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Flood Risk Assessment and Drainage Strategy

Land off Ploughley Road, Ambrosden, OX25 2AD

B05927-CLK-XX-XX-RP-FH-1001

Archstone Ambrosden and Bellway Homes Limited

clarkebond

MULTIDISCIPLINARY ENGINEERING CONSULTANTS

Report No.	Date
B05927-CLK-XX-XX-RP-FH-1001	06/09/22

Project
Land off Ploughley Road, Ambrosden Flood Risk Assessment & Drainage Strategy

Client Name
Archstone Ambrosden Ltd and Bellway Homes Ltd

Issue Date	Number	Status	Description of Amendments
01-09-2022	P1	S1 Draft	
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Contents

Executive Summary

Client	Archway Ambrosden and Bellway Homes Limited
Site	The site is located on approximately 9.46ha of land off Ploughley Road, Ambroston, Bicester, Oxfordshire, OX25 2AD
Development Description and Planning Policy	The Proposal is to develop the current agricultural land for residential use. The proposed development is 5ha for up to 120 residential units and 4.46ha as public space. The main access to the site will be provided from Ploughley road As the Proposal includes residential land use, this is classified as 'More Vulnerable' in accordance with paragraph 066 of the NPPG.
Flood Sources & Flood Risk	According to the EA 'Flood Map for Planning' the site is in Flood Zone 1 and is therefore considered safe from fluvial/tidal flooding. It therefore automatically passes the Sequential Test. Other types of flood risk were also assessed, including: • Ordinary Watercourse – very low risk • Groundwater – low risk • Sewer – low risk • Surface Water – very low risk • Flooding from the potential failure of existing artificial infrastructure – no identifiable risk The risk of flooding elsewhere from the Proposal was assessed to be low – moderate.
Flood Risk Management Measures	The flood risk management hierarchy found in Section 5 of BS 8533:2017 has been applied to determine the most appropriate mitigation measures, where applicable.
Drainage Strategy	<u>Surface Water</u> A Ground investigation including Infiltration testing is yet to be undertaken to confirm the site conditions. But at present, the assumption is that no infiltration is possible across the development so SuDS will be required for volumetric control before the surface water discharges into the existing ditch to the Northwest corner of the site. The site discharge into the watercourse will be controlled at the greenfield runoff rate of 4.19l/s/ha. <u>Foul Water</u> There are no nearby foul water sewers to connect via gravity, therefore, a pumped solution is required. The proposed route of the rising main and its point of connection is to be confirmed with Thames Water. The total site foul discharge is currently estimated at 5.56l/s.

1 Introduction

1.1 Overview

Clarkebond (UK) Ltd was commissioned by Archstone Ambrosden and Bellway Homes Ltd to provide a Flood Risk Assessment (FRA) to support an outline planning application for the proposed development (all matters reserved except for access).

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). The assessment of flood risk was informed by the Level-1 Strategic Flood Risk Assessment (SFRA) 2017 for the Local Planning Authority (LPA) Cherwell District Council and Lead Local Flood Authority (LLFA) Oxfordshire County 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 proposed development site is on approximately 9.46ha of greenfield land, in the village of Ambrosden at approximately 2.3m south-east of the town of Bicester, Northeastern Oxfordshire. It can be located by nearest postcode OX25 2AD and National Grid Reference (NGR) ST 60442 19974. The site is bounded predominantly by agricultural fields to the west, north and north-east, as well as the village of Ambrosden to the east and south-east. The main access route to the site is via Ploughley Road to the south west. Site boundary can be seen in **Figure 1**.

Figure 1: Site Boundary

1.3 Proposed Development

The Proposal is to develop the current agricultural land for residential use. The proposed development is 5ha for up to 120 residential units and 4.46ha as public space. The main access to the site will be provided from Ploughley road

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

1.4 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
- Demonstrate that the development will not increase flood risk elsewhere, and where possible, will reduce flood risk.

1.5 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 flood risk is set out in paragraphs 155 to 165 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 is avoided, which is achieved via application of the Sequential Test.

2.1.1 Sequential Test Process

In summary this test aims to highlight the areas at lowest probability of flooding (Flood Zone 1) and steer new development to these areas. If the location of the low-risk area is not suitable due to wider sustainability objectives then progressively higher risk areas (Flood Zone 2/Flood Zone 3) can be considered, provided the development will be suitably safe from flooding and does not increase flood risk to other areas.

The process for undertaking the Sequential Test is shown in **Figure 2**. Flood Zones 1-3 relate to the risk of flooding from Main Rivers (rivers managed by the EA) and the sea and are used as the primary indicator of whether land is suitable for development. **Table 1** (taken from Table 1 of NPPG) details the corresponding meaning of flood zones in relation to flood risk. Please refer to section 4.1 where it states that a sequential test is not required for this site as it is located entirely in flood zone 1.

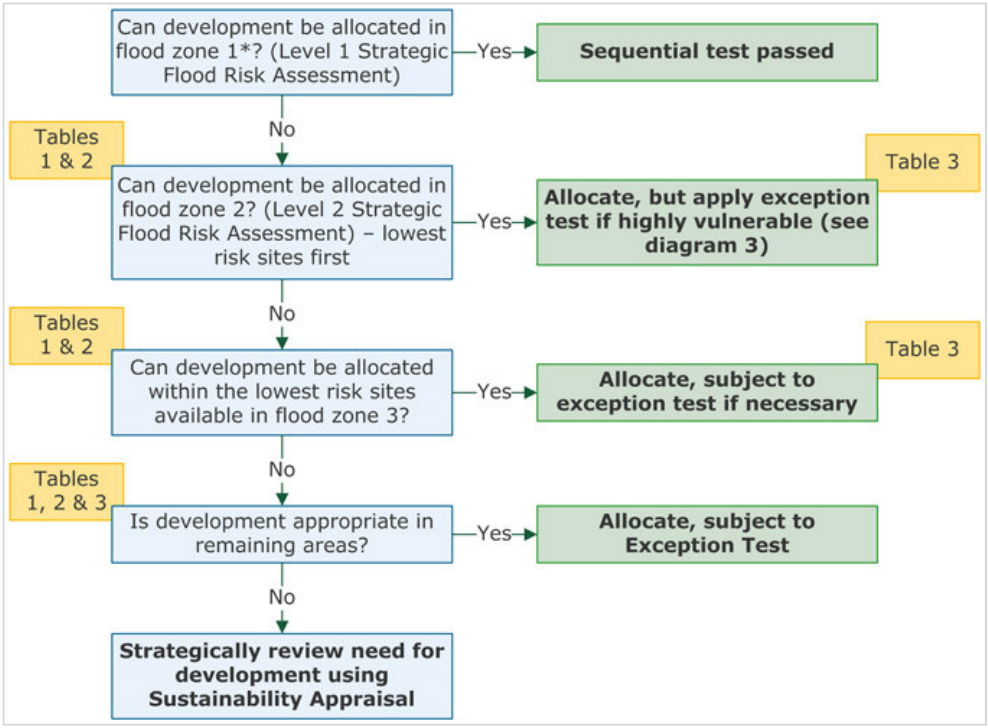

Figure 2: Process of the Sequential Test

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

Flood Zone	Definition
Zone 1 Low Probability	Land having a less than 1 in 1,000 annual probability of river or sea flooding.
Zone 2 Medium Probability	Land having between a 1 in 100 and 1 in 1,000 annual probability of river flooding; or Land having between a 1 in 200 and 1 in 1,000 annual probability of sea flooding.
Zone 3a High Probability	Land having a 1 in 100 or greater annual probability of river flooding; or Land having a 1 in 200 or greater annual probability of sea flooding.
Zone 3b The Functional Floodplain	This zone comprises land where water must flow or be stored in times of flood. The Strategic Flood Risk Assessments should identify the areas of functional floodplain and its boundaries accordingly, in agreement with the Environment Agency.

The Sequential Test is assessed to be passed if a site is within Flood Zone 1 or has been allocated in the Council's Local Plan where the Sequential Test has already been undertaken. If neither of these applies, a Sequential Test is required to demonstrate that there are no other available and suitable sites at a lower risk of flooding.

2.1.2 Development Vulnerability, Flood Zone Compatibility and the Exception Test

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 066) of NPPG which shows the vulnerability classifications of various land use types and Table 3 (Paragraph 067) of NPPG which shows the compatibility of the different vulnerability categories with the Flood Zones and requirements for the Exception Test. Please refer to section 4.1 where it states that a exception test is not required for this site as it is located entirely in flood zone 1.

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 located in the lowest risk parts of the site (unless there is an overriding reason to choose a different location).

Certain development may require an Exception Test before it is considered acceptable in Flood Zones 2 and 3. To pass this test, the following needs to be demonstrated:

1. The development provides wider sustainability benefits to the community that outweigh flood risk, informed by a Strategic Flood Risk Assessment where one has been prepared; and

2. the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.

2.1.3 Design Flood Event

The development should be flood resistant and resilient including safe access and escape routes for the following extreme flood events, also known as the 'design flood' (taken from Paragraph 055 of NPPG):

- 1 in 100 year (1%) fluvial flood accounting for climate change
- 1 in 200 year (0.5%) tidal/coastal flood accounting for climate change

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 residential development is accepted as 100 years in accordance with NPPG; from a baseline of **2023** (assumed date of first occupancy) this means assessing the flood level up to **2123**.

2.1.4 Surface Water Runoff Disposal Hierarchy

Surface water drainage from the proposed development must be dealt with in accordance with the following hierarchy taken from Paragraph 080 of NPPG:

1. Infiltration to the ground using a soakaway or other suitable 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. Discharge at a controlled rate to a combined sewer system – this will only be considered if the above have all been investigated and it has been proved that none of these options are suitable. The approval for this can only be given by the Water Authority.

Guidance on how surface water runoff should be managed, notably the discharge rate with which can leave a development site, is taken from the 'Non-Statutory Technical Standards for Sustainable Drainage Systems' (2015).

2.2 Flood Risk Assessment Requirements

Footnote 50 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:

- Cherwell Local Plan 2011-2031 (re-adopted 2016);
- Cherwell Level – 1 SFRA (2017);
- Oxfordshire county council Local Flood Risk Management Strategy (2014);
- Oxfordshire county council Local standards and guidance for surface water drainage on major developments in Oxfordshire (2021);
- Oxfordshire Preliminary Flood Risk Assessment (2011).

2.3.1 Cherwell local Plan 2011-2031 (re-adopted 2016) – Policy ESD6

The Local Plan was re-adopted in December 2016 replacing the previous Cherwell Local Plan 2011-2031 (2011), incorporating Policy Bicester 13. The Local Plan sets out the “blueprint and vision” for the district council of Cherwell. The key policy relating to flood risk is ‘Policy ESD 6 Sustainable Flood Risk Management’ (**Figure 3**), which is broadly in line with current national policy however provides some additional detail and requirements. Other policies such as ESD7 and 8 also refer to flood risk and drainage measures.

Policy ESD 6: Sustainable Flood Risk Management

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.

Figure 3: Policy ESD6 of the Local Plan 2011-2031

2.3.2 Cherwell Level-1 SFRA Update (2017)

The current Level-1 SFRA (2017) replaces the previous report published in 2009. The Level 1 SFRA provides a baseline assessment of the flood risk within Cherwell district as well as provides guidance for how site-specific flood risk assessments should be completed.

2.3.3 Oxfordshire County Council Local Flood Management Strategy (2014)

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

2.3.4 Oxfordshire County Council Local standards and guidance for surface water drainage on major developments in Oxfordshire (2016)

This guide provides Oxfordshire 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.

2.3.5 Oxfordshire Preliminary Flood Risk Assessment (2011)

As a Lead Local Flood Authority (LLFA) the Council 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 Oxfordshire.

3 Background Information

3.1 Site Levels

A topographic survey was carried out in April 2022 by AHP Surveys, covering the entire red line boundary and some of the adjacent vegetated and road areas. This can be found in **Appendix B**.

The highest level on site can be found in the north-east corner, adjacent south of more agricultural land, at 77.83m AOD. The lowest level on site can be found in the south-west corner of the site at 64.12m AOD; however, in general, site levels decrease in the south-west direction of the site. The site fluctuates between heights of 77.83 – 64.12 mAOD in a non-uniform manner.

3.2 Public Sewers

Sewer asset records were acquired from the sewerage undertaker for the site; Thames Water. These records have been provided in **Appendix C**. No Public sewers were located on the site.

3.3 Hydrology

According to the EA's 'Main Rivers Map' and 'Catchment Data Explorer', the site is located within the catchment of a main river, the River Ray. A main river refers to those watercourses under the jurisdiction of the EA. **Figure 4** shows the extent of the catchment boundary.

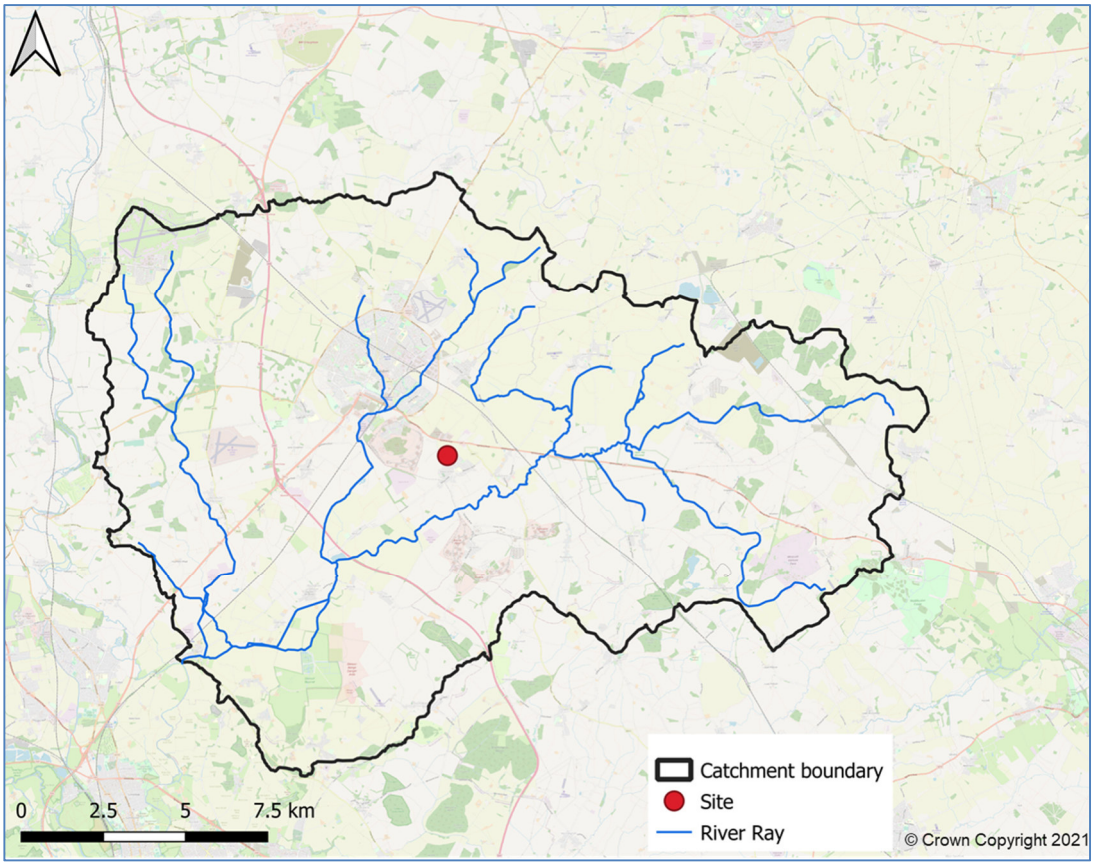

Figure 4: River Ray & Catchment

According to OS maps, there are no "ordinary watercourses" identified on site. Ordinary watercourses refer to those under the jurisdiction of the LLFA, which in this case is Cherwell District Council. However, the topographical survey has indicated the presence of a drainage ditch on site. The ditch links to the tributary west of the site boundary which subsequently discharges into the river Ray. There are also field ditches present along the field boundary to the North. The presence of ditches and ordinary watercourses will need to be confirmed by a drainage survey.

To the Northwest of the site is a tributary of the River Ray, and alongside it a pond known as the Gothic Pond. The pond is known to overflow and inundate adjacent areas and fields at times of prolonged wet weather where it crosses Ploughley Road via a culvert.

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:

Superficial Deposits

No superficial deposits have been recorded for this site.

Bedrock

- Kellaways Sand member (interbedded Sandstone and Siltstone)
- Kellaways Clay member (Mudstone)
- Cornbrash formation–Limestone, Secondary an Aquifer
- Forest Marble Formation (Interbedded Limestone and Mudstone)

With regards to groundwater vulnerability, according to 'Magic' maps the site is in a 'Secondary Aquifer A' (formerly Minor Aquifer High)' area. However, it does not fall within a Source Protection Zone (SPZ). According to the EA, a Secondary A aquifer refers to 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.

According to LandIS 'Soilscapes', the site is underlain by 'Soilscape 3: Freely draining lime-rich, loamy soils. This is known to be freely draining to local groundwater and rivers. A review of available historic borehole data show evidence of a possible shallow water table in the Forest Marble Formation with water strikes at 1.2m and 3.7m in boreholes to the north of the site.

4 Flood Risk Assessment

4.1 Flood Zones and Development Compatibility

The EA 'Flood Map for Planning' shows that the site is located within Flood Zone 1 (see **Figure 5**). This means the site has annual probability of flooding of less than 0.1% (1 in 1000-year return period) from both fluvial and tidal sources.

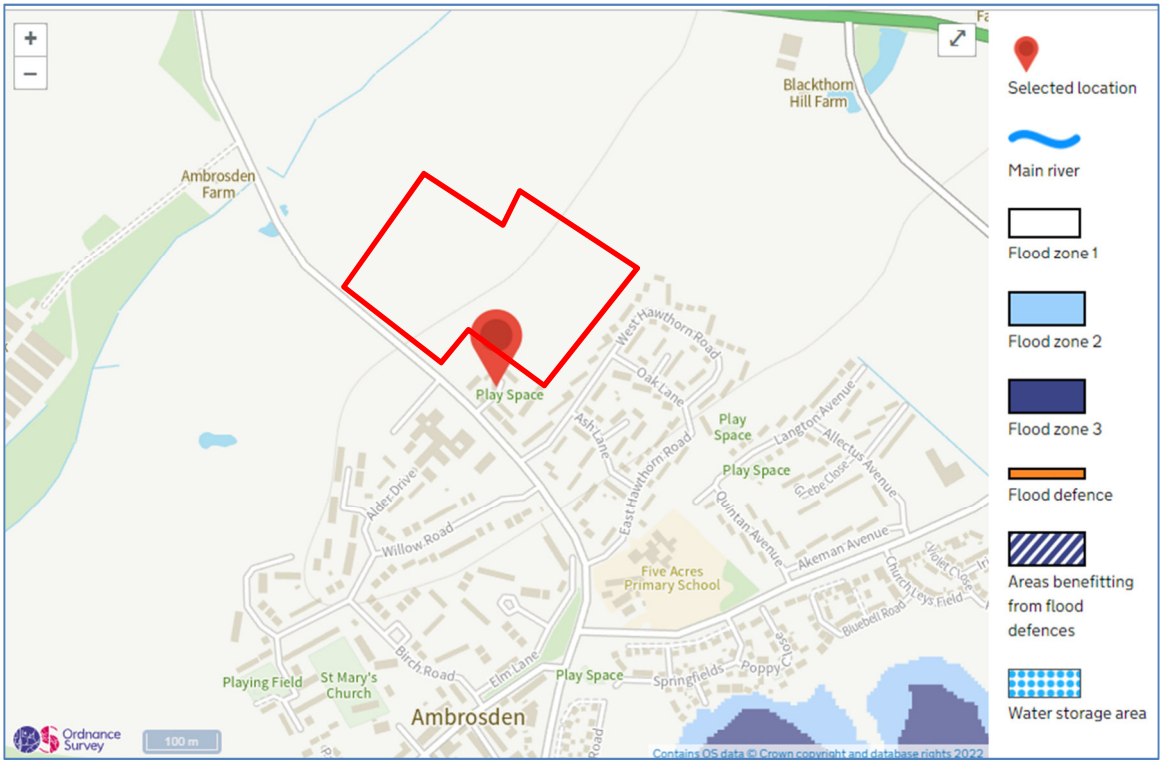

Figure 5: EA 'Flood Map for Planning'

The Proposal can be classified as a 'More-Vulnerable' development, in accordance with Paragraph 066 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). Therefore, the Proposal automatically passes the Sequential Test and is not required to undertake an Exception Test.

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

Flood Risk Vulnerability Classification		Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zones	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 the development is appropriate and **X** means the development should not be permitted*

4.2 Impact of Climate Change

As the site is not identified as being within a high-risk zone for fluvial/tidal modelled flood data, the NPPF states that the FRA should assess the increased risk posed by climate change over the development lifetime. 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 flows over the projected lifetime of the development.

In the UK precautionary allowances for net sea level rise and other parameters such as wind speed, wave height, river flow and rainfall intensity are provided by the UK Climate Impacts Programme (UKCIP, 2018). Historically simple uplift ratios (defined by Defra within Flood and Coastal Defence Appraisal Guidance FCDPAG3) have been used to make a baseline assessment of the potential impact of climate change on an asset. However, the use of a nationally uniform allowance particularly for peak river flow has been assessed for suitability under FD2020 and new regionalised climate change guidelines for flood management have been published by the EA in July 2021 specific to management catchments and flood vulnerability classifications and updated for peak rainfall intensity in May 2022. The proposed development site is situated within the Cherwell and Ray Management Catchment, within the Thames River basin district with a development lifespan of ~100 years. Based on NPPG guidance for 'More Vulnerable' development in Flood Zone 1, the central allowance should be used to assess a range of allowances for fluvial flood events, as shown in **Table 3**.

Table 3: Peak River Flow Allowances for Thames River Basin District

	Total Change 2020s	Total Change 2050s	Total change 2080s
Upper End	24%	27%	49%
Higher Central	11%	10%	25%
Central	6%	4%	15%

While for fluvial the impact of climate change will result from increased flow, for tidal the impact will be as a result of sea-level rise.

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.

3.3% annual exceedance event	2050s	2070s
Upper End	35%	35%
Central	20%	25%
1% annual exceedance event	**2050s**	**2070s**

Upper End	40%	40%
Central	20%	25%

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

4.3 Fluvial Flood Risk

As stated previously, the site is in Flood Zone 1 which is the lowest risk classification given by the EA. It is an area where safe refuge should be sought from flooding and therefore can be considered safe. Also, according to EA data, there have been no recorded flood incidents on site (see **Figure 6**).

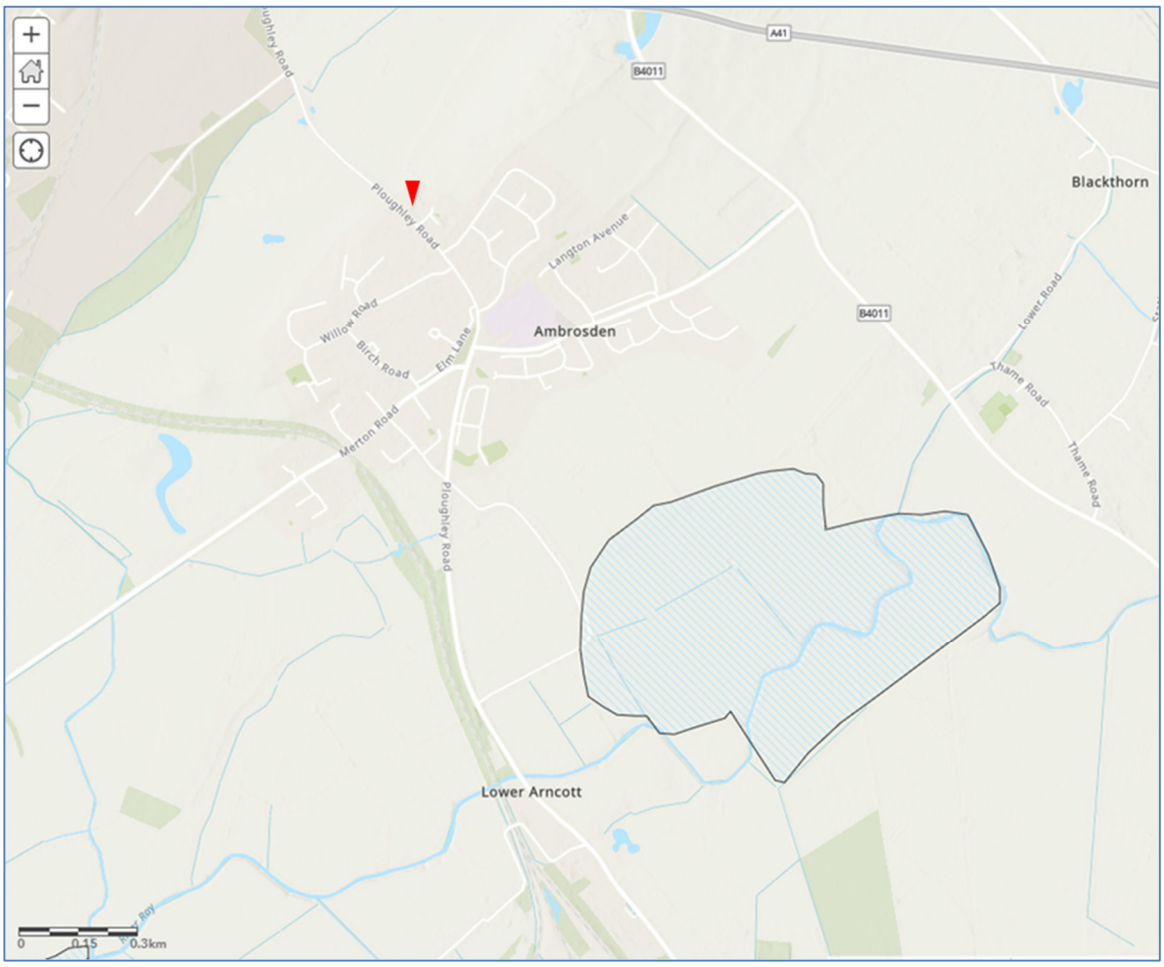

Figure 6: EA Historic Flood Map Data (EA, 2019)

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 site is approximately 1.4km from the River Ray and is located on higher ground. Therefore, a judgement can be made that the impact of climate change will not cause the floodplain to encompass the site.

Therefore, the risk from fluvial flood risk is assessed to be **very low**. Tidal flood risk has been discounted.

4.4 Other Sources of Flood Risk

Other sources of flooding which need to be 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

4.4.1 Ordinary Watercourse Flooding

According to OS maps, there are no "ordinary watercourses" identified on site. However, the presence of a drainage ditch has been indicated by the topographic survey. The ditch links to the tributary west of the site boundary which subsequently discharges into the river Ray. There are also field ditches present along the field boundary to the North. The presence of ditches and this ordinary watercourse will need to be confirmed by a drainage survey. The risk of flooding from these ditches and possible ordinary watercourse is assessed to be **low -medium**.

4.4.2 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 Cherwell district, providing a map of 1km^2 grid areas with varying susceptibility to groundwater (**Appendix D**). The site is in an area where 25% of the land is susceptible to groundwater flood risk. It should be noted that this provides an assessment of the ability for groundwater to emerge (based on ground conditions) and not the probability of occurrence. The presence of historic flooding provides a better measure of probability.

While this gives an indication of where the conditions conducive for groundwater emergence are, it is an unreliable assessment of groundwater flood risk. 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 although nearby Merton that has a similar underlying geology has been identified as higher risk to ground water flooding.

Additionally, the Phase 1 Geo-environmental assessment undertaken by Clarkebond (UK) Ltd in May 2022 did not indicate a risk of groundwater flooding at the site.

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**.

4.4.3 Sewer Flooding

Thames Water is the statutory water undertaker and keeps a record of historic sewer flood events in a database called the DG5 register. It should be noted the DG5 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. It has been established that based on historic flood records the probability of sewer flooding is low at the site.

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

4.4.4 Surface Water Flooding

As can be seen from the EA surface water flood map (**Figure 7**), much of the site is at very low risk of surface water flooding. This represents a less than 0.1% annual probability of occurrence. There are several small pockets of low risk (0.1 – 1% annual probability. However, outside the site boundary are 2 areas of high surface water flood risk, 1 located to the south of the site and is identified as an existing pond and the other to west of the site boundary where the Gothic Pond is located.
It is believed that outflows from the pond south of the site boundary may be hydrologically connected to an existing ditch at the northwest of the site via existing below ground drainage. Refer to drainage strategy in **Appendix F** to identify the existing ditch at the northwest of the site. This ditch connects into another ditch network that feeds directly to the River Wey.

It is recommended that a detailed drainage survey is undertaken to confirm existing drainage and the link between the pond and the existing ditch at the northwest of the site. This should establish the route of this drainage and condition.

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.

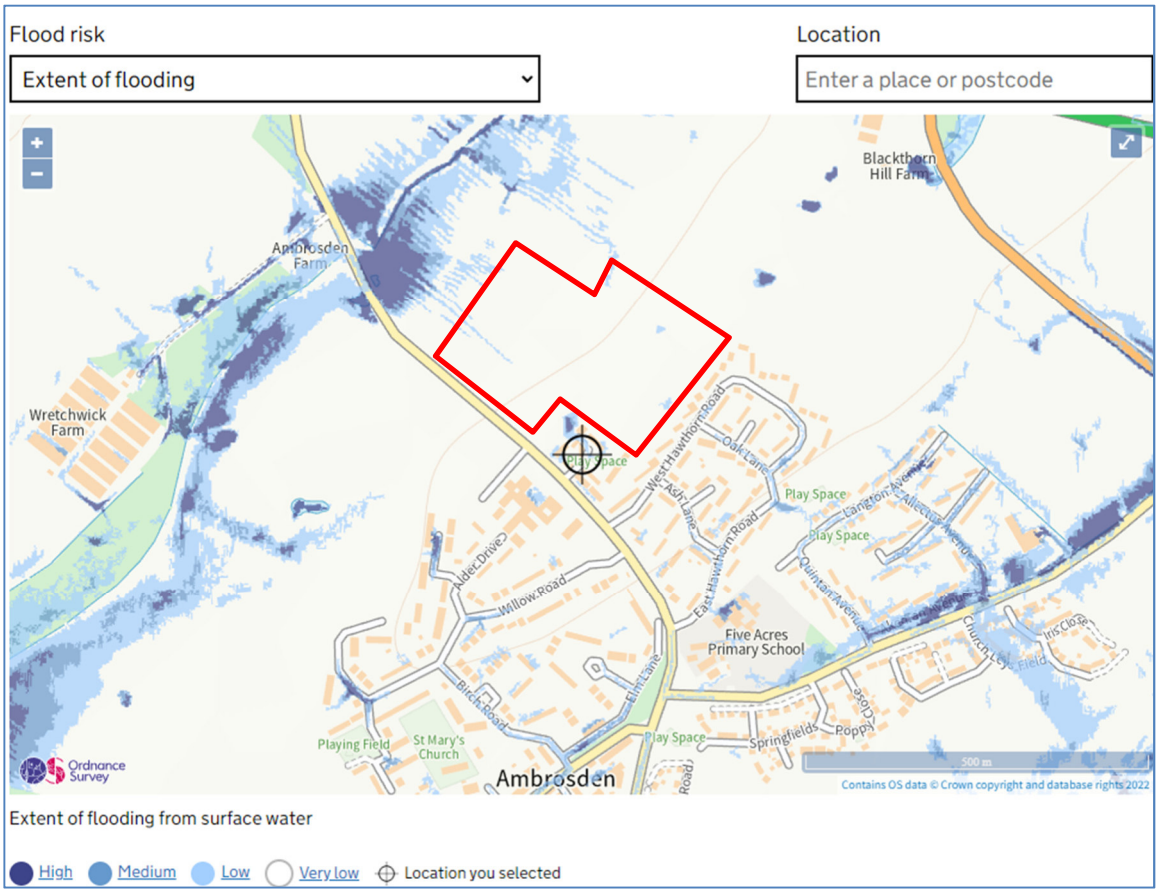

Figure 7: EA Surface Water Flood Map

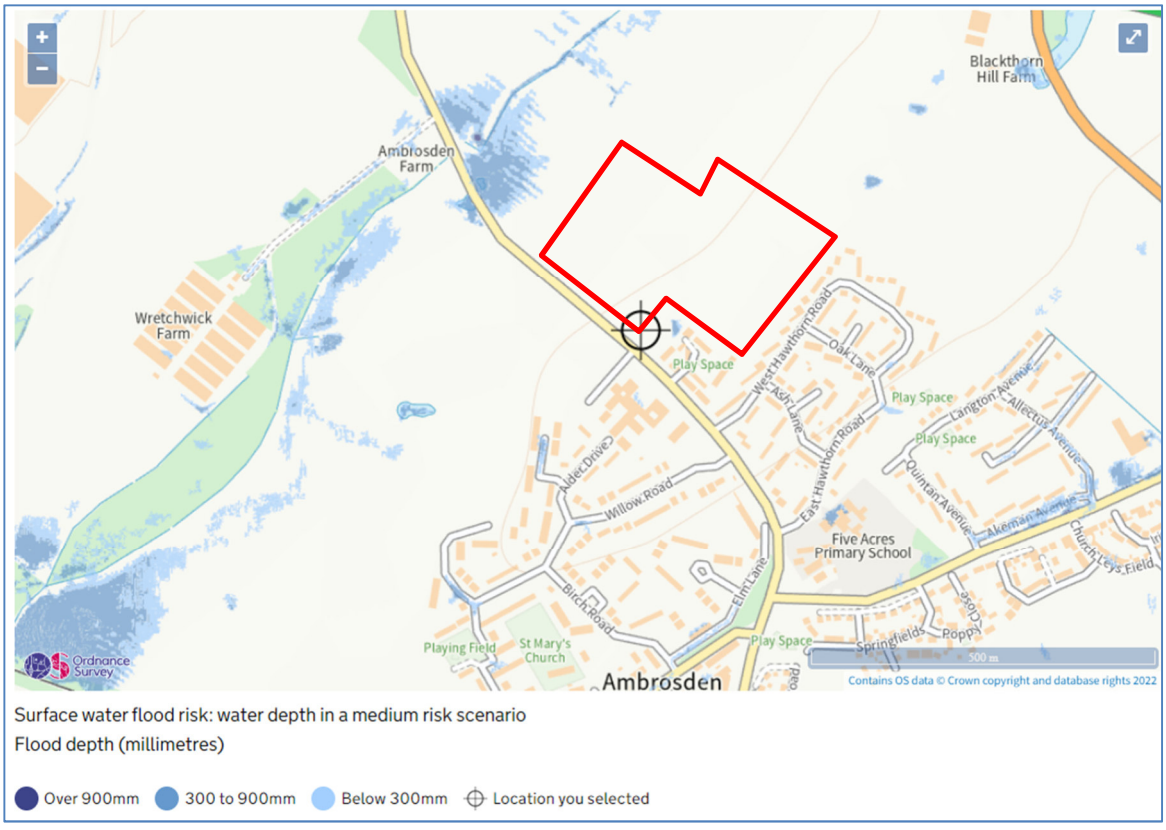

Figure 8:High Surface Water Flood Risk (Depth)

Figure 8 shows the modelled depth for the medium risk scenario. As has already been identified, there is an area where surface water is expected to pond. The EA flood map indicates that this will not occur on site.

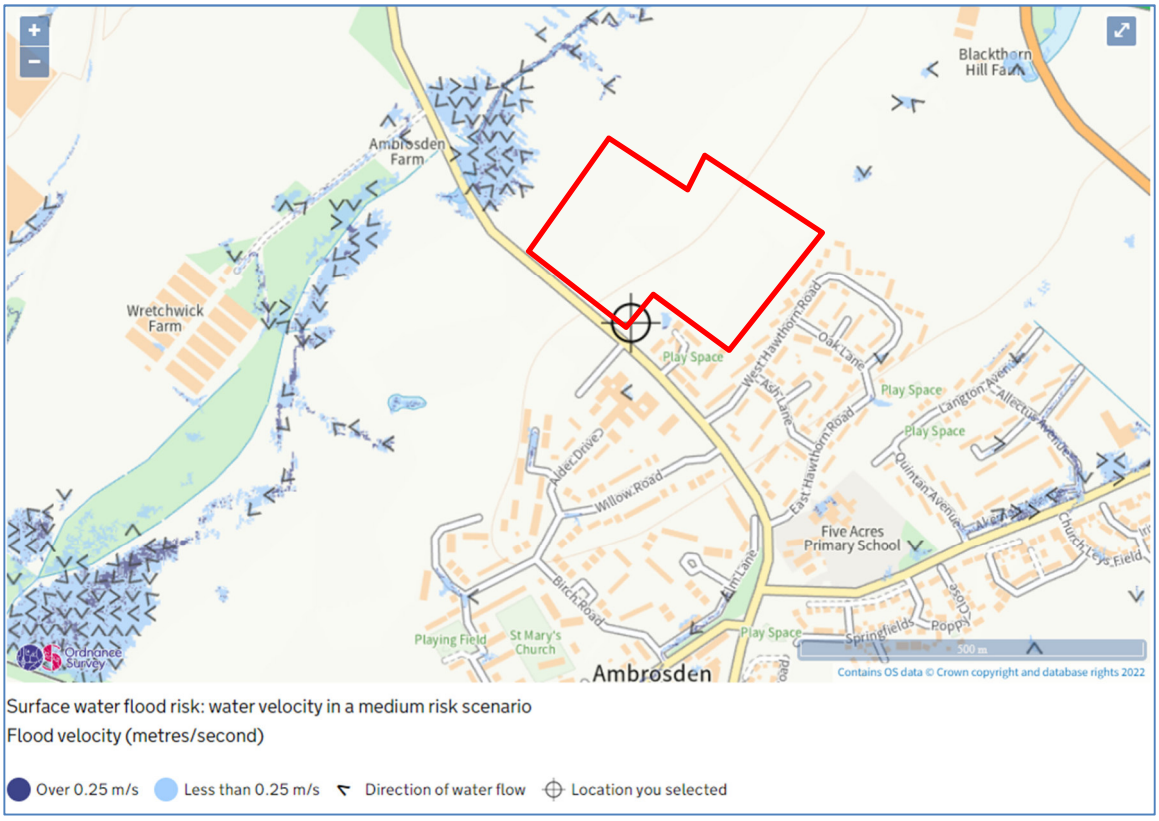

Figure 9: Medium Surface Water Flood Risk (Velocity)

Figure 9 shows the modelled flood velocity (metres/second) for the 'medium risk' scenario (>1% AEP).

Velocity (m/s)	Depth of flooding (m)											
	0.05	0.10	0.20	0.30	0.40	0.50	0.60	0.80	1.00	1.50	2.00	2.50
0.00												
0.10												
0.25												
0.50												
1.00												
1.50												
2.00												
2.50												
3.00												
3.50												
4.00												
4.50												
5.00												

Key:
Danger for some
Danger for most
Danger for all

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

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, as recommended in the FD2321/7400/PR supplementary note (2008).

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

4.4.5 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 Artificial Infrastructure Failure is **none**.

4.5 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).

As the site is not expected to be affected by the 1% AEP fluvial flood event, any changes on site will not displace floodwater. Therefore, the Proposal will not increase fluvial flood risk elsewhere.

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.

As the site is currently Greenfield, the potential impact could be significant. However due to the actual pathways to receptors (indicated by topography), and the general low risk of the area, this risk is assessed to be **moderate**.

As the site is in Flood Zone 1, development at the site will not have an impact on the tidal or fluvial floodplain; therefore, not increasing risk elsewhere for these flood hazards.

The proposed development has the potential to adversely affect surface water flood risk elsewhere from increase surface runoff, as a result of increasing impermeable area, and/or re-direction of existing flows. The proposed drainage network will inherently mitigate this risk, by capturing all flows on site before attenuating and discharging at a controlled rate.

Increasing the hardstanding area of the site will likely reduce the ability for groundwater to emerge. Due to the complexity of groundwater mechanics, and whether the site is in fact an area of preferential emergency, an accurate judgement on whether risk will increase to elsewhere cannot be made.

4.6 Cumulative Impact on Flood Risk

According to the Council's planning portal, there is one other large-scale development taking place within the vicinity of the site approximately 0.5km to the north-east consisting of proposed 130 dwellings and recreation space. It is judged that there is limited cumulative impact from the Proposal and other developments due to the topography of the site draining in the opposite direction of the other proposed site.

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.

As most of the surrounding area is greenfield land, any redevelopment of these areas alongside with the Proposed site, are unlikely to cause a worsening flood risk situation.

The surrounding area is at very low risk from fluvial/tidal sources of flood hazards 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 policy.

4.7 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. However as mentioned above the areas of high surface water flood risk offsite may impact access and egress from Ploughley road, north of the site.

4.8 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. However, mitigation will be required for high surface water flood risk offsite to ensure safe access and egress at times of flooding.

   It is believed that outflows from the pond south of the site boundary may be hydrologically connected to the existing ditch at the northwest of the site via existing below ground drainage. This ditch connects into another ditch network that feeds directly to the River Wey.

   It is recommended that a detailed drainage survey is undertaken to confirm existing drainage and the link between the pond and the existing ditch at the northwest of the site. This should establish the route of this drainage and condition.

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:**
   The Drainage Strategy will be the main mitigation tool for managing groundwater, surface water and sewer flood risk to and from the site. As the existing drainage ditch is expected to take water away from the site towards the tributary to the River Ray it is thought to have reduced the flood risk to the Gothic pond by diverting surface runoff away from the pond. This is anticipated to reduce any access problems via ploughley road in an event of surface water flood. (see **Appendix E**)

5. **Stage 5 – Resistant/resilient building techniques**:
   This is not required as appropriate mitigation is provided by way of Stage 4 measures.

6. **Stage 6 – Safety:**
   Safe access and egress are possible to and from the site, as well as it will be a place of safe refuge during a fluvial flood event. As mentioned in stage 4 above the proposed drainage stagey should reduce any risk posed by the water bodies offsite allowing for safe access and egress in all events.

4.9 Summary Table

Flood Source	Current Level of Risk	Mitigation Required	Residual Risk
Fluvial/Tidal		None Required	
Ordinary Watercourse		None Required	
Groundwater		Contractor's H&S procedures De-watering of excavated area (if required)	
Sewer		Drainage Strategy (specifying exceedance flow routes)	
Surface Water		Drainage Strategy	
Artificial Infrastructure			
Flood Risk to Elsewhere		Drainage Strategy	
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 in order to reduce peak flows in a receiving watercourse/sewer (Options 2, 3 and 4 in drainage hierarchy).

Table 7 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 4: 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. High permeability of the bedrock and freely draining soils, in line with the guidance of the SFRA, means that infiltration drainage methods are possible for the development.
2. There are no main or ordinary watercourses that cross the site, or are within an appropriate distance, therefore discharge to a watercourse is not 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 a result of development does not have a negative impact on the downstream drainage network.

The existing Greenfield runoff rates were calculated the results of which are presented in **Table 7** and. The rates were calculated for the proposed developable area (~9.46ha), excluding the area to remain permeable.

Table 5: Greenfield Runoff Calculations

Return Period	Greenfield Runoff Rate (l/s/1ha)	Greenfield Runoff Rate (l/s/9.5ha)
QBAR	4.19	**39.81**
1 in 30 Year	9.63	**91.49**
1 in 100 Year	13.36	**126.92**
1 in 100 year +45% CC	19.37	**184.03**

5.3.3 Proposed Surface Water Strategy

An outline drainage strategy proposal as per **Table 7** of the SUDS hierarchy can be found in **Appendix F**.

A Ground investigation including Infiltration testing is yet to be undertaken to confirm the site conditions. There are several soil types across the development area that may allow the site to discharge via infiltration. At present, the assumption is that no infiltration is possible across the development, therefore SuDS features will be required for volumetric control before the surface

water discharges into the existing ditch to the Northwest corner of the development boundary, from where it will then connect into the river Rey.

The site discharge into the watercourse will be controlled at the greenfield runoff rate of 4.19l/s/ha as per **Table 7.** The measured impermeable area of the development indicates that there is approximately 2.920ha of impermeable area as outlined in **Table 10** below.

Table 6: Proposed Storage Requirements

Zone	Impermeable Area(ha)
Adopted Highway	1.046
Private Roads and Drives	0.814
Plots & Garages	1.060
Total	**2.920**

A 10% urban creep factor has been applied to allow for future development where extensions to plots and additional impermeable area may enter the network.

Using the greenfield runoff rates and the measured impermeable area, a total site discharge rate into the existing watercourse of **12.2l/s** will be applied. A storage estimate model indicated that for the given discharge rate and impermeable areas, an additional volume of 2191m^3 - 2923m^3 is required for surface water attenuation based on no infiltration.

Locations have been shown on the strategy plan to indicate where potential SuDS features can be implemented into the development, the locations of these features are indicative only at this stage and will be subject to soakaway tests and the development of the overall site masterplan.

5.4 Proposed Foul Water Strategy

As indicated on the Thames Water asset plans in **Appendix C**, there are no nearby foul water sewers to connect via gravity. Therefore, a pumped solution is required and will factored into the development layout. The route of the rising main and its point of connection is to be confirmed with Thames Water.

There are 120 units on the development, as per the Design and Construction Guidance (DCG) B3.1.1b: *The peak design flow rates for dwelling should, at the discretion of the designer should be 4000 litres per dwelling per day*. As a result, the total site foul discharge is currently estimated at 5.56l/s.

5.5 Operation & Maintenance

There will be several parties to the operation and maintenance of the drainage features on the site, the parties to the operation and maintenance are;

- The Water Authority, Thames Water.
- The Highway Authority, Oxfordshire County Council.
- An appointed management company.

The above parties will perform reactive maintenance after significant rainfall events as well as seasonal maintenance that will be specified within an Operation and Maintenance manual or to the relevant authority's maintenance regime.

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 types of flood risk were also assessed, including:

- Ordinary Watercourse – very low risk
- Groundwater – low risk
- Sewer – low risk
- Surface Water – very low risk
- Flooding from the potential failure of existing artificial infrastructure – no identifiable risk

The risk of flooding elsewhere from the Proposal was assessed to be low – moderate.

A Ground investigation including Infiltration testing is yet to be undertaken to confirm the site conditions. But at present, the assumption is that no infiltration is possible across the development so SuDS will be required for volumetric control before the surface water discharges into the existing ditch to the Northwest corner of the site.
The site discharge into the watercourse will be controlled at the greenfield runoff rate of 4.19l/s/ha.

There are no nearby foul water sewers to connect via gravity as site levels do not allow this, therefore, a pumped solution is required. The proposed route of the rising main and its point of connection is to be confirmed with Thames Water. The total site foul discharge is currently estimated at 5.56l/s.

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.