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Flood Risk Assessment & Drainage Strategy

South Farm, Wickwar

B05313-CLK-XX-XX-RP-FH-1001

Bloor Homes

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ENGINEERING OUTSTANDING SOLUTIONS FOR COMMUNITY AND PLACE

Report No.	Date
B05313-CLK-XX-XX-RP-FH-1001	21/02/23

Project
South Farm, Wickwar Flood Risk Assessment & Drainage Strategy

Client Name
Bloor Homes

Issue Date	Number	Status	Description of Amendments
08-10-2021	P1	S2 Draft	
13-12-2021	P2	S2 Final	Updated Drainage Strategy Drawing and relevant text
27-01-23	P3	S2 Final	Updating FRA and DS following a change in Layout of the proposed development
20-02-23	P4	S2 Final	Minor changes to text
21-02-23	P5	S2 Final	Minor changes to text

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Executive Summary

Client	Bloor Homes
Site	The development area covers approximately 7.90ha of greenfield land on the periphery of south-west Wickwar, located by National Grid Reference of ST 72334 87387 and nearest postcode of GL12 8PB.
Development Description and Planning Policy	This FRA has been produced for a development, which comprises up to 180 dwellings, a local shop and associated infrastructure. As the Proposal includes residential land use, this is classified as 'More Vulnerable' in accordance with paragraph 079 of the NPPG.
Flood Sources & Flood Risk	According to the EA 'Flood Map for Planning' the site is in Flood Zone 1 – i.e., safe from fluvial/tidal flooding (i.e., **low flood risk**). It is also predominantly at **low risk** from surface water flooding. The site is therefore assessed to have automatically passed the Sequential Test. Other sources of flood hazards assessed included: • Flooding from ordinary watercourses – **low to moderate flood risk** • Flooding from groundwater – **low flood risk** • Flooding from sewers – **very low flood risk** • Flooding from the possible failure of existing artificial infrastructure – **no identifiable risk** The greatest flood risk posed to off-site areas by the proposed development is from the potential for increased surface water runoff from impermeable areas. However, this will not be allowed to occur as the proposed Drainage Strategy will intercept all surface runoff from these areas and allow the controlled discharge of flows off-site at the rate agreed with the Lead Local Flood Authority (LLFA) and water company.
Flood Risk Management Measures	Vulnerable land uses including proposed dwellings should be setback from existing watercourses by a minimum buffer of 6m to mitigate flood risk (including risks posed by future effects of climate change). Mitigation of risk to off-site areas will be achieved by the proposed Drainage Strategy, which will ensure that surface water runoff from the impermeable areas is captured by the positive drainage network. Groundwater flood risk during construction will be mitigated by the relevant contractor health and safety procedures for working in confined spaces and by the Construction Environmental Management Plan (CEMP). In extreme cases, dewatering/pumping may be required to remove any groundwater present.
Drainage Strategy	**Surface Water** Surface runoff from all impermeable areas of the development will discharge through separate adoptable surface water sewers via outfalls into an attenuation basin, designed to attenuate flows produced by a 1 in 100 year + 40% climate change event with an attenuation volume of 4089m^3. Please note that the 'upper

	end' climate change allowance of 45% was also applied to test the storage sensitivity for more severe rainfall events. The basin is proposed to discharge surface water into the minor watercourse at the west of the site, via an adoptable surface water flow control chamber limiting discharge to a maximum discharge rate of 25l/s. **Foul Water** Foul water from the development will drain via a network of adoptable foul water sewers to an adoptable pumping station at the north-west of the application site. This will subsequently pump foul water flows east to the nearest public foul sewer to the site on Sodbury Road (B4060) adjacent to the eastern boundary of the site subject to capacity checks with Wessex Water.

1 Introduction

1.1 Overview

Clarkebond (UK) Ltd was commissioned by Bloor Homes to provide a Flood Risk Assessment (FRA) to support an outline planning application for residential development on land to the south of South Farm, Sodbury Road, Wickwar, GL12 8PG, in South Gloucestershire. This FRA has been produced for the proposed development, which comprises up to 180 residential dwellings, a local shop and associated infrastructure. This lies opposite (and west) of two land parcels which were recently granted planning consent. These are:

- Land south of Poplar Lane: 80 residential units PK16/4006/O, (Outline, granted 2017) and PK17/5966/RM (Reserved matters, granted 2018)
- Land south of Horwood Lane, Sodbury Road: 90 residential units PK17/4552/O (Outline, granted 2018) and P19/5258/RM (Reserved Matters, granted 2019)

The flood risk and drainage supporting documents for these developments have provided data and scope to inform this FRA.

The report has been undertaken in accordance with flood risk policy contained within the National Planning Policy Framework (NPPF, 2021) and guidance found in the Flood Risk and Coastal Change National Planning Policy Guidance (NPPG 2022). The assessment of flood risk was informed by the Level-1 Strategic Flood Risk Assessment (SFRA) 2021 for the Local Planning Authority (LPA) and Lead Local Flood Authority (LLFA) South Gloucestershire Council, Environment Agency (EA) data and information available on government websites.

The main purpose of the report is to provide sufficient flood risk information to ensure the development is safe from flooding and would not pose a risk to third parties, with a particular focus on the management of surface water runoff.

1.2 Site Location and Description

The development area covers approximately 7.90ha of greenfield land on the periphery of south-west Wickwar, located by National Grid Reference of ST 72334 87387 and nearest postcode of GL12 8PB. Refer to red-line boundary in **Figure 1** and the proposed Master Plan in **Figure 2**.

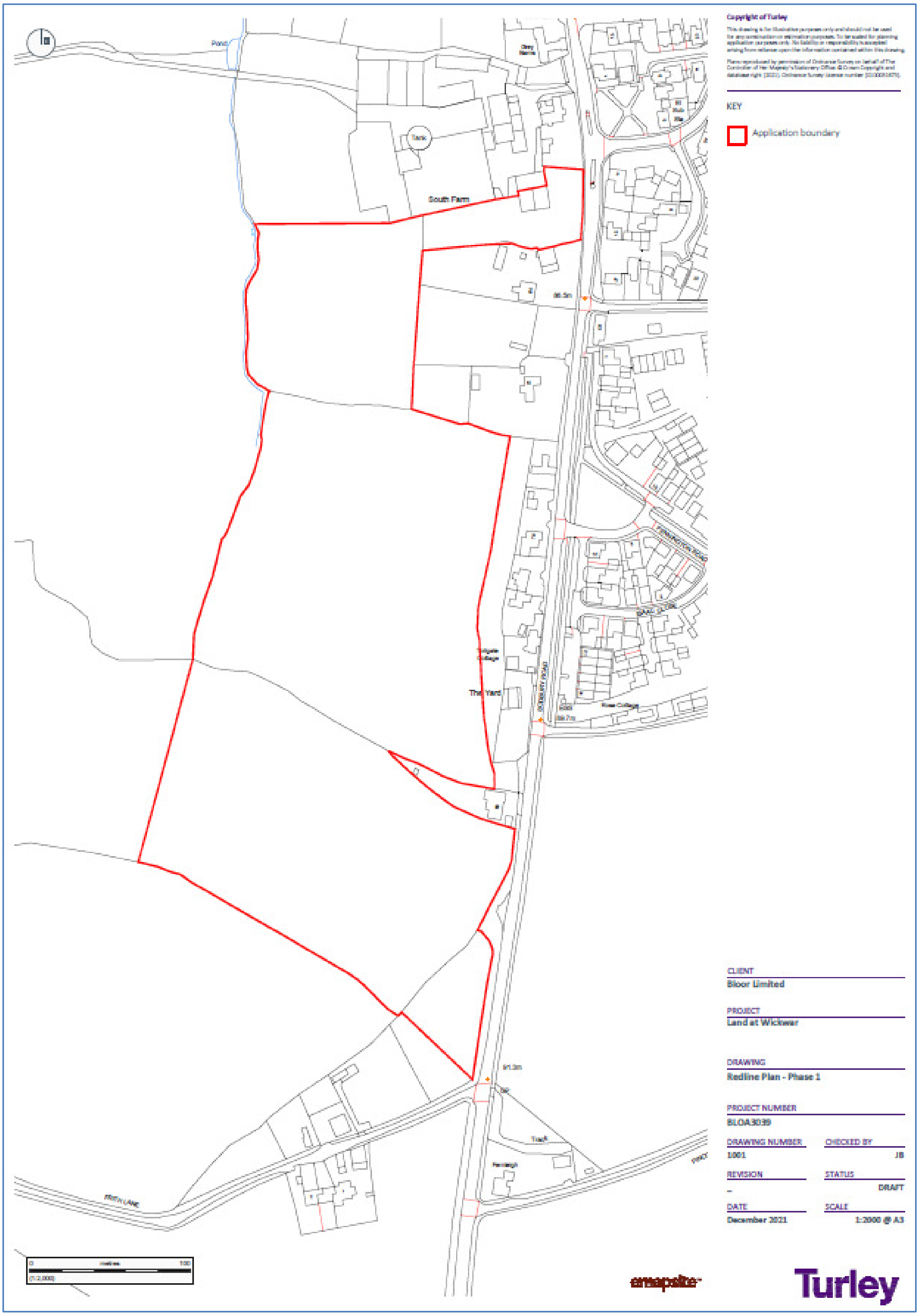

Figure 1: Overall Site Boundary

Figure 2: Site Masterplan

A copy of the proposed layout is also included as **Appendix A**.

1.3 Objectives

The main objectives of this FRA report, as recommended in the NPPF, are:

- To assess the site suitability in terms of the Sequential Test and, if required, the Exception Test.
- To identify the probability of flooding at the development.
- To assess the compatibility of the development with the flood risk zone.
- To identify the consequence of flooding at the development and suitable mitigation measures if required.
- To demonstrate that the development will not increase flood risk elsewhere, and where possible, will reduce flood risk.

1.4 Limitations

The information, views and conclusions drawn concerning the site are based, in part, on information supplied to Clarkebond by other parties. Clarkebond has proceeded in good faith on the assumption that this information is accurate. Clarkebond accepts no liability for any inaccurate conclusions, assumptions or actions taken resulting from any inaccurate information supplied to Clarkebond from others.

2 Planning and Flood Risk Policy Review

2.1 Overview of National Planning Policy Framework (NPPF)

National policy on planning and flood risk is set out in paragraphs 159 to 169 of the NPPF (2021) which is also supplemented by National Planning Practice Guidance (NPPG) for flood risk and coastal change. The overarching aim of the NPPF is to ensure inappropriate development in areas at risk of flooding are avoided, which is achieved via application of the Sequential Test.

2.1.1 Sequential Test Process

The Sequential Test ensures that a sequential, risk-based approach is followed to steer new development to areas with the lowest risk of flooding, taking all sources of flood risk and climate change into account. Where it is not possible to locate development in low-risk areas, the Sequential Test should go on to compare reasonably available sites:

- Within medium risk areas; and
- Then, only where there are no reasonably available sites in low and medium risk areas, within high-risk areas.

The process for undertaking the Sequential Test is shown in **Figure 3a and 3b**. **Table 1** (taken from Table 1 of NPPG) details the corresponding meaning of flood zones in relation to flood risk.

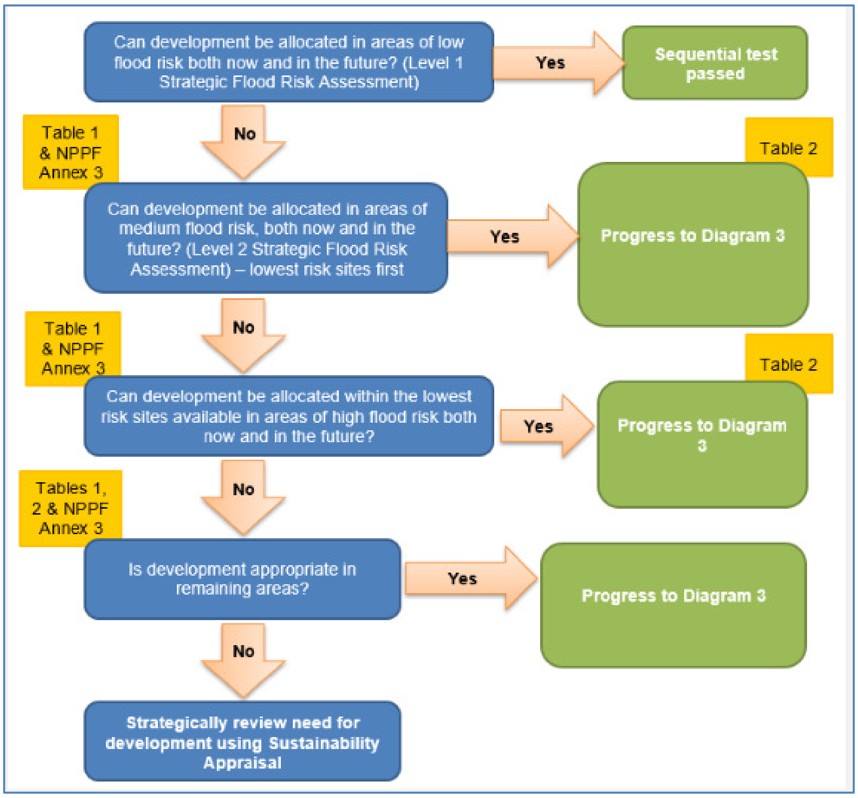

Figure 3a: Process of the Sequential Test (Diagram 2 – PPG Paragraph 025)

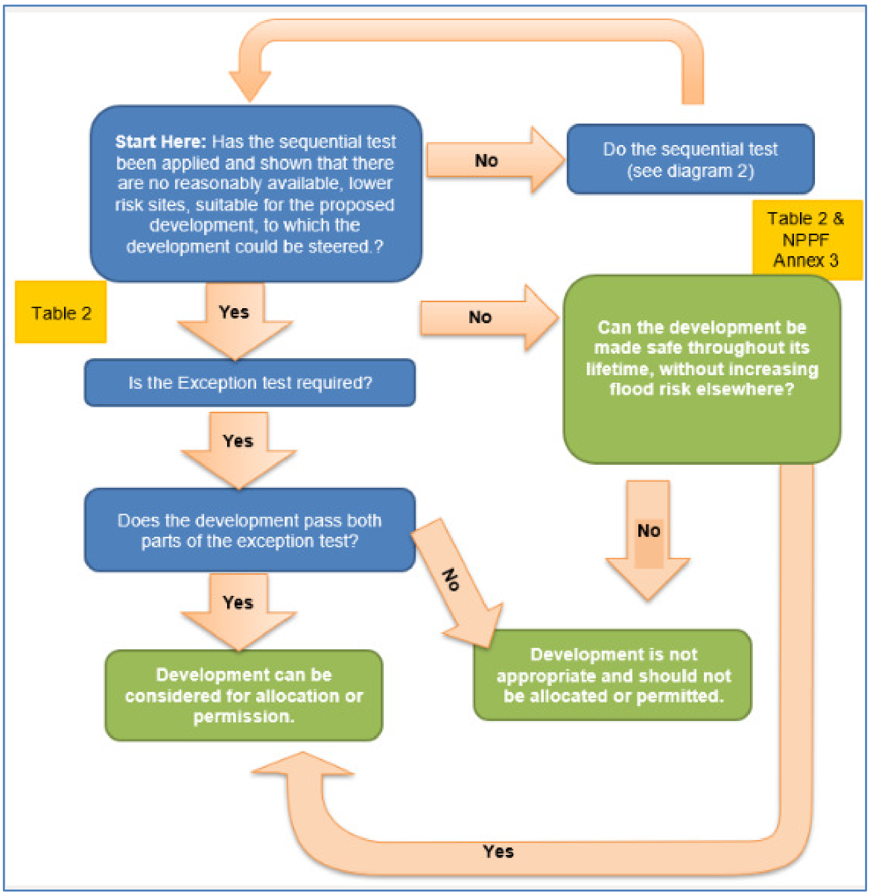

Figure 3b: Process of the Sequential Test (Diagram 3 – PPG Paragraph 025)

Table 1: Definition of Flood Zones (as defined in the NPPG)

Flood Zone	Definition
Zone 1 Low Probability	Land having a less than 0.1% annual probability of river or sea flooding. (Shown as 'clear' on the Flood Map for Planning – all land outside Zones 2, 3a and 3b).
Zone 2 Medium Probability	Land having between a 1% and 0.1% annual probability of river flooding; or land having between a 0.5% and 0.1% annual probability of sea flooding. (Land shown in light blue on the Flood Map).
Zone 3a High Probability	Land having a 1% or greater annual probability of river flooding; or Land having a 0.5% or greater annual probability of sea. (Land shown in dark blue on the Flood Map).
Zone 3b The Functional Floodplain	This zone comprises land where water from rivers or the sea must flow or be stored in times of flood. The identification of functional floodplain should take account of local circumstances and not be defined solely on rigid probability parameters. Functional floodplain will normally comprise:

	• land having a 3.3% or greater annual probability of flooding, with any existing flood risk management infrastructure operating effectively; or • land that is designed to flood (such as a flood attenuation scheme), even if it would only flood in more extreme events (such as 0.1% annual probability of flooding).

It is advisable to contact the local planning authority to confirm whether the exception test needs to be applied and to ensure the appropriate level of information is provided.

2.1.2 Development Vulnerability and Flood Zone Compatibility

After undertaking the Sequential Test, the vulnerability of development to flooding must be considered so that more vulnerable uses are given priority for lower risk land. This exercise is undertaken by referring to Table 2 (Paragraph 079) of NPPG which shows the Flood risk vulnerability and flood zone 'incompatibility' and requirements for the Exception Test.

If a site has a range of flood zones, a sequential approach to development should also be taken within the site itself to direct development to the areas of lowest flood risk (Flood Zone 1 first, followed by Flood Zone 2, and finally Flood Zone 3). If it isn't possible to locate all the development in Flood Zone 1, then the most vulnerable elements of the development should be in the lowest risk parts of the site (unless there is an overriding reason to choose a different location).

2.1.3 Design Flood Event

The development should be flood resistant and resilient including having safe access and escape routes for the following extreme flood events, also known as the 'design flood' (taken from Paragraph 002 of NPPG):

- river flooding likely to occur with a 1% annual probability (a 1 in 100 chance each year); or
- tidal flooding with a 0.5% annual probability (1 in 200 chance each year); or
- surface water flooding likely to occur with a 1% annual probability (a 1 in 100 chance each year),

Climate change is projected to increase the likelihood of flooding from most flood sources and therefore an assessment of the effects of climate change should be considered over the estimated development lifetime.

The lifetime of a residential development is accepted as 100 years in accordance with NPPG; from a baseline of **2023** (this means assessing the flood level up to **2124** on later**)**.

2.2 Flood Risk Assessment Requirements

Footnote 55 of the NPPF states that a site-specific FRA is required for developments which:

- Are in Flood Zone 2 or 3.
- Are more than 1 hectare (ha) in Flood Zone 1.
- Are in an area which has critical drainage problems as notified by the Environment Agency.
- Land identified in a strategic flood risk assessment as being at increased flood risk in the future.
- Could be affected by sources of flooding other than rivers and the sea (e.g., surface water drains, reservoirs).
- Where a development will introduce a more vulnerable use.

The focus of FRAs for the higher risk zones is to fully assess the extent, depth, and hazard of flood waters, detail the required mitigation to manage flood risk (e.g., floor levels and access, evacuation routes, compensatory storage) and outline a surface water management plan. FRAs for sites where the risk of flooding from rivers or the sea is classified as low (Flood Zone 1) will still need to assess all other sources of flood risk but will have a strong focus on management of surface water runoff.

2.3 Relevant Local Planning Policy

Local planning policy provides more specific detail on development requirements based on the flood risk in the local county or borough. Although these policies will broadly be in line with national policy, where additional requirements are required, this will take precedence.

A list of relevant planning policy documents that were consulted during this FRA include:

- South Gloucestershire Local Plan: Core Strategy (adopted 2013).
- South Gloucestershire Local Plan: Policies, Sites and Places Plan (adopted 2017).
- New South Gloucestershire Local Plan (2018 – 2036).
- South Gloucestershire Level – 1 SFRA (2021).
- South Gloucestershire Level – 2 SFRA (2011).
- SGC Local Flood Risk Management Strategy (2015-2020).
- SGC Surface Water Management (2016).
- SGC Preliminary Flood Risk Assessment (2011).

2.3.1 South Gloucestershire Local Plan: Core Strategy (adopted 2013)

The Core Strategy is the key planning policy document for South Gloucestershire and was formally adopted in December 2013. It does not have a specific policy relating to flood risk, instead covering it across several related policies. These include:

- Policy CS1 – High Quality Design Criteria 11
- Policy CS5 – Location of Development
- Policy CS9 – Managing the Environment and Heritage

- Policy CS25 – Communities of the North Fringe of Bristol Urban Area (specifically relevant to the Site)

2.3.2 South Gloucestershire Local Plan: Policies, Sites and Places Plan (adopted 2017)

The Policies, Site and Places Plan forms a constituent part of the wider Local Plan, alongside the Core Strategy and Joint Waste Core Strategy. Its purpose is to support the Core Strategy by setting out further development management policies and identifying site allocations. The relevant policy from the document is 'Policy PSP20 – Flood Risk, Surface Water and Watercourse Management' (see **Figure 4**).

POLICY PSP20 - FLOOD RISK, SURFACE WATER AND WATERCOURSE MANAGEMENT

1. Flood Risk and Surface Water Management

All development proposal(s) should follow the sequential approach to flood risk, for all potential flood risk sources.

Development proposal(s) will be expected to:

(i) reduce surface water discharge from the site, wherever practicable and feasible on:

a) previously developed land, by reducing post development runoff rates for events up to and including the 1 in 100 year return period, with an allowance for climate change, to that of a greenfield condition. Where it can be demonstrated that this is not practical or feasible, a 30% betterment to the existing condition will be required;

b) greenfield sites, by restricting discharge to a watercourse or surface water sewer to the estimated mean Greenfield runoff rate (QBAR) by means of a controlled outflow. The drainage system should be designed so that flooding does not occur on any part of the development for the 3.33% (1 in 30 year) rainfall event other than in those areas/systems designated to store or convey water. Flooding within the development site should not occur in any part of a building or utility plant susceptible to water during a 1% (1 in 100 year) event, with an allowance for climate change; and;

(ii) incorporate Sustainable Drainage Systems (SuDS) to reduce surface water runoff and minimise the flood risk, supported by an appropriate surface water drainage strategy; and

(iii) ensure that surface water drainage proposals are designed to not increase off-site flood risk; and

(iv) wherever practicable achieve the top tier of the following Surface Water Discharge Hierarchy, providing justification where lower tiers are considered appropriate:

1. infiltration
2. surface water body (watercourse/ditch) (non-infiltration)
3. surface water sewer (non-infiltration)
4. combined sewer (non-infiltration)

2. Land Drainage and Water Quality

Development proposals will be acceptable where:

i) watercourses, ponds and lakes are retained, protected and enhanced as natural landforms, floodplains and wildlife habitats; and

ii) It is designed and located to protect the existing floodplain and enable suitable access for maintenance; and

iii) Practicable the water environment is left in its natural state, and designed to avoid engineering activities which would cause harm to the water environment; and

iv) prevention and mitigation measures are sensitively designed to minimise the risk of pollution to the water environment.

3. Operation and Maintenance

Applicants must provide evidence of appropriate arrangements for future ownership, operation and maintenance of new and existing surface water drainage features, including SuDS, for the lifetime of the development proposal(s).

Figure 4: Policy PSP20

2.3.3 New South Gloucestershire Local Plan (2018 – 2036)

SGC is currently in the process of producing the New South Gloucestershire Local Plan, which will review and eventually replace the existing Core Strategy and Policies, Sites and Places Plan. The document was published for public consultation between February and April 2018. It is not yet known when it will be formally adopted.

2.3.4 South Gloucestershire Level – 1 SFRA (2021)

The Level 1 SFRA provides a baseline assessment of the flood risk within South Gloucestershire, as well as provides guidance for how site-specific flood risk assessments should be completed.

The SFRA has been updated from the previous 2009 version to meet be compliant with the latest guidance described in the revised National Planning Policy Framework (NPPF) (February 2019). The 2021 SFRA provides flood risk evidence and long-term strategy to support the management and planning of development, protect the environment and deliver infrastructure.

2.3.5 South Gloucestershire Level – 2 SFRA (2011)

The Level 2 SFRA was produced by JBA Consulting on behalf on South Gloucestershire Council to complement the existing Level 1 SFRA report. Its scope was to build on the previous work to facilitate application of the Sequential and Exception Tests, consider detailed nature of flood hazards, allow sequential approach to site allocation, and ensure that development within Flood Zones 2 and 3 satisfy the Exception Test. However, much the same as the Level-1 SFRA, the report predates the NPPF, NPPG and EA climate change guidance.

2.3.6 SGC Local Flood Risk Management Strategy (2015 - 2020)

This strategy is an important tool in understanding the Council's management of flood risks throughout South Gloucestershire, in particular the responsible authorities and objectives in place.

2.3.7 SGC Surface Water Management (2016)

Typically, the LLFA will produce a Surface Water Management Plan, which will address flood risk sources other than from the river/sea and identify how surface water should be managed in the district. SGC has produced a note (2016), which outlines the requirements that a planning application should adhere to in relation to surface water management.

2.3.8 SGC Preliminary Flood Risk Assessment (2011)

As an LLFA, SGC has produced this report to meet its duty to manage local flood risk. This provides an additional information source and baseline assessment of flood risk for South Gloucestershire.

3 Background Information

3.1 Site Levels

A topographic survey was carried out by Dando Surveying Ltd in April 2021, covering the site. This can be found in **Appendix B**.

The highest level is at the south-east of the site at 90.75m AOD. The lowest level surveyed is at the north-west/west site boundary, adjacent to the unnamed watercourse, at 82.77m AOD. The gradient generally falls from the south-east towards the north-west.

A review of the topographic survey indicates that there is enough land gradient and depth of ground cover to suggest that drainage via gravity is achievable.

3.2 Public Sewers

Sewer asset records were provided by Wessex Water (see **Appendix C**). These confirm that there are no public sewers on site. Multiple public foul sewers run parallel with the B4060, adjacent to the eastern boundary of the site. A private rising main also runs parallel with the B4060, adjacent to the south-east of the site. A network of public surface water sewers is located within the residential area east of the site. Multiple highway drains are also located on the B4060, adjacent to the east of the site.

3.3 Hydrology

According to the EA's 'Main Rivers Map' and 'Catchment Data Explorer', the south and south-western half of the site red-line boundary are within the catchment of a main river, the unnamed tributary of the Ladden Brook, which itself is a tributary of the Little Avon River. A main river refers to those watercourses under the jurisdiction of the EA.

Much of the areas to the north drain via another minor watercourse that discharges into the Little Avon River further downstream. The OS Map identifies this minor watercourse which flows from south-north, parallel to the B4060 as an ordinary watercourse. Ordinary watercourses refer to those under the jurisdiction of the LLFA, which in this case is the Council. **Figure 5a and 5b** show the extents of these catchment boundaries.

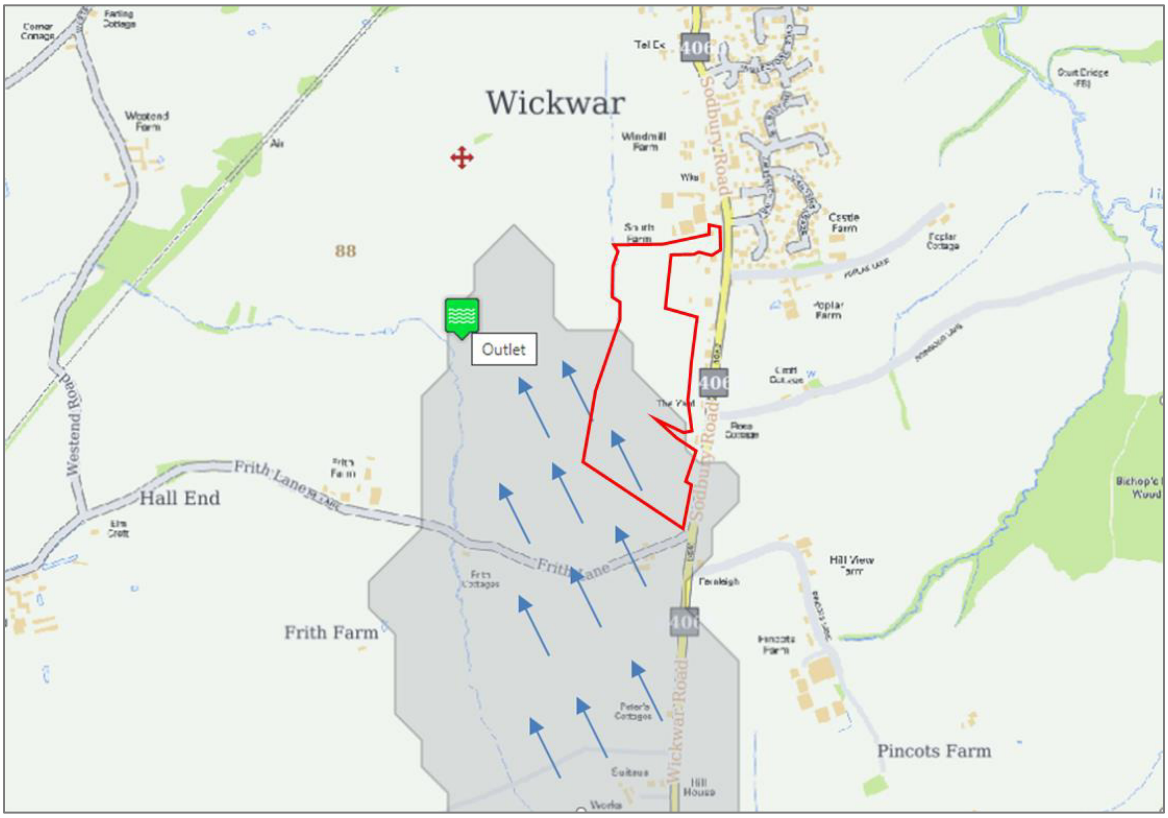

Figure 5a: Unnamed tributary of the Ladden Brook at the SW of Site

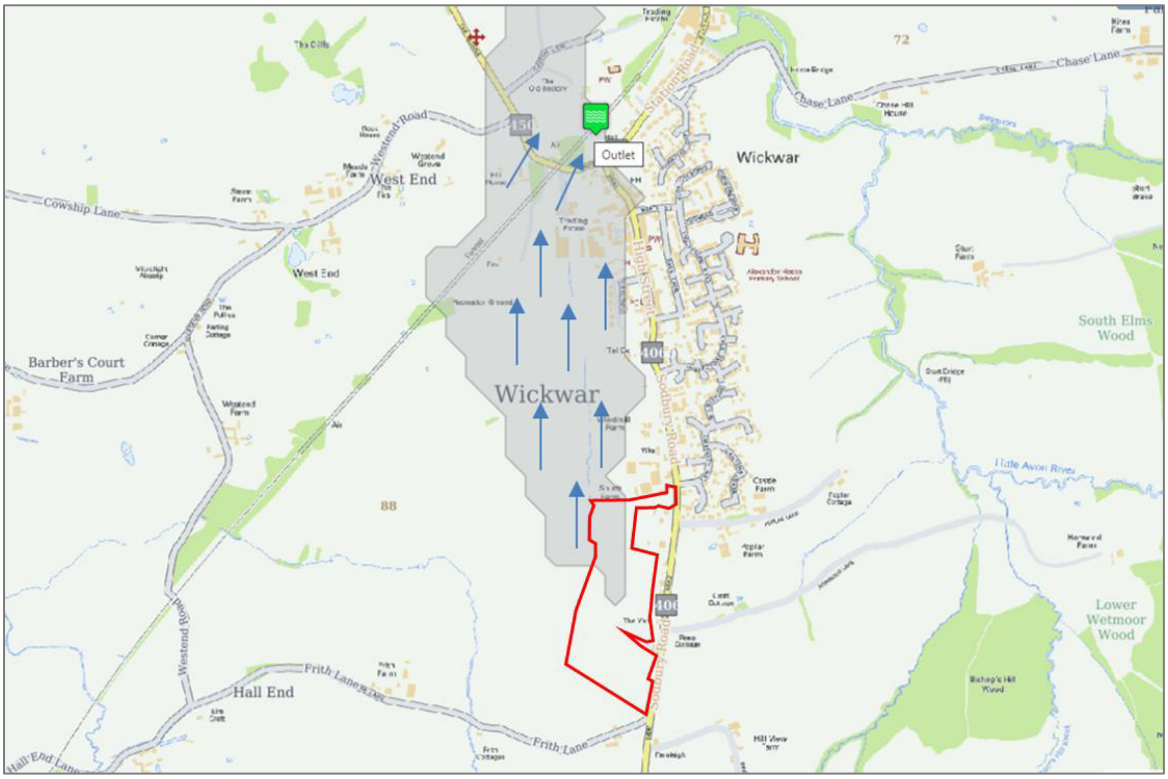

Figure 5b: Minor Watercourse on Site Draining North Toward the Little Avon River

3.4 Geology, Groundwater and Soils

The geology of the site is shown on the 1:50,000 scale British Geological Survey (BGS) map and on the BGS website's Geology of Britain viewer. A review of the available data indicates the anticipated geology at the site can be summarised as follows:

<u>Superficial Deposits</u>

- None recorded.

<u>Bedrock</u>

- Langport Member and Wilmcote Limestone Member (undifferentiated) - Limestone and Mudstone underlying the south of the site.
- Westbury Formation and Cotham Member (undifferentiated) – Mudstone underlying the east of the site.
- Avon Group - Interbedded Mudstone and Limestone underlying the west of the site.

The site is underlain by 3 aquifers:

- Principal aquifer, underlying the site to the west and north. These are layers of rock or drift deposits that have high intergranular and/or fracture permeability - meaning they usually provide a high level of water storage.
- Secondary A Aquifer, underlying small areas to the east and south of the site. These are permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers.
- Secondary B Aquifer, underlying most of the south of the site. This refers to predominantly lower permeability layers which may store and yield limited amounts of groundwater due to localised features such as fissures, thin permeable horizons, and weathering.

The site boundary does not fall within a Source Protection Zone (SPZ).

According to LandIS 'Soilscapes', the site is underlain by 'Soilscape 18: this is slowly permeable, seasonally wet, slightly acid but base-rich loamy and clayey soils. This area is known to have impeded drainage.

A Phase 2 Ground Investigation conducted by Clarkebond in May 2021 (Ref. B05313-CLK-XX-XX-RP-GT-0002) concluded that all infiltration testing undertaken at the site failed and that the site is unsuitable for infiltration drainage.

4 Flood Risk Assessment

4.1 Flood Zones and Development Compatibility

The site red-line boundary is entirely in Flood Zone 1, which means that the risk of fluvial flooding is less than a 1 in 1000 year or 0.1% probability in a given year. This is the lowest classification of flood risk and therefore flooding from fluvial source is not a constraint to development at the site.

There is a narrow band (approximately 4m) of Flood Zone 2 (FZ2) associated with the tributary of the Ladden Brook, which is located approximately 215m southwest of the site boundary.

The Environment Agency indicative flood risk map is shown in **Figure 6**.

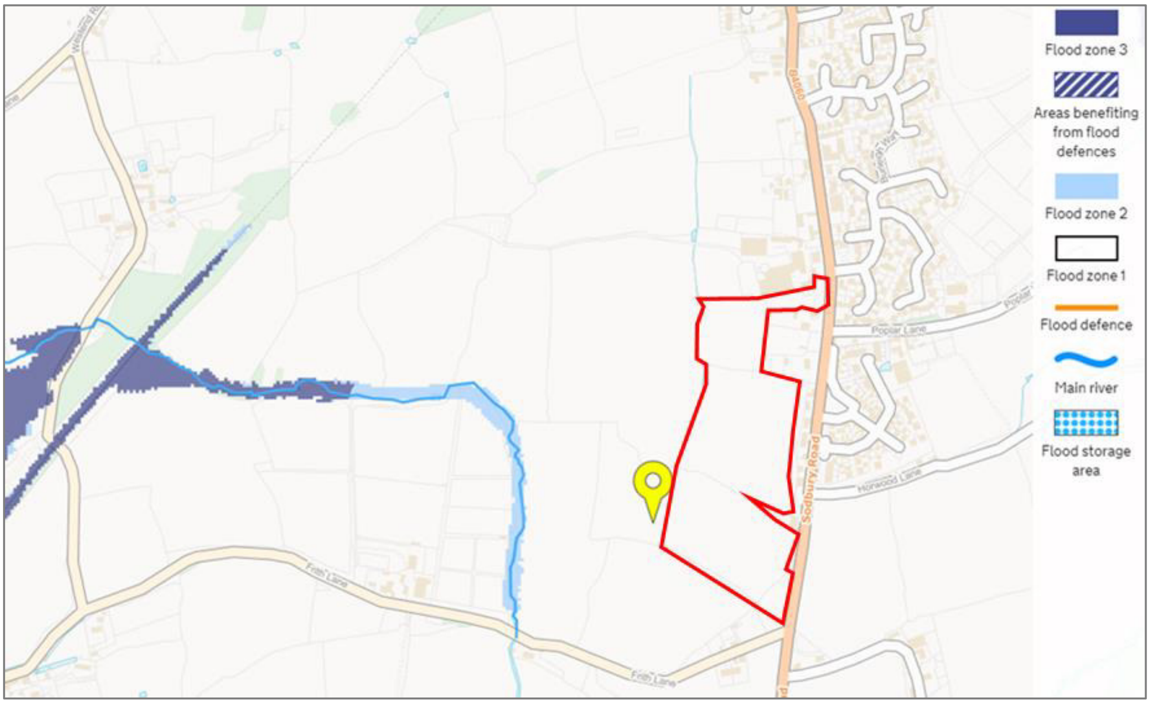

Figure 6: EA 'Flood Map for Planning'

The Proposal can be classified as a 'More-Vulnerable' development, in accordance with Paragraph 079 of the NPPG. All forms of development are compatible in Flood Zone 1 in accordance with **Table 2** (taken from Table 3 of the NPPG).

Table Table 2: Flood Risk Vulnerability and Flood Zone 'Compatibility'

Flood Risk Vulnerability Classification		Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood	Zone 1	✓	✓	✓	✓	✓
	Zone 2	✓	✓	Exception Test required	✓	✓

	Zone 3a†	Exception Test required†	✓	X	Exception Test required	✓
	Zone 3b*	Exception Test required*	✓*	X	X	X

*Where ✓ means Exemption Test is not required, and **X** means the development should not be permitted.*

"†" In Flood Zone 3a essential infrastructure should be designed and constructed to remain operational and safe in times of flood.

"" In Flood Zone 3b (functional floodplain) essential infrastructure that has passed the Exception Test, and water-compatible uses, should be designed and constructed to:*

- *remain operational and safe for users in times of flood.*
- *result in no net loss of floodplain storage.*
- *not impede water flows and not increase flood risk elsewhere.*

4.2 Impact of Climate Change

Although the site is not identified as being within a high-risk zone for fluvial/tidal flooding, the NPPF states that the FRA should assess the increased risk posed by climate change over the projected lifetime of the development. The site will also be affected by the projected increased risk of surface water and sewer flooding and so the new drainage system for the site should accommodate the projected increase in surface water runoff over the lifetime of the development.

EA guidance on climate change allowances came into effect in February 2016 (revised 2021). The proposed development site is in the "Avon Bristol and North Somerset Streams Management Catchment" and has a projected development lifespan of ~100 years; therefore, based on NPPG guidance for 'More Vulnerable' development in Flood Zone 1, the central allowance for climate change should be applied to assess a range of allowances for fluvial flood events at the site, as shown in **Table 3**.

Table 3: Peak River Flow Climate Change Allowances for "Avon Bristol and North Somerset Streams Management Catchment"

	Central	Higher	Upper
2020s	10%	15%	27%
2050s	12%	19%	38%
2080s	26%	39%	71%

Table 4 shows the recommended allowances for peak rainfall intensity for different statistical likelihoods. The upper end allowance should be used in areas where there are known flooding issues and there is highly vulnerable development in the downstream sewer network. The upper end allowance should also be used to test the sensitivity to more severe events likely to occur as a result of climate change.

Table 4: Peak Rainfall Intensity Allowance in Small and Urban Catchments

3.3% annual exceedance event	Central allowance	Upper end allowance
2050s	20%	35%
2070s	25%	40%
1% annual exceedance event	**Central allowance**	**Upper end allowance**
2050s	25%	40%
2070s	25%	45%

4.3 Fluvial Flood Risk

As previously mentioned, the site is in Flood Zone 1 which is the lowest risk classification given by the EA.

The NPPF requires that the future impact of climate change on flood risk should be considered, even for those areas currently in Flood Zone 1. The proposed residential area is located on higher ground than the outer extent of Flood Zone 2 (which is approximately 215m southwest of the site boundary), with the topography increasing by approximately 5m. Therefore, a judgement can be made that the impact of climate change will not cause the floodplain to extend to reach the site.

Therefore, the risk from fluvial flood risk is assessed to be **very low**.

4.4 Tidal Flood Risk

The site is located far inland and is outside of the influence of any tidal watercourses. The risk of tidal flooding is therefore negligible.

4.5 Other Sources of Flood Risk

Other sources of flood hazards assessed are:

- Ordinary watercourses (watercourses not under jurisdiction of EA)
- Groundwater
- Surface water
- Sewers (sewer and drain exceedance and pumping station failure)
- Reservoirs, canals, and other artificial waterbodies

4.5.1 Ordinary Watercourse Flooding

According to OS Maps and topographic survey, there is an unnamed ordinary watercourse that flows from south to north along the western boundary of the site. This is a minor watercourse, and the EA flood map in **Figure 6** does not show a floodplain associated with this watercourse – probably because it has not been modelled.

The floodplain of this unnamed watercourse would not be expected to be as wide as 6m, given the relatively small upstream contributing catchment, and the narrow FZ2 floodplain for the tributary of the Laden brook described in **Section 4.1**. It is therefore recommended that the proposed development is located at least 6m from this watercourse to minimise the risk of flooding – particularly when the future effects of climate change are considered.

The flood risk associated with this minor watercourse is assessed to be **low**.

4.5.2 Groundwater Flooding

Groundwater flooding typically occurs when water levels rise above surface elevations from underlying rocks or springs following prolonged rainfall. The two most common mechanisms of groundwater flooding are:

1. Bedrock Flooding – Occurs following extended periods of rainfall in areas underlain by a permeable bedrock outcrop. Typically, chalk aquifers pose the greater risk, where the large pore spaces in the rock allow the water table to rise rapidly. Settlements most at risk are those in low-lying areas and at the base of steep-sided valleys at the interface between permeable and impermeable strata (where the groundwater table is naturally closer to the ground surface).

2. Superficial Deposit Flooding – Occurs in permeable unconsolidated deposits (e.g., gravel) which lie on river floodplains following high in-bank river levels.

The Level-1 SFRA provides a general assessment of groundwater flood risk in South Gloucestershire. According to the SFRA, information on groundwater flooding is limited within South Gloucestershire, in part, due to the underlying substrate. The main area identified to be at risk from 15 February 2009 South Gloucestershire Council Level 1 Strategic Flood Risk Assessment groundwater flooding is to the south of Thornbury. The site is located approximately 7km east of Thornbury.

A more reliable measure of groundwater flood risk is whether there have been recorded groundwater flood events in the past. The Level-1 SFRA makes no mention of any recorded flood events within the vicinity of the site attributed to groundwater.

Additionally, the Phase 1 Geo-environmental assessment undertaken by Clarkebond (UK) Ltd in April 2020 states that the site is not located within 50m of an area recorded to be susceptible to groundwater flooding.

As the Proposal will not be developing in a manner sensitive to groundwater flooding (basement dwelling etc.), and for the reasons discussed above, the risk from groundwater flooding is assessed to be **low**.

4.5.3 Sewer Flooding

Wessex Water is the statutory water undertaker and keeps a record of historic sewer flood events in a database called the SIRF (Sewer incident Report Form). According to data presented in the Level-1 SFRA, taken from the SIRF, there have been four incidents of sewer flooding within the GL12 8 Postcode (Wickwar), the most recent being 2013. It should be noted the SIRF register provides a ‘snapshot’ in time and will be outdated by the addition of new properties. However new properties may in fact create betterment, from both application of the SuDS Hierarchy and the potential for capital investment in the public sewer system. In addition to this, the SFRA Historical and Potential Flood Sources Map (included as **Appendix D**) does not identify any incidences of sewer flooding within Wickwar.

It has been established that based on historic flood records the probability of sewer flooding is low at the site. However, there are public sewers located adjacent to the eastern boundary of the site underlying the B4060. Despite this, there is no clear pathway for this flood hazard as the prevailing topography suggest that sewer flood water emerging from the manholes would flow away from the site.

For the reasons discussed, and the relationship between probability and impact, the baseline risk to the site from sewer flooding is determined to be **very low**.

4.5.4 Surface Water Flooding

Surface water flooding is caused by heavy rainfall events that cause significant surface runoff and ponding of accumulated water. The probability and impact of flooding is heavily dependent on the topography of a site, as well as the ground conditions and its infiltration capability.

As can be seen from the EA surface water flood map (**Figure 7**), most of the site is at very low risk of surface water flooding. This represents a less than 0.1% annual probability of occurrence. There is an established overland flow path extending from the south-east of the site to the western boundary where it joins the minor watercourse along the western boundary. This overland flow route contains areas of low (0.1 – 1% annual probability), medium (1 – 3.3 % annual probability) and high (>3.3% annual probability) risk.

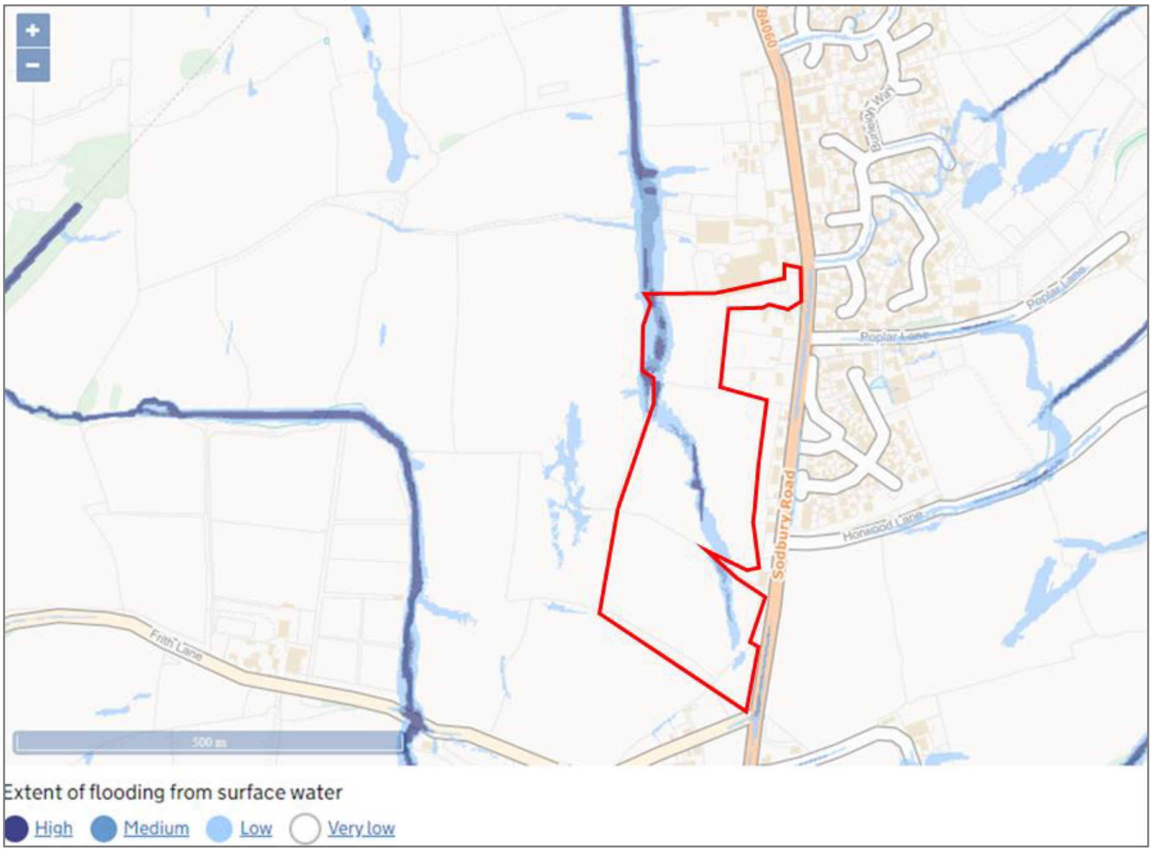

Figure 7: EA Surface Water Flood Map

For the purposes of detailed assessment, the 'medium' level of risk will be considered, as this is the same probability as the design fluvial flood event (>1% AEP). From both the modelled velocity and depth for this event, a flood hazard rating can be determined.

Figure 8 shows the modelled depth for the medium risk scenario. The EA surface water flood map indicates that for the medium level risk scenario the overland flow route has depth below 300mm.

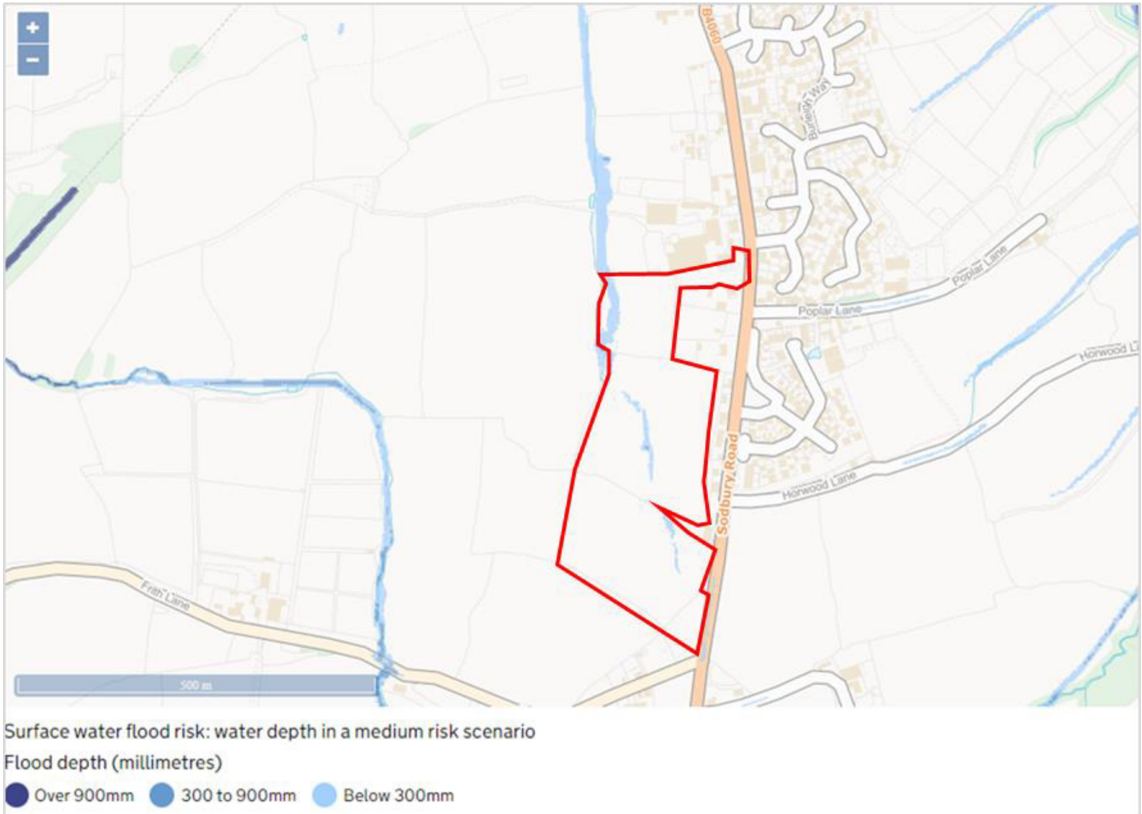

Figure 8: Medium Surface Water Flood Risk (Depth)

Figure 9 shows the modelled flood velocity (metres/second) for the ‘medium risk’ scenario (>1% AEP). The established overland flow path is expected to flow at a velocity of over 0.25m/s.

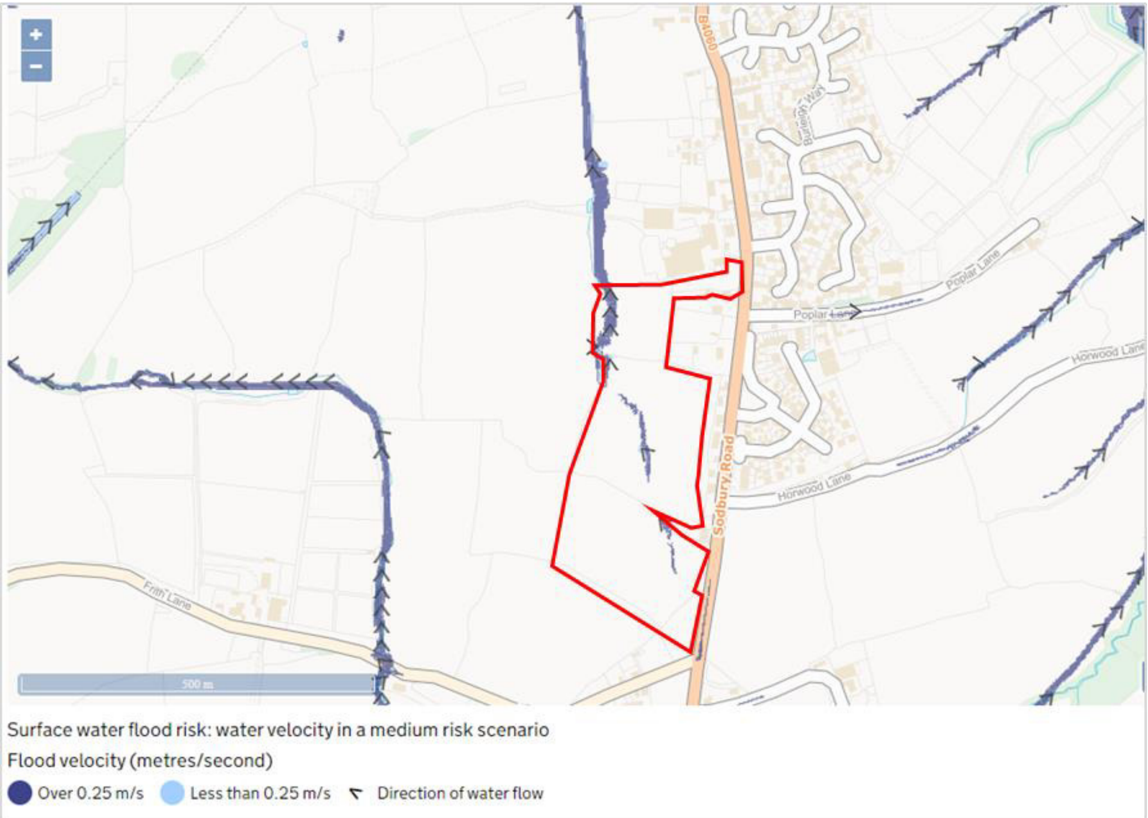

Figure 9: Medium Surface Water Flood Risk (Velocity)

Considering both velocity and depth of flooding, a flood hazard can be determined. When applied to the flood hazard matrix (**Figure 10**), this would result in a low hazard in accordance with FD2320/TR2 assessment methodology, and the FD2321/7400/PR supplementary note (2008).

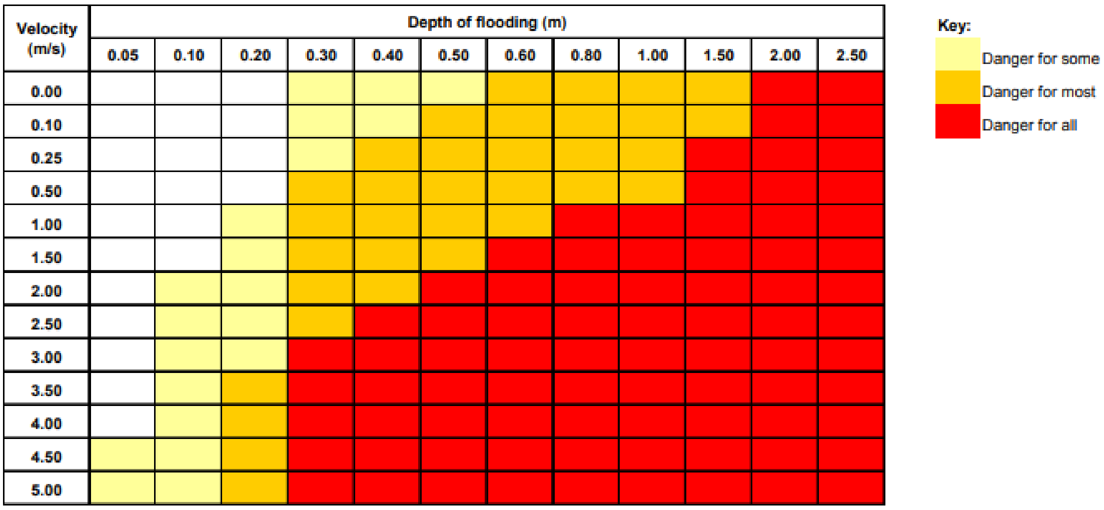

Figure 10: Flood Hazard Matrix (FD2320/TR2, DEFRA, 2005)

Therefore, the risk from surface water flooding to the site is to be **low**.

Proposed Post-development Surface Water Management Measures

The proposed drainage strategy (see **Section 5.3**) will allow for the overland flow route shown in **Figure 11** from the southern parcel to be intercepted by the swale shown and flows directed into the proposed attenuation basin.

Vulnerable land uses including proposed dwellings should be setback from existing watercourses (such as the ordinary watercourse at the west of the site) by a minimum buffer of 6m to mitigate flood risk (including risks posed by future effects of climate change).

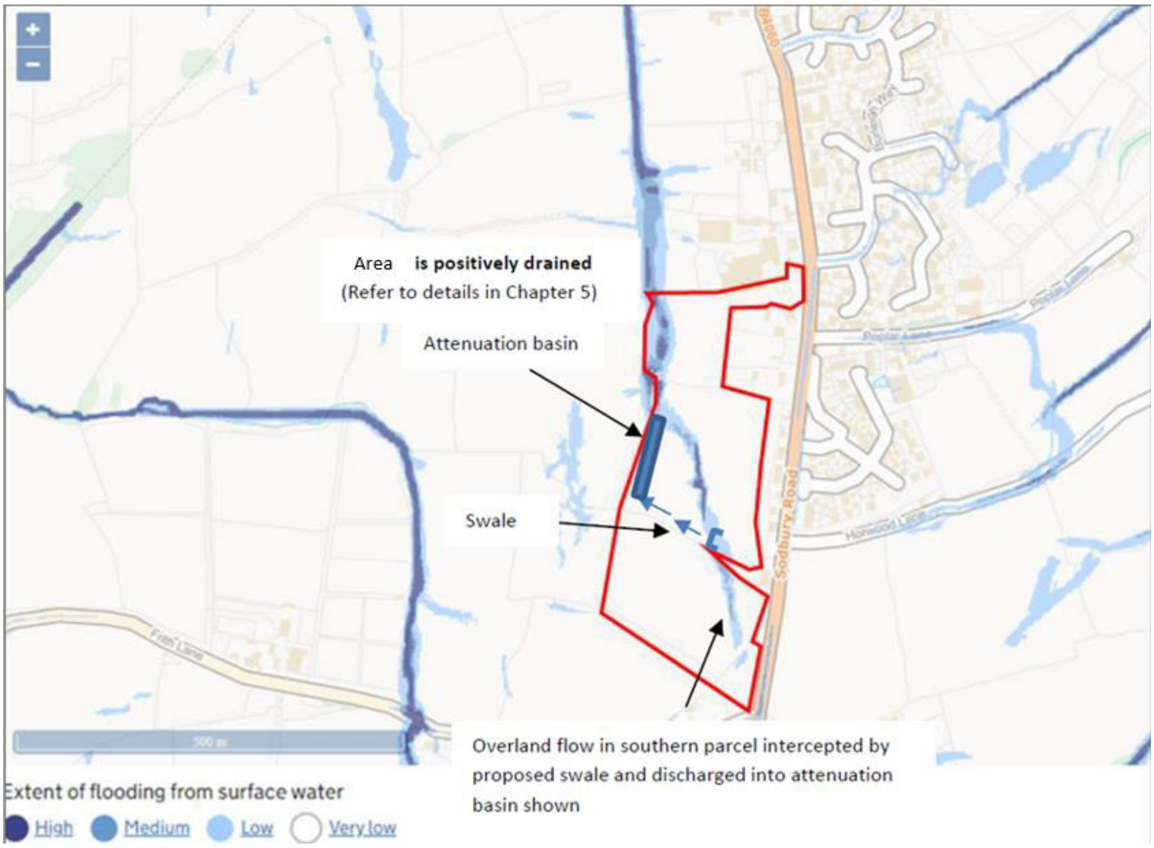

Figure 11: Proposed Surface Water Management Measures

4.5.5 Flooding from Artificial Infrastructure Failure

The proposed development site is not within an area at risk of flooding from reservoirs; therefore, the risk posed to the site from failure of existing artificial infrastructure is **none**.

4.6 Impact of Development on Flood Risk Elsewhere

A key requirement of this FRA, along with assessing flood risk to the site, is to adequately assess the impact of the Proposal on flood risk elsewhere. This involves determining the source of risk (e.g., changes to the site), the pathway of risk (e.g., re-direction of flow) and the receptors to the risk (e.g., nearby properties).

The Proposal has the potential to adversely affect surface water flood risk elsewhere by increasing impermeable area and/or re-direction of flow. Additionally, sewer flood risk could also potentially increase elsewhere if the Proposal were to increase off-site discharge to surface water and foul network. The proposed drainage network will inherently mitigate these risks, by capturing all flows on site before attenuating and discharging at a controlled rate.

As the site is not expected to be affected by the 1% AEP fluvial flood event, any changes on site will not displace fluvial floodwater. **Section 4.5.4** explains the measures to be implemented to manage the overland flows. Therefore, the Proposal will not increase fluvial flood risk elsewhere, and this risk is assessed to be **very low**.

4.7 Cumulative Impact on Flood Risk

Under the new NPPF guidelines, the cumulative impact on flood risk from both the Proposed Development and surrounding developments must be assessed. This should involve determining where there are common flood sources, pathways and receptors and assessing the scale and timings of any impacts likely.

According to the Council's planning portal, an area of land 300m east of the site is an application for the screening opinion for the erection of up to 150 dwellings. Also, adjacent to the southeast border, there is an application for the erection of up to 90 residential dwellings with public open space, landscaping, sustainable drainage system and vehicular access from Sodbury Road.

These surrounding areas are largely at very low risk from fluvial/tidal sources of flood hazards and would have incorporated mitigation measures as part of the planning consent process to reduce the risk of flooding elsewhere; therefore, the key risks to the wider area are likely from surface water and sewers. Any changes to the drainage of neighbouring sites will be subject to the same policy as this Proposed Development; therefore, for most of the surrounding area there is likely to be a beneficial cumulative impact from the implementation of existing local and national flood risk polices.

Therefore, it is judged that there is limited cumulative impact from the Proposal and other developments.

4.8 Safe Access and Egress

The SFRA stipulates that safe access and egress should be maintained for the lifetime of the development. As the site is in Flood Zone 1, and is at limited risk from other flood sources, safe access and egress is possible over the lifetime of the development.

4.9 Mitigation and Management Requirements

Flood risk mitigation and management measures for the development are determined by way of the hierarchical process outlined in Section 5 of the BS 8533:2017 'Assessing and Managing Flood Risk in Development – Code of Practice'. Application of this hierarchy is as follows:

1. **Stage 1 – Assessing and understanding the flood risk:**
   A sound understanding of the sources of flood risk and how it varies over the site has been achieved.

2. **Stage 2 – Avoiding the Risk:**
   As the site automatically passes the Sequential Test, this is not required.

3. **Stage 3 – Substitution:**
   As the site automatically passes the Sequential Test, this is not required.

4. **Stage 4 – Land raising, flood control/surface water management incorporation:**

   Vulnerable land uses including proposed dwellings should be setback from existing watercourses (such as the ordinary watercourse at the west of the site) by a minimum buffer of 6m to mitigate flood risk (including risks posed by future effects of climate change).

   The Drainage Strategy and CEMP will also mitigate the risk of flooding from groundwater, surface water etc. to and from the site.

5. **Stage 5 – Resistant/resilient building techniques**:
   All development should be situated at least 6m away from the ordinary watercourse located at the west of the site, to mitigate the risk of flooding and account for the effects of climate change.

6. **Stage 6 – Safety:**
   Safe access and egress are possible to and from the site.

Mitigation of risk to off-site areas will be achieved by the proposed Drainage Strategy, which will ensure that surface water runoff from the impermeable areas is captured by the positive drainage network. Equally foul water flows will be discharged into the existing system subject to agreement with Wessex Water.

Groundwater flood risk during construction will be mitigated by the relevant contractor health and safety procedures for working in confined spaces and by the Construction Environmental Management Plan (CEMP). In extreme cases, dewatering/pumping may be required to remove any groundwater present.

4.10 Summary Table

Flood Source	Current Level of Risk	Mitigation Required	Residual Risk
Fluvial/Tidal		None Required	
Ordinary Watercourse		All development should be situated at least 6m away from the ordinary watercourse located at the east of the site.	
Groundwater		Contractor's H&S procedures De-watering of excavated area (if required)	
Sewer		Drainage Strategy (specifying exceedance flow routes)	
Surface Water		Drainage Strategy (specifying exceedance flow routes)	
Artificial Infrastructure		None Required	
Flood Risk to Elsewhere		None Required	
Key		**High Risk** – Major constraint to development requiring active consideration in mitigation proposals	
		Moderate Risk – Issue requires consideration but not a significant constraint to development	
		Low – Issue requires some consideration and is not a significant constraint to development	
		Very Low - Issue requires little to no consideration and is not a significant constraint to development	
		Negligible Risk - No noticeable impact to site and not considered to be a constraint to development	

5 Drainage Strategy

5.1 General

As a minimum, the drainage strategy will need to adhere to the guidance set out in the NPPF and best practice guidance which requires surface water to be managed so that flood risk (both on site and to third-parties) is not increased and where possible flood risk should be reduced from the existing situation.

Best-practice guidance has been followed to identify the most appropriate and sustainable method for managing surface water at this development. **Sections 5.3 and 5.4** constitute the outline surface water and foul drainage strategy which will form the basis of the detailed design.

All private drainage will be constructed in accordance with Building Regulations and adoptable drainage constructed in accordance with the relevant Sewers for Adoption Guidance.

5.2 Guidance and Policy

5.2.1 Building Regulations Guidelines

An appraisal was undertaken of the most suitable and sustainable method for managing surface water runoff from the development in accordance with the following hierarchy as discussed in Part H of Building Regulations and Paragraph 080 (Reference ID: 7-080-20150323) of NPPG:

1. Infiltration to the ground using a sustainable drainage system.
2. If this is not feasible, discharge to a watercourse or river; generally, at a controlled rate unless it does not affect flood risk e.g., if to the sea or an estuary.
3. Discharge at a controlled rate to a surface water sewer or drain.
4. Only if the above have all been investigated and it has been proved that none of these options are suitable will discharge at a controlled rate to a combined sewer system be considered and the approval for this can only be given by the Water Authority.

5.2.2 Sustainable urban Drainage Systems (SuDS)

SuDS seek to manage surface water as close to its source as possible, mimicking surface water flows arising from the site prior to the proposed development. Wherever possible, a SuDS technique should seek to contribute to each of the three goals identified below with the favoured system contributing significantly to each objective.

1. Reduce flood risk (to the site and neighbouring areas),
2. Reduce pollution, and,
3. Provide landscape and wildlife benefits.

There are various SuDS measures which can be adopted which can be designed to infiltrate runoff to reduce the overall volume of water leaving a site (Option 1 in drainage hierarchy) and/or attenuate (slow) runoff to reduce peak flows in a receiving watercourse/sewer (Options 2, 3 and 4 in drainage hierarchy).

Table 5 includes examples of commonly used components in a SuDS system. The proposed drainage strategy will make use of relevant components where possible and whilst considering the various site constraints and design objectives.

Table 5: Examples of Sustainable Drainage Systems

SuDS Measure	Description	Source/Site Control?
Infiltration/attenuation basins, ponds, and wetlands	Depressions in the ground that are utilised for surface runoff storage and provide high potential for ecological, aesthetic and amenity benefits.	Site control
Swales	Vegetated channels used to convey rainwater, which remove pollutants and may permit infiltration in permeable soils.	Site control
Infiltration trenches	Gravel-filled channel which conveys flows, sometimes with a perforated pipe at the base to outfall to a receiving waterbody.	Site control
Soakaway	Gravel-filled pit which water is piped into so it drains slowly out into the surrounding permeable soil	Source control
Soft Landscaping	Planted vegetation and green space used to increase the permeable area of the site and promote infiltration and interception of rainfall.	Source control
Filter strips	Vegetated areas of gently sloping ground alongside impermeable areas which remove pollutants and promote infiltration/evaporation.	Site control
Permeable paving	Paving that allows infiltration of rainwater either to the underlying soil (permeable sites) or permeable sub-base (impermeable sites).	Source or site control depending on design
Green roofs	Vegetated roofs that reduce the volume and rate of runoff entering downpipes and remove pollution.	Source control
Rainwater Harvesting/Butts	Collects water from roof runoff for re-use in household appliances or gardens.	Source control
Attenuation tanks	Below-ground tanks used to store attenuated flows, to be gradually released into the sewer network.	Site control

N.B. This table outlines examples of SuDS which may be considered as part of a drainage strategy for any suitable site. The examples outlined within the table are not necessarily suitable for, or included within, the drainage strategy for this site.

5.3 Surface Water Strategy

5.3.1 Site Drainage Hierarchy

As set out in **Section 5.2.1**, there is a hierarchy for the preferred method of drainage from the site. When applied to the site, these are the results of the assessment:

1. Permeability of the bedrock, subject to BRE Digest 365 Soakaway Tests and ground investigation, means that infiltration drainage methods are expected to be viable at the site.
2. If this is not viable, the unnamed tributary of the Ladden Brook is located at the south-west boundary of the site, so surface water drainage can discharge into this watercourse.
3. Public Surface water sewers are also located close to the eastern boundary of the site; connection to which is also possible.

5.3.2 Greenfield Runoff Rates

In accordance with the NPPF and Defra guidance, development on existing Greenfield sites should restrict runoff to Greenfield rates to ensure the increased impermeable area as does not have a negative impact on the downstream drainage network.

The existing Greenfield runoff rates were calculated using the IH124 method from the HR Wallingford Greenfield Runoff Estimation Tool, the results of which are presented in **Table 6**. The rates were calculated for the entire wider development site (38ha), including the parkland with enhanced cycle and pedestrian routes at the west of the site.

Table 6: Greenfield Runoff Calculations

Return Period	Greenfield Runoff Rate (l/s/38ha)	Greenfield Runoff Rate (l/s/ha)
QBAR	216.1	5.7
1 in 30 Year	432.1	11.4
1 in 100 Year	555.3	14.6

5.3.3 Proposed Surface Water Strategy

According to the 'Non-statutory technical standards for sustainable drainage systems' (2015) and 'West of England Sustainable Drainage Developers Guide' (2015), the aim should be to reduce the discharge to as close to greenfield rates as possible.

It is assumed that post-development, the surface water strategy will consist of gravity adoptable surface water sewers collecting and directing surface water runoff from impermeable areas of the development to attenuation basins situated on site.

For the development, surface runoff from all impermeable areas will discharge through separate adoptable surface water sewers via outfalls into an attenuation basin, designed to attenuate flows produced by a 1 in 100 year + 40% climate change event with an attenuation volume of 4089m^3. The upper end allowance for climate change of 45% was applied to test the sensitivity for more severe rainfall events due to climate change. The basin is proposed to discharge surface water into the minor watercourse at the west of the site, via an adoptable surface water flow control chamber limiting discharge to a maximum discharge rate of 25l/s. Storage calculations can be found in **Appendix E**.

The calculations include an allowance for 10% urban creep which results in a total impermeable area of 4.44ha for the development.

A copy of the drainage strategy (drawings **B05313-SW115-EN-504P05** & **B05313-SW115-EN-505P05**) have been included in **Appendix F**.

5.4 Proposed Foul Water Strategy

Foul water will drain via a network of adoptable foul water sewers to an adoptable pumping station at the north-west of the site boundary. This will subsequently pump foul water flows east to the nearest public foul sewer to the site on Sodbury Road (B4060) adjacent to the eastern boundary of the site subject to capacity checks with Wessex Water.

A copy of the drainage strategy (drawings **B05313-SW115-EN-504P05** & **B05313-SW115-EN-505P05**) have been included in **Appendix F**.

6 Summary & Conclusion

The site is located within Flood Zone 1, meaning there is a less than 0.1% annual probability of fluvial/tidal flooding occurring. This is the lowest flood zone classification given by the EA and is considered safe from flooding. It has also been assessed that the impact of climate change will not significantly change the probability of flooding at the site.

Other sources of flood risk were also assessed at the proposed development area, as well as flood risk from the Proposal elsewhere. Ordinary watercourse flooding was assessed to be moderate, there is a minor watercourse located at the western boundary.

Groundwater flood risk is assessed to be low, as there is no evidence of historic flooding. However, an awareness of the risk is required, especially during construction.

Sewer flood risk is considered very low, as there are no sewers underlying the site and there are no potential pathways for sewer flood water to flow onto the site when sewer capacity is exceeded. Furthermore, there are no recorded historical incidences of flooding within the area. Any residual risk will be mitigated by the proposed Drainage Strategy.

Surface water flood risk was assessed to be low, as there is an overland flow path located on site, flowing northwards. The proposed drainage strategy will allow for the overland flow route from the southern parcel to be intercepted by a swale directed into a proposed attenuation basin.

The risk of flooding to the site from the potential failure of artificial infrastructure was ruled out.

The greatest flood risk posed to off-site areas by the proposed development is from the potential for increased surface water runoff from impermeable areas. However, this will not be allowed to occur as the proposed Drainage Strategy will intercept all surface runoff from these areas and allow the controlled discharge of flows off-site at the rate agreed with the Local Planning Authority LPA and water company.

Vulnerable land uses including proposed dwellings should be setback from existing watercourses by a minimum buffer of 6m to mitigate flood risk (including risks posed by future effects of climate change).

Mitigation of risk to off-site areas will be achieved by the proposed Drainage Strategy, which will ensure that surface water runoff from the impermeable areas is captured by the positive drainage network.

Groundwater flood risk during construction will be mitigated by the relevant contractor health and safety procedures for working in confined spaces and by the Construction Environmental Management Plan (CEMP). In extreme cases, dewatering/pumping may be required to remove any groundwater present.

For the development, runoff from all impermeable areas will discharge through separate adoptable surface water sewers via outfalls into an attenuation basin, designed to attenuate flows produced by a 1 in 100 year + 40% climate change event with an attenuation volume of 4089m^3. Please note that the ‘upper end’ climate change allowance of 45% was also applied to test the storage sensitivity for more severe rainfall events.

The basin is proposed to discharge surface water into the minor watercourse at the west of the site, via an adoptable surface water flow control chamber limiting discharge to a maximum discharge rate of 25l/s.

Foul water will drain via a network of adoptable foul water sewers to an adoptable pumping station at the north-west of the site. This will subsequently pump foul water flows east to the nearest public foul sewer to the site on Sodbury Road (B4060) adjacent to the eastern boundary of the site subject to capacity checks with Wessex Water.

This report has satisfied the objectives set in Section 1.4, demonstrating that the site is not at a significant level of flood risk from any of the sources of flood hazards assessed and that the Proposal will not increase flood risk elsewhere. Appropriate mitigation and flood management measures have been recommended for the proposed development.