managed appropriately and that the proposed development does not increase flood risk on the site and/or to surrounding areas.

6.2 The NPPF states that flood risk to land and property must not be increased as a result of development. The NPPF also states that flood risk should not increase for events up to and including a 1 in 100-year return period, including an appropriate allowance for climate change. These requirements have formed the basis of the surface water drainage strategy, which described in this section.

6.3 The proposed surface water management strategy has been derived based upon the principles of SuDS, in accordance with NPPF and the LLFA SuDS guide. It has subsequently been used to inform the Land Use Parameters Plans, Framework Plan and Illustrative Masterplan (Appendix A).

Proposed Surface Water Discharge Receptor

6.4 The LLFA SuDS guide refers to the drainage hierarchy (provided within The Building Regulations – Part H) for the discharge of surface water from the site, with this aiming to discharge surface water as high up the following hierarchy of options as practicable:

i) An adequate soakaway or some other adequate infiltration system; or, where not reasonably practicable;

ii) A watercourse; or where not reasonably practicable,

iii) A sewer.

6.5 Discharge options were investigated in the order of preference specified in the drainage hierarchy. A site-specific ground investigation was undertaken by Hydrock and as described in Section 3 the ground conditions recorded were not considered to be suitable for the use of an infiltration led surface water drainage strategy.

6.6 It is therefore proposed to use an attenuation-led surface water strategy with a restricted discharge to an appropriate receptor. Town Brook and its tributaries are present on various site boundaries; therefore, these features will be used for connectivity purposes. This will mimic the existing conditions on site.

6.7 It should be noted that, whilst not identified on the LLFA drainage hierarchy, rainwater reuse is also being considered for the development proposals.

Existing Greenfield Runoff Rates

6.8 As agreed with the LLFA, the IH124 method has been used to calculate the existing greenfield runoff rates for the site. The parameters utilised are detailed in Table 3, which show the calculation was undertaken for 1 ha of the total site area.

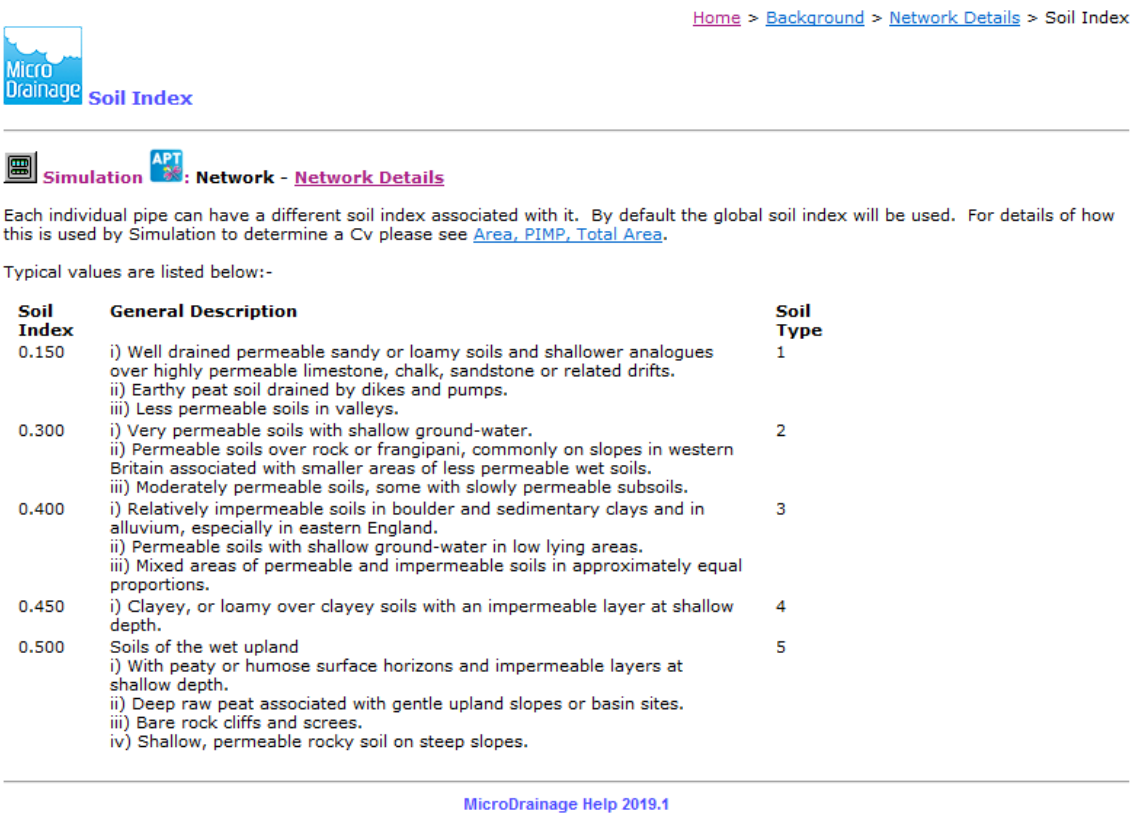
Table 3: Calculation Parameters

Parameter	Value	Unit
Area	1.0	ha
SAAR	635	mm
Soil Type	2	-
Region	6	-

6.9 The various soil types are summarised in Figure 5, which has been extracted from MicroDrainage software. A soil type value of 2 was adopted, as shown in Table 3. Whilst desktop information suggested a value of 1 was appropriate, this was modified because of the findings of the site investigation. As discussed in Section 3, the site investigation identified sporadic results in terms of infiltration, with some areas draining quickly and others not draining at all. Side-by-side test pits experienced variable results. A clay topsoil was identified above the more permeable material, with shallow groundwater.

6.10 This conflicted with the desktop information which reflected more permeable conditions. The site investigation concluded that a soil type 2 was more applicable to the site (see extracts enclosed in Appendix E). This approach was agreed in principle during a meeting with the LLFA.

6.11 It could be argued that a soil type 3 was also applicable, but a soil type 2 was adopted at this stage as a precautionary approach.



Home > Background > Network Details > Soil Index

Micro Drainage **Soil Index**

Simulation : **Network** - Network Details

Each individual pipe can have a different soil index associated with it. By default the global soil index will be used. For details of how this is used by Simulation to determine a Cv please see Area, PIMP, Total Area.

Typical values are listed below:-

Soil Index	General Description	Soil Type
0.150	i) Well drained permeable sandy or loamy soils and shallower analogues over highly permeable limestone, chalk, sandstone or related drifts. ii) Earthy peat soil drained by dikes and pumps. iii) Less permeable soils in valleys.	1
0.300	i) Very permeable soils with shallow ground-water. ii) Permeable soils over rock or frangipani, commonly on slopes in western Britain associated with smaller areas of less permeable wet soils. iii) Moderately permeable soils, some with slowly permeable subsoils.	2
0.400	i) Relatively impermeable soils in boulder and sedimentary clays and in alluvium, especially in eastern England. ii) Permeable soils with shallow ground-water in low lying areas. iii) Mixed areas of permeable and impermeable soils in approximately equal proportions.	3
0.450	i) Clayey, or loamy over clayey soils with an impermeable layer at shallow depth.	4
0.500	Soils of the wet upland i) With peaty or humose surface horizons and impermeable layers at shallow depth. ii) Deep raw peat associated with gentle upland slopes or basin sites. iii) Bare rock cliffs and screes. iv) Shallow, permeable rocky soil on steep slopes.	5

MicroDrainage Help 2019.1

Figure 5: Soil Index (Source: MicroDrainage)

6.12 The calculated rates are presented in Table 4 and in Appendix I. The QBAR rate was estimated to be 1.63 l/s/ha.

Table 4: Greenfield Runoff Rates

Return Period	Peak Greenfield Discharge (l/s)
QBAR	1.63
Q1	1.38
Q30	3.74
Q100	5.19

6.13 The LLFA SuDS guide states that to limit peak discharge rates and volumes from a developed site, the following approach can be adopted "limit discharge rates for rainfall events up to and including the 1 in 100 year event (including climate change allowances) to the agreed QBAR rate (or 2 l/s/ha whichever is greater) and 1 in 1 year event to the corresponding green field event".

6.14 The estimated QBAR rate is 1.63 l/s/ha and therefore 2 l/s/ha was adopted. During the meeting with the LLFA, it was agreed that instead of restricting the 1 in 1 year event to the corresponding green field event, unlined shallow swales can be used (where groundwater levels permit) to manage these smaller storms through infiltration.

Conceptual Surface Water Drainage Strategy

6.15 The conceptual surface water management strategy proposed for the site has been derived based upon the principles of sustainable drainage as detailed in the CIRIA SuDS Manual (2015) and the LLFA SuDS guide.

6.16 SuDS will be utilised to manage surface water runoff from the entire site. This will largely consist of a series of attenuation basins and swales, as shown on the Preliminary Surface Water Drainage Strategy, enclosed in Appendix J. Whilst additional source control features will be required, this are of too small scale to present on the Preliminary Surface Water Drainage Strategy and as part of this outline planning application. However, these are discussed in further detail later.

6.17 The concept of sustainable drainage is that environmental and social factors such as the quantity and quality of runoff and amenity value of surface water in the urban or developed environment are considered when making decisions about drainage. SuDS can be used to compliment or replace conventional piped urban drainage to recreate the natural water cycle.

6.18 This process can be used in certain locations to reduce or even eliminate the existing problems associated with such conventional piped systems, which can include the risk of flooding, the potential of pollution or poor water quality and damage to the natural environment.

6.19 As discussed above, the surface water drainage strategy has been based on the discharge of surface water runoff from the site into the adjacent streams and ditches. This will be restricted to the rate of 2

l/s/ha. This restricted discharge rate from the site will be achieved using a hydrobrake (or similar approved) at the outfall of each final attenuation basin.

Attenuation Volumes

6.20 The surface water drainage strategy has been based on providing attenuation up to and including the 1 in 100 year plus a 40% allowance climate change event, which is in accordance with the LLFA SuDS guidance, and in excess of the SPD requirements.

6.21 Given the topographical characteristics of the site and the various ditches / streams present, four catchments have been identified. These have been based on the natural drainage routes across the site, which will be retained to ensure that runoff from the development continues to feed the riparian environment and mimic a natural drainage arrangement.

6.22 These catchments are identified on the Preliminary Surface Water Drainage Strategy, enclosed in Appendix J. Attenuation storage requirements have been estimated for each catchment. Table 5 includes a series of key parameters which have been used to estimate these attenuation storage requirements.

6.23 The impermeable area of each catchment has been calculated based upon a 60% impermeable ratio (i.e. that 60% of the developed area would have an impermeable cover). In accordance with the LLFA SuDS guidance, an additional allowance of 10% to account for the potential of urban creep.

Table 5: Attenuation Storage Parameters

Catchment	Developable Area (ha)	Impermeable Area (ha)	Future Impermeable Area (ha)	Discharge Rate (l/s)
1	3.13	1.88	2.07	6.3
2	6.68	4.01	4.41	13.4
3	1.35	0.81	0.89	2.7
4	0.97	0.58	0.64	1.9

Basin Design – Sizing

6.24 A MicroDrainage source control calculation for each catchment using the values presented in Table 5. The purpose of this was to ensure that each basin could be accommodated, whilst offering the following:

i) 1 in 100 year design event plus a 40% allowance climate change;

ii) Earthworks with average side slopes of 1 in 3.5;

iii) Approximately 0.3 m freeboard above the effective storage depth.

6.25 Table 6 presents evidence of how this has been achieved and is a summary of the MicroDrainage source control calculations. It shows the available area for each attenuation basin, at the top or crest

of the feature as shown on the Preliminary Surface Water Drainage Strategy (Appendix J). The calculations are enclosed in Appendix I.

Table 6: Preliminary Basin Design Details

Basin	Basin Area (m^2)	Total Basin Depth (m)	Attenuation Storage (m^3)
Catchment 1	1,772	1.5	1,600
Catchment 2	3,470	1.5	3,429
Catchment 3	1,250	1.0	691
Catchment 4	666	1.5	497

Basin Design – Positioning

6.26 The basin area and storage volumes identified in Table 6 are the total requirements for each catchment. To meet with LLFA requirements, these have been split across a number of separate basins across the site. Each basin will require its own flow control structure, which is subject to a more detailed stage of design. However, the final attenuation basin (i.e. prior to the outfall into the stream or ditch), will be restricted to 2 l/s/ha.

6.27 Additional space has also been allocated around each attenuation basin for any earthworks and access for maintenance requirements. All attenuation basins have been steered out of the fluvial and surface water floodplain.

6.28 The final attenuation basin in Catchment 1, 2 and 4 have been set back as far as possible from the adjacent watercourse. Whilst subject to a more detailed stage of design, the basins will be elevated over 2 m above the adjacent stream. This will help to minimise the impact of a surcharged outfall on the ability of the basin to release water during a flood event. It is recommended that a surcharged outfall analysis is undertaken as part of the reserved matters application. The attenuation basin in Catchment 3 drains into a small field ditch, with a limited catchment. A significantly surcharged outfall is therefore unlikely.

Wider SuDS Proposals

Swales

6.29 Swales are shallow (i.e. around 0.5 m) vegetated open channels designed to convey, treat and in certain circumstances attenuate surface water runoff. They enhance the natural landscape and provide aesthetic and biodiversity benefits. These can be ‘wet’ where water gathers above the surface, or ‘dry’ where water gathers in a gravel layer beneath.

6.30 It is proposed to incorporate swales across the site for the conveyance of surface water. Where positioned on slopes, check dams can be incorporated at appropriate distances across the width of the swales to store water in the swale, thereby providing some limited attenuation and reducing flow velocity.

6.31 As discussed previously, where groundwater is not shallow, the swales will be unlined to allow runoff from smaller storms to infiltrate.

6.32 The potential storage volume offered by swales has not been considered within the calculations at this stage. The indicative locations of swales across the proposed development is shown on the Preliminary Surface Water Drainage Strategy (Appendix J).

Other SuDS Features

6.33 The LLFA have identified that other more local, or source control, SuDS are required across the site but acknowledged that it is difficult to determine the detail of source control attenuation and conveyance features at the outline stage. However, this could consist of permeable paving, filter strips, highway swales, bio-retention or tree pits etc, used in parts of the site to supplement the attenuation basins and swales. These could also offer both water quality improvements and attenuation storage. However, these opportunities will be considered at a more detailed stage of design.

Rainwater Harvesting

6.34 It is also intended to harvest rainwater to reduce potable water demand. Water may be stored for this purpose either at the property level or at the site-wide scale. Further details are outlined in the Technical Note on the water efficiency measures prepared by Stantec.

Biodiversity and Landscape

6.35 In addition to their drainage function, SuDS can be designed to deliver significant community and environmental benefits. Attenuation basins and swales provide an opportunity to create high value habitat and contribute an important biodiversity, aesthetic and recreational function for the site.

6.36 The CIRIA SuDS Manual (2015) provides some useful insight into effective design of both basins and swales. These opportunities will be considered at a more detailed stage of design. However, for the basins, the following design principles will be taken forward:

i) Average 1:3.5 side slopes will allow for variation and will help to ensure that they appear as natural as possible.

ii) Reed beds can be created at the inlet.

iii) The outlet can be set as far from the inlet as possible to maximise the benefits to water quality passing through.

iv) Sediment forebays will be created, where necessary.

v) Slightly deeper areas within the basin to allow retention of water all year round.

6.37 It is understood that to maximise ecological benefits, the aspiration includes the creation of permanently wet areas, with surrounding areas offering wetland and meadow landscapes.

6.38 The CIRIA SuDS Manual (2015) provides an example of a typical plan view and profile of an attenuation basin illustrating how the feature could look on the site, as shown in Figure 6.

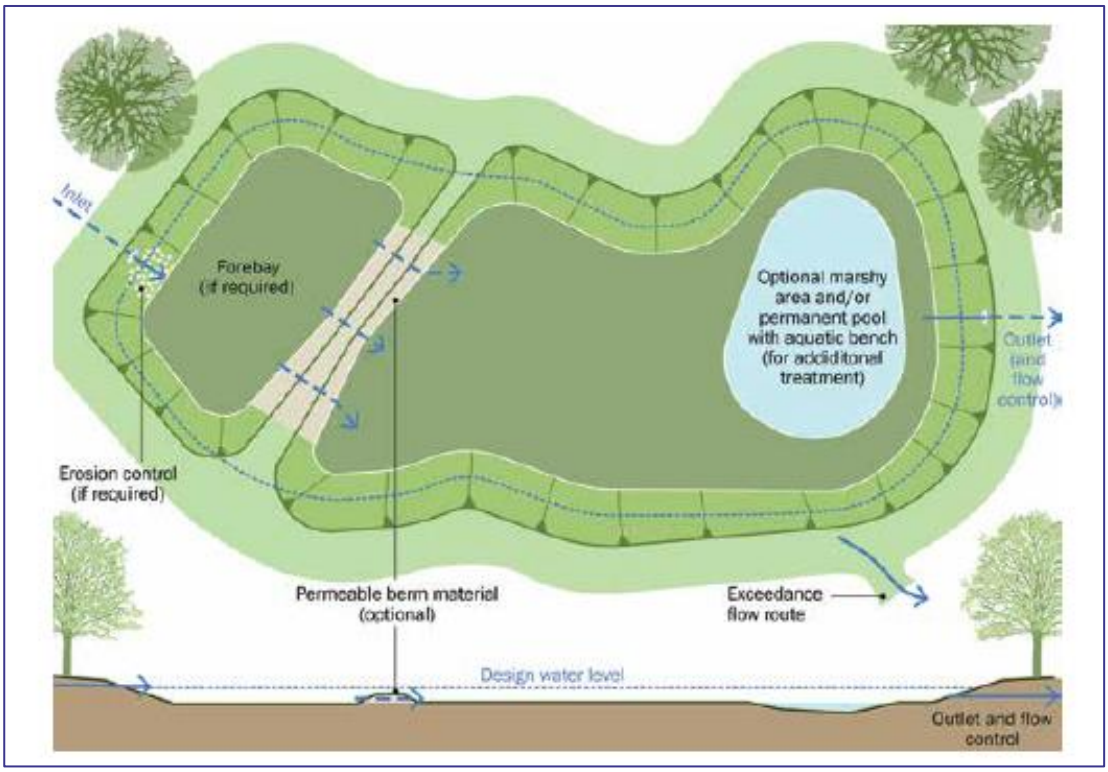


Figure 6: Plan of Attenuation Basin

6.39 Figure 7 presents a cross section of a wet swale extracted from the CIRIA SuDS Manual (2015). It identifies how these can be designed to offer biodiversity, landscape, and associated water quality benefits, through pre-treatment, wetland planting and permanent water storage.

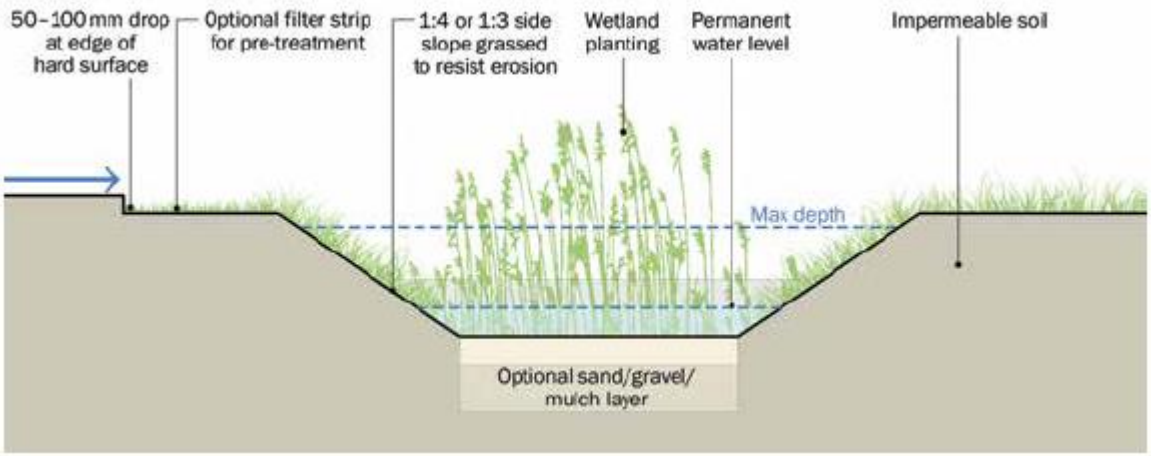


Figure 7: Typical Wet Swale Cross Section

Conveyance of Exceedance Surface Water Flooding

6.40 The surface water drainage strategy must consider an exceedance scenario, i.e. for flows in excess of the 1 in 100 year plus climate change rainfall event. Exceedance flows must be managed in conveyance routes across a site that minimise the risk to people and property.

6.41 The design for exceedance will be addressed at a more detailed stage. However, in an exceedance scenario, roads would be designed to convey any exceedance flows away from people and property using appropriate kerbing for channelling. Exceedance flow routes will ultimately be directed into the swales or basins located across the site.

Water Quality

6.42 In accordance with the CIRIA SuDS Manual (2015), SuDS components must have a total pollution index that equals or exceeds the pollution hazard index for different land use classifications. It is considered that the SuDS provided as part of the surface water drainage strategy would offer sufficient mitigation for the land use classification as demonstrated in Table 6 and Table 7 (as informed by Table 26.2 and 26.4 of the CIRIA SuDS Manual (2015), respectively).

Table 6: Pollution Hazard Indices

Land Use	Pollution Hazard Indices for Different Land Use Classifications			
	Pollution Hazard Level	Total Suspended Solids (TSS)	Metals	Hydro-carbons
Residential Roofs	Very Low	0.2	0.2	0.05
Individual property driveways, residential car parks, low traffic roads and non-residential car parking with infrequent change	Low	0.5	0.4	0.4
Total	Low	0.7	0.6	0.45

Table 7: SuDS Mitigation Indices (for discharges to surface water)

Type of SuDS	Mitigation Indices		
	TSS	Metals	Hydro-carbons
Swales	0.50	0.60	0.50
Ponds[1]	0.35	0.35	0.25
Total	0.85	0.95	0.75

1 As per the CIRIA SuDS Manual (2015), where the mitigation index of an individual component is insufficient, two components (or more) will be required. However, a factor of 0.5 is used to account for the secondary or tertiary components associated with the already reduced inflow concentrations.

Operation and Maintenance

6.43 Some of the SuDS could be offered for adoption to Thames Water, which would be confirmed at a more detailed stage of deisgn. The operational and maintenance requirements would then be outlined by Thames Water.

6.44 Should this not be achieved, it is likely that the SuDS would be managed privately. Where privately maintained, the general maintenance requirements should be undertaken in accordance with the recommendations outlined in the CIRIA SuDS Manual (2015), extracts of which are provided on the following page. Full details of the maintenance proposals will be addressed at a more detailed stage of design.

TABLE 22.1 Operation and maintenance requirements for detention basins

Maintenance schedule	Required action	Typical frequency
Regular maintenance	Remove litter and debris	Monthly
	Cut grass – for spillways and access routes	Monthly (during growing season), or as required
	Cut grass – meadow grass in and around basin	Half yearly (spring – before nesting season, and autumn)
	Manage other vegetation and remove nuisance plants	Monthly (at start, then as required)
	Inspect inlets, outlets and overflows for blockages, and clear if required.	Monthly
	Inspect banksides, structures, pipework etc for evidence of physical damage	Monthly
	Inspect inlets and facility surface for silt accumulation. Establish appropriate silt removal frequencies.	Monthly (for first year), then annually or as required
	Check any penstocks and other mechanical devices	Annually
	Tidy all dead growth before start of growing season	Annually
	Remove sediment from inlets, outlet and forebay	Annually (or as required)
	Manage wetland plants in outlet pool – where provided	Annually (as set out in Chapter 23)
Occasional maintenance	Reseed areas of poor vegetation growth	As required
	Prune and trim any trees and remove cuttings	Every 2 years, or as required
	Remove sediment from inlets, outlets, forebay and main basin when required	Every 5 years, or as required (likely to be minimal requirements where effective upstream source control is provided)
Remedial actions	Repair erosion or other damage by reseeding or re-turfing	As required
	Realignment of rip-rap	As required
	Repair/rehabilitation of inlets, outlets and overflows	As required
	Relevel uneven surfaces and reinstate design levels	As required

TABLE 17.1 Operation and maintenance requirements for swales

Maintenance schedule	Required action	Typical frequency
Regular maintenance	Remove litter and debris	Monthly, or as required
	Cut grass – to retain grass height within specified design range	Monthly (during growing season), or as required
	Manage other vegetation and remove nuisance plants	Monthly at start, then as required
	Inspect inlets, outlets and overflows for blockages, and clear if required	Monthly
	Inspect infiltration surfaces for ponding, compaction, silt accumulation, record areas where water is ponding for > 48 hours	Monthly, or when required
	Inspect vegetation coverage	Monthly for 6 months, quarterly for 2 years, then half yearly
	Inspect inlets and facility surface for silt accumulation, establish appropriate silt removal frequencies	Half yearly
Occasional maintenance	Reseed areas of poor vegetation growth, alter plant types to better suit conditions, if required	As required or if bare soil is exposed over 10% or more of the swale treatment area
Remedial actions	Repair erosion or other damage by re-turfing or reseeding	As required
	Relevel uneven surfaces and reinstate design levels	As required
	Scarify and spike topsoil layer to improve infiltration performance, break up silt deposits and prevent compaction of the soil surface	As required
	Remove build-up of sediment on upstream gravel trench, flow spreader or at top of filter strip	As required
	Remove and dispose of oils or petrol residues using safe standard practices	As required

LLFA SuDS Proforma

6.45 Some of the requirements of the LLFA Technical Assessment Pro-forma appear to conflict with the LLFA SuDS Guide. The pro-forma also does not allow for an outline or a full planning application and the different information that is required, or available, for each. Nevertheless, the LLFA Technical Assessment Pro-forma has been prepared and is enclosed in Appendix K. It is anticipated that this FRA provides more helpful information.

Summary

6.46 The conceptual surface water drainage strategy has been prepared to demonstrate that the proposed development of the site can meet national and local requirements. The management of surface water runoff will be achieved through attenuation using SuDS within each catchment, prior to a controlled discharge from the site to an adjacent stream or ditch. Small rainfall events will be managed using unlined swales, to promote infiltration, where groundwater levels permit. The approach replicates the existing surface water drainage regime.

6.47 The SuDS will offer wider benefits including biodiversity and recreational opportunities, as well as aesthetic improvements.

6.48 The concepts outlined herewith will be subject to more detailed design considerations at a later stage.

7 Other Considerations

Existing Watercourses

7.1 The North West Bicester SPD refers to a minimum 60 metre corridor along key watercourses to provide a landscape feature and for biodiversity gain. This has been adopted in the Land Use Parameters Plans, Framework Plan and Illustrative Masterplan.

Community Engagement

7.2 Different forms of SuDS will be located across the site, which will be interwoven with areas of recreation and the urban environment. This presents the opportunity to engage with the community through signage and associated activities, which can help to raise awareness of their function and the wider environment.

8 Conclusions

8.1 This Flood Risk Assessment and surface water drainage strategy has been undertaken to accompany the outline planning application for the proposed residential development at North West Bicester.

8.2 This report has been prepared by Vectos on behalf of Firethorn Developments Limited in accordance with the guidelines set out in National Planning Policy Framework, regional and local guidance documents.

8.3 The site lies primarily within Flood Zone 1 (i.e. land having a less than 1 in 1,000 annual probability of river or sea flooding, with this considered to be low risk). However, part of the site is located within Flood Zone 2 and 3, which is associated with Town Brook.

8.4 All proposed buildings and including Sustainable Drainage Systems (SuDS) has been directed towards the lowest risk of flooding (i.e. Flood Zone 1).

8.5 An attenuation led conceptual surface water drainage strategy has been proposed to manage the surface water runoff from the site. Attenuation will be provided in a series of attenuation basins, which will restrict runoff to greenfield rates before discharging into the adjacent streams and ditches. The basins will be supplemented with a series of swales, whilst wider SuDS will be considered at a more detailed stage of design.