

Level 2 Strategic Flood Risk Assessment – Land North and West of Eynsham

Final Report

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Contract

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Purpose

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- Environment Agency
- Oxfordshire County Council

- West Oxfordshire District Council
- Evenlode Catchment Partnership

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Executive summary

SFRA objectives

The objectives of this Level 2 SFRA update are to:

- Using available data, provide information and maps presenting flood risk from all sources for two strategic sites allocated for development in the West Oxfordshire Local Plan 2031 – land to the north of Eynsham and land to the west of Eynsham.
- Inform the Sequential Test (whereby new development is steered towards areas at lowest risk of flooding).
- Serve as guidance for developers to complete the Exception Test if applicable (i.e. if development has to take place in Flood Zone 2 (medium risk) or Zone 3 (high risk)).
- Provide an assessment of residual flood risk and climate change.
- Where flood risk information is unavailable or limited, conduct appropriate hydraulic modelling where possible to determine the flood risks to the allocated sites.
- Take into account the most recent national and local policy and guidance documents, update information on the requirements for site-specific FRAs, considerations for suitable surface water management methods and opportunities to reduce flood risk to existing communities through new development.

Level 2 SFRA outputs

The Level Two assessment includes detailed assessments of the site allocations. These include:

- An assessment of the highest risk flooding mechanism and most likely flooding type for each site.
- An assessment of all sources of flooding including fluvial flooding, surface water flooding, groundwater flooding, reservoir flooding, mapping of the functional floodplain and the potential increase in fluvial and surface water flood risk due to climate change.
- An assessment of existing flood warning at the sites, including whether there is safe access and egress during an extreme event.
- Advice and recommendations on the likely suitability of Sustainable Drainage Systems (SuDS) for managing surface water runoff.

As part of the Level 2 SFRA, detailed site summary tables have been produced for the two allocated sites at Eynsham. To accompany each site summary table, there are a series of maps, containing all of the mapped flood risk outputs.

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Abbreviations and Definitions

Term	Definition
AAP	Area Action Plan
AEP	Annual Exceedance Probability
CC	Climate change - Long term variations in global temperature and weather patterns caused by natural and human actions.
CIRIA	Construction Industry Research and Information Association
Conveyance feature	A term used to describe a feature of a sustainable drainage system which is designed to convey (move) water through the system (e.g. a swale or rill)
Defra	Department for Environment, Food and Rural Affairs
EA	Environment Agency
Flood defence	Infrastructure used to protect an area against floods as floodwalls and embankments; they are designed to a specific standard of protection (design standard).
Flood Risk Area	An area determined as having a significant risk of flooding in accordance with guidance published by Defra and WAG (Welsh Assembly Government).
Fluvial Flooding	Flooding resulting from water levels exceeding the bank level of a main river
FRA	Flood Risk Assessment - A site specific assessment of all forms of flood risk to the site and the impact of development of the site to flood risk in the area.
Ha	Hectare
Infiltration feature	A term used to describe a feature of a sustainable drainage system which is designed to allow water to soak (infiltrate) into the ground (e.g. a soakaway or infiltration basin)
JBA	Jeremy Benn Associates
LLFA	Lead Local Flood Authority - Local Authority responsible for taking the lead on local flood risk management
LPA	Local Planning Authority
Main River	A watercourse shown as such on the Main River Map, and for which the Environment Agency has responsibilities and powers. However, the Environment Agency are not responsible for all maintenance on Main Rivers, as the Environment Agency have permissive powers, but the riparian owner has the responsibility.
NPPF	National Planning Policy Framework
Ordinary Watercourse	All watercourses that are not designated Main River. Local Authorities or, where they exist, IDBs have similar permissive powers as the Environment Agency in relation to flood defence work. However, the riparian owner has the responsibility of maintenance.

Term	Definition
PPG	National Planning Policy Guidance
Resilience Measures	Measures designed to reduce the impact of water that enters property and businesses; could include measures such as raising electrical appliances.
Return Period	Is an estimate of the interval of time between events of a certain intensity or size, in this instance it refers to flood events. It is a statistical measurement denoting the average recurrence interval over an extended period of time.
Residual risk	The risk that remains after measures have been taken to alleviate flooding.
Risk	In flood risk management, risk is defined as a product of the probability or likelihood of a flood occurring, and the consequence of the flood.
RoFfSW	Risk of Flooding from Surface Water map. Environment Agency national map showing risk of flooding from surface water.
Sewer flooding	Flooding caused by a blockage or overflowing in a sewer or urban drainage system.
SFRA	Strategic Flood Risk Assessment
SoP	Standard of Protection - Defences are provided to reduce the risk of flooding from a river and within the flood and defence field standards are usually described in terms of a flood event return period. For example, a flood embankment could be described as providing a 1 in 100-year standard of protection.
SDA	Strategic Development Area
SPZ	Source Protection Zone - The Environment Agency have defined Source Protection Zones (SPZs) for groundwater sources such as wells, boreholes and springs used for public drinking water supply. These zones show the risk of contamination from any activities that might cause pollution in the area. The closer the activity, the greater the risk. The maps show three main zones (inner, outer and total catchment) and a fourth zone of special interest, which is occasionally applied, to a groundwater source.
SuDS	Sustainable Drainage Systems - Methods of management practices and control structures that are designed to drain surface water in a more sustainable manner than some conventional techniques
SPD	Supplementary Planning Document
Surface water flooding	Flooding from surface water runoff as a result of high intensity rainfall when water is ponding or flowing over the ground surface before it enters the underground drainage network or watercourse, or cannot enter it because the network is full to capacity, thus causing what is known as pluvial flooding.
WFD	Water Framework Directive

1 Introduction

The West Oxfordshire Local Plan 2031, adopted in September 2018, includes two strategic allocations at Eynsham; land to the north of Eynsham which is allocated for about 2,200 homes and 40 hectares of business land in the form of a new Garden Village (Policy EW1) and land to the west of Eynsham which is allocated for about 1,000 homes as an urban extension (Policy EW2). To take the detailed planning of these sites forward, the Council is preparing an Area Action Plan (AAP) for the Garden Village and a Supplementary Planning Document (SPD) for West Eynsham.

As part of this process, the Council is preparing an evidence base which will support the policies and proposals set out in the AAP and SPD. This Level 2 Strategic Flood Risk Assessment (SFRA) is one piece of the evidence base.

The Level 2 SFRA will be used to inform decisions on the location of future development and the preparation of sustainable policies for the long-term management of flood risk from all sources. It will also be used to inform the determination of any planning applications that come forward in respect of the two Eynsham strategic sites.

1.1 SFRA Objectives

The [Planning Practice Guidance](#)¹ advocates a tiered approach to flood risk assessment and identifies two levels of SFRA:

- Level 1: where flooding is not a major issue and where development pressures are low. The assessment should be sufficiently detailed to allow application of the Sequential Test.
- Level 2: where land outside flood risk areas cannot appropriately accommodate all the necessary development. In these circumstances, the assessment should consider the detailed nature of the flood characteristics.

West Oxfordshire District Council has completed a Level 1 SFRA² which identified the potential need for a Level 2 SFRA if land outside flood risk areas cannot appropriately accommodate all necessary development (as is the case in West Oxfordshire). The objectives of this Level 2 SFRA are to consider the detailed nature of the flood characteristics within the two allocated sites at Eynsham, and for areas at risk from other sources of flooding.

1.2 How to use the Level 2 SFRA

The Level 2 SFRA report gives a short non-technical summary of how the allocated sites were selected, the detailed flood risk data that was used to carry out individual site-level assessments for each of the Level 2 sites, and how climate change, other sources of flooding and residual risk were assessed.

The main outputs of the Level 2 assessment are the individual site summary sheets, in Appendix A, which offer high level flood risk assessments and conclusions for each site.

1.3 Consultation

This document has been prepared with the guidance and input of the Environment Agency (EA) and Oxfordshire County Council.

¹ Ministry of Housing, Communities & Local Government (2014) Planning Practice Guidance - Flood risk and coastal change: Flood Strategic Flood Risk Assessment (Paragraph 009). Available at: <https://www.gov.uk/guidance/flood-risk-and-coastal-change#Strategic-Flood-Risk-Assessment-section>

² West Oxfordshire Council (2016) Strategic Flood Risk Assessment (Level 1). Available at: <https://www.westoxon.gov.uk/media/1572191/ENV9-West-Oxfordshire-District-Council-Strategic-Flood-Risk-Assessment-Update-Report-November-2016-.pdf>

2 How were sites identified for a Level 2 assessment?

The Level 1 SFRA for West Oxfordshire considered development suitability at a district-scale. The SFRA used the five sub-areas of the Local Plan 2031 which are based upon the landscape characteristics and areas which in key services and facilities are located:

- Witney Sub-Area
- Carterton Sub-Area
- Chipping Norton Sub-Area
- Eynsham – Woodstock Sub-Area
- Burford – Charlbury Sub-Area

The two sites considered as part of this Level 2 SFRA are located within the Eynsham – Woodstock Sub-Area.

The sites were allocated through main modifications to the Local Plan published by the District Council in November 2016. This was a response to an increase in the District's overall housing requirement as well as the need to make provision for a proportion of Oxford City's 'unmet' housing need. The merits of the two Eynsham site allocations were considered at examination through 2017/18 and the Local Plan was formally adopted in September 2018.

The Eynsham sites require a Level 2 SFRA as areas of both sites lie within Flood Zone 2 and 3.

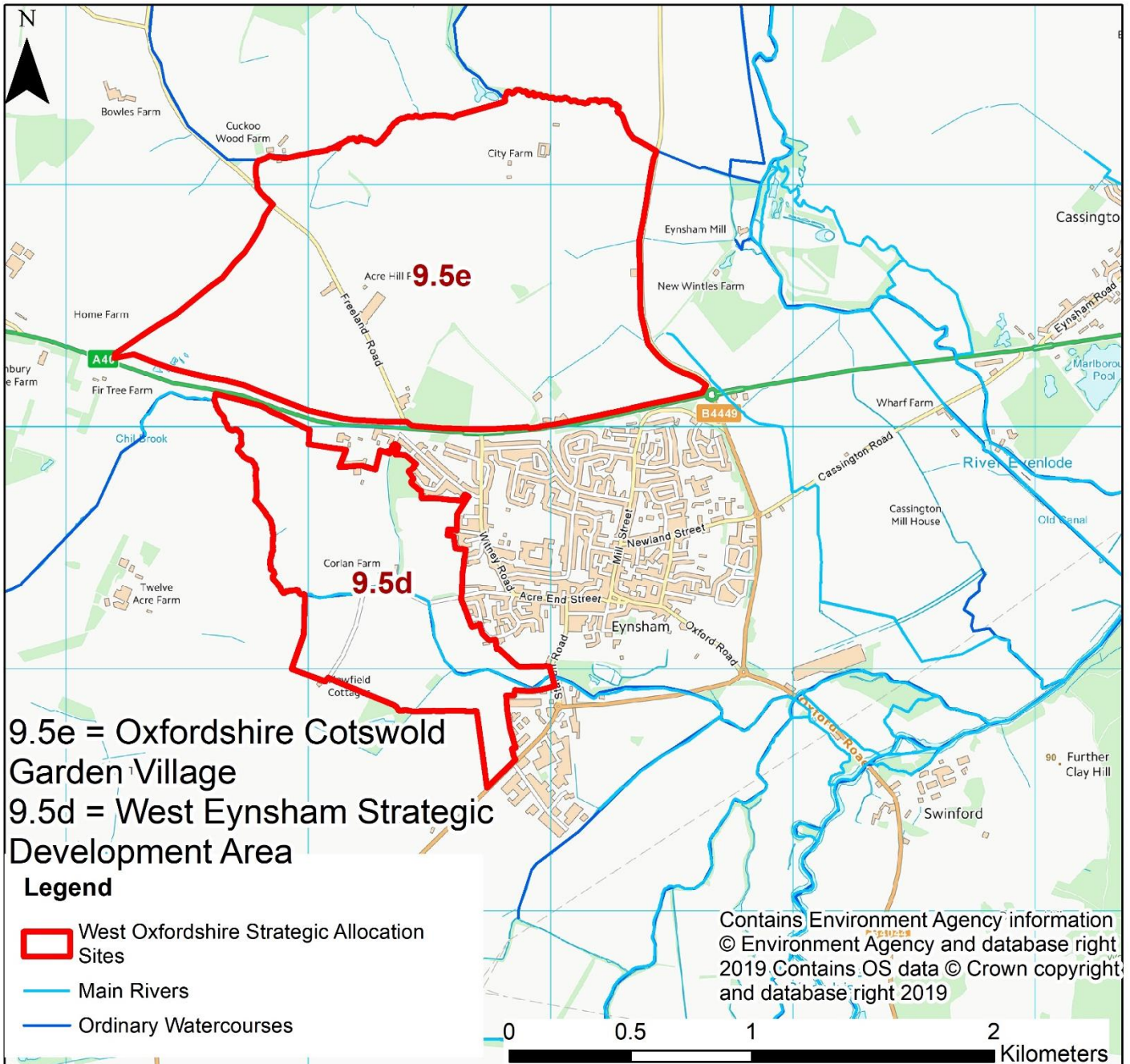


Figure 2-1: Sites assessed within Level 2 SFRA.

3 What flood risk information has been used?

3.1 Data sources

The Level 2 SFRA draws upon all the information and data sources that were compiled as part of the Level 1 assessment, examining them in more detail on a site-by-site basis. These sources include:

- EA Main Rivers GIS layer and OS OpenRivers GIS layer;
- EA Risk of Flooding from Surface Water Map (RoFfSW);
- EA detailed hydraulic models (summarised in Table 3-1);
- EA Recorded Flood Outline;
- EA Spatial Flood Defences layer;
- EA Risk of Flooding from Reservoirs map;
- West Oxfordshire District Council Parish flood defence updates (December 2015); and
- West Oxfordshire District Council consultation responses which referenced flooding in the area.

The latest available hydraulic models were requested from the EA, for use within the Level 2 SFRA. A summary of the available models which were used in the SFRA is provided in Table 3-1.

Table 3-1: List of hydraulic models used within the Level 2 SFRA.

Model	Provider	Type	Year	Used to create FZ3b?	Used to create FZ3a + CC?
Chil Brook to Eynsham	Environment Agency	ISIS-TUFLOW	2014	Yes – 20-year extent	Yes – 35% and 70% allowances

4 Implications for development and requirements for the Exception Test

4.1 Implications for Flood Zone 2 and 3 and the Exception Test

The NPPF sets out a Sequential Test to steer new development to areas with the lowest probability of flooding. This is initially based on the Flood Map for Planning (Rivers and Sea), as provided by the EA, but should be refined by the SFRA to take into account the probability of flooding, other sources of flooding and the impact of climate change.

Subject to consideration of the Sequential Test, the Exception Test will be required if built development is proposed in Flood Zone 2 or 3 and will be dependent upon the flood risk vulnerability of the proposed development. The classification of flood risk vulnerability for different types of development is defined in Table 2 (Paragraph 066) of the Planning Practice Guidance³, and also provided in Table 6-1 (p.21) of the West Oxfordshire Level 1 SFRA (2016)⁴. Detailed site-specific Flood Risk Assessments (FRAs) for development within the two allocated sites are required to enable a more detailed assessment, to appropriately define areas of flood risk from all sources, and to model the effect of climate change on flood risk.

Climate change assessments should be undertaken using the relevant allowances (February 2016) for the type of development and level of risk (see Section 5), in consultation with the EA where necessary. The requirements for FRAs are set out in the Level 1 SFRA⁴. Further detail is provided in this Level 2 SFRA on the relevant summary sheets in Appendix A.

Both the West Eynsham SDA and the Garden Village site contain areas within Flood Zones 2 and 3. Due to the large size of the two sites, and the significant area available within Flood Zone 1, the EA would expect the site layout to be designed sequentially and all development to be located within Flood Zone 1.

However, in the unlikely event that all development cannot be accommodated within areas of Flood Zone 1, the Exception Test will need to be applied should the following development vulnerability be proposed:

- If More Vulnerable and Essential Infrastructure is located in FZ3a.
- If Highly Vulnerable development is located in FZ2.
- If Essential Infrastructure is located in FZ3b.

Development will not be permitted in the following scenarios:

- Highly Vulnerable infrastructure within FZ3a and FZ3b. More Vulnerable and Less Vulnerable Infrastructure within FZ3b.

The site and building design will need to ensure that the developments are safe and resilient to the modelled flood risk, and any residual risk in defended areas.

A flood mitigation and adaptation approach is likely to be required. Development should be designed using a sequential approach, with built development / higher vulnerabilities located towards areas of lower risk and hazard.

Areas of the sites within the functional floodplain, Flood Zone 3b, and areas of higher hazard should be preserved for appropriate uses such as public open space or for essential

³ Ministry of Housing, Communities & Local Government (2014) Planning Practice Guidance - Flood risk and coastal change: Flood Zone and flood risk tables. Table 1 (Paragraph 066). Available at: <https://www.gov.uk/guidance/flood-risk-and-coastal-change#Table-2-Flood-Risk-Vulnerability-Classification>

⁴ West Oxfordshire Council (2016) Strategic Flood Risk Assessment (Level 1). Available at: <https://www.westoxon.gov.uk/media/1572191/ENV9-West-Oxfordshire-District-Council-Strategic-Flood-Risk-Assessment-Update-Report-November-2016-.pdf>

infrastructure (subject to the sequential and exception tests). This is particularly important for the West Eynsham SDA site, where the floodplain of the Chil Brook forms a large area at the centre of the site. Further detail is provided on the relevant summary sheets.

4.2 Implications of flooding from ordinary watercourses

Both sites contain several ordinary watercourses or land drainage features, which form tributaries to the Chil Brook and River Evenlode, respectively.

Flood Zones do not exist for these watercourses, and therefore the RoFfSW mapping has been used to represent their fluvial flood extents.

When applying the Sequential Test, this source of flooding should be taken into account, however a site will not require the Exception Test based on flood risk within Flood Zone 1 from ordinary watercourses alone. In the case of the two Eynsham sites, limited areas of the sites are at risk. As long as the sites are sequentially designed, it should not affect the viability of development, however the impact on developable area should be considered from an early stage.

FRAs for the two sites should involve consultation with Oxfordshire County Council as Lead Local Flood Authority (LLFA) and the EA to determine whether detailed modelling of any ordinary watercourses on the site should be carried out, in order to define the Flood Zones and model the effect of climate change in greater detail. The requirements for FRAs are set out in the Level 1 SFRA. Further detail is given on the relevant summary sheets at Appendix A.

4.3 Implications of surface water flooding

Both sites are over 1ha and therefore must carry out a FRA to assess all sources of flooding. They must also develop a drainage strategy, to manage surface water flood risk within the sites.

Surface water flood risk to the sites is low to medium, however at both sites greater than 10% of the area is at risk of surface water flood risk during a 1 in 1,000-year risk area.

At the detailed FRA stage, developers should consult Oxfordshire County Council (LLFA), to determine whether surface water modelling is required to define the impacts of development on surface water flood risk, including the effects of climate change.

Oxfordshire County Council local standards⁵, Defra National Standards⁶ and the CIRIA SuDS Manual (C753)⁷ require drainage designs to 'design for exceedance', by safely managing flows caused by blockages or from larger storms, in excess of a 1 in 100-year rainfall event. In addition, existing surface water flow routes should be accommodated within the site design. Building designs (threshold levels etc.) should ensure that development is safe from flooding.

As long as the sites are sequentially designed, surface water risk should not affect the viability of development, however the impact of surface water flow routes on developable area should be considered from an early stage. The requirements for surface water strategies and FRAs are set out in the Level 1 SFRA.

Further detail is provided on the relevant summary sheets in Appendix A. Early engagement with West Oxfordshire District Council and Oxfordshire County Council (LLFA) is advised for both sites.

⁵ Oxfordshire County Council (2018) Local Standards and Guidance for Surface Water Drainage on Major Development in Oxfordshire. Available at: <https://www.oxfordshirefloodtoolkit.com/wp-content/uploads/2018/12/LOCAL-STANDARDS-AND-GUIDANCE-FOR-SURFACE-WATER-DRAINAGE-ON-MAJOR-DEVELOPMENT-IN-OXFORDSHIRE.pdf>

⁶ Department for Environment, Food and Rural Affairs (2015) Sustainable Drainage Systems Non-statutory technical standards for sustainable drainage systems Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/415773/sustainable-drainage-technical-standards.pdf

⁷ CIRIA (2015) The SuDS Manual (C753). Available at: https://www.ciria.org/Resources/Free_publications/SuDS_manual_C753.aspx

4.4 Sites at risk of significant groundwater flooding

At both of the sites, greater than 25 - 35% of the site area is within Zones 3 or 4 of the JBA Groundwater Flood Map.

These categories are defined as:

- Zone 3 - Groundwater levels are predicted to be between 0.025m and 0.5m below the ground surface in a 1 in 100-year flood event. Within this zone there is a risk of groundwater flooding to surface and subsurface assets, and the possibility of groundwater emerging at the surface locally in a 1 in 100-year event.
- Zone 4 - Groundwater levels are predicted to be either at or very near (within 0.025m of) the ground surface in a 1 in 100-year flood event. Within this zone there is a risk of groundwater flooding to both surface and subsurface assets, and the potential for groundwater to emerge at significant rates in a 1 in 100-year event, with the capacity to flow overland or pond in low spots.

The risk is highest in the Garden Village site, where the eastern portion of the site is within Zone 4, however the northern and southern areas of the West Eynsham SDA site are also within Zones 3 and 4. These areas of higher groundwater flood risk correspond with surface deposits of sand and gravel, close to watercourses.

Groundwater may emerge at significant rates and has the capacity to flow overland and/or pond within any topographic low spots. These sites will still need to pass the Sequential Test, taking into account this non-fluvial source of flooding, but will not require the Exception Test on the basis of groundwater risk alone. Detailed FRAs at these sites should consider conducting further analysis of groundwater behaviours within the site, to define the level of flood risk. Oxfordshire County Council guidance⁸ requires the risk of high groundwater to be accounted for in the design of surface water drainage systems, with a clearance of 1.0m to be maintained above the recorded maximum groundwater level.

Site design, including any SuDS features, should be resilient to groundwater flooding and building design (such as threshold levels) should ensure the development is safe from flooding. Habitable basements are not recommended in areas of groundwater flood risk. Liaison with Oxfordshire County Council (LLFA) is advised for sites within Flood Zone 1 that contain significant groundwater flood risk.

4.5 Opportunities for flood betterment

These two major development sites offer real opportunities to provide flood betterment alongside sustainable development. Such opportunities should be discussed with the LLFA and EA as appropriate at an early planning stage.

These include:

- The developments should take the opportunity to implement exemplar SuDS design, delivering multiple benefits for the development (water quality, biodiversity, amenity, green infrastructure). There are particular opportunities to deliver SuDS with educational and recreational benefits including potentially in conjunction with the proposed primary school in the West Eynsham SDA site, and the business park in the Garden Village site.
- There are opportunities for developer contributions to support flood mitigation options under consideration by West Oxfordshire District Council, Oxfordshire

⁸ Oxfordshire County Council (2018) Local Standards and Guidance for Surface Water Drainage on Major Development in Oxfordshire. Available at: <https://www.oxfordshirefloodtoolkit.com/wp-content/uploads/2018/12/LOCAL-STANDARDS-AND-GUIDANCE-FOR-SURFACE-WATER-DRAINAGE-ON-MAJOR-DEVELOPMENT-IN-OXFORDSHIRE.pdf>

County Council, Thames Water and the EA, for example, the Natural Flood Management (NFM) initiatives currently being implemented by the River Evenlode Catchment Partnership⁹.

- Consultation should be undertaken with Thames Water, as sewerage undertaker, and Oxfordshire County Council, as Highway Authority, and opportunities taken to increase the capacity of the sewer network and highway drainage system in Eynsham.
- Improvements to the capacity of bridges crossing the Chil Brook on Chilbridge Road and Station Road in the West Eynsham SDA site, as well as the three culverts which pass beneath Lower Road in the Garden Village site, will reduce the residual flood risks to the sites associated with blockages.
- All existing watercourses on the sites should remain as open channels, and the EA and e a presumption against the culverting of watercourses. In addition, any other structures encountered on the site which may restrict flow of water should be removed, to allow better management of flood risk, provide amenity space and improve habitats.
- Any proposed river crossings on the sites must ensure they are clear span in design and allow sufficient clearance of flood flows, to prevent future risk of blockage and backing up.
- Opportunities for mitigation of surface water flow routes to improve flood risk on adjoining land – particularly to public buildings, such as the proposed schools in both sites.

⁹ Wild Oxfordshire (2019) Evenlode Catchment Partnership. Available at: <https://www.wildoxfordshire.org.uk/biodiversity/river-catchments/evenlode-catchment/>

5 How has climate change been assessed?

5.1 Fluvial flooding

The EA published updated climate change guidance on 19 February 2016¹⁰, which must be considered in all new developments and planning applications.

The guidance for peak river flows provides a range of climate change allowances which are dependent on location (by river basin) and timescale of development (epoch). It also provides several bands (termed 'central', 'higher central' and 'upper end') to test, depending on the vulnerability of the development and the Flood Zone within which it is located. The various vulnerabilities of development types to flood risk are in Table 2 (Paragraph 066) of the Planning Practice Guidance¹¹, and also provided in Table 6-1 (p.21) of the West Oxfordshire Level 1 SFRA (2016)³.

West Oxfordshire is within 'Thames' river basin district, for which climate change allowances under the guidance are shown in Table 5-1.

Table 5-1: Peak river flow climate change allowances for the Thames River Basin

River basin district	Allowance category	Total potential change anticipated for the '2020s' (2015 to 2039)	Total potential change anticipated for the '2050s' (2040 to 2069)	Total potential change anticipated for the '2080s' (2070 to 2115)
Thames	Upper end	25%	35%	70%
	Higher central	15%	25%	35%
	Central	10%	15%	25%

For the purposes of strategic planning, the key epoch to consider is 2070-2115 as this reflects the lifetime of residential development. The Planning Practice Guidance flood risk vulnerability of focus is 'more vulnerable' as this represents a conservative classification incorporating all vulnerabilities. Therefore, the significant allowances to consider for Flood Zone 3a are the higher central and upper end (35% and 70% in Thames river basin district) as shown in Table 5-1. These allowances have been used to assess the impacts of climate change on the Chil Brook.

On ordinary watercourses, where there was no coverage of Flood Zones or detailed hydraulic models, it was agreed with the EA that the Risk of Flooding from Surface Water map could be used as a proxy for fluvial flood risk. Here, the 1 in 1,000-year surface water flood extent event was used to represent Flood Zone 2, and the 1 in 100-year flood extent used to represent Flood Zone 3 and the 1 in 30-year extent used to represent Flood Zone 3b.

5.2 Surface water flooding

Climate change is predicted to increase rainfall intensity in the future by a range of between 20% and 40% (the recommended national precautionary sensitivity range for 2085 to 2115) as shown in Table 5-2. This will increase the likelihood, frequency and extent of surface water flooding.

¹⁰ Environment Agency (2016) Flood risk assessments: climate change allowances. Available at: <https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances>.

¹¹ Ministry of Housing, Communities & Local Government (2014) Planning Practice Guidance - Flood risk and coastal change: Flood Zone and flood risk tables. Table 1 (Paragraph 066). Available at: <https://www.gov.uk/guidance/flood-risk-and-coastal-change#Table-2-Flood-Risk-Vulnerability-Classification>

Table 5-2: Peak rainfall intensity allowance in small and urban catchments

Applies across all of England	Total potential change anticipated for 2010 to 2039	Total potential change anticipated for 2040 to 2059	Total potential change anticipated for 2060 to 2115
Upper end	10%	20%	40%
Central	5%	10%	20%

The Level 2 assessment of present-day surface water flood risk is based on the EA Risk of Flooding from Surface Water (RoFfSW) map. The RoFfSW 1 in 1,000-year flood extent has been used as a proxy to represent the impact of climate change on the 1 in 100-year event.

There are no changes to the surface water climate change information used within the Level 1 SFRA.

5.3 Groundwater flooding

The effect of climate change on groundwater flooding, and those watercourses where groundwater has a large influence on winter flood flows is more uncertain, and it is not possible to quantitatively assess this for an SFRA.

Generally, research suggests that milder wetter winters may increase the frequency of groundwater flooding incidents in areas that are already susceptible, but warmer drier summers may counteract this effect by drawing down groundwater levels to a greater extent during the summer months.

6 How has residual flood risk been assessed?

'Residual risk' refers to the risks that remain in circumstances after measures have been taken to alleviate flooding. It is important that these risks are quantified to confirm that the consequences can be safely managed.

6.1 Flood defence failure and overtopping

The influence of defences on residual flood risk has been assessed using the following information:

- EA Spatial Flood Defences dataset.
- EA Areas Benefitting from Defences dataset.
- Details of defences provided in the EA Chil Brook mode and accompanying report.
- West Oxfordshire District Council Parish flood defence updates (December 2015).

The Garden Village site contains no existing flood defences and therefore is not at risk from defence failure or overtopping.

The south east corner of West Eynsham SDA site is defended by a small flood alleviation bund. A short section of wall located along the Chil Brook, adjacent to Corlan Farm, also provides an informal defence for the farm property.

The overtopping of these defences would result in flooding of areas which they were designed to protect and so the associated properties may not be prepared for this event. In the case of the flood alleviation bund on the West Eynsham SDA site, the defence and its impacts on flood risk in the event of failure have been modelled as part of the EA 2014 Chil Brook study (Post 2007 ABD – Chil Brook)¹².

Further details of the extent of residual risk for each site are provided in Appendix A.

6.2 Structure blockage

Culverts and structures susceptible to blockage, located within or close to the allocated sites, were identified using OS mapping, available hydraulic models and site observations.

Structures have been identified within and along the boundaries of both sites, as shown in Figure 6-1.

In the West Eynsham SDA site, a series of bridges cross the Chil Brook, notably at Chilbridge Road in the centre of the site, and at Station Road in the south east corner of the site. These structures had been previously surveyed and used to inform the EA Chil Brook modelling study, which has been assessed within this Level 2 SFRA.

As part of the Level 2 SFRA, the Chil Brook model has been re-run for 50% and 95% blockage scenarios, to assess the impact of bridge blockage to flood risk on the West Eynsham SDA site. A summary of the scenarios, and results, are provided in Table 6-1.

¹² Environment Agency (2014) Model Operation Manual: Post 2007 ABD – Chil Brook. Available on request.

Figure 6-1: Overview of assets and structures within the sites.

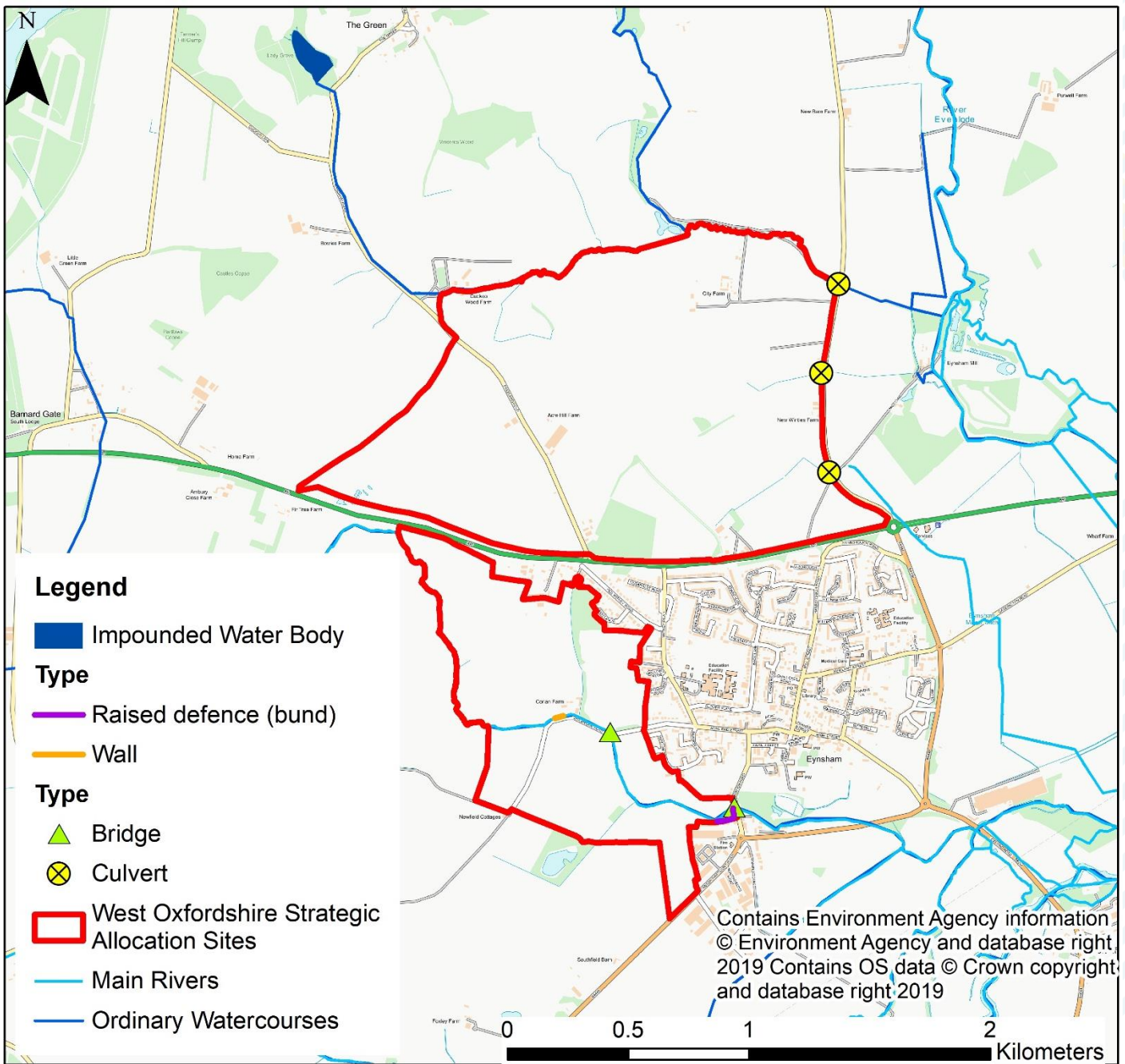


Table 6-1: Summary of structures modelled as part of Level 2 SFRA.

Site	Watercourse	Structure	% blockage modelled	Results (1 in 100-year + blockage)
West Eynsham SDA	Chil Brook	Bridge at Chilbridge Road	50% 95%	Localised increase in the 1 in 100-year flood extent between Corlan Farm and Merton Court. Relatively small increase in flood extent for both blockage events, as river flows overtop the bridge even in a blockage-free 1 in 100-year flood event. Flooding remains less than the extent of Flood Zone 2.
		Bridge at Station Road	50% 95%	Significant increase in the 1 in 100-year flood extent between Merton Court and Station Road for both blockage events. During the 95% blockage event, river flows overtop the bridge and flood Station Road. This would cause access issues, particularly for the nearby Fire Station. Flooding extent remains within the extent of Flood Zone 2.

Within the Garden Village site, three unnamed ordinary watercourses are culverted under Lower Road, at the eastern border of the site. As a detailed hydraulic model was not available for these watercourses, a higher-level assessment was carried out using LIDAR data, to determine:

- The size of the culvert, whether it presents a barrier to flow in the event of a blockage, or whether the structure could be by-passed in the event of a blockage.
- The likely impact on the flood risk area within the site, considering the topography. As flow through culverts in the east of the site does not appear to be represented in RoFfSW data, the flood outlines provide a proxy for flood risk extent in the event of a culvert blockage, as the flood extents do not take their capacity into account.

A description of the findings is included in the site summary sheets in Appendix A.

6.3 Impounded waterbody failure

Maintenance of reservoirs should ensure that failure does not occur. Risk can increase in a storm event, increasing pressure on the asset, if the structure is not maintained correctly. Reservoirs provide large residual risk as the volume of flood water could be significantly high impacting on a large area.

The impact of breach from large raised reservoirs holding more than 25,000m³ of water was assessed using the EA's Reservoir Flood Map Maximum Flood Outline. Where smaller lakes were present, the residual impact was assessed by looking at the topography and likely routing of flood flows, if the water feature were to breach or overtop.

At the West Eynsham SDA site, a residual risk of reservoir flooding is present from Scott's House Lake, which lies north-west of the site. There is a risk to the Garden Village site from Lady Grove Lake, located north west of the site, on Wroslyn Road. In addition, the modelled reservoir flood extent from Blenheim Lake is within 30m of the site.

Following consultation with the EA, it was recommended that a high-level assessment of reservoir flood risk to the Garden Village site from Lady Grove Lake was carried out. Details and results of the assessment are provided in Appendix C.

Appendix A contains further details on the extent of residual risk at each site.

7 How has the cumulative impact of development been assessed?

The requirement to consider the cumulative impact of development was introduced into the NPPF in 2018. When allocating land for development, consideration should be given to the potential cumulative impact on flood risk within a catchment. Development increases the impermeable area within a catchment, which if not properly managed, can cause loss of floodplain storage, increased volumes and velocities of surface water runoff, and result in heightened downstream flood risk. Whilst individual developments designed to current guidelines should only have a minimal impact on the hydrology and flood risk of an area, the cumulative effect of multiple developments may be more severe.

In considering the potential cumulative impact of the Level 2 sites, the Water Framework Directive (WFD) catchment areas (Figure 7-1) have been used to determine how many potential development sites (including the two strategic allocation sites at Eynsham, and other sites allocated within the Local Plan 2031) fall within the same hydrological catchment and the percentage of catchment land area which they cover.

A measure of the potential for cumulative impact within a catchment has been determined using the percentage of land area of the catchment covered by potential development alongside the flood risk to properties within each catchment (Table 7-1). To represent the impact of flood risk on property, the catchments have been ranked based on the number of postcode points located within a combined area of fluvial and surface water flood risk.

Table 7-1: Risk matrix scoring of cumulative impacts within the Level 2 SFRA.

	Cumulative Impact Score 1 - % code points within combined fluvial and pluvial flood risk extent - 100yrs	Cumulative Impact Score 2 - % code points within combined RoFSW1000 + FZ3+35CC	Cumulative Impact Score 3 - % code points within Historic Flood Map	Cumulative Impact Score 4 - Development Pressure as % of total catchment
Low	<1%	<1%	<1%	<1%
Medium	1 – 5%	1 – 5%	1 – 5%	1 – 5%
High	>5%	>5%	>5%	>5%

For each WFD catchment within Eynsham, the susceptibility of the catchments to increased flows was examined. Due to the large size of the catchments and the relatively rural nature of their floodplains, the cumulative impacts of development on the catchments themselves was low to medium (Table 7-2). The Thames (Evenlode to Thame) catchment was identified as having the marginally highest sensitivity to the cumulative impacts of development.

However, both of the proposed strategic allocation sites are located immediately upstream of Eynsham, a village at the confluence of the River Thames, Chil Brook and River Evenlode, which was affected by significant flooding during the Summer 2007 flood event. Therefore, the immediate downstream susceptibility to negative cumulative impacts of development is relatively high.

Ultimately the whole of Eynsham drains to the River Thames, which has a high level of flood risk to properties and communities. However, as it is a very large catchment, the relative impact on total flows, from an increase in flows on tributaries, is reduced.

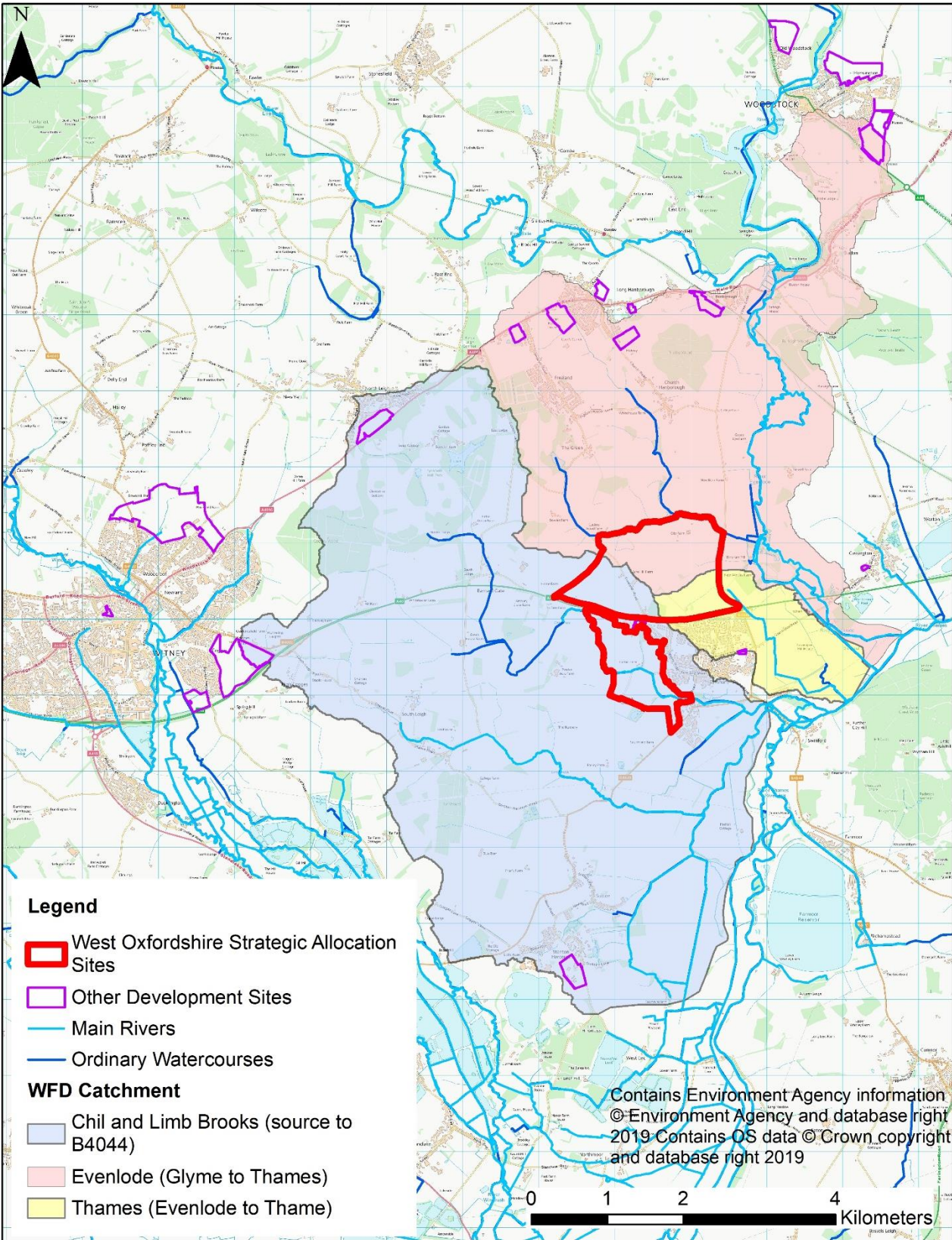
To avoid negative cumulative impact of development on flood risk within Eynsham and the wider Thames catchment, development of the two sites should be limited to discharge rates and volumes of greenfield rates or lower. Development of the sites should also look at opportunities to contribute towards further Natural Flood Management measures in the upper River Evenlode

and Chil Brook catchments, to help to reduce and delay the peak flows which arrive in Eynsham village.

Table 7-2: Sensitivity of catchments surrounding Eynsham to cumulative impacts of development on flood risk

WFD Catchment	Sensitivity to Cumulative Impacts
Evenlode (Glyme to Thames)	Medium
Chil and Limb Brooks (Source to B4044)	Low
Thames (Evenlode to Thame)	Medium

Figure 7-1: WFD catchments covering the Eynsham study area.



8 Level 2 flood risk summaries

8.1 Site level assessments

The flood risk summary sheets and maps in Appendix A give flood risk information for both of the allocated sites at Eynsham to support the application of the Sequential Test and inform the Council whether the Exception Test would be required.

These include:

- Basic site information (area, type of site, % of site in each Flood Zone).
- Description of sources and mechanisms of flooding.
- Flood Zone (1% and 0.1% annual probability events) and functional floodplain extent maps, flood hazard map, flood depth map, flood velocity map, climate change impact maps. Where a site is not covered by detailed modelling, information on flood hazard, depth and velocity will not be available.
- Information on rate of onset and duration of flooding.
- Assessment of flood defences.
- A high-level assessment of how the sites might be affected during events where there is failure of flood risk management measures (breach or failure), or they are overwhelmed by events that exceed their envisaged design capacity (overtopping).
- An assessment of flood warning coverage.
- An assessment of emergency planning procedures and how safe access and egress will be managed.
- An assessment of the effect of land use and structures on flood risk both within the potential local plan site and for other development nearby.
- Recommendations on the requirements for drainage control and impact mitigation, including an assessment of likely SuDS suitability and flood betterment opportunities.
- Site-specific development management advice (including for example sequential site design, access and egress, requirements for SuDS, recommendations for drainage control and impact mitigation)
- Information on the requirements for the Exception Test, Flood Risk Assessments (FRAs) and site design.

These summary sheets and maps form the main output of the Level 2 SFRA.

9 Future use of SFRA data

The Level 2 SFRA has examined flood risk from all sources for the two strategic allocations in Eynsham. The aim of the Level 2 assessment is to provide evidence to support a decision on whether or not the Sequential (and Exception Test if appropriate) could be passed (i.e. development could be achieved safely) for sites that have been found to be at flood risk by the Level 1 assessment.

If the Council finds the two sites to pass the Sequential Test (and Exception test if appropriate), detailed FRAs will be required on both sites, to ensure that they are designed safely. The Level 2 SFRA has provided thorough recommendations on site specific requirements to be addressed by FRAs, guidance for site design and making development safe from flooding, and requirements for SuDS and surface water management.

It is important to recognise that the SFRA has been developed using the best available information at the time of preparation. This relates both to the current risk of flooding from rivers, and the potential impacts of future climate change. Developers must ensure that they obtain and use the most up to date model data for detailed site-specific FRAs.

The SFRA should be periodically updated as appropriate when new information on flood risk, flood warning or new planning guidance or legislation becomes available. New information on flood risk may be provided by Oxfordshire County Council (in its role as LLFA), Thames Water, the EA or other relevant stakeholders such as Parish Councils. A further reason for updating the SFRA would be following the identification of any further planned growth through a subsequent review of the Local Plan for example.

Appendices

A Level 2 Site Summary Sheets

Level 2 SFRA Detailed Site Summary Tables



Site details	Site Name	Land north of A40, Eynsham (Oxfordshire Cotswolds Garden Village)
	Site Code	9.5e
	Area	215.1Ha
	Current land use	<ul style="list-style-type: none"> The current land use is primarily agriculture. Bordering the fields are developed hedgerows and treelines with watercourses, as well as public rights of way. The small areas of existing development are predominantly farm buildings, several of which are listed buildings. In the south, a commercial development provides a service area for the A40. Also, in the south, there is an area of community woodland owned by the Woodland Trust. A well-developed aggregate recycling centre exists in the south, which has planning permission for waste management use in perpetuity.
	Proposed site use	<ul style="list-style-type: none"> The site consists of a proposed Garden Village which will contribute to the delivery of 100,000 homes across Oxfordshire by 2031. An initial estimate suggests that the site will provide about 2,200 homes. The site also has potential to provide a new 'science park' comprising of B-class business and commerce buildings. As a garden village, the site also aims to incorporate extensive green infrastructure throughout.
Environmental Descriptors	Bedrock Geology	<ul style="list-style-type: none"> The majority of the site is underlain by clay (Oxford Clay Formation and West Walton Formation). A band of sandstone and siltstone (Kellaways Sand Member) runs along the northern and eastern boundary. A small area of Kellaways Clay Member is also present in the north east.
	Superficial Geology	<ul style="list-style-type: none"> Approximately half of the site is overlain by surface geology deposits. The majority are sands and gravels (Summertown-Radley Member). In the east there is a small area of river deposits (alluvium) comprising of clay, silt, sand and gravel.
	Soil Type	<ul style="list-style-type: none"> Soils in the western half of the site are slowly permeable, seasonally wet and slightly acid, with loamy and clayey soils. The east of the site is freely draining, with lime-rich loamy soils. Along the eastern boundary there is a small area of loamy soil with naturally high groundwater.
	Typical Slope	<ul style="list-style-type: none"> The site has a slope of approximately 3%, towards the lowest point at around 64mAOD, in the east of the site. The highest point is at the centre of the site, measuring approximately 85mAOD.
	Groundwater Source Protection Zone	The site is not within a Groundwater Source Protection Zone.

	Ecology and Biodiversity	<ul style="list-style-type: none"> The site is not listed within any nationally protected areas. However, as the current land use is well-developed farmland with hedgerows and trees, there are still likely to be well-established habitats and species present. Within the site there are two Local Wildlife Sites (City Farm and South Freeland Meadows) recognised as of value in supporting local biodiversity. Beyond the site boundary, Castles Copse (~800m north west of the site) and Vincents Wood (~500m north west of the site) are both areas of ancient woodland. Oxford Meadows, a Special Area of Conservation (SAC), is located approximately 4km east of the site boundary. Future development of the Garden Village should consider the impacts of any development upon this site. 			
	Historic Landfill Site	<ul style="list-style-type: none"> The two industrial landfill sites of New Wintles Farm and City Farm are located within the site. 			
Flood risk and drainage	Watercourses	<ul style="list-style-type: none"> There are no Main Rivers within the site boundary. An unnamed watercourse (OW1) forms the northern boundary of the site, and flows eastwards into the River Evenlode. The River Evenlode is located approximately 500m east of the site, (Main River) and flows southwards to join the River Thames at Eynsham. Eynsham Mead Ditch (Main River), which forms another tributary to the River Thames, is located within 40m of the south-eastern corner of the site. 			
	Existing drainage features	<ul style="list-style-type: none"> Within the site, there are several smaller ordinary watercourses which appear to be artificial and provide a land drainage function. One drain joins OW1 at the northern boundary, east of Cuckoo Wood Farm. Two further drains for in to the north and south of New Wintles Farm, and flow in an easterly direction below Lower Road, to join Eynsham Mead Ditch and the River Evenlode. In the south west corner of the site, there is a group of small of ponds, which may retain some water generated within the site. A larger pond is also present upstream of the northern site boundary, which may provide some detention of overland and river flows upstream of the site. 			
	Flood history	<ul style="list-style-type: none"> The site has little recorded data concerning flood history, with the EA Historical Flood Map showing that only 0.5% of the site has experienced flooding. This area of recorded flooding is along the eastern boundary where a drain is culverted below Lower Road. However, lack of formal flood history evidence in rural areas is often due to the under reporting of flooding, rather than its lack of occurrence. A site visit attended by Oxfordshire County Council identified that the northern boundary watercourse (OW1) has a flashy response due to its clay catchment, and floods regularly. Consultation responses to the issues paper also highlighted flooding associated with the site including: <ol style="list-style-type: none"> Lower Road Cuckoo Lane Northern part of the site (potentially the area mapped as Flood Zone 3) Several other consultation responses noted that flooding occurs across the site. However, the exact location of this flooding is not specified. 			
	Fluvial	Proportion of site at risk			
	Flood Zone 3b	Flood Zone 3a	Flood Zone 2	Flood Zone 1	
	2%	2%	4%	97%	

		The majority of the site is within Flood Zone 1 and so considered at a low fluvial flood risk. Along the boundary of the north-western corner, a small area of the site is within Flood Zone 3a. Where there is no coverage of Flood Zones 2 and 3 on the northern watercourse, the Risk of Flooding from Surface Water mapping has been used as a proxy.		
	Surface Water	Proportion of site at risk (RoFSW)		
		1 in 30-year	1 in 100-year	1 in 1,000-year
		4%	6%	14%
		<ul style="list-style-type: none"> • Surface water flood extents are shown in Appendix B. • There is a high-risk surface water flow path along the northern boundary of the site, collecting flow from the west and north, which is associated with unnamed Ordinary Watercourse 1 (OW1). Another flow path flows eastwards from the centre of the site. • East of the site, both flow paths join the fluvial floodplain and pond against Lower Road in the 1 in 30-year event and higher return periods. • In the south west corner of the site, a flow path forms between the 1 in 100 and in the 1 in 1,000-year rainfall event, flowing south towards Chil Brook. • Adjacent to Cuckoo Lane in the south west of the site, an additional flow path forms and flows southwards into Chil Brook, occurring in the 1 in 30-year event and greater return periods. • There are several other smaller flow paths across the site, as well as areas of ponding which occur within natural low points in the topography. • Changes in ground levels during future development of the site, are likely to influence these flow paths and areas of ponding. 		
	Groundwater	Proportion of site at risk in JBA Groundwater Map 1 in 100-year risk categories		
Depth below surface 0-0.025m		Depth below surface 0.025 to 0.5m	Total in highest risk categories	
16%		8%	24%	
<ul style="list-style-type: none"> • The east of the site is at a high groundwater flood risk. The band of high risk forms a north-south alignment within and adjacent to, the eastern boundary of the site. These areas correlate with sand and gravel superficial deposits. • There is also an isolated area of medium to high groundwater flood risk near the centre of the site. • All other areas have negligible flood risk. 				
Reservoir	<ul style="list-style-type: none"> • Risk of flooding from reservoirs has a much lower probability of occurrence than other flood risks. • Beyond the site, there is a small area of reservoir flood risk associated with potential flooding from Scott's House Lake immediately south west of the site. • To the east, the reservoir flood extent from Blenheim Lake is located within 30m of the site boundary. • Although not of sufficient size to be designated a reservoir, the lake at Lady Grove (north west of the site) provides a residual flood risk (detailed further in <i>Residual Risk</i> section). 			
Sewer incidents	The study area is within the Eynsham Woodstock Sub-Area. Thames Water sewer flooding data identifies that 12 properties within this area have experienced between 1 and 5 sewer flooding incidents within the last 20 years.			
Defences	There are no known defences within this site.			

Flood risk management infrastructure	Residual Risk	Culvert/ structure blockage?	<ul style="list-style-type: none"> • The site is bounded by Lower Road, Cuckoo Lane and the A40. • The passage of watercourses beneath these roads creates an inherent residual risk of flooding due to the blockage and backing up of culverted watercourses below the roads. • Along the eastern boundary, there are three culverts: the first on the unnamed Evenlode tributary (OW1), and two on the unnamed ordinary watercourses north and south of New Wintles Farm. • The unnamed watercourse along the northern boundary of the site is also culverted beneath small track roads. • As flow through ordinary watercourse culverts in the east of the site does not appear to be represented in RoFfSW data, the flood outlines provide a proxy for flood risk extent in the event of a culvert blockage. • If culverts became blocked, RoFfSW data suggests that flows would back up behind Lower Road, causing areas of ponding at the eastern boundary of the site, from City Farm, to south of New Wintles Farm, during a 1 in 30-year and greater events.
		Impounded water body failure?	<ul style="list-style-type: none"> • Although not classified as a reservoir, the lake at Lady Grove (north-west of the site) is an impounded water body which poses a residual flood risk to the site. The potential impacts of a breach event on Lady Grove Lake are assessed in Appendix C. • Immediately south west of the site, there is a residual risk of flooding caused by failure of Scott's House Lake. • This flood extent partially encroaches on the southern boundary, but also affects the A40, which may have implications for site access. • Access from the eastern side of the site would be affected by failure of Blenheim Lake.
		Defence breach/over topping?	Breach Zone
Emergency planning and flood mitigation	Flood warning and Alerts	<ul style="list-style-type: none"> • The north-eastern corner of the site, as well as a small area on the eastern boundary, are included within a Flood Alert Area (River Evenlode from Moreton in Marsh to Cassington and also the River Glyme at Wootton and Woodstock). • The eastern boundary of the site is also within a Flood Warning Area (River Evenlode at Eynsham Mill down to and including Cassington Mill near Cassington). • Environment Agency flood warnings are issued to individuals via the Flood Information Service. 	

	Access and egress	<ul style="list-style-type: none"> • There are currently no proposed new access routes for the site. However, two new roundabouts are likely to be installed along the A40, providing access to both the Garden Village and West Eynsham SDA sites. • As the exact location of these roundabouts is unclear, the flood risks to the wider A40 in this location has been considered. • At the western site boundary, the A40 is intersected by Flood Zone 2. Localised areas of the road are also affected by surface water flooding, predominantly in the 1 in 1,000-year event. • A surface water flow path is also present across the A40 adjacent to the junction with Cuckoo Lane, during the 1 in 30-year and greater rainfall events. Cuckoo Lane, which may provide access to the west of the site, is reported to flood during heavy rain (according to consultation responses). • Improvement to the roundabout junction between the A40 and Lower Road is also proposed. This roundabout is affected by surface water in all return periods, with consultation responses specifying that Lower Road is often subject to surface water flooding in the event of heavy rain. 		
Climate Change	Climate change allowances for '2080s'	River Basin	Higher Central	Upper End
		Thames Basin	35%	70%
	% increase in flood extent compared to Flood Zone 3a	1% (Flood Zone 2)		
	Impact of climate change on fluvial flooding and the Flood Zone classification	The impacts of climate change on the site are likely to remain within the existing extent of Flood Zone 2 (or 1 in 1,000-year surface water flood extent where not available).		
	Impact of climate change on flood risk from other sources	Climate change is predicted to increase rainfall intensity in the future by a range of between 20% and 40% (the recommended national precautionary sensitive range for 2085 to 2115). This will increase the likelihood, frequency and extent of surface water flooding. The effect of climate change on groundwater flooding, and those watercourses where groundwater has a large influence on winter flood flows is more uncertain. Milder wetter winters may increase the frequency of groundwater flooding incidents in areas that are already susceptible, but warmer drier summers may counteract this effect by drawing down groundwater levels to a greater extent during the summer months.		

<p>Requirements for drainage control and impact mitigation</p>	<p>Broad scale assessment of possible SuDS</p>	<ul style="list-style-type: none"> • The scale of the proposed site, and integration of residential and employment space, allows for the implementation of exemplar SuDS, offering multiple benefits. • The natural environment is integral to the site, and sensitively landscaped SuDS should be implemented to enhance this. Storage and conveyance of surface water should be within above-ground, 'natural' SuDS features wherever possible, such as ponds, swales and basins. These should be incorporated into public open spaces, to provide amenity and biodiversity benefits. • As Eynsham is an area of water stress, buildings within the site should utilise opportunities for water efficiency and re-use, for example through the use of rainwater harvesting and green roofs. • Opportunities should be taken to promote education of water resources and sustainability, within the planned science park area of the development. Visible, well-signed SuDS features should be designed. To promote community stewardship, engagement with local residents and groups should be sought on designs, where possible. • The site geology is a key consideration in the design and location of SuDS features. The naturally low permeability of the clay geology will potentially limit the infiltration permeability. However, across the site there are superficial geological deposits which may allow shallow infiltration. • It should be noted that alluvial deposits can be subject to elevated groundwater levels, and so infiltration tests should be undertaken to assess the suitability in the design of SuDS features. SuDS used for the purpose of attenuation in these areas, may require lining to prevent ingress of groundwater, and loss of storage capacity. • SuDS should be designed to accommodate existing areas of fluvial and surface water flood risk. Drainage features in the north east of the site should be designed to remain resilient to fluvial flooding, with suitable drain down times and minimal raised features. • Due to the presence of two historic landfill sites, water quality should be a consideration when designing SuDS. The SuDS management train should be followed, and drainage components may need to be lined, to prevent leaching of pollutants into soils and watercourses.
<p>NPPF and planning implications</p>	<p>Exception Test requirements</p>	<p>The Sequential Test must be passed. Only once the Sequential Test is passed should the Exception Test be applied. It is expected that all built development will be sequentially located within Flood Zone 1, but the Exception Test would be required:</p> <ul style="list-style-type: none"> • If More Vulnerable and Essential Infrastructure is located in Flood Zone 3a. • If Highly Vulnerable development is located in Flood Zone 2 or Flood Zone 3a plus climate change. • If Essential Infrastructure is located in Flood Zone 3b <p>Development will not be permitted in the following scenarios:</p> <ul style="list-style-type: none"> • Highly Vulnerable development within Flood Zone 3a or Flood Zone 3a plus climate change and Flood Zone 3b. • More Vulnerable and Less Vulnerable development within Flood Zone 3b.

	<p>Requirements and guidance for site-specific Flood Risk Assessment</p>	<p>Flood risk assessment:</p> <ul style="list-style-type: none"> • At the planning application stage, a site-specific flood risk assessment will be required, in line with government guidance (https://www.gov.uk/guidance/flood-risk-assessment-for-planning-applications). • All sources of flooding, particularly the risk of fluvial, surface water flooding, groundwater flooding, and the interaction between them should be considered as part of a site-specific flood risk assessment. • Consultation with OCC, the Lead Local Flood Authority, should be undertaken at an early stage and the Environment Agency should be consulted on fluvial flood risk to the site. • OCC, as the Highways Authority, should be consulted on any proposed connections into the highway drainage network, and existing capacity and flood risk issues discussed. The impact of the development on any existing sewer flooding issues in Eynsham should be discussed with Thames Water at an early stage (including proximity to the existing sewage treatment works). • Detailed modelling, for a range of return periods including climate change, is required for the watercourse along the northern boundary. It should also be noted that the current Flood Zones covering for the lower reach of this watercourse are based upon National Generalised Modelling and so do not provide adequate detail for a detailed FRA. • Detailed surface water modelling should be undertaken to better understand baseline and post-development surface water risk flowing into the site, on site and downstream. • Culverts beneath roads on the eastern and northern boundary of the site present a residual flood risk, due to potential blockage. Therefore, the option of improving the capacity of these culverts should be considered, in consultation with OCC and WODC, alongside modelling the impact of blockage upon flood risk. • No reservoir flood extents currently exist for Lady Grove Lake, at the north west of the site. A high-level breach assessment has been undertaken as part of this SFRA (see Appendix C). However, an investigation should be taken to understand whether an emergency plan has been put in place for a situation whereby this lake overtops, putting downstream areas at increased risk. Access and egress from the site should consider the risk of flooding from this impounded water body. • Climate change for all sources should be assessed using recommended climate change allowances at the time of the assessment (https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances) for the type of development and level of risk. The current allowances were published in February 2016 but may be subject to change in the future.
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Guidance for site design and making development safe from flooding

Guidance for site design and making development safe:

- The development should be designed using a sequential approach. Development should be steered away from surface water flow routes, preserving these areas as green infrastructure.
- Development must seek opportunities to reduce overall level of flood risk at the site.
- All development should integrate source control SuDS techniques to reduce the risk of flooding due to post-development runoff. This aim extends to reducing runoff rates to greenfield levels or lower.
- SuDS design should follow current best practice (CIRIA Manual 2015) and OCC guidance on runoff rates and volumes, to deliver multiple benefits including water quality, biodiversity, amenity, green infrastructure etc.
- Existing surface water flow routes from off-site must be accommodated within the masterplan. The design of SuDS schemes must take into account the seasonally high groundwater table. Infiltration techniques may be ineffective and may pose a pollution risk. SuDS may need to be shallow and take up larger areas. Above ground conveyance and attenuation can be used but care must be taken that groundwater does not enter the SuDS feature and reduce the storage capacity and structural integrity of the design.
- The site design must ensure that flows resulting from rainfall in excess of a 1 in 100-year event are managed via exceedance routes that minimise the risks to people and property.
- Detailed site investigations will be required including infiltration testing and groundwater monitoring during the winter months (November through to March).
- Mitigation for seasonal high groundwater levels must be considered (for example by raising finished floor levels to an appropriate height above ground level).
- Safe access and egress should be demonstrated in areas located within Flood Zone 3a + 70% climate change, as well as within the 1 in 100-year plus 40% climate change rainfall event. Raising of access routes must not impact on flow routes. Access and egress from the site should also consider the risk of reservoir flooding from breach of Lady Grove Lake.
- An emergency plan should be developed for the site, taking into consideration evacuation of the site in the event of flood events from a number of sources, including fluvial, surface water and reservoir events.

Level 2 SFRA Detailed Site Summary Tables



Site details	Site Code	9.5d
	Site Name	Land West of Eynsham
	Area	87.9Ha
	Current land use	<ul style="list-style-type: none"> The current site use is primarily agricultural farmland, which is divided by well-developed hedgerows and trees. There are multiple farm complexes across the site, as well as the former Eynsham Nursery and Plant Centre in the north (which now has planning permission for 77 dwellings). A residential scheme of 160 units is currently under construction on the land west of Thornbury Road which falls within the SDA boundary.
	Proposed site use	<ul style="list-style-type: none"> The allocation makes provision for about 1,000 homes, together with a new primary school.
Environmental Descriptors	Bedrock Geology	<ul style="list-style-type: none"> The bedrock geology is entirely clay, and formed of the Oxford Clay and West Walton Formations.
	Superficial Geology	<ul style="list-style-type: none"> The centre and east of the site are overlain with superficial deposits of the Summertown-Radley Sand and Gravel Member group.
	Soil Type	<ul style="list-style-type: none"> The northern part of the site is made up of slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils. However, the majority of the site is dominated by freely draining lime-rich loamy soils.
	Typical Slope	<ul style="list-style-type: none"> The highest elevations are found in the north of the site, where the highest ground is approximately 73mAOD. The site slopes south to south-eastwards, with a low point of around 62.8mAOD at the south east corner of the site. The resulting slope of the site is approximately 2%.
	Groundwater Source Protection Zone	The site is not within a Groundwater Source Protection Zone.
	Ecology and Biodiversity	<ul style="list-style-type: none"> The site is not listed within any nationally protected areas, although the existing hedgerows and trees on the agricultural land provide an important habitat. The Chil Brook is an environmentally sensitive area and so development will require careful planning. The EA require that any proposed development maintains a distance of 8m from the Chil Brook In the north of the site, the former orchard is protected by a Tree Preservation Order (TPO). Potential impacts of development on Oxford Meadows, a Special Area of Conservation (SAC) approximately 4km east of the site, should also be taken into consideration.
	Historic Landfill Site	<ul style="list-style-type: none"> There are no historic landfill sites within this development site boundary.

Flood risk and drainage	Watercourse	<ul style="list-style-type: none"> The Chil Brook (Main River) forms the western boundary of the site and flows south-eastwards through the site. It exits the site at the south eastern corner, where it passes below a bridge at Station Road. Two unnamed Ordinary Watercourses, which form tributaries of the Chil Brook, are located in the north east and south of the site. 			
	Existing drainage features	<ul style="list-style-type: none"> At the western boundary of the site, there is a small unnamed Ordinary Watercourse, believed to be a land drain, which drains westwards into the Chil Brook. A medium-sized pond is located beyond the southern boundary of the site. 			
	Flood history	<ul style="list-style-type: none"> The site is identified as having experienced fluvial flooding along the floodplain of the Chil Brook, as recorded within the EA Historical Flood Map, which shows the maximum extent of Recorded Flood Outlines. Station Road, on the south eastern boundary of the site, often experiences flooding, with restriction of the Chil Brook at the road bridge suggested to be the cause. The following flood events associated with the Chil Brook have been recorded in the vicinity of the site: <ul style="list-style-type: none"> July 1968 – flooding extent similar to 2007 with flooding of four properties December 1985 – flooding of adjacent farmland and internal property flooding (one property). February 2002 – flooding of adjacent farmland and internal property flooding (four properties). January 2007 – flooding of adjacent farmland but no internal property flooding on Station Road. June 2007 – seven properties experienced severe flooding with depths of up to 600mm recorded. Flooding is commonly reported to have occurred as a result of high rainfall causing an increase in flow in the Chil Brook, exceeding capacity of the channel. 			
	Fluvial	Proportion of site at risk			
		Flood Zone 3b	Flood Zone 3a	Flood Zone 2	Flood Zone 1
		16%	19%	30%	70%
	The majority of the site is within Flood Zone 1. Flood Zones 2 and 3 represent the floodplain of the Chil Brook and cover the north west, centre and south east of the site.				
	Surface Water	Proportion of site at risk (RoFSW)			
1 in 30-year		1 in 100-year		1 in 1,000-year	
13%		17%		25%	
<ul style="list-style-type: none"> The dominant surface water flow path within the site is associated with the channel of the Chil Brook and its tributaries. In the centre of the site, a flow path runs southwards to join the brook. The full connectivity of this flow path is only achieved in the 1 in 1,000-year event, however ponding does occur along this path in the 1 in 30-year event. A smaller flow path, which forms in all return periods, also joins the brook in the east of the site. 					
Groundwater	Proportion of site at risk in JBA Groundwater Map 1 in 100-year risk categories				
	Depth below surface 0-0.025m		Depth below surface 0.025 to 0.5m		Total in highest risk categories
	28%		7%		35%

		<ul style="list-style-type: none"> Approximately one third of the site is predicted to have a high groundwater flood risk. The groundwater flood risk is associated with sand and gravel superficial deposits found along both the northern and southern boundaries of the site. In these areas, groundwater is estimated to be within 0.5m of the surface during a 1 in 100-year groundwater flood event. All other areas are deemed to have a negligible groundwater flood risk. 	
	Reservoir	<ul style="list-style-type: none"> This site is at risk of flooding from Scott's House Lake, in the unlikely event of reservoir breach. A flow path exists through the site, from south east to north west. The flow path follows the Chil Brook and is similar in extent to Flood Zone 2. 	
	Sewer incidents	<ul style="list-style-type: none"> The study area is within the Eynsham Woodstock Sub-Area. Within this area, 12 properties have experienced between 1 and 5 sewer flooding incidents within the last 20 years. (https://www.westoxon.gov.uk/media/1572191/ENV9-West-Oxfordshire-District-Council-Strategic-Flood-Risk-Assessment-Update-Report-November-2016-.pdf) 	
Flood risk management infrastructure	Defences	<ul style="list-style-type: none"> In the south-east corner of the site there is a small raised earth bund, which was installed in 2009 by Oxfordshire County Council. It ties into existing ground levels of 62.55mAOD at the western edge of the bridge headwall. The Chil Brook hydraulic modelling study estimates the bund to have a 1 in 75-year standard of protection, and defends the south eastern corner of the site. In the centre of the study area, there are flood walls adjacent to Corlan Farm, along Chilbridge Road (these are not noted as formal defences). 	
	Residual risk	Culvert/ structure blockage?	<ul style="list-style-type: none"> Across the development site, there are two bridges over the Chil Brook which restrict the watercourse and pose a residual flood risk. One bridge is situated in the centre of the site, where the Brook flows beneath Chilbridge Road, and the second is where it leaves the site below Station Road. Blockage of these bridges has been modelled as part of the SFRA. Blockage of 50 – 95% of the Chilbridge Road bridge opening led to a small localised increase in the 1 in 100-year flood extent between Corlan Farm and Merton Court. Blockage of the bridge on Station Road had a more significant impact on the 1 in 100-year flood extent, with a 95% blockage spilling onto Station Road and impacting on access. However, in both locations, a 95% blockage of the bridges resulted in flood extents which remained within the existing extent of Flood Zone 2.
		Impounded water body failure?	<ul style="list-style-type: none"> Failure of Scott's House Lake (north west of site) poses a flood risk to the site, as the flow path from the reservoir would follow the course of the Chil Brook through the centre of the site. The flooding associated with a reservoir breach would remain within the extent of Flood Zone 2.
		Defence breach/ overtopping?	<ul style="list-style-type: none"> Breach of the flood defence bund in the south-east of the site poses a risk to housing on/near Station Road. The Chil Brook hydraulic modelling study estimates that during the 1 in 100-year flood event, the bund is bypassed on its western edge, where it ties into the ground. Breach of the informal wall in the centre of the site could potentially increase flood risk to Corlan Farm.

Emergency planning and flood mitigation	Flood warning and alerts	<ul style="list-style-type: none"> The site is within the River Thames and Tributaries from Buscot Wick down to Kings Lock Flood Alert Area. Environment Agency flood warnings are now issued to individuals via the Flood Information Service. 		
	Access and egress	<p>Several possible access points for vehicles and/or pedestrians and cyclists have been identified in the Council's initial issues paper, however none of these have been finalised. The potential access points include the A40, B4449, Chilbridge Road, Thornbury Road, Station Road, Merton Court/Merton Close and Old Witney Road. The use of these access points, in terms of providing pedestrian/cyclist or vehicular access, is also under discussion.</p> <ul style="list-style-type: none"> A40: the possible access point from the A40 is located on the northern site boundary, and would connect into a new spine road through the site, ending at the B4449. This section of the A40 is within Flood Zone 1, with some isolated surface water ponding predicted to occur during the 1 in 100-year and 1 in 1,000-year events. To the west of this point, the southern side of the A40 is encroached by Flood Zone 2 of the Chil Brook, and more extensive surface water flooding is predicted to occur. B4449 (Stanton Harcourt Road): the southern end of the B4449 could provide an access point for the south of the site, via the potential new spine road. This section of road is located within Flood Zone 1 and is at very low risk of surface water flooding. Chilbridge Road: the road crosses the site and is affected by both Flood Zone 2 and 3. Thornbury Road: currently a cul-de-sac adjacent to the eastern boundary of the site, this road is located entirely within Flood Zone 1. The current extent of surface water flood risk does not cover Thornbury Road, however as the road is to be extended as part of the current residential development under construction to the west of Thornbury Road, a flow path extending to the Chil Brook becomes a consideration. Station Road: at the eastern boundary of the site, the road is intersected by Flood Zones 2 and 3. The length of Station Road is at risk of surface water flooding during the 1 in 100-year and 1,000-year rainfall events. Merton Court/Merton Close: the road is entirely within Flood Zone 1, however, both Flood Zones 2 and 3 are within approximately 100m of Merton Court. As a result, expansion of the road, into the site, may lead to an increase in flood risk to the road. Merton Close is partly affected by surface water flooding in the 1 in 1,000-year event. Similarly, any extension to the road would lead to an increase in surface water flood risk. Old Witney Road: the road is entirely within Flood Zone 1, however the northern section is affected by surface water flooding in all return periods, due to a flow path from the Chil Brook catchment. Further south, a small area of the road is affected by surface water flooding in the 1 in 1,000-year event, and the junction with Witney Road is at risk in the 1 in 100-year and 1,000-year events. 		
Climate Change	Climate change allowances for '2080s'	River Basin District	Higher Central	Upper End
		Thames	35%	70%
	% increase in flood extent compared to Flood Zone 3a	1%		
	Impact of climate change on fluvial flooding and the Flood Zone classification	<ul style="list-style-type: none"> Climate change under both the +35% and +70% scenarios is predicted to increase the area of Flood Zone 3a to be similar to the current Flood Zone 2 extent. Flooding is likely to become more frequent under both climate change scenarios, and the impact of an event with a given probability is also likely to become more severe, with water depths, velocities and flood hazard increasing. 		

	<p>Impact of climate change on flood risk from other sources</p>	<ul style="list-style-type: none"> • Climate change is predicted to increase rainfall intensity in the future by a range of between 20% and 40% (the recommended national precautionary sensitive range for 2085 to 2115). This will increase the likelihood, frequency and extent of surface water flooding. • The effect of climate change on groundwater flooding, and those watercourses where groundwater has a large influence on winter flood flows is more uncertain. Milder wetter winters may increase the frequency of groundwater flooding incidents in areas that are already susceptible, but warmer drier summers may counteract this effect by drawing down groundwater levels to a greater extent during the summer months.
<p>Requirements for drainage control and impact mitigation</p>	<p>Broad scale assessment of possible SuDS</p>	<ul style="list-style-type: none"> • The size and greenfield nature of the site provide opportunities for a variety of SuDS features. • A potential aspect of the site design is a possible linear park alongside the Chil Brook. This provides an ideal opportunity to incorporate conveyance and attenuation SuDS, to slow and store surface water flow before it enters the Chil Brook. However, attenuation storage features must be located outside the Chil Brook floodplain, so they remain operational during a fluvial flood event. • SuDS incorporated within the linear park and wider site should provide spaces for amenity and biodiversity, through attractive, 'natural' features, such as swales, grassed basins and wetlands, which provide recreational spaces, as well as habitats for native species. • All proposed development should adopt source control SuDS techniques. Conveyance features should be designed above ground and following natural flow paths where possible. • The low permeability clay bedrock and naturally wet soils across the site favour the use of conveyance and detention SuDS techniques, such as swales and basins. • Due to the impermeable underlying geology, deep infiltration systems (e.g. soakaways) are likely to be inappropriate. However, sand and gravel deposits on the site surface may allow the localised use of shallow infiltration techniques. • Superficial geological deposits can be subject to high groundwater levels, and so it would be necessary to conduct infiltration tests and groundwater monitoring to assess the suitability. • The design of conveyance and storage features must take into account the seasonally high groundwater table, particularly in the centre and east of the site. SuDS may need to be shallower in depth and take up larger areas, and impermeable lining may be required, to prevent loss of storage capacity during periods of high groundwater. • SuDS design must follow the Oxfordshire County Council (OCC) guidance, meet the Defra National Non-Statutory Technical Standards, and follow current best design practice (CIRIA Manual 2015).
<p>NPPF and planning implications</p>	<p>Exception Test requirements</p>	<p>The Sequential Test must be passed. Only once the Sequential Test is passed should the Exception Test be applied. It is expected that all built development will be sequentially located within Flood Zone 1, but the Exception Test would be required:</p> <ul style="list-style-type: none"> • If More Vulnerable and Essential Infrastructure is located in Flood Zone 3a. • If Highly Vulnerable development is located in Flood Zone 2 or Flood Zone 3a plus climate change. • If Essential Infrastructure is located in Flood Zone 3b <p>Development will not be permitted in the following scenarios:</p> <ul style="list-style-type: none"> • Highly Vulnerable development within Flood Zone 3a or Flood Zone 3a plus climate change and Flood Zone 3b. • More Vulnerable and Less Vulnerable development within Flood Zone 3b.

Requirements and guidance for site-specific Flood Risk Assessment

Flood Risk Assessment:

- At the planning application stage, a site-specific flood risk assessment and surface water drainage strategy will be required, in line with government guidance (<https://www.gov.uk/guidance/flood-risk-assessment-for-planning-applications>).
- All sources of flooding, particularly the risk of fluvial, surface water flooding, groundwater flooding, and the interaction between them should be considered as part of a site-specific flood risk assessment.
- Consultation with OCC, the Lead Local Flood Authority, should be undertaken at an early stage and the Environment Agency should be consulted on fluvial flood risk to the site.
- OCC, as the Highways Authority, should be consulted on any proposed connections into the highway drainage network, and existing capacity and flood risk issues discussed. The impact of the development on any existing sewer flooding issues in Eynsham should be discussed with Thames Water at an early stage (including proximity to the existing sewage treatment works).
- The unmodelled tributaries of the Chil Brook located within the site boundary do not have associated Flood Zones. Where not yet carried out, hydraulic modelling should be conducted, to determine the level of flood risk from these watercourses.
- Climate change should be assessed using recommended climate change allowances at the time of the assessment (<https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances>) for the type of development and level of risk. The current allowances were published in February 2016 but may be subject to change in the future.
- A detailed assessment of the risk and location of high groundwater levels and groundwater emergence should be undertaken, including groundwater monitoring during the winter months.
- At the centre of the site, the Chil Brook is bridged by Chilbrook Road, and further downstream by Station Road. The potential to increase capacity of these bridges, which are historic structures, should be considered alongside, options to improve flow and reduce flood risk.

	<p style="text-align: center;">Guidance for site design and making development safe from flooding</p>	<p>Guidance for site design and making development safe:</p> <ul style="list-style-type: none"> • All residential development should be placed within Flood Zone 1. Development must seek opportunities to reduce overall level of flood risk at the site, for example by reducing volume and rate of runoff and creating space for flooding. • The site should be designed using a sequential approach. Development should be steered away from surface water flow routes and areas where groundwater is likely to emerge, preserving these areas as green infrastructure, where possible. • All development should integrate source control SuDS techniques to reduce the risk of flooding due to post-development runoff. This aim extends to reducing runoff rates to greenfield levels or lower. • SuDS design should follow current best practice (CIRIA Manual 2015) and OCC guidance on runoff rates and volumes, to deliver multiple benefits including water quality, biodiversity, amenity, green infrastructure etc. • The design must ensure that flows resulting from rainfall in excess of a 1 in 100-year event are managed via exceedance routes that minimise the risks to people and property. Ensure that attenuation storage for higher return periods is outside of the fluvial floodplain. • Existing surface water flow routes from off-site must be accommodated within the masterplan. The design of SuDS schemes must take into account the seasonally high groundwater table. Infiltration techniques may be ineffective and may pose a pollution risk. SuDS may need to be shallow and take up larger areas. Above ground conveyance and attenuation can be used but care must be taken that groundwater does not enter the SuDS feature and reduce the storage capacity and structural integrity of the design. • Safe access and egress should be demonstrated in areas located within Flood Zone 3a + 70% climate change, as well as within the 1 in 100-year plus 40% climate change rainfall event. Raising of access routes must not impact on flow routes. Access and egress from the site should also consider the risk of reservoir flooding from breach of Scott's House Lake. • Detailed site investigations will be required including infiltration testing and groundwater monitoring during the winter months (November through to March). • Mitigation for seasonal high groundwater levels must be considered (for example by raising finished floor levels to an appropriate height above ground level, and avoiding the construction of habitable basements). • Any proposed bridge crossings over Chil Brook must be clear span in design and allow sufficient clearance room for flood flows. The Environment Agency will require evidence of these considerations at planning application stage. • An emergency plan should be developed for the site, taking into consideration evacuation of the site in the event of flood events from a number of sources, including fluvial, surface water and reservoir events.
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B Level 2 Site Summary Sheet Maps

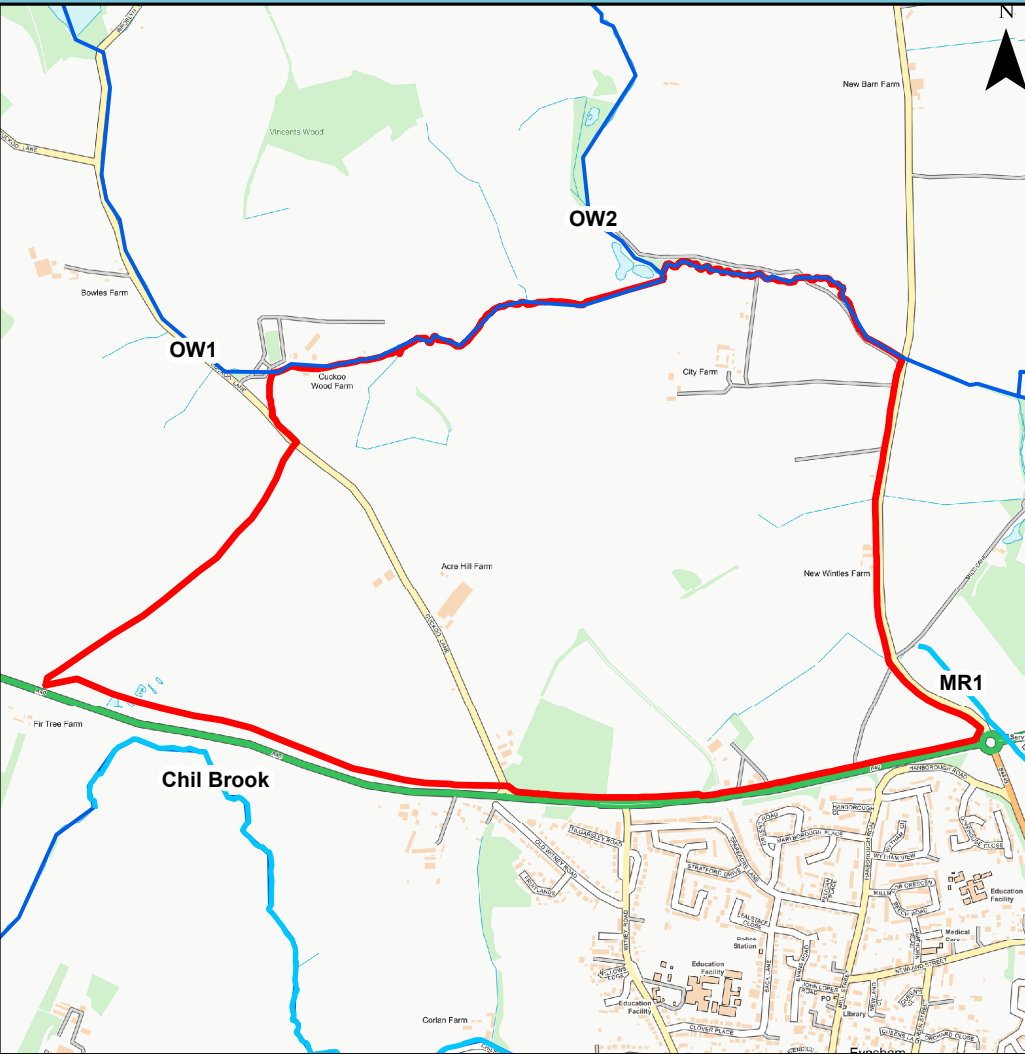
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Site Code	9.5e

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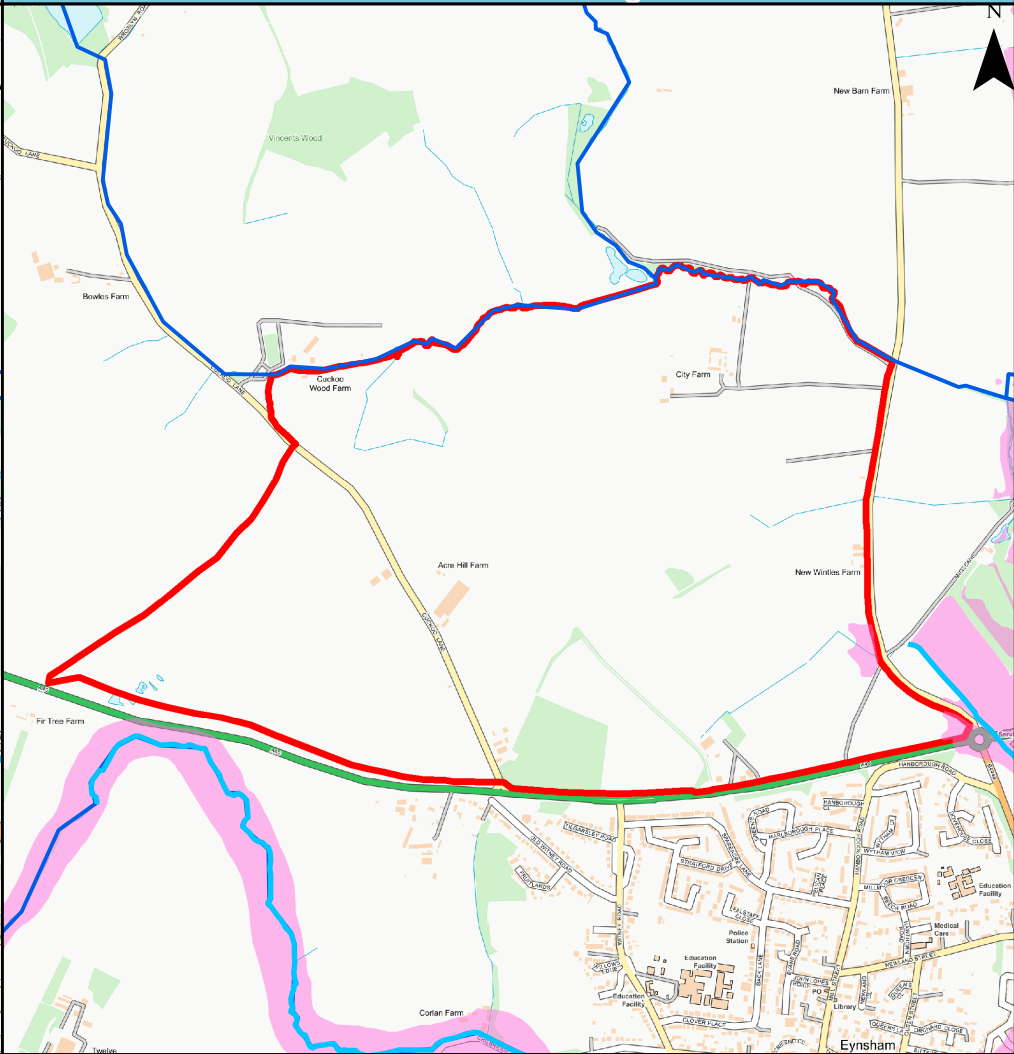


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Watercourses



Historic Flooding



- Main Rivers
- Ordinary Watercourses
- Site Boundary

0 0.275 0.55 1.1

Km

- Historic Flood Extent
- Main Rivers
- Ordinary Watercourses
- Site Boundary

0 0.275 0.55 1.1

Km

Site name	Land North of A40, Eynsham
Site Code	9.5e

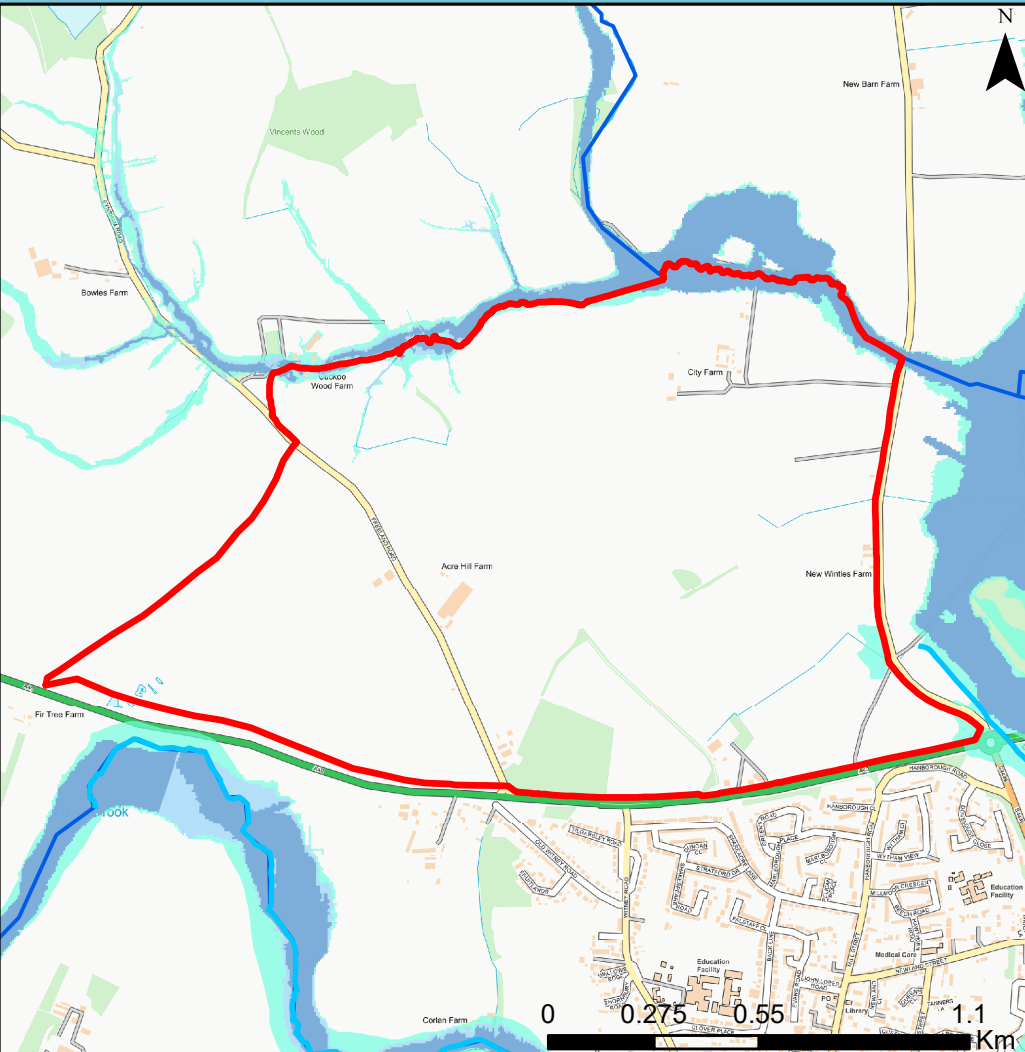
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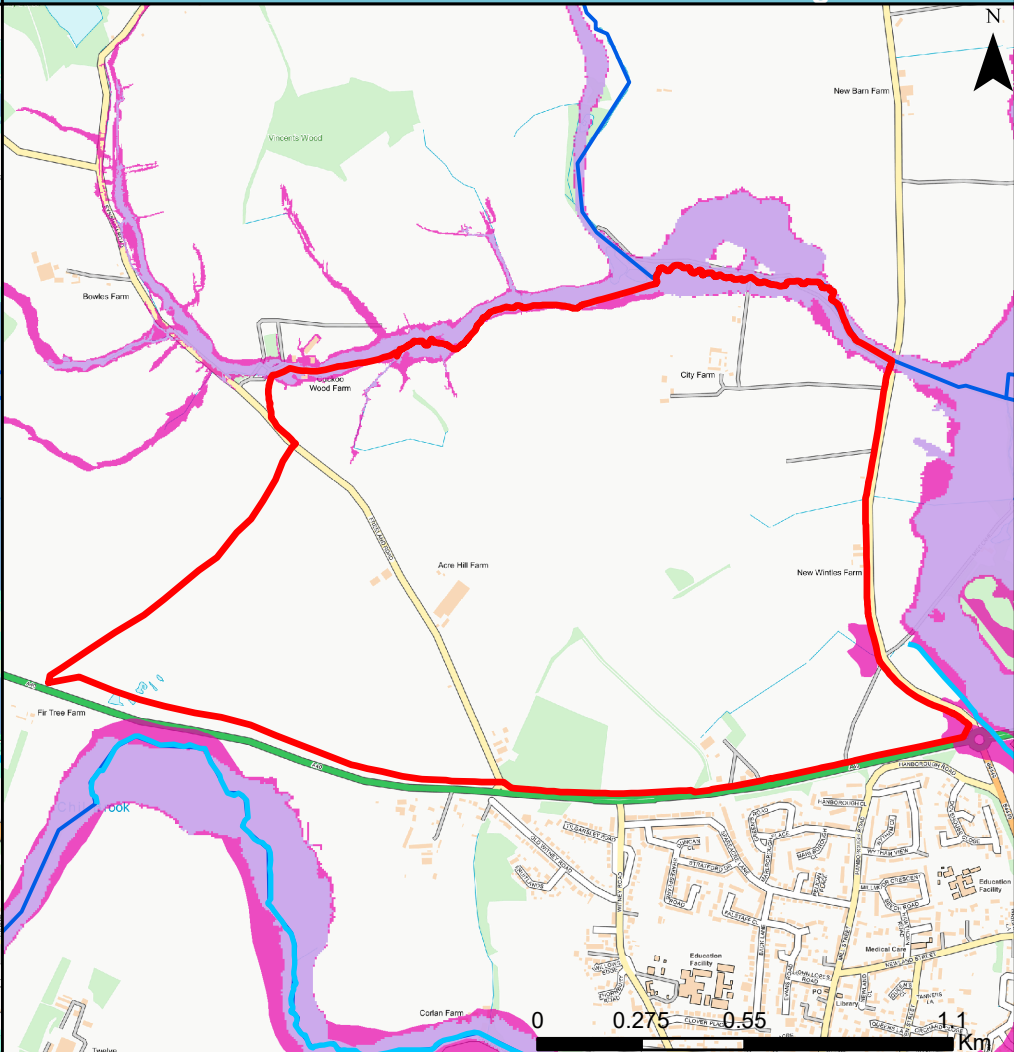

WEST OXFORDSHIRE DISTRICT COUNCIL







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Flood Zones



Flood Zones + Climate Change



	Site Boundary		Flood Zone 3b (as no Q20 extent available = FZ3)
	Main Rivers		Flood Zone 3
	Ordinary Watercourses		Flood Zone 2

	Site Boundary		Flood Zone 3
	Main Rivers		Flood Zone 3a + 35 / 70% CC (as no detailed model = FZ2)
	Ordinary Watercourses		

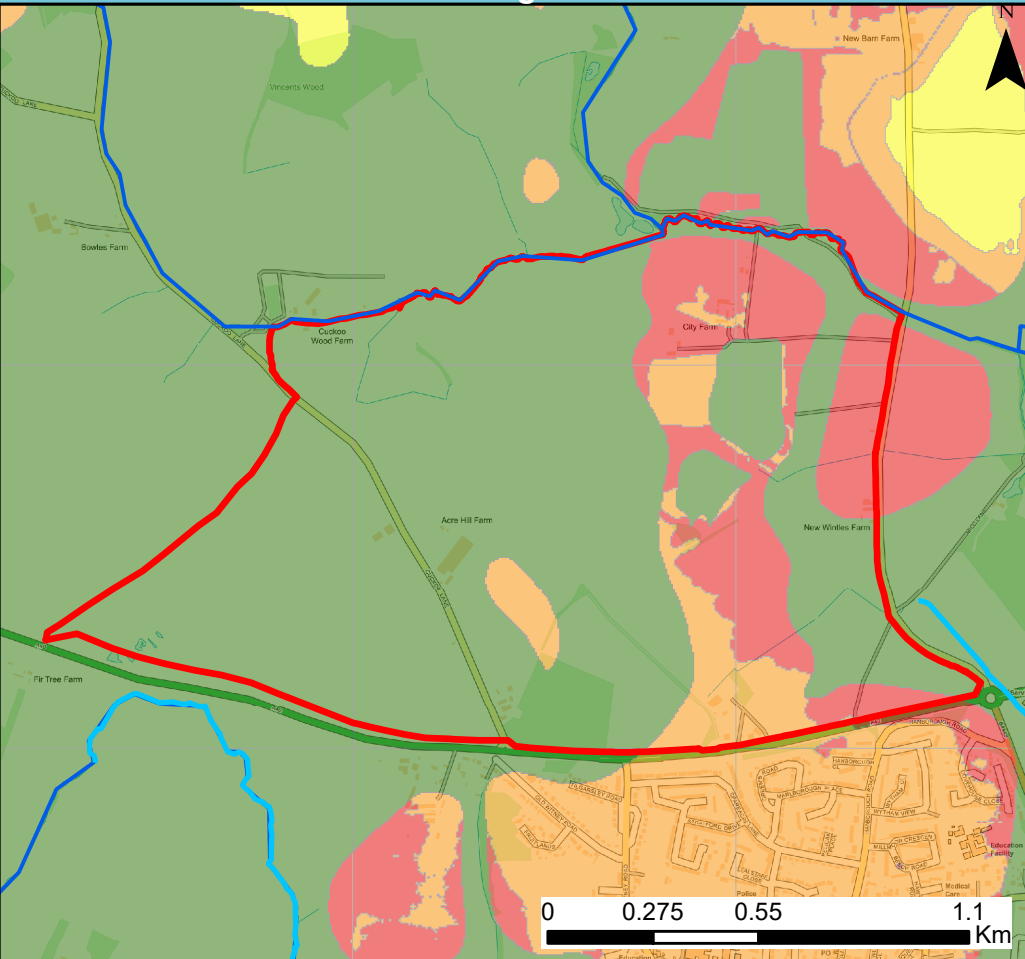
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Site Code	9.5e

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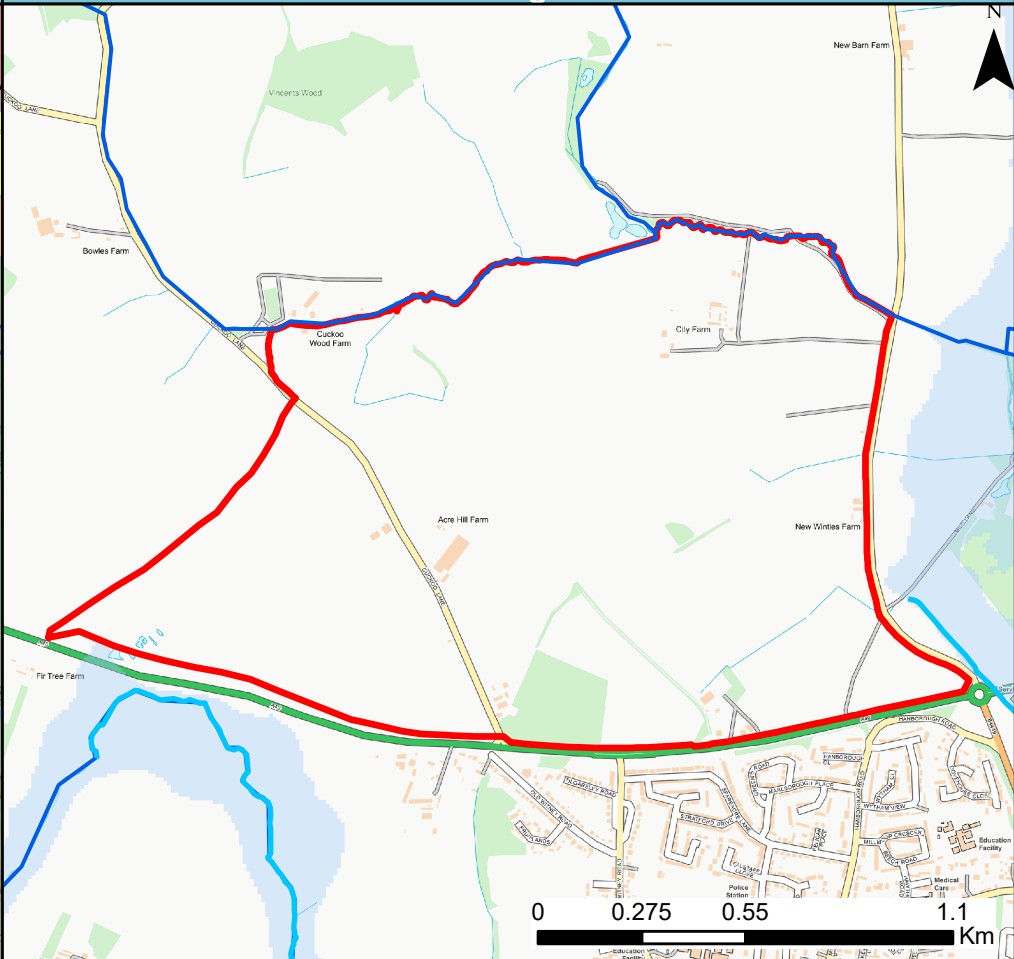
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Risk of Flooding from Groundwater



<ul style="list-style-type: none"> Main Rivers Ordinary Watercourses Site Boundary 	<p>Groundwater Flood Risk</p> <ul style="list-style-type: none"> Negligible risk Groundwater levels are at least 5m below the ground surface. Groundwater levels are between 0.5m and 5m below the ground surface. Groundwater levels are between 0.025m and 0.5m below the ground surface. Groundwater levels are either at or very near (within 0.025m of) the ground surface.
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Risk of Flooding from Reservoirs



<ul style="list-style-type: none"> Reservoir Flood Extent Main Rivers Ordinary Watercourses Site Boundary

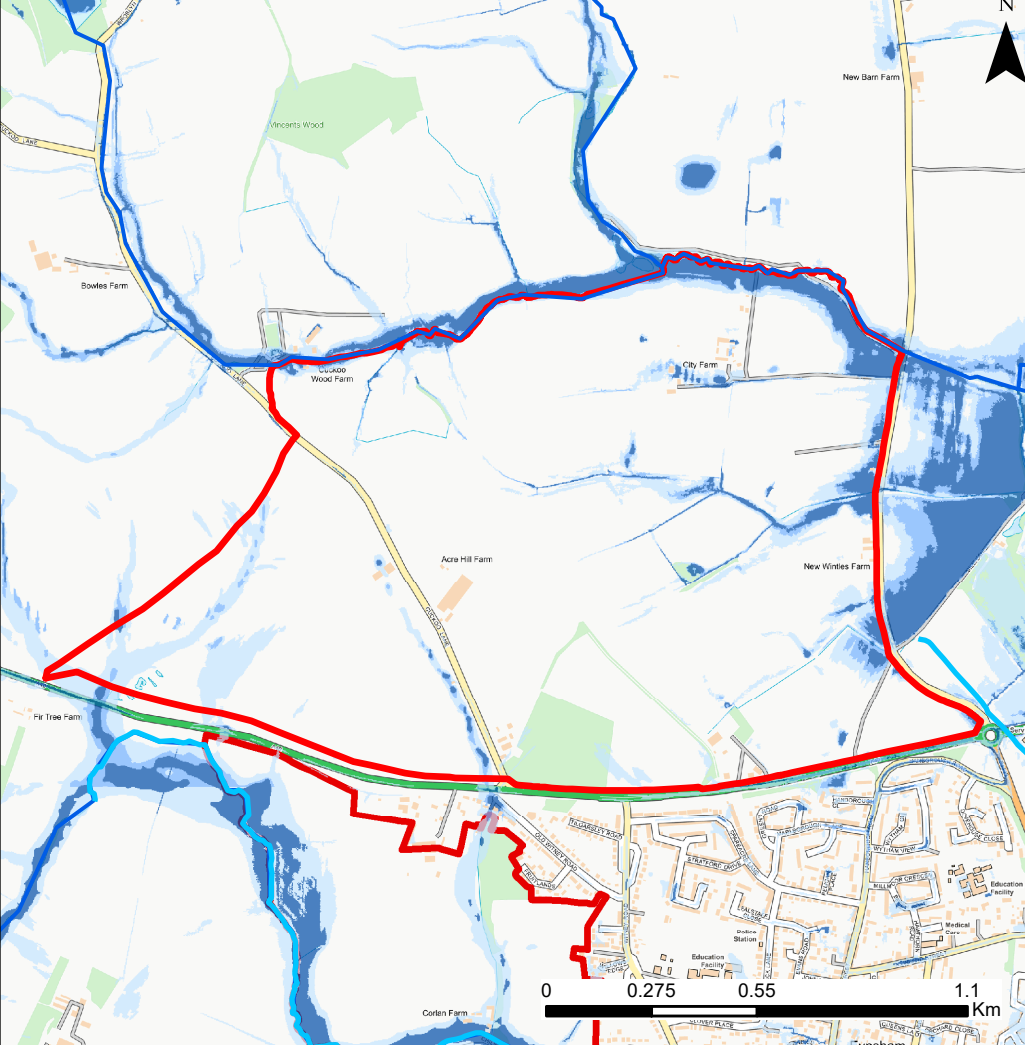
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Site Code	9.5e

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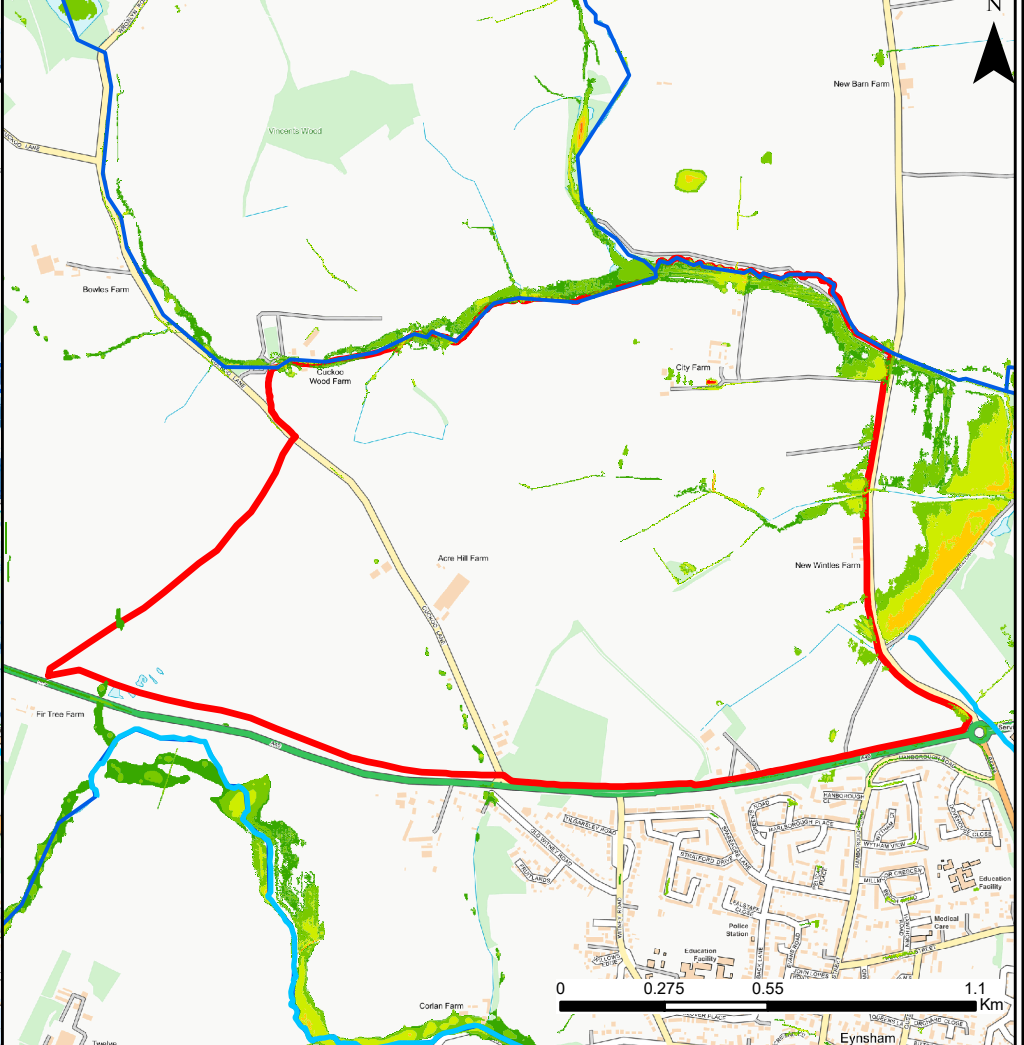


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Extent of Surface Water Flooding



Depth of Surface Water Flooding (3.33% AEP)



Main Rivers	RoFSW 1 in 30 year event (3.33%AEP)
Ordinary Watercourses	RoFSW 1 in 100 year event (1%AEP)
Site Boundary	RoFSW 1 in 1000 year event (0.1%AEP)

Main Rivers	Depth (m)	
Ordinary Watercourses	0.00 - 0.15	0.60 - 0.90
Site Boundary	0.15 - 0.30	0.90 - 1.20
	0.30 - 0.60	> 1.20

Site name	Land North of A40, Eynsham
Site Code	9.5e

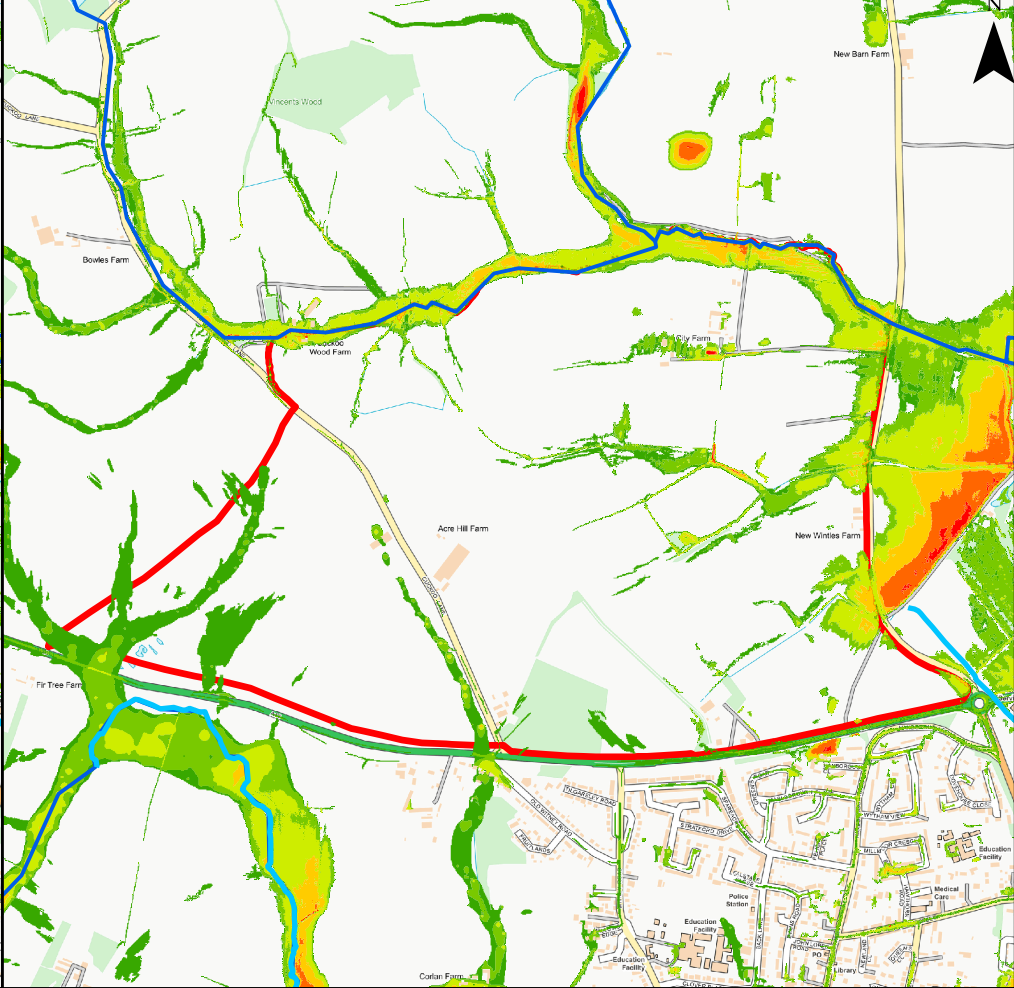
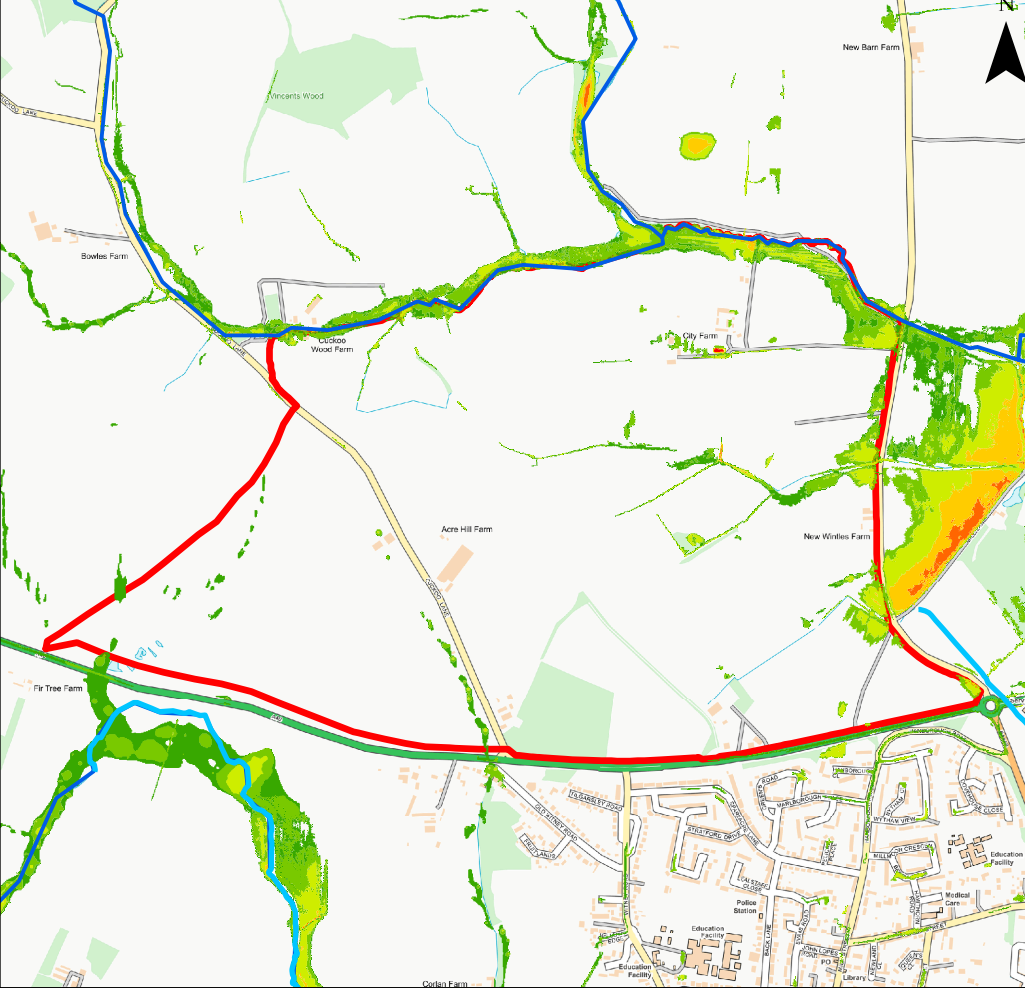
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Depth of Surface Water Flooding (1%AEP)

Depth of Surface Water Flooding (0.1%AEP)



Surface Water Depth (m)

	0.00 - 0.15		Main Rivers
	0.15 - 0.30		Ordinary Watercourses
	0.30 - 0.60		Site Boundary
	0.60 - 0.90		
	0.90 - 1.20		
	> 1.20		

0 0.275 0.55 1.1
Km

Surface Water Depth (m)

	0.00 - 0.15		Main Rivers
	0.15 - 0.30		Ordinary Watercourses
	0.30 - 0.60		Site Boundary
	0.60 - 0.90		
	0.90 - 1.20		
	> 1.20		

0 0.275 0.55 1.1
Km

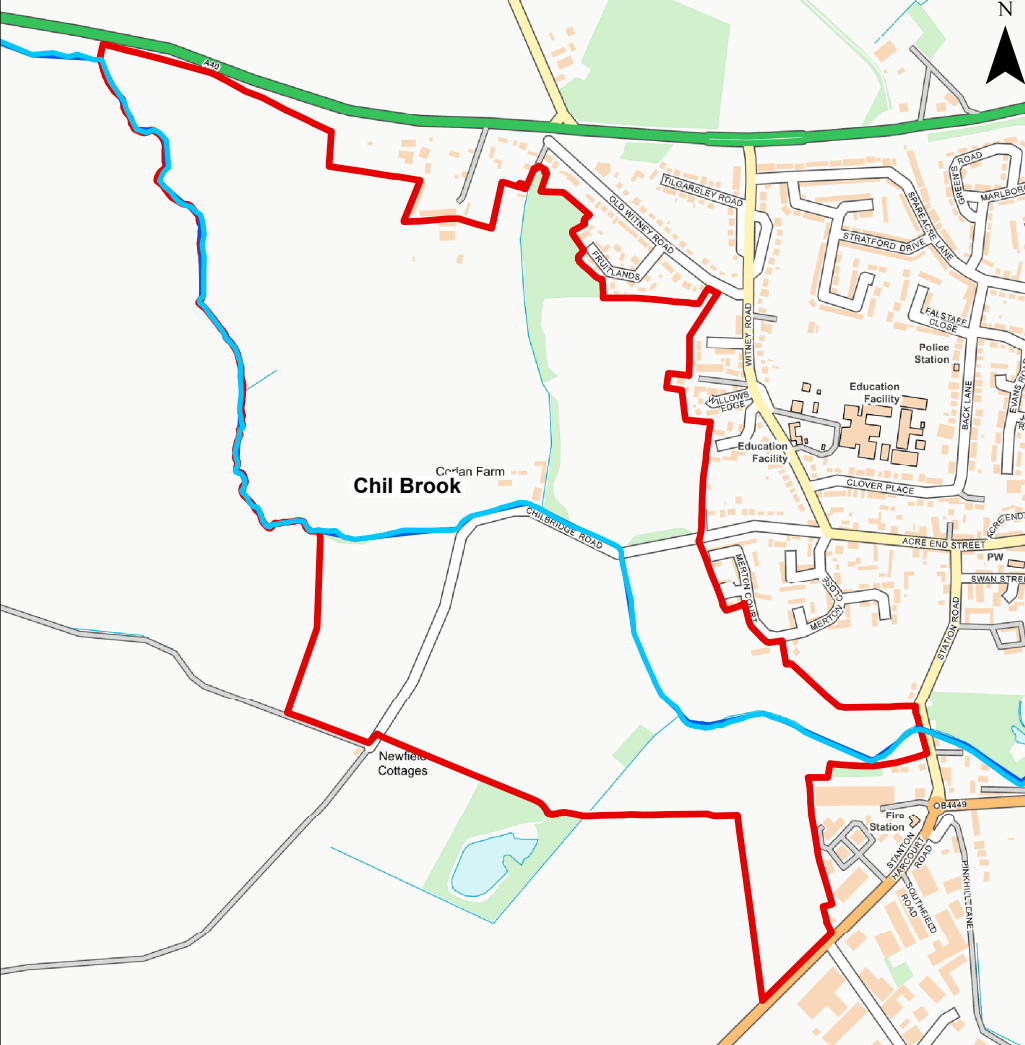
Site name	Land West of Eynsham
Site Code	9.5d

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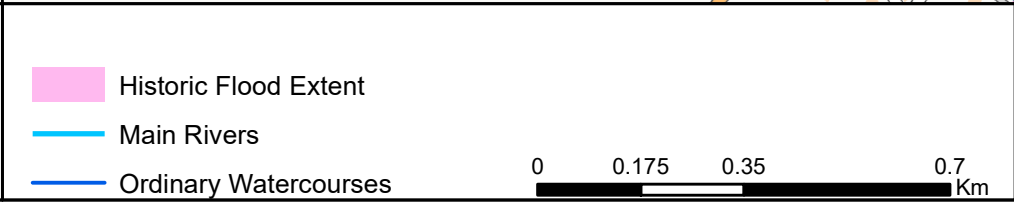
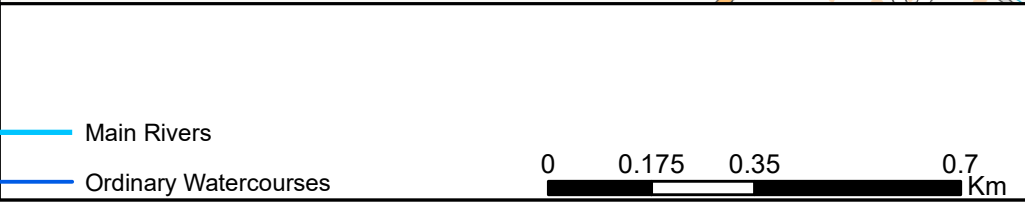
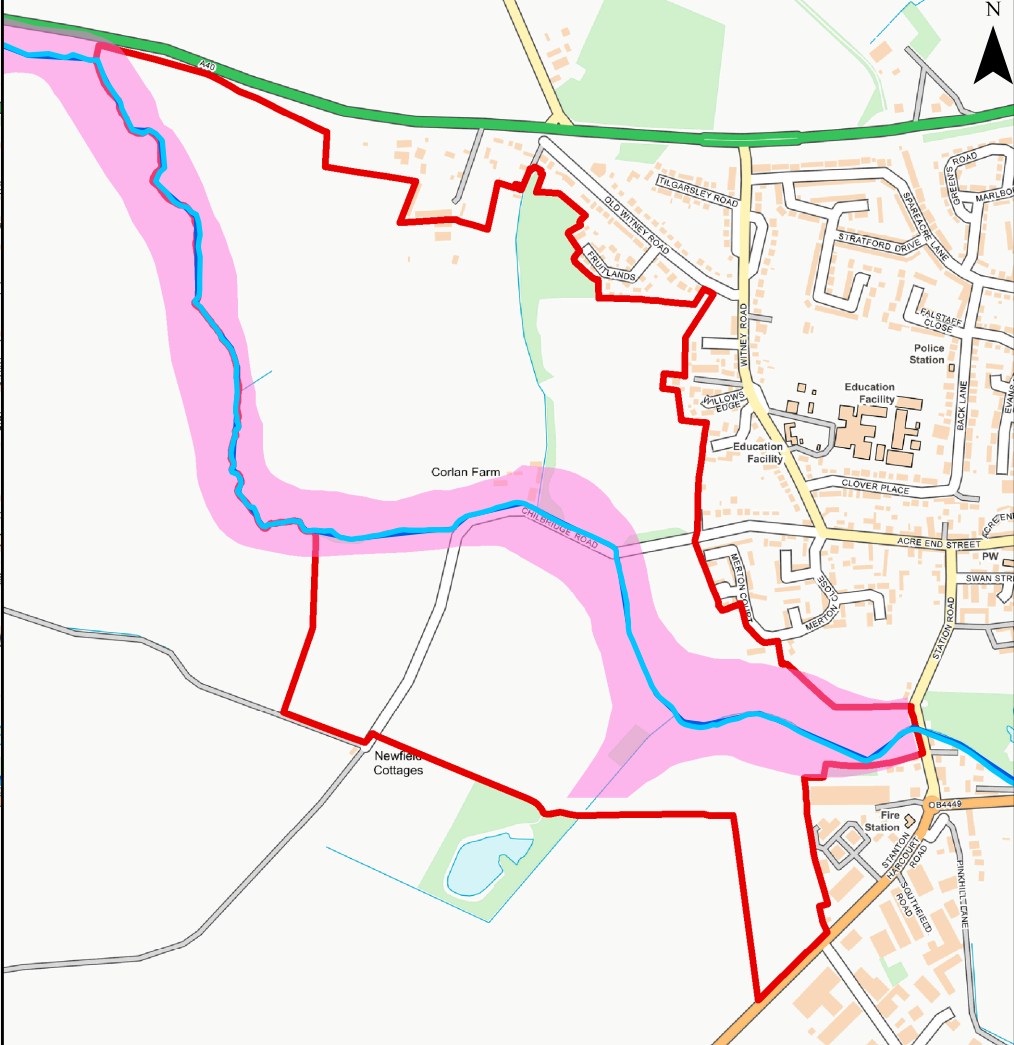


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Watercourses



Historic Flooding

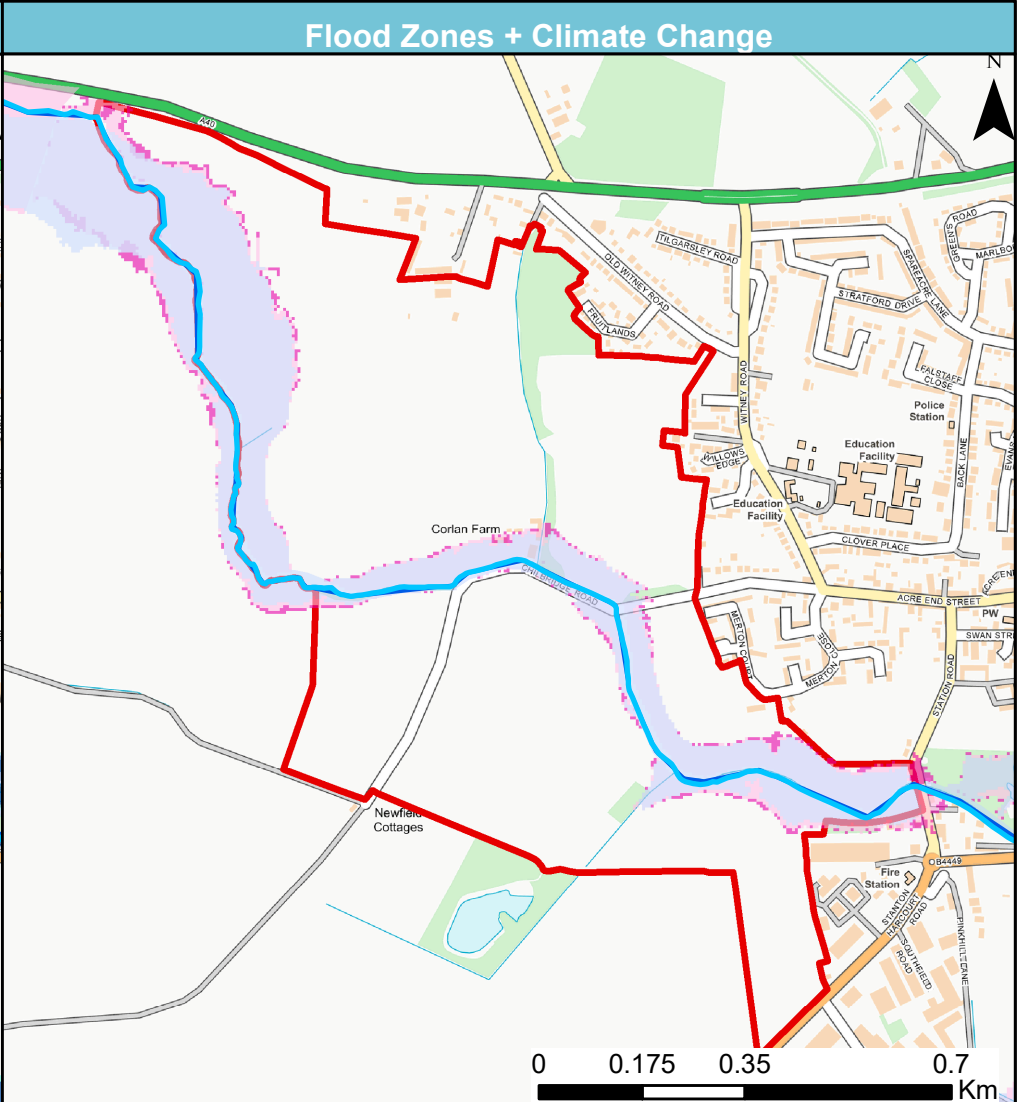
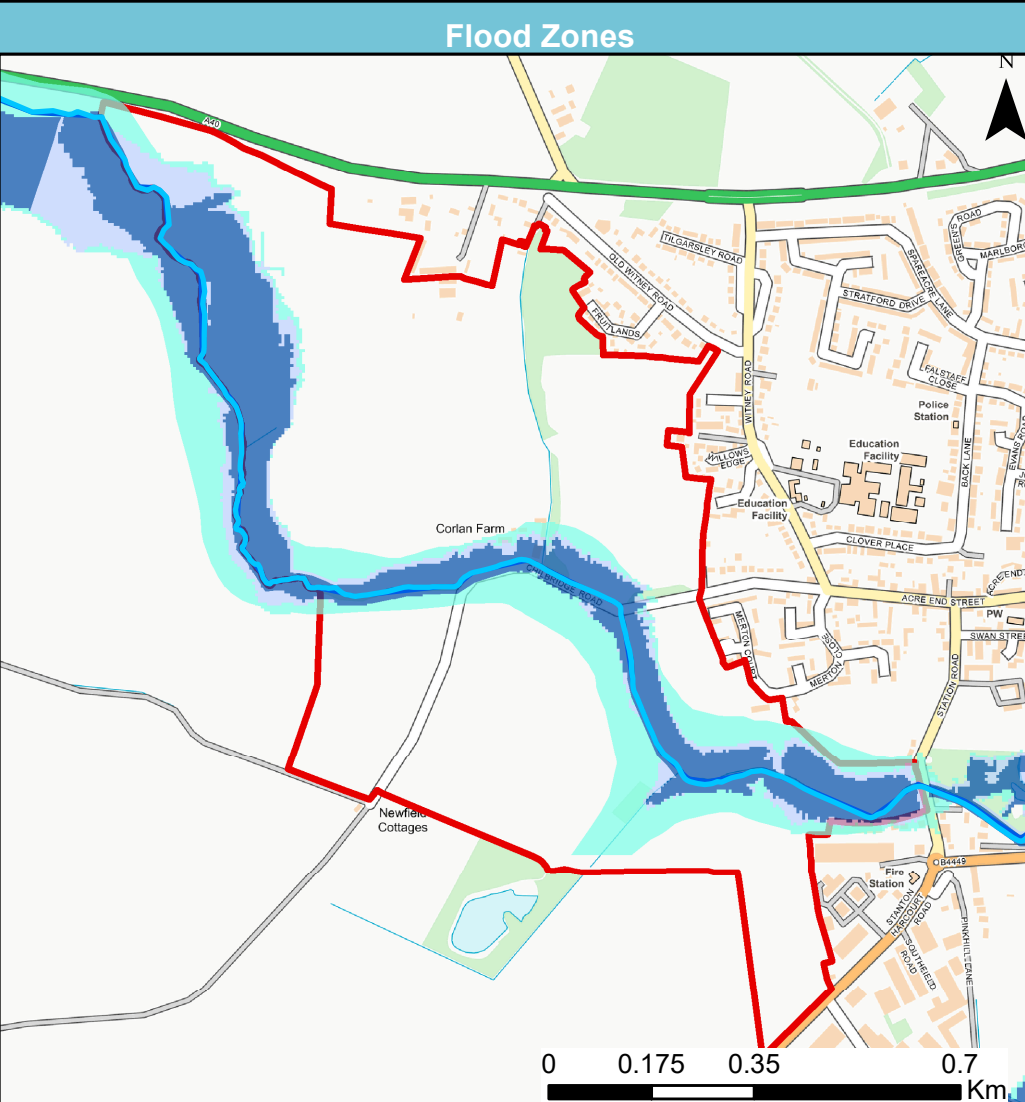


Site name	Land West of Eynsham
Site Code	9.5d

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Site Boundary	Flood Zone 2
Main Rivers	Flood Zone 3
Ordinary Watercourses	Flood Zone 3b

Site Boundary	Flood Zone 3
Main Rivers	Flood Zone 3a +35% CC
Ordinary Watercourses	Flood Zone 3a +70% CC

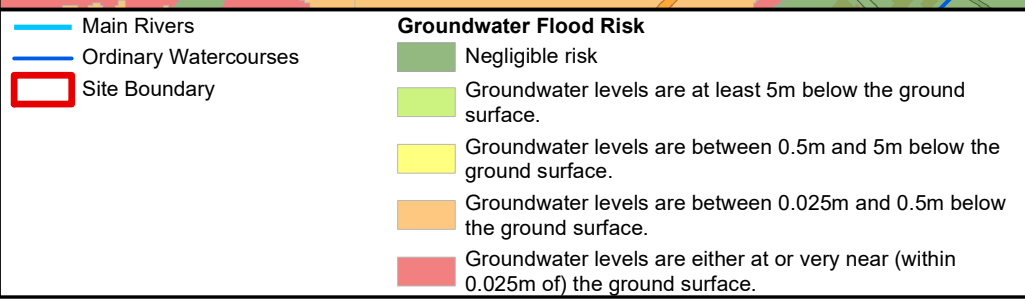
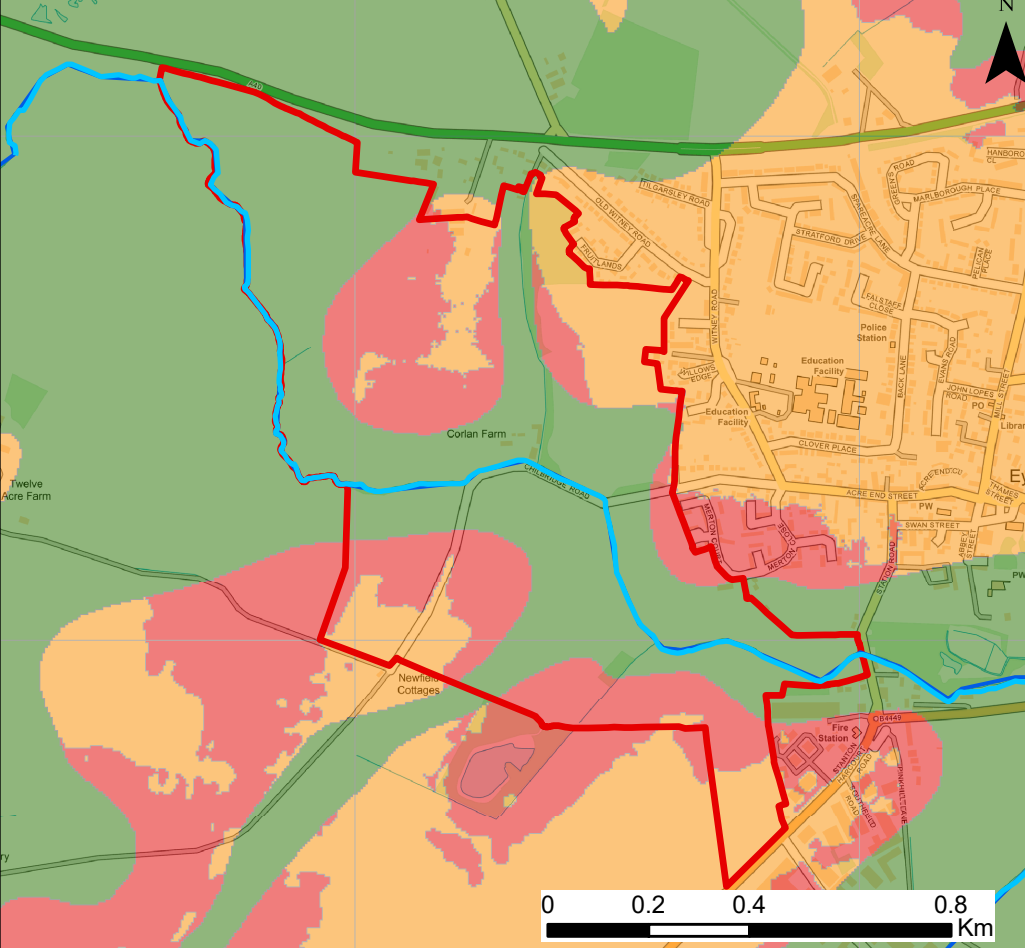
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Site Code	9.5d

West Oxfordshire Strategic Flood Risk Assessment Level 2 - Site Summary Sheet Mapping

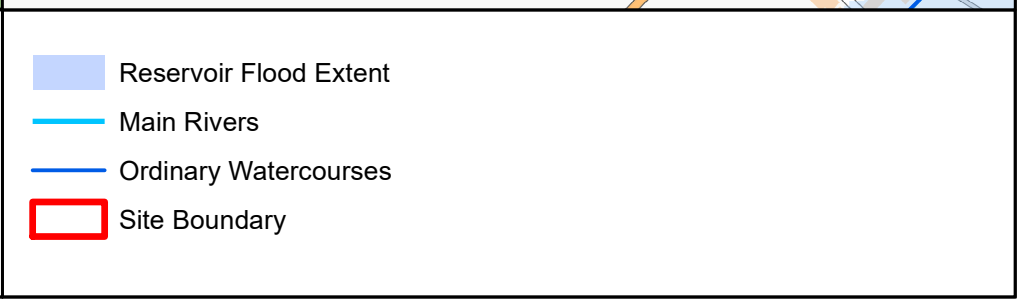
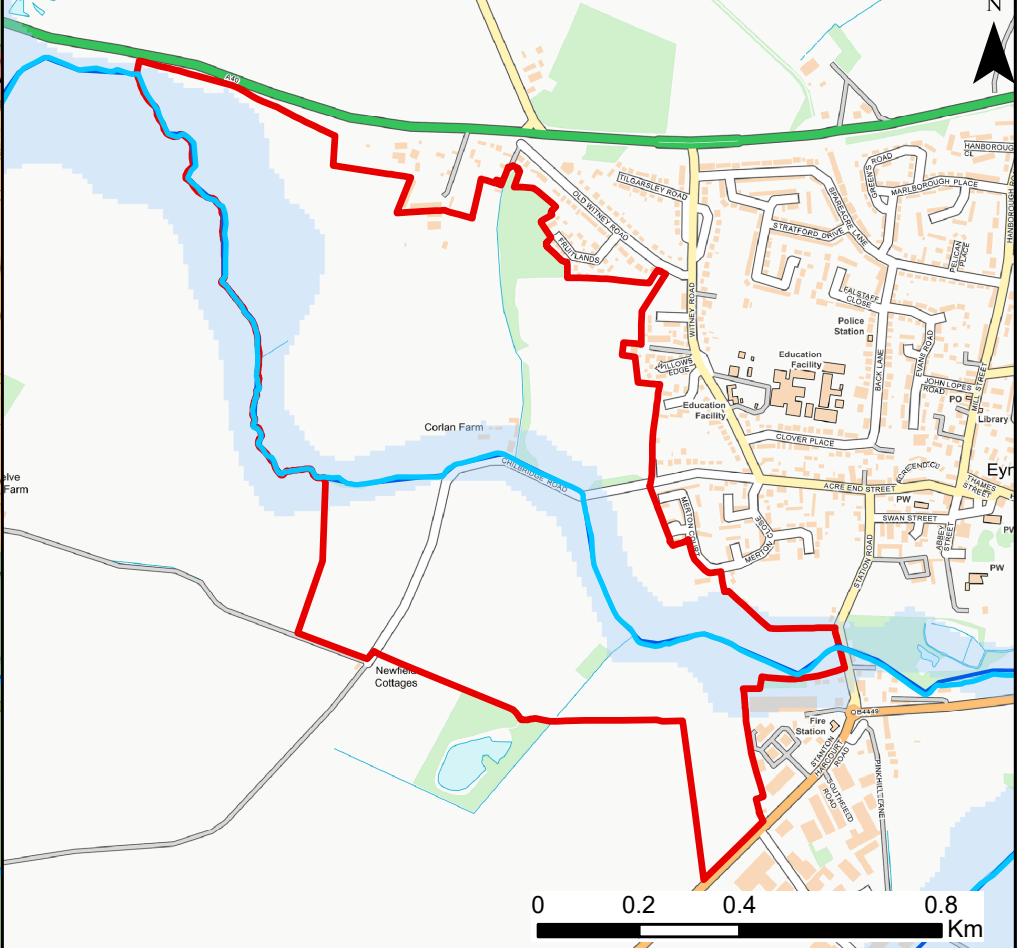


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Risk of Flooding from Groundwater



Risk of Flooding from Reservoirs



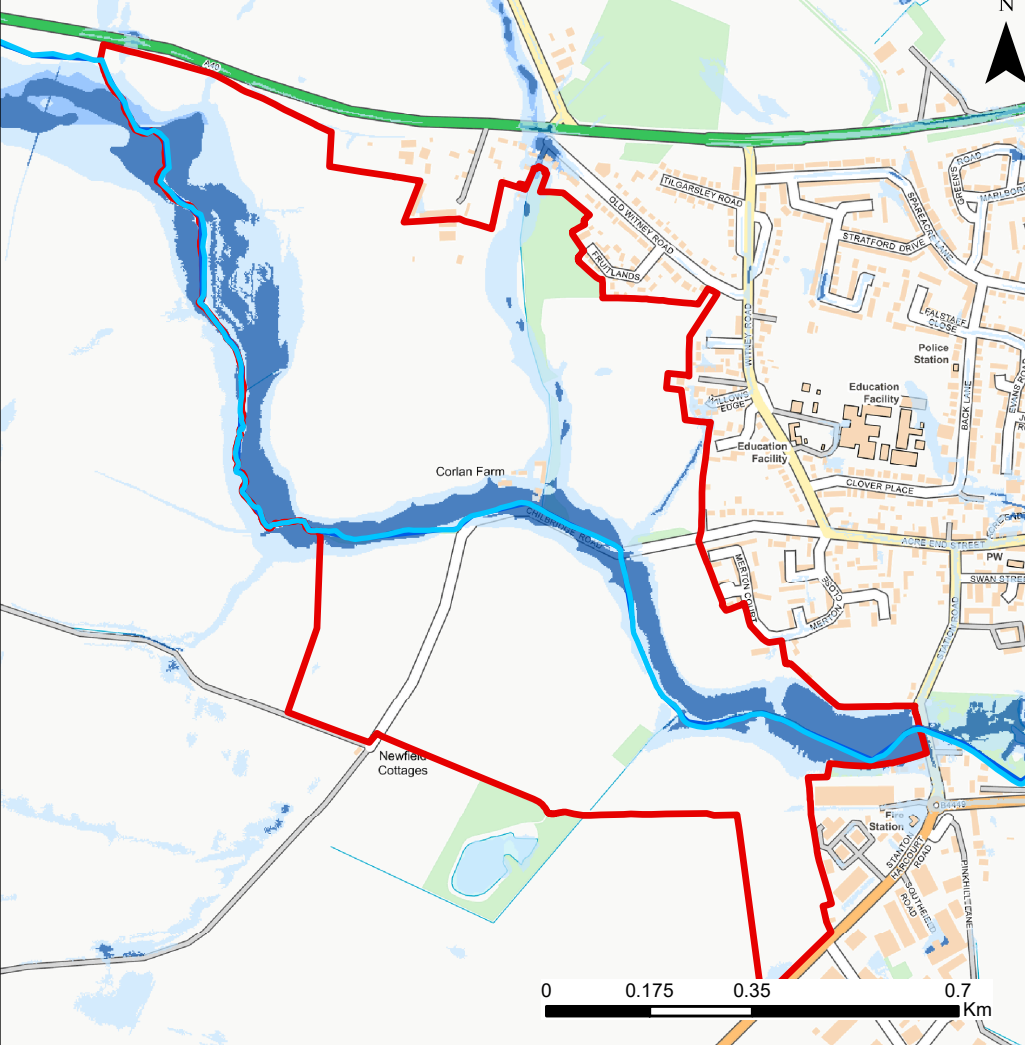
Site name	Land West of Eynsham
Site Code	9.5d

West Oxfordshire Strategic Flood Risk Assessment Level 2 - Site Summary Sheet Mapping

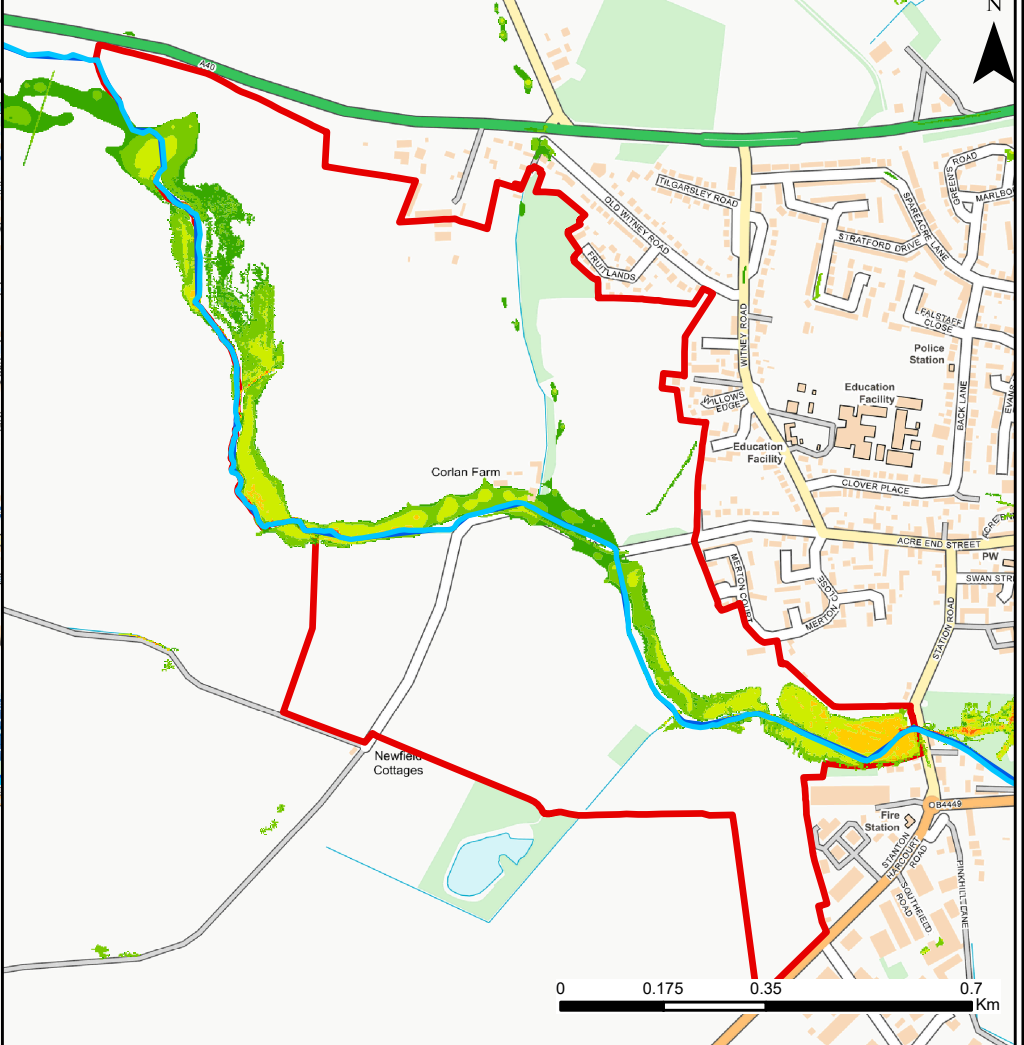


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Extent of Surface Water Flooding



Depth of Surface Water Flooding (3.33% AEP)



Main Rivers	RoFSW 1 in 30 year event (3.33%AEP)
Ordinary Watercourses	RoFSW 1 in 100 year event (1%AEP)
	RoFSW 1 in 1000 year event (0.1%AEP)

Main Rivers	Depth (m)	
Ordinary Watercourses	0.00 - 0.15	0.60 - 0.90
Site Boundary	0.15 - 0.30	0.90 - 1.20
	0.30 - 0.60	> 1.20

Site name	Land West of Eynsham
Site Code	9.5d

West Oxfordshire Strategic Flood Risk Assessment Level 2 - Site Summary Sheet Mapping

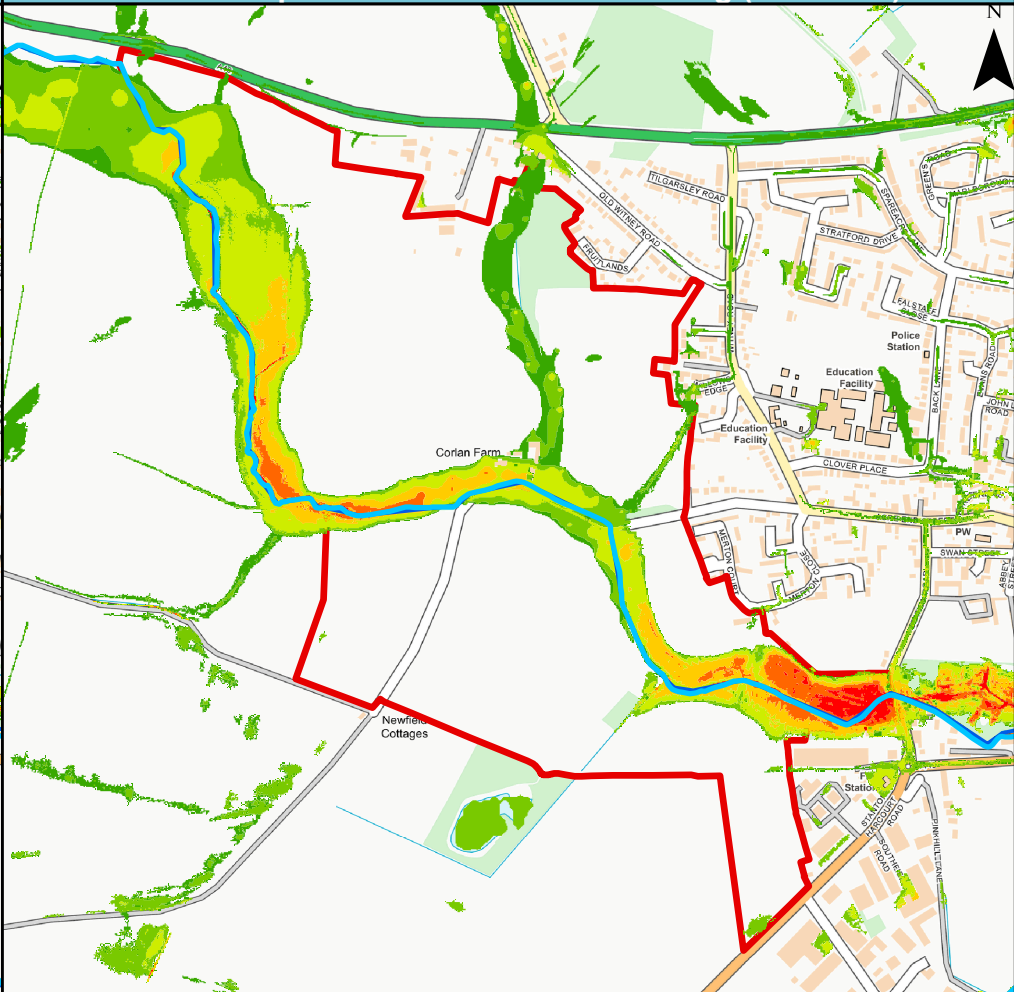


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Depth of Surface Water Flooding (1%AEP)



Depth of Surface Water Flooding (0.1%AEP)



Surface Water Depth (m)

	0.00 - 0.15		Main Rivers
	0.15 - 0.30		Ordinary Watercourses
	0.30 - 0.60		Site Boundary
	0.60 - 0.90		
	0.90 - 1.20		
	> 1.20		

0 0.175 0.35 0.7 Km

Surface Water Depth (m)

	0.00 - 0.15		Main Rivers
	0.15 - 0.30		Ordinary Watercourses
	0.30 - 0.60		Site Boundary
	0.60 - 0.90		
	0.90 - 1.20		
	> 1.20		

0 0.175 0.35 0.7 Km

C Lady Grove Lake High Level Breach Assessment

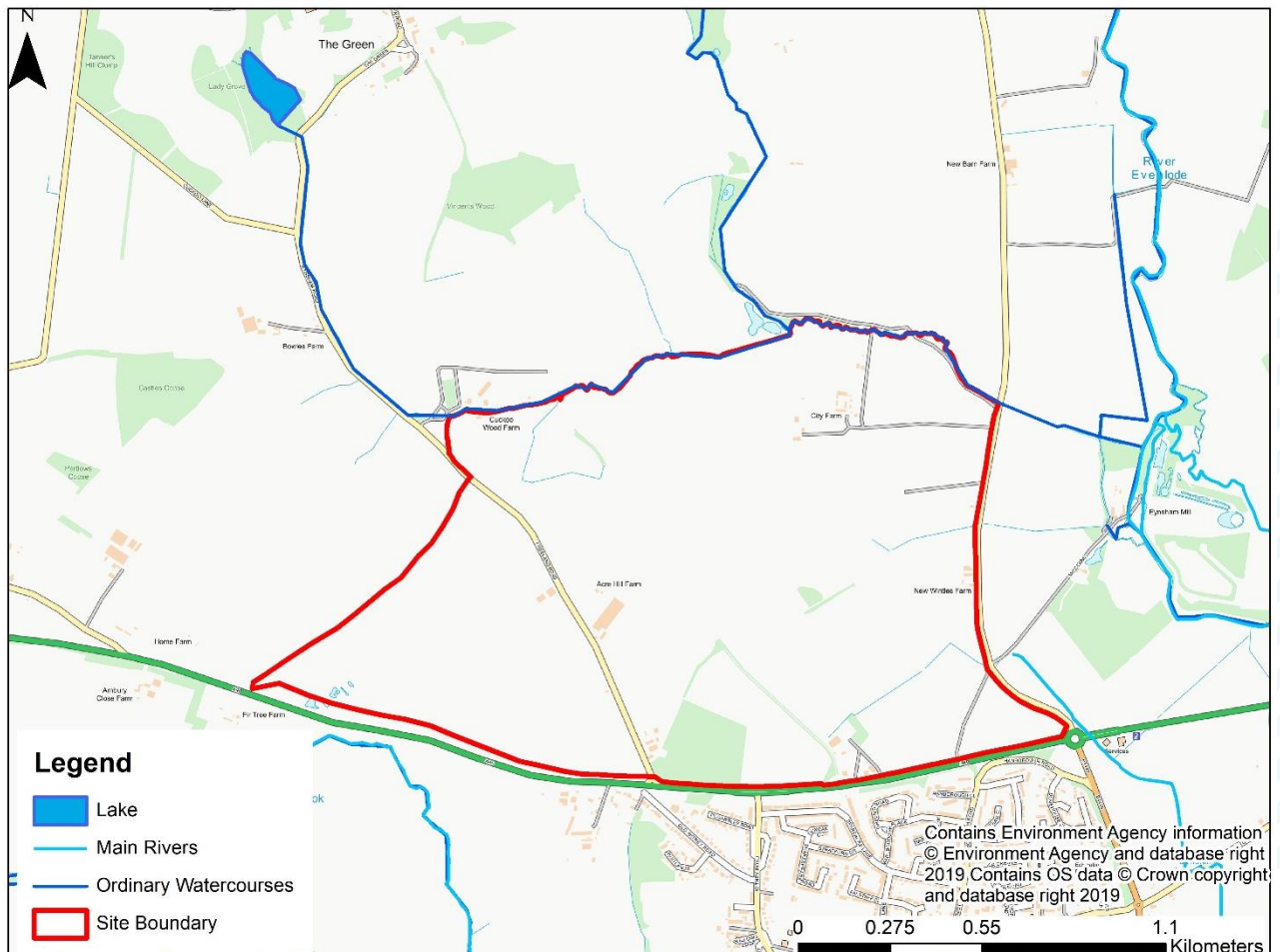
C Appendix C: High-level assessment of flood risk from Lady Grove Lake

C.1 Background to assessment

As part of the Level 2 Strategic Flood Risk Assessment (SFRA) for two Local Plan allocation sites in Eynsham, flood risks were assessed for the Oxfordshire Cotswolds Garden Village Site to the north of Eynsham.

The assessment identified a large waterbody located on Wroslyn Road, approximately 1km north west of the site, here referred to as Lady Grove Lake (Figure 1). As flood risk from the lake has not been assessed within the Environment Agency Reservoir Flood Outline mapping, it was assumed that the waterbody must hold less than 25,000m³ of water. As a result, the maintenance, inspection and emergency planning requirements associated with raised waterbodies over 25,000m³ in volume do not currently apply for this asset.

Figure 1: Location of the lake in relation to the Oxfordshire Cotswolds Garden Village Site



The potential flood risks associated with Lady Grove Lake were discussed with the Environment Agency as part of the SFRA. A recommendation from the Agency was to

undertake a 'high level assessment of the reservoir looking into its condition and some basic breach analysis to establish what, if any, impact it could have on the site'¹.

In line with the recommendation, this high-level assessment aims to assess the current condition of Lady Grove Lake and to determine any potential flood risks to the Garden Village Site in Eynsham, in the event of a lake breach.

C.2 Lady Grove Lake

C.2.1 Characteristics

Lady Grove Lake is located in the upper catchment of an unnamed ordinary watercourse. Topographic data suggests that the watercourse forms an inflow to the lake, however this is difficult to discern from mapping and aerial imagery, due to the heavily wooded areas surrounding the north of the lake.

Water is discharged from the lake into a narrow watercourse which runs along the north of Wroslyn Road (see Figure 2) before crossing the road to follow the southern side of Wroslyn Road and Cuckoo Lane. The watercourse continues south eastwards, flowing along the northern boundary of the Garden Village site and discharges into the River Evenlode east of Lower Road.

Figure 2: Outgoing watercourse for Lady Grove Lake, on northern side of Wroslyn Road.



¹ Correspondence with Environment Agency Thames Area Sustainable Places Team. Email dated 18/03/2019.

The lake was created in the early 19th century, as part of the landscaping for the grounds of Freeland Lodge². Current ownership of the lake is unknown, however the feature remains within the grounds of private property.

The lake has an area of over 17,000m², with water impounded by a straightened, raised embankment at the downstream extent of the lake.

Without access to the lake bed, the depth and capacity of the lake cannot be accurately calculated. Instead, a series of assumptions have been made to allow the lake to be represented within the breach assessment. These are summarised in Table 2.

As flood risk from the lake is not included in the Environment Agency Risk of Reservoir Flood Extent, it is noted that the lake must have a volume of less than 25,000m³. To provide a precautionary estimate of the lake volume, a capacity of 24,900m³, close to this threshold, has been assumed for the lake.

Table 1: Criteria used to represent Lady Grove Lake

Lake area (m ²)	Assumed lake depth (m)	Assumed lake capacity (m ³)	Embankment length (m)	Assumed embankment level (mAOD)	Assumed lake water level (mAOD)
17,436	1 - 2	24,900	104	89.8	89.5

A small number of residential properties are currently located downstream of the lake, however future development of the Garden Village site will change land uses, presenting the possibility of an increase in the number of receptors at risk of flooding from a reservoir breach.

C.2.2 Current condition of lake

Aerial imagery shows the lake to be overgrown on its northern, upstream end (Figure 3). Sedimentation appears to have taken place within the northern portion of the lake, as well as along the western boundary, allowing mature vegetation to become established within the lake itself. This growth has significantly reduced the surface area of the lake, which is likely to reduce its capacity to store water.

The lake water itself looks relatively stagnant, with algal bloom present in the centre and south of the waterbody. This suggests a reduction in flows from the watercourse which feeds the lake, or flows being restricted from reaching the lower lake, perhaps due to the heavy vegetation growth.

The condition of the embankment forming the southern boundary of the lake is difficult to ascertain, as the lake is situated on private land, and visibility is restricted by heavy tree coverage. However, the outgoing watercourse at Wroslyn Road appears clear of debris.

² A P Baggs, W J Blair, Eleanor Chance, Christina Colvin, Janet Cooper, C J Day, Nesta Selwyn and S C Townley, 'Eynsham: Other estates', in A History of the County of Oxford: Volume 12, Wootton Hundred (South) Including Woodstock, ed. Alan Crossley and C R Elrington (London, 1990), pp. 123-127. Available at: British History Online <http://www.british-history.ac.uk/vch/oxon/vol12/pp123-127>.

Figure 3: Aerial image of Lady Grove Lake



C.3 High-level assessment of breach risk

C.3.1 Method

Hydraulic model

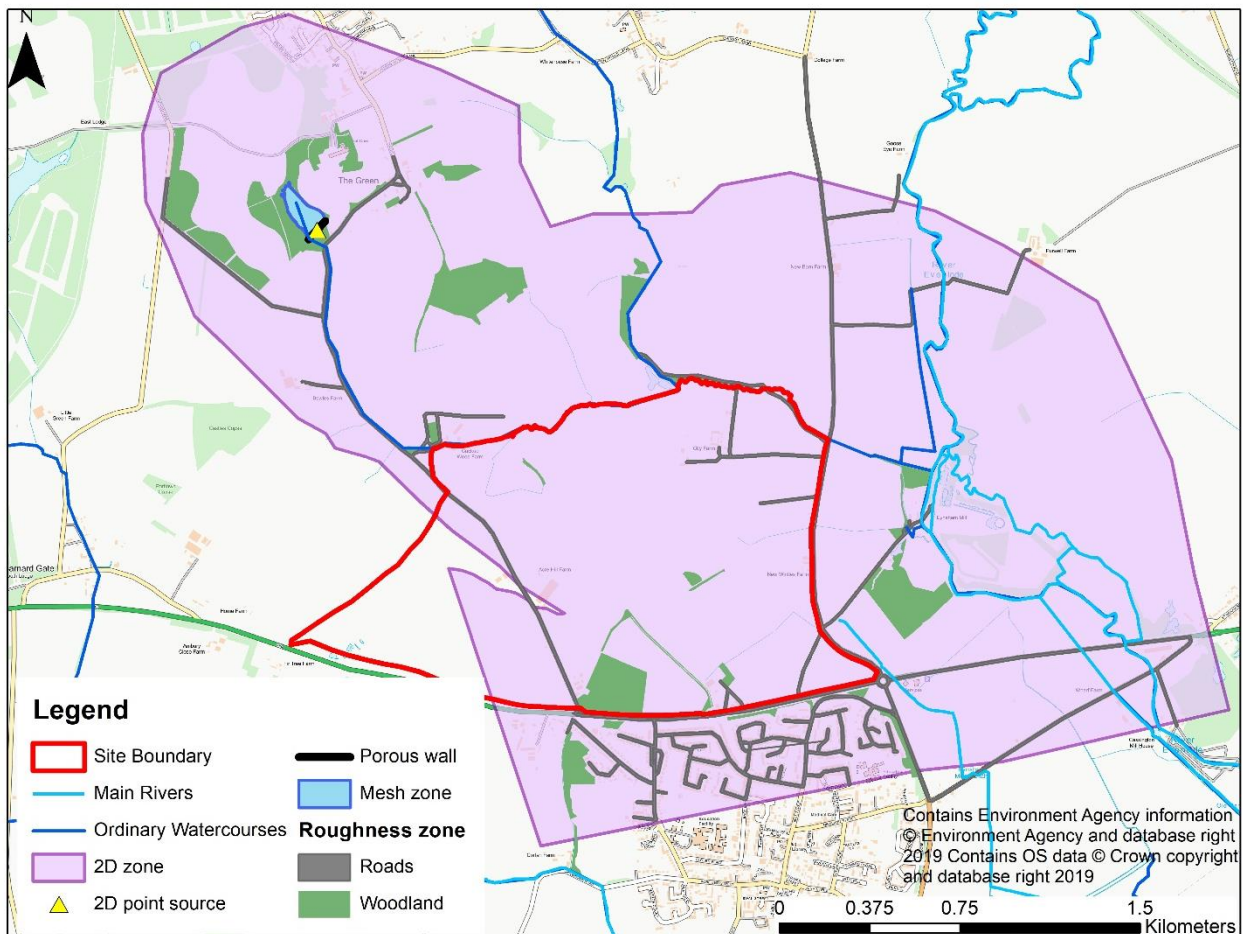
A simple hydraulic model of the lake and surrounding area was built using InfoWorks ICM software. An overview of the features modelled is provided in Table 2, with an overview of the schematisation shown in Figure 4.

Table 2: Overview of features represented in the Lady Grove Lake model.

Physical Feature	Model Features	Description
Lady Grove Lake	Mesh Zone Porous Wall (lake crest level) 2D point source	The lake was digitised from OS mapping and represented as a mesh zone, set to the estimated water level of 89.5mAOD. A porous wall was used to represent the reservoir crest. The reservoir breach flows were applied to the model as a 2D point source, positioned at the reservoir crest.
Buildings	Porous Polygons	The buildings were imported from OS VectorMap mapping of buildings.

Physical Feature	Model Features	Description
		The buildings represent a significant flow obstruction and therefore they were raised by 15cm to represent a property threshold , and a porosity of 30% set.
Roads	Roughness Zones	The roughness zones for roads were imported from OS VectorMap mapping. A Manning's n roughness value of 0.03 was applied.
Woodland	Roughness Zones	The roughness zones for woodland areas were imported from OS VectorMap mapping. A Manning's n roughness value of 0.13 was applied, to represent coppices of trees.
Topography	2D zone	The 2D zone was then divided into a mesh of elements, with each element taking its elevation from a Digital Terrain Model based on 1m LIDAR. The roughness of each element in the 2D model was set by overlying roughness zones, as described above. A Manning's n value of 0.08 was assigned to all surfaces outside a roughness zone, to represent the predominant grassland land use.

Figure 4: Schematisation of features in Lady Grove Lake breach model

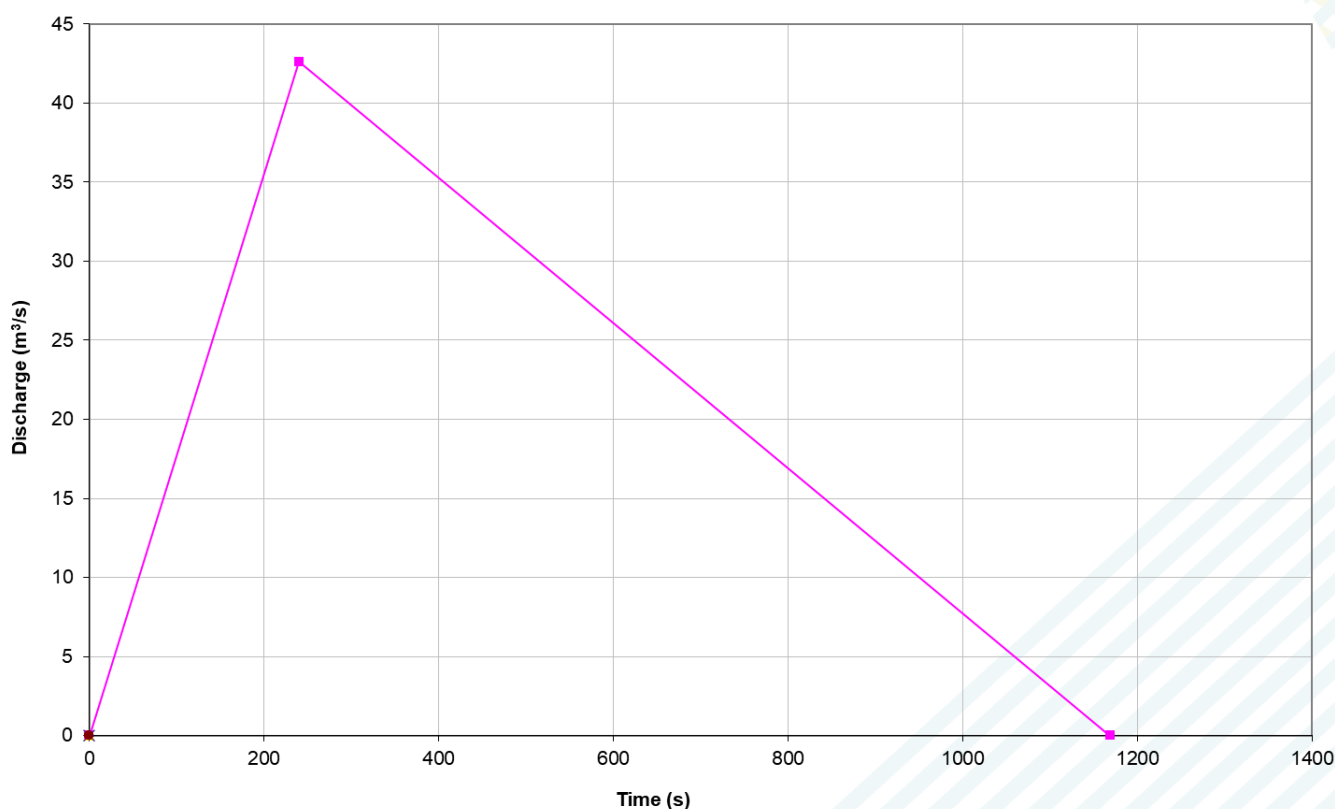


Breach Hydrology

A breach hydrograph was applied to the model, to represent the rapid discharge of water from Lady Grove Lake, in the event of its failure. The breach hydrology was calculated in line with Reservoir Flood Map (RFM)³ methodology, using the lake dimensions provided in Table 1.

The lake was classified as an impounded waterbody, contained by an earth embankment. Therefore, in line with RFM methodology, the breach scenario assumed that water is discharged from embankment at a depth of 0.5m. The resulting breach hydrograph is shown in Figure 5, with peak discharge of 43m³ estimated to occur 4-minutes into the breach event.

Figure 5: Breach hydrograph calculated for Lady Grove Lake



C.3.2 Results

Results indicate that a breach event on Lady Grove Lake would largely be confined within the topography of the existing floodplain of the watercourse at the Garden Village Site, with the breach flows extending beyond Flood Zone 2 (1 in 1,000-year fluvial flood extent) at the north western and north eastern corners of the site (Figure 6).

The depth (Figure 8) and hazard (Figure 7) of flooding is highest immediately downstream of Lady Grove Lake and along the northern boundary of the Garden Village site, where flows are routed through the deep channel of the watercourse.

The majority of breach flows then overtop Lower Road, at the east of the site, continuing onwards to the floodplain of the River Evenlode. During this overtopping, some flow is routed southwards at the upstream side of Lower Road, and is predicted to cause flooding to the low-lying areas alongside the eastern boundary of the site. However, depths remain

3 Defra (2014) Reservoir Flood Maps (RFM): External Guidance. LIT 6882. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/558441/LIT_6882.pdf

relatively shallow at this location (largely between 0.08 - 0.2m), with an isolated area around the northern site access road reaching a flood depth of 0.5m.

It should be noted that the volume of the lake is a precautionary estimate, and discharges may be lower, which would result in a reduced flood extent.

C.4 Implications for development of the Garden Village site

The breach of a raised waterbody is a rare event and very unlikely to occur. However, residual flood risks should be taken into account when planning the development of a site.

The following aspects should be considered within Flood Risk Assessments (FRAs) and future planning of the Garden Village site:

- Determine ownership of the lake, in partnership with West Oxfordshire District Council, the Environment Agency and Oxfordshire County Council as Lead Local Flood Authority, and clarify the maintenance regime undertaken by the lake owner.
- Site-specific FRAs for the Garden Village site will need to build on high level assessment undertaken, and provide evidence of how the residual risk of flooding from the lake will be managed on the site.
- Site-specific FRAs should prepare an emergency flood plan, taking into account access and egress from the site from all sources of flood risk, including the breach of Lady Grove Lake.

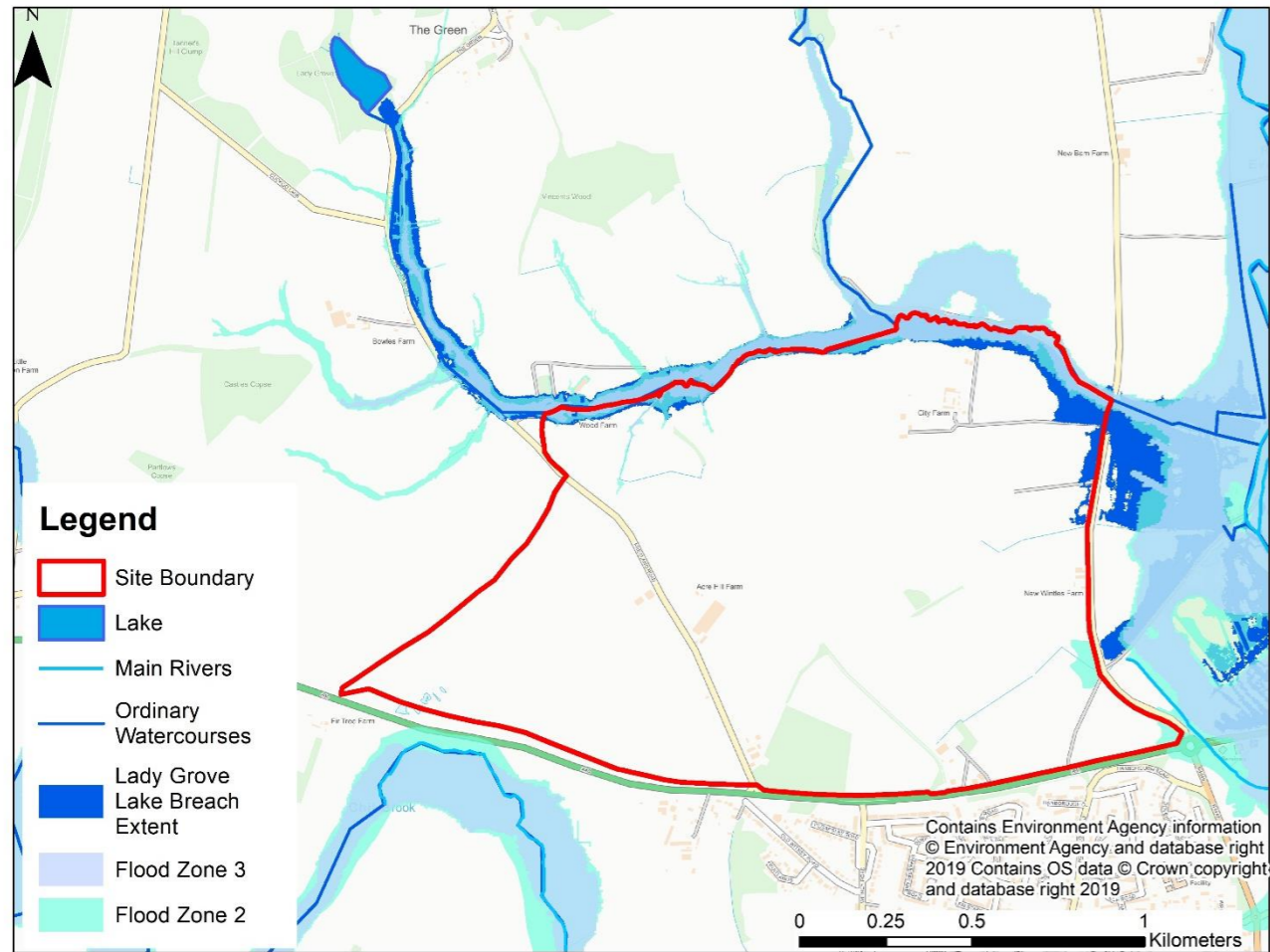


Figure 6: Modelled flood extent for the Lady Grove Lake breach scenario

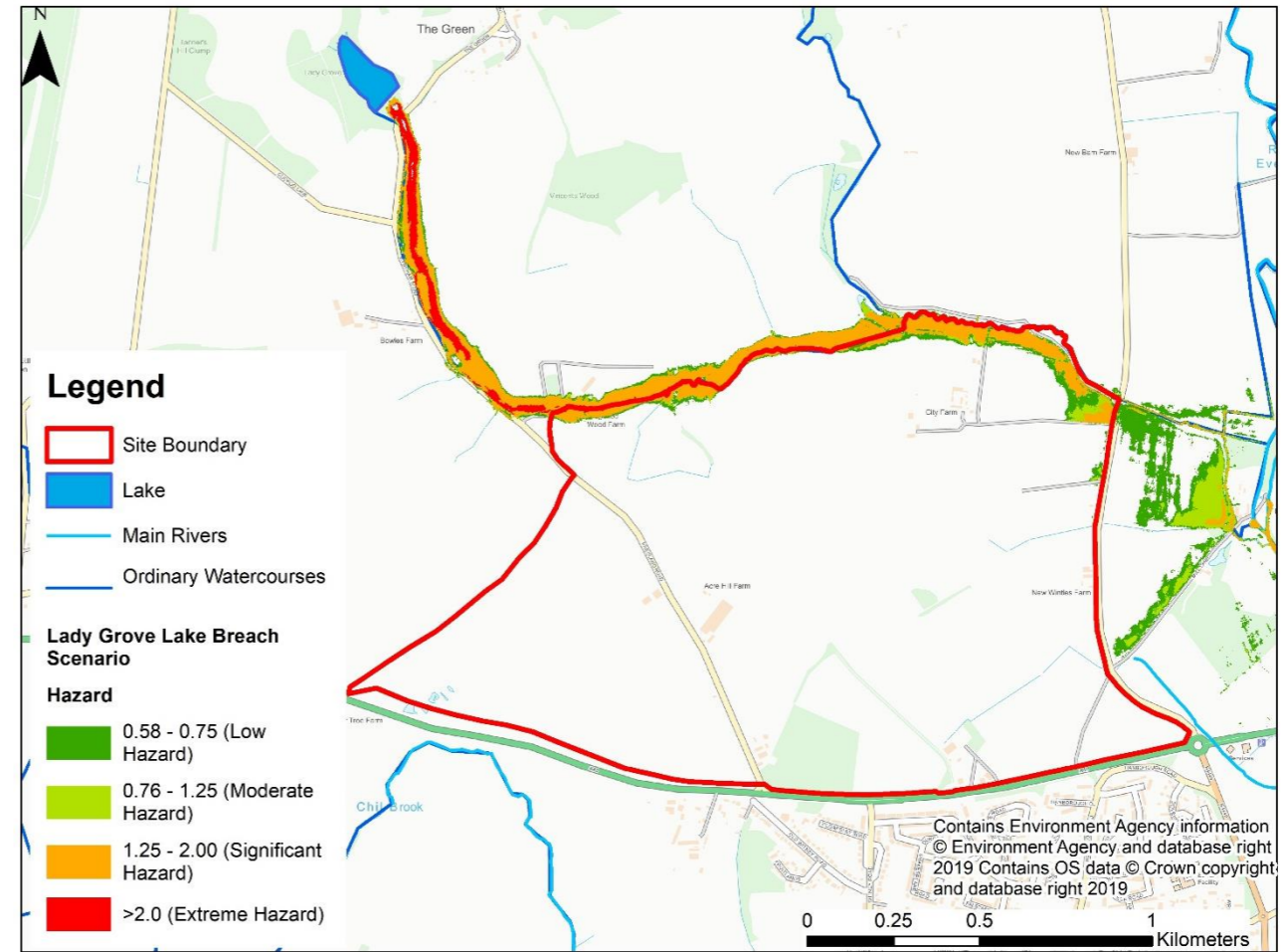
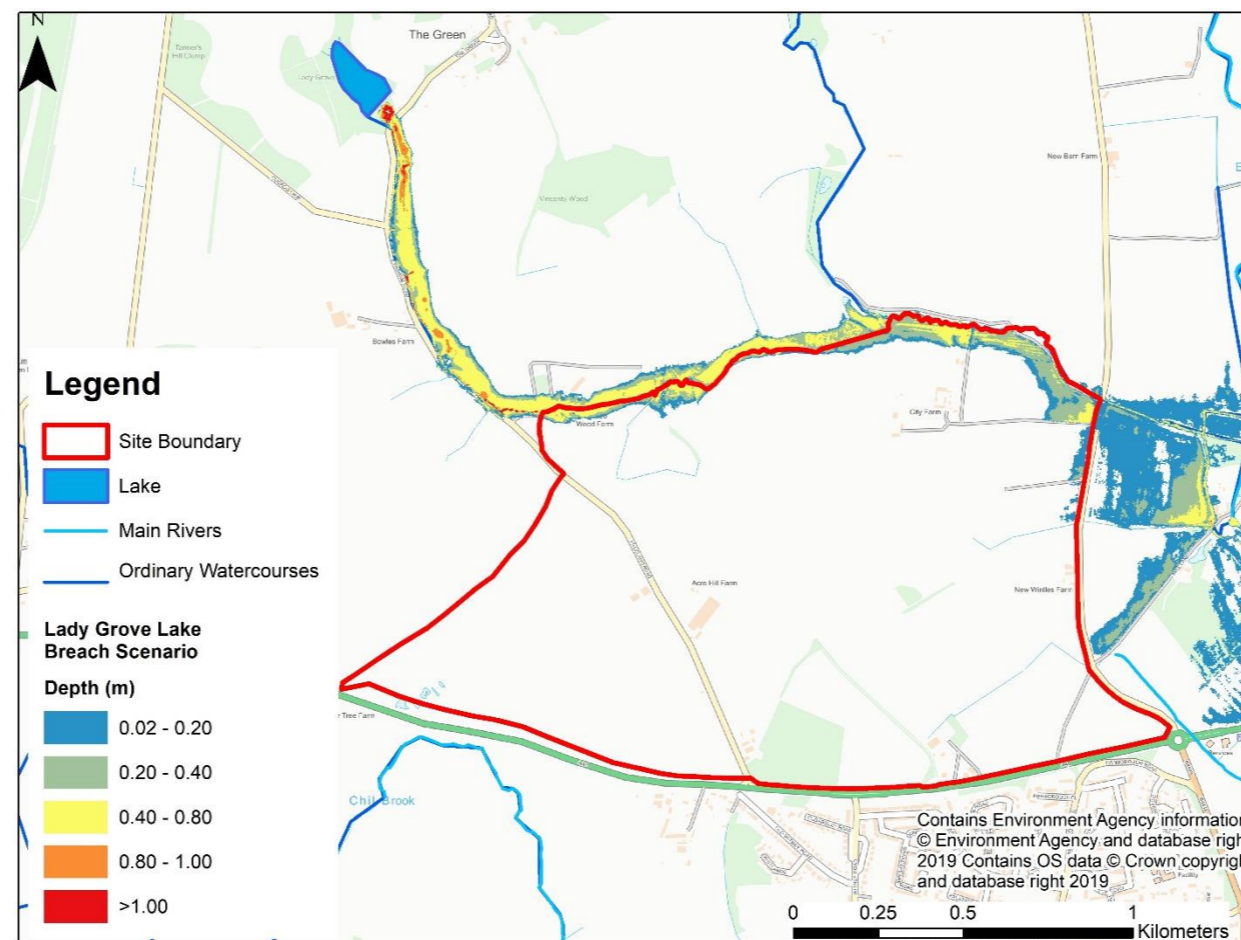


Figure 7: Modelled flood hazard for the Lady Grove Lake breach scenario

Figure 8: Modelled flood depth for the Lady Grove Lake breach scenario



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