# 16 Water Resources and Flood Risk

## 16.1 Introduction

16.1.1 This chapter of the ES assesses the likely environmental effects of the Proposed Development with respect to water resources and flood risk. This chapter also describes the methods used to assess the effects; the baseline conditions currently existing at the Site and surrounding area; the mitigation measures required to prevent, reduce or offset any significant adverse effects; and the likely residual effects after these measures have been adopted. The chapter is accompanied by:

- Appendix 16.1: Flood Risk Assessment (including Drainage Strategy)

16.1.2 A Flood Risk Assessment (FRA) for the Site has been prepared in accordance with the NPPF[1] and the accompanying National Planning Practice Guidance[2]. A Drainage Strategy has also been prepared which forms and appendix to the FRA (Appendix E), which provides information on how surface water from the Proposed Development will be managed to ensure existing surface water management and flood risk are not compromised. The Drainage Strategy also outlines proposals for the management of foul water from the Proposed Development.

16.1.3 A separate assessment of the potential effects on groundwater resources and groundwater quality is provided in Chapter 15: Ground Conditions and Contamination. This chapter considers groundwater and surface water in so much as they interact with land contamination. A summary of existing conditions on groundwater is provided within this chapter.

16.1.4 Ecological effects related to the water environment, including aquatic and terrestrial habitats and species, are assessed in Chapter 13: Ecology.

### Competence

16.1.5 This assessment has been written by Paul Norman and Andrea Gergely. Paul has seven years of experience working as an environmental consultant during which he has undertaken multiple water resources EIA chapters. He is a chartered environmentalist and a Full Member of the Institute of Environmental Management and Assessment (MIEMA).

16.1.6 Andrea is a graduate environmental consultant with a BSc in Nature Conservation Engineering (University of Debrecen), and an MSc in Environmental Management (Glasgow Caledonian University).

16.1.7 This assessment has been reviewed and signed off by Mark Crowther. Mark Crowther is Director Environmental Assessment and Management at Buro Happold. He has a BSc in Environmental Geology and an MSc in Catchment Dynamics and Management (River Hydrology). Mark has authored more than 50 water resource and flood risk assessments for EIAs, in addition to signing off multiple assessments authored by others. This assessment has been reviewed and signed off by Mark Crowther. Mark Crowther is Director Environmental Assessment and Management at Buro Happold. He has a BSc in Environmental Geology and an MSc in Catchment Dynamics and Management (River

Hydrology). Mark has authored more than 50 water resource and flood risk assessments for EIAs, in addition to signing off multiple assessments authored by others.

16.1.8 Both the FRA and drainage strategy have been produced and reviewed by experienced water and infrastructure engineers.

## 16.2 Legislation, Planning Policy and Guidance

### Legislation Context

16.2.1 The following legislation is relevant to the Proposed Development:

- The Water Resources Act (1991)[3];
- The Water Resources Act (Amendment) (England and Wales) Regulations (2009)[4];
- The Water Act (2014)[5];
- The Environment Act (1995)[6];
- The Environmental Protection Act (1990)[7];
- The Control of Substances Hazardous to Health Regulations (2002)[8];
- Flood and Water Management Act (2010)[9];
- The Anti-Pollution Works Regulations (1999)[10];
- The Water Supply (Water Quality) Regulations (2016)[11];
- The Control of Pollution (Oil Storage) (England) Regulations (2001)[12];
- The Water Environment (Water Framework Directive) (England and Wales) Regulations (2017)[13] ('WFD Regulations');
- The Environmental Damage Regulations (2009)[14];
- The Environmental Permitting (England and Wales) (Amendment (No. 2) Regulations (2016)[15];
- Future Water (2008)[16];
- Making Space for Water[17]; and
- Water for Life (White Paper) (2011)[18].

### Planning Policy Context

16.2.2 The following national, regional and local planning policy is relevant to the Proposed Development.

16.2.3 Appendix 16.1: Flood Risk Assessment includes further details in terms of Planning Policy Context.

#### National

- National Planning Policy Framework (NPPF) (2021)[19]; and
- National Planning Practice Guidance – Water Supply, Wastewater and Water Quality (2014)[20].

### Regional

- Environment Agency River Basin Management Plan: Thames River Basin District (2022)[21]; and
- Thames River Basin District Flood Risk Management Plan (2022)[22].

### Local

- Cherwell Local Plan 2011-2031 (2015)[23];
- Cherwell Local Plan 2011-2031 (Part 1) Partial Review - Oxford's Unmet Housing Need (2020)[24];
- Cherwell Level 2 SFRA Addendum[25]

### Guidance

16.2.4 The following guidance is relevant to the Proposed Development:

- National standards for sustainable drainage systems (2011)[26];
- Code of Practice for Works affecting the Canal & River Trust (2017)[27];
- Local Standards and Guidance for Surface Water Drainage on Major Development in Oxfordshire[28];
- Pollution Prevention Guidance (2009 – 2015) *withdrawn[29];*
- Construction Industry Research and Information Association Guidance (CIRIA) (2001 – 2017)[30];
- CIRIA -The SuDS manual (C753F) (2015)[31], and
- Flood risk and coastal change PPG (2022)[32].

## 16.3 Assessment Methodology

### Consultation

#### Pre-Application Consultation

16.3.1 Table 16.1 summarises key comments raised by consultees of relevance to this assessment during pre-application meetings and/or communication exchanges and how the assessment has responded to them.

Table 16.1: Consultation Response Summary

| Consultee and Comment | Response |
|---|---|
| *Environment Agency (October 2022)* | |
| Email correspondence with the Environment Agency (EA) advised that the current hydraulic modelling (which the EA flood maps are based on) is likely to be based on JFLOW data, which is not suitable for this Site-specific FRA. The EA instructed that detailed hydraulic modelling is required to support the outline planning application. | Detailed hydraulic baseline modelling was undertaken for this assessment and application. The Hydraulic Modelling Report is included in Appendix B of the Appendix 16.1: FRA. |

| Consultee and Comment | Response |
|---|---|
| *Environment Agency (16th November 2022)* | |
| Technical Note provided to the EA during pre-app:<br>▪ The EA requested that the Hydraulic Modelling Strategy Technical Note (dated 7th November 2022, provided by Buro Happold to the EA) be updated to include strong justification for each assumption within the proposed methodology.<br>▪ The EA recommended that the 'Central' allowance of 26% be tested as well as the 'Higher' allowance of 41% for peak river flow allowances to check that infrastructure classified as 'Essential' is not impacted.<br>▪ The EA confirmed a 300mm freeboard should be applied on top of the Design Flood Elevation level if permittable development located in Flood Zone 2 or 3.<br>▪ The EA advised that if development is in Flood Zone 1, a freeboard is not required to be applied. Although it was suggested to include this 300mm freeboard above the DFE level. | An initial Hydraulic Modelling Strategy Technical Note was shared with the EA on 9th November 2022. An updated Hydraulic Modelling Strategy Technical Note was shared with the EA and LLFA on 2nd December 2022, taking into account the EA's comments on the initial Note. At the time of writing this ES, Buro Happold have received no comment from the EA on the Hydraulic Modelling Strategy Technical Note.<br><br>The design criteria and guidance given by the EA has been adopted within the flood risk strategy. |
| *Canal and River Trust (21st November 2022)* | |
| The Canal and River Trust were consulted to obtain information for the assessment. This correspondence confirmed:<br>▪ That there are no current outfalls/ discharge points between Lock 42 and 44.<br>▪ Control levels given for the pounds above Lock 43 and 44, in the vicinity of the Site. | Information regarding Oxford Canal has been utilised within the hydraulic modelling. |

### EIA Scoping Opinion

16.3.2 A request for a Scoping Opinion was submitted by the Applicant to CDC on 9th December 2022. An EIA Scoping Report (the 'Scoping Report') accompanied the request (Appendix 3.2). A Scoping Opinion was issued by the CDC on the 27th of January 2023 (Appendix 3.3) which included comments from statutory consultees. Table 16.2 summarises key comments raised by consultees of relevance to this assessment and how the assessment has responded to them.

Table 16.2: EIA Scoping Opinion Response

| Consultee and Comment | Response |
|---|---|
| *Lead Local Flood Authority (LLFA) (27th January 2023)* | |
| A detailed surface water management strategy must be submitted in accordance with the Local | An outline surface and foul water drainage strategy has been undertaken in line with |

| Consultee and Comment | Response |
|---|---|
| Standards and Guidance for Surface Water Drainage on Major Development in Oxfordshire, and the Sustainable Drainage Systems (SuDS) Policy. | the standards referred to and is provided as an appendix to the FRA (Appendix 16.1: FRA (Appendix E)). |
| In line with this guidance, runoff must be managed at source (i.e. close to where it falls) with residual flows then conveyed downstream to further storage or treatment components, where required. The proposed drainage should mimic the existing drainage regime of the Site as much as possible. | This approach is embedded within the approach to the surface water drainage strategy (Appendix 16.1: FRA (Appendix E)). |
| A Site-specific Flood Risk Assessment (FRA) is also required for developments of 1 hectare or greater in Flood Zone 1; all developments in Flood Zones 2 and 3 or in an area within Flood Zone 1 notified as having critical drainage problems; and where development or a change of use to a more vulnerable class may be subject to other sources of flooding. | A surface water and foul water drainage strategy has been undertaken and is provided as an appendix the FRA (Appendix 16.1: FRA (Appendix E)). |
| The National Planning Policy Framework (NPPF), which was updated in February 2019 provides specific principles on flood risk (Section 14, from page 45). National Planning Practice Guidance (NPPG) provides further advice to ensure new development will come forward in line with the NPPF. As stated in Paragraph 158 of the NPPF, we will expect a sequential approach to be used in areas known to be at risk now or in the future from any form of flooding. | This is embedded within the approach taken in the FRA (Appendix 16.1). |
| Space must be made for shallow conveyance features throughout the Site and by also retaining existing drainage features and flood flow routes, this will ensure that the existing drainage regime is maintained, and flood risk can be managed appropriately. | This approach embedded within the surface water elements of the Drainage Strategy (Appendix 16.1: FRA (Appendix E)). |
| By the end of the Concept Stage evaluation and initial design/investigations Flows and Volumes should be known. | Flows and volumes for flood management, surface water drainage and foul water drainage have been calculated based on best-practice methods. Further details are included in the FRA and Drainage Strategy. |
| *Oxford County Council Property (27th January 2023)* | |
| No area of the school Sites shall be located in flood zones 2 or 3 which are located towards the east of the Site and consideration must be given to this when proposing the school location. | This requirement is adhered to and reflected in the proposed siting of the school Sites. |

| Consultee and Comment | Response |
|---|---|
| *Canal and Rivers Trust (27th January 2023)* | |
| The role and opportunity of the Canal Corridor in the provision of water through the construction activity has been highlighted by the Canal and Rivers Trust. | Noted. |
| *Thames Water (27th January 2023)* | |
| Thames Water are satisfied that the report has considered the water and sewerage needs of the development as set out in The EIA Regulations 2017 Schedule 4. | Noted. |
| *Natural England* | |
| The assessment should take account of the risks of water pollution and how these can be managed or reduced. A number of water dependent protected nature conservation Sites have been identified as failing condition due to elevated nutrient levels and nutrient neutrality is consequently required to enable development to proceed without causing further damage to these Sites. The ES needs to take account of any strategic solutions for nutrient neutrality or Diffuse Water Pollution Plans, which may be being developed or implemented to mitigate and address the impacts of elevated nutrient levels. Further information can be obtained from the Local Planning Authority | The assessment considers impacts on water quality on water receptors within the Site and within surrounding sites where there are any hydrological connections. This includes SSSI designations north and south of the Site. All receptors, with the exception of a semi-culverted drainage ditch in the south of the site, have been classified as highly sensitive and assessed on that basis. |

## 16.4 Summary of Assessment Scope

16.4.1 This chapter assesses the potential significant effects of the Proposed Development on the surrounding water environment and the potential effects of the water environment on the proposals and its users. This includes an assessment of the potential changes in water supply, foul drainage, surface water drainage, pollution prevention and flood risk.

16.4.2 A WFD compliance assessment is proposed to be scoped out as it is not considered that any activities will be undertaken as part of the development that will include works or modifications to the Oxford Canal water body.

16.4.3 The current drainage arrangements for the Site have been reviewed as part of the drainage strategy, which has been developed for the Proposed Development in consultation with the LLFA. Appropriate consultation has been held with Thames Water (TW) Utilities Limited (foul water and surface water) to agree connections and flow rates.

16.4.4 As outlined within the EIA Scoping Report (Appendix 3.2), and as agreed with CDC via the EIA Scoping Opinion (Appendix 3.3), the scope of the ES within this chapter is limited to the following assessment of effects:

### Construction

16.4.5 The scope of the assessment of impacts and effects as a result of the construction phase includes the following aspects:

- Effects on water quality of water bodies – including within the Rushy Meadows SSSI area – due to localised changes in surface water flow regime during rainfall events, deterioration of the quality of surface water runoff from the Site, and accidental leaks and spillages of hazardous materials;
- Impacts on flood risk to construction workers and plant; and
- Demand and supply on water network.

### Completed Development

16.4.6 The scope of the assessment of impacts of the Proposed Development once it is operational includes the following aspects:

- A change in surface water discharge rates which may influence flood risk to the Site, adjacent Sites, and areas downstream, including surface water runoff and hydrological changes affecting Rushy Meadows SSSI;
- The vulnerability of the Proposed Development to flood risk;
- Change of surface water flow regime across the Site changing capacity requirements for surface water sewer network;
- Change in the quality of surface water run-off, which may influence the quality of nearby water bodies; and
- Increased potable water demand and foul water demands from the Proposed Development placing pressure on existing infrastructure.

### Non-Significant Effects

16.4.7 The EIA Scoping Report made reference to the Kingsbridge Brook, the River Cherwell and the River Evenlode, listing them as possible receptors depending on water infrastructure connections. At the time of writing the Scoping Report, there was no confirmation on where surface or foul water would be discharged. The drainage strategy has now been developed to ensure that there will be no connectivity to the River Cherwell or River Evenlode. Therefore, these water bodies are not considered further in this assessment.

16.4.8 Potential impacts and effects on aquifers or groundwater are not included as these are addressed in Chapter 12: Ground Conditions and Contamination.

## Study Area

16.4.9 The study area and Zone of Influence ('ZoI') covers all water bodies present on the Site, as well as other natural water bodies hydrologically connected to the Site through surface run-off or connections through sewer infrastructure. These receptors are listed and shown in maps found within the baseline conditions section. This ZoI has been defined to capture

any potential pollution and flood linkages as a result of changes to the surface water flows and management regime during construction and operation of the Proposed Development.

### Establishing Baseline Conditions

16.4.10 The baseline assessment considers the existing conditions both on and around the Site. Data has been gathered from the following sources:

- Site visits on the 23rd August 2022, and the 12th October 2022 (Photos taken during the site visits are shown in Figure 16.1, and in Figure 16.2);
- Ground Investigation (GI) studies undertaken by Hydrock (2022)[33], (2023)[34]
- A review and summary of relevant international, national and local legislation and policy relating to the water environment;
- Review of relevant CDC Local Plan studies, including:
  - Rushy Meadows SSSI – Hydrological & Hydrogeological Desk Top Study (DTS) (2018)[35];
  - Cherwell Water Cycle Study (AECOM, 2019)[36];
- Consultation with the EA and LLFA;
- Information from the following sources:
  - EA Flood Mapping[37]
  - LLFA data on ordinary watercourses[38]
  - WRSE consultation documents[39]
  - EA data on current quality of existing surface water features in line with the requirements of WFD;
  - Cherwell Level 2 Strategic Flood Risk Assessment (AECOM, 2018)[40];
  - Review of existing permitted discharges and surface and ground water abstractions;
  - Infiltration study (soil infiltration rate assessment) (Hydrock, 2021); and

16.4.11 A detailed FRA and drainage strategy informs the baseline study and form appendices to this ES Chapter.

Figure 16.1: Photo of the Oxford Canal, taken during the second site visit

Figure 16.2: Ditch culverted under a road on site (photo taken during second site visit)

## Assessing Likely Significant Effects

16.4.12 Assessment criteria incorporates the consideration of receptor sensitivity, the magnitude of change upon it and an evaluation of the resulting effect significance. The likely impacts and magnitude of change and significance of environmental effects have been defined for both the construction and operational phases. A matrix is used to determine the overall effect significance as presented in the Determining Effect Significance section of this chapter.

16.4.13 The same approach to assessment of effects is employed for both the construction and operational (completed development) effects.

16.4.14 The baseline year for the EIA is 2023, with the Site in its current state. Effects are considered both during the construction and operational phases of the Proposed Development. Effects are assessed in the context of whether they are permanent, temporary, direct or indirect.

### Construction

16.4.15 The methodology adopted in this assessment involves the following:

- Review of international, national and local legislation, policies and guidelines in relation to water resources, water quality and flood risk;
- Establishment of baseline conditions on and around the Site through literature review and analysis of existing data obtained from the EA and TW;
- Identification of sensitive receptors through desk study and consultations as reported within FRA and the Drainage Strategy for the Proposed Development and summarise in the ES chapter;
- Identification of risks to water quality, water resources and flooding from the Proposed Development and hence the likely magnitude of change and significance of environmental effects during both the construction and operational phases;
- Proposed Development of mitigation strategies through consultation with the design team;
- Identification of opportunities for enhancement of surface water quality and surface water management through design and mitigation; and
- Identification of residual effects and identification of cumulative effects.

16.4.16 Impacts during construction can happen at various points depending on the activities and processes being undertaken. The temporal scope for the assessment of construction effects covers the whole of the construction period from enabling works through to completion of the final stages of construction.

16.4.17 The EA instructed that detailed hydraulic modelling is required to support the Outline Planning Application. Therefore, a Baseline Hydraulic Modelling has been undertaken to produce flood mapping to provide more accurate definition of the flood zones than those provided by the EA flood maps. The building of the baseline hydraulic model includes but not limited to:

- Derivation of input hydrographs for inflow points into the hydraulic model;
- Derivation of the rainfall hyetographs for Site rain on grid inputs, or on-Site inflow hydrographs;

- Preparation of the ground surface for the model based on the topographic information (survey/LiDAR)
- Development of material layers (2d) and roughness values (1d)
- Incorporation of hydraulic structures into the model, in 1d or 2d depending on modelling methodology
- Definition of the downstream boundary conditions for the hydraulic model
- Simulation of models for the following scenarios:
- 1 in 30 year
- 1 in 100 year
- 1 in 100 + CC (assume for 2 scenarios of Central and Higher Central for 2080s)
- 1 in 1000 year
- Confirmation of the model sensitivity to key parameters

16.4.18 Further details regarding the Baseline Hydraulic Modelling are included in Appendix B of the Appendix 16.1: FRA.

### Completed Development

16.4.19 The water environment is unlikely to change between now and the completion / future baseline year of 2033, so the water feature receptors considered in the construction assessment are the same as those considered in the completed development assessment. The completed development assessment also considers the water supply based on increased demand as well as the capacity of water infrastructure, and flooding impacts on people and property.

### Cumulative Effects

16.4.20 The cumulative assessment for water resources and flood risk considers the potential impact of all proposed cumulative schemes being developed. The cumulative schemes are listed in Appendix 3.4 From a construction perspective, it will qualitatively assess the combined effects of the cumulative schemes that share common receptors, in a scenario where construction is occurring simultaneously. Similarly, the operational assessment will consider all schemes that share common receptors.

## Determining Effect Significance

16.4.21 This section details the methodology employed in the assessment of effects relevant to construction and the completed Proposed Development.

16.4.22 These tables present standard criteria used in EIA assessment of Water Resource and Flood Risk, and have been derived from International and National policies listed in the Policy and Guidance section of this report.

### Sensitivity of Receptor

16.4.23 The qualitative criteria used to assess receptor sensitivity is described in Table 16.3.

Table 16.3: Receptor Sensitivity Descriptors

| Sensitivity | Criteria |
|---|---|
| High | Water body of high amenity value, including areas of bathing and water sports are regularly practiced.<br>Water body of good or high chemical or ecological status. Includes designated bathing waters, shellfish and salmonid fisheries.<br>A source used for public water supply or designated as a source protection zone.<br>Site of Special Scientific Interest (SSSI), Special Protection Area (SPA)/Special Area of Conservation (SAC), Ramsar Site or highly sensitive aquatic ecosystem.<br>Water bodies currently failing water quality objectives.<br>Areas which are highly vulnerable. With reference to flood risk. These can include essential infrastructure, emergency services and basement dwellings. |
| Moderate | Water body of moderate amenity value including public parks, boating, non-contact sports, popular footpaths adjacent to water courses, or water courses running through housing developments/town centres.<br>Water body of moderate ecological status and/or non-public water supply or cyprinid fishery.<br>Water body of nature conservation importance at the regional level or a moderately sensitive aquatic ecosystem e.g. Site of Nature Conservation Interest (SNCI).<br>Areas which are more vulnerable. With reference to flood risk, these can include hospitals, residential units, educational facilities and waste management Sites. |
| Low | Water body of poor ecological status.<br>A source in close proximity to a source protection zone or abstraction point.<br>Water body of particular local social/cultural/educational interest.<br>Water body of low amenity value with only casual access, e.g. along a road or bridge in a rural area.<br>Areas which are less vulnerable. With reference to flood risk, these can include retail, commercial and general industrial units, agricultural/forestry Sites and water/sewage treatment plants. |
| Negligible | Low sensitivity aquatic ecosystem.<br>Water of poor ecological status.<br>Water body of no amenity value, seldom used for amenity purposes, in a remote or inaccessible area.<br>Areas which are considered to be water-compatible. With reference to flood risk, these can include flood control infrastructure, docks/marinas, pumping stations and recreational/landscape areas. |

### Magnitude of Impact

16.4.24 The qualitative criteria used to assess how far an effect deviates from the baseline condition, i.e. the magnitude of change, are described in Table 16.4.

Table 16.4: Magnitude of Impact Descriptors

| Magnitude | Criteria |
|---|---|
| Large | Wholesale changes to the watercourse channel, route or hydrology.<br>Significant changes to soil erosion or sedimentation patterns.<br>Major changes to the water chemistry of surface run-off and groundwater.<br>Changes to Site resulting in an increase in discharge/run-off with flood/sewerage exceedance potential.<br>A large increase to flood risk of water bodies and areas downstream. A large risk of flooding to Site infrastructure and users, as determined by an on-Site FRA in accordance with NPPF.<br>Changes to Site resulting in an increase in discharge/run-off with flood/sewerage exceedance potential.<br>A large increase to flood risk of water bodies and areas downstream.<br>A large risk of flooding to Site infrastructure and users, as determined by an on-Site FRA in accordance with NPPF. |
| Medium | Some fundamental changes to the watercourse and hydrology.<br>Moderate changes to soil erosion or sedimentation patterns.<br>Moderate changes to the water chemistry of surface run-off and groundwater.<br>Changes to Site resulting in an increase in discharge/run-off within system capacity. A medium increase to flood risk of water bodies and areas downstream.<br>A medium risk of flooding to Site infrastructure and users, as determined by an on-Site FRA in accordance with NPPF. |
| Small | Minor changes to the watercourse.<br>Minor changes to soil erosion or sedimentation patterns.<br>Minor changes to the water chemistry of surface run-off and groundwater.<br>Changes to Site resulting in slight increase in discharge/run-off well within drainage system capacity.<br>A small increase to flood risk of water bodies and areas downstream.<br>A small risk of flooding to Site infrastructure and users, as determined by an on-Site FRA in accordance with NPFF. |
| Negligible | No change to the watercourse, run-off and soil erosion and sedimentation patterns and water chemistry.<br>Very minor to no change in discharge run-off and increased pressure on sewer capacity.<br>No increased flood risk to water bodies and areas downstream.<br>No risk of flooding to Site infrastructure and users, as determined by an on-Site FRA in accordance with NPPF. |

### Assessing Significance

16.4.25 The significance of a potential effect is derived by considering both the sensitivity of the feature and the magnitude of change, as demonstrated in Table 16.5.

Table 16.5: Matrix for Determining Effect Significance

| | | Magnitude of change / impact | | | |
|---|---|---|---|---|---|
| | | **Large** | **Medium** | **Small** | **Negligible** |
| Receptor sensitivity | **High** | Major | Major | Moderate/Minor | Negligible |
| | **Moderate** | Major | Moderate | Minor | Negligible |
| | **Low** | Moderate/Minor | Minor | Minor | Negligible |
| | **Negligible** | Negligible | Negligible | Negligible | Negligible |

16.4.26 Moderate and major effects are considered to be 'significant'.

### Assumptions and Limitations

16.4.27 The water environment is well understood for the purpose of this assessment. The understanding with regard to flood risk, foul water drainage and surface water drainage has been informed though a number of best practice modelling techniques where necessary, to produce the best accurately available baseline and future scenario.

16.4.28 Within the Site allocation in the Local Plan, it is recognised that there should be a provision for a bridge crossing over the Oxford Canal to allow a connection between the Proposed Development and the land to the south east of the canal. This bridge is not being proposed as part of this outline planning application and therefore has not been considered as part of the FRA or ES chapter. The bridge will be brought forward in a separate planning application by Network Rail and an FRA will need to be undertaken to assess the impact of the proposed bridge and outline any mitigation required.

16.4.29 It has been assumed that Thames Water has taken future impacts of climate change into account when reviewing water supply and wastewater capacities.

## 16.5 Baseline Conditions

### Existing Land Use

16.5.1 Chapter 2: Site and Setting provides a description of the current Site use. The majority of the Site is currently in agricultural use for arable farming and includes access roads and nine farm buildings which are likely to be demolished. Begbroke Science Park is located within the central northern portion of the Site, and it comprises of a number of one and two storey buildings which accommodate laboratories, engineering facilities and administrative buildings. The Cherwell Valley railway line passes through the Site on an approximate north-south alignment. The Site is approximately 170ha, of which about 80ha is considered to be developable land within which development can more easily located and which has les environmental constraints.

### Existing Site Levels

16.5.2 The topography of the Site is relatively level, although it rises within central areas, around the northern edge of Yarnton. It ascends to its highest point along Sandy Lane, near to the northeast edge of Yarnton, at approximately 69m AOD. The Site's topography falls gently towards its eastern boundary (at approximately 63m AOD); and to the fields within the southern extent of the Site (approximately 61m AOD). The wider topographical context of the Site is characterised by an undulating plateau landform, with a series of broad river valleys. Within this context, the Site and the adjoining settlements are located upon low-lying areas of land that forms part of the wider broad valley basins.

16.5.3 Key features of the Site topography include:

- BSP sits at the highest point of the Site. The surrounding land falls away in all directions towards low points at Rowel Brook, Hallam Land and the Network Rail boundary.
- Sandy Lane forms an east-west topographical ridge which intercepts surface water flowing north-south.

16.5.4 For more details on topography refer to Chapter 15 Ground Conditions and Contamination.

### Existing Surface Water and Foul Water Drainage

#### Existing Surface Water Features

16.5.5 The Site lies within the Ock Operational Catchment which is within the Thames River Basin District. The River Ock itself is over 15km south of the Site and is therefore not considered to be a receptor for this assessment. There are a number of surface water bodies within and surrounding the Site which comprise the surrounding surface water environment, as shown in Figure 16.3.

16.5.6 The Oxford Canal borders much of the Site to the east and forms a natural barrier between the Site and Kidlington. Kingsbridge Brook (classified by the EA as a Main River) is connected to the Oxford Canal and merges with it approximately 225m south of the Site. Rowel Brook (Main River) is a small stream which runs through the north of the Site between the Oxford Canal at Kidlington and Begbroke. This runs parallel to Oxford Canal and recrosses the Site, running along a ditch/culvert parallel to Kidlington Lane (part of the Eastern Drainage Ditches) and the Site boundary. It then diverts and runs along the track parallel to the south-western Site boundary. In the southern area of the Site there are some ditches and culverts which are also classified as Main Rivers by the EA. These include a ditch/culvert (part of the Eastern Drainage Ditches) which crosses the railway line to the east of the Site.

16.5.7 On the north-eastern boundary of the Site and adjacent to the Oxford Canal is Rushy Meadows SSSI – an unimproved alluvial grassland with meadows with fen communities. A small watercourse (Thrupp Ditch) runs through the SSSI, flowing in a north-south direction, and converges with Rowel Brook to the south of the SSSI boundary.

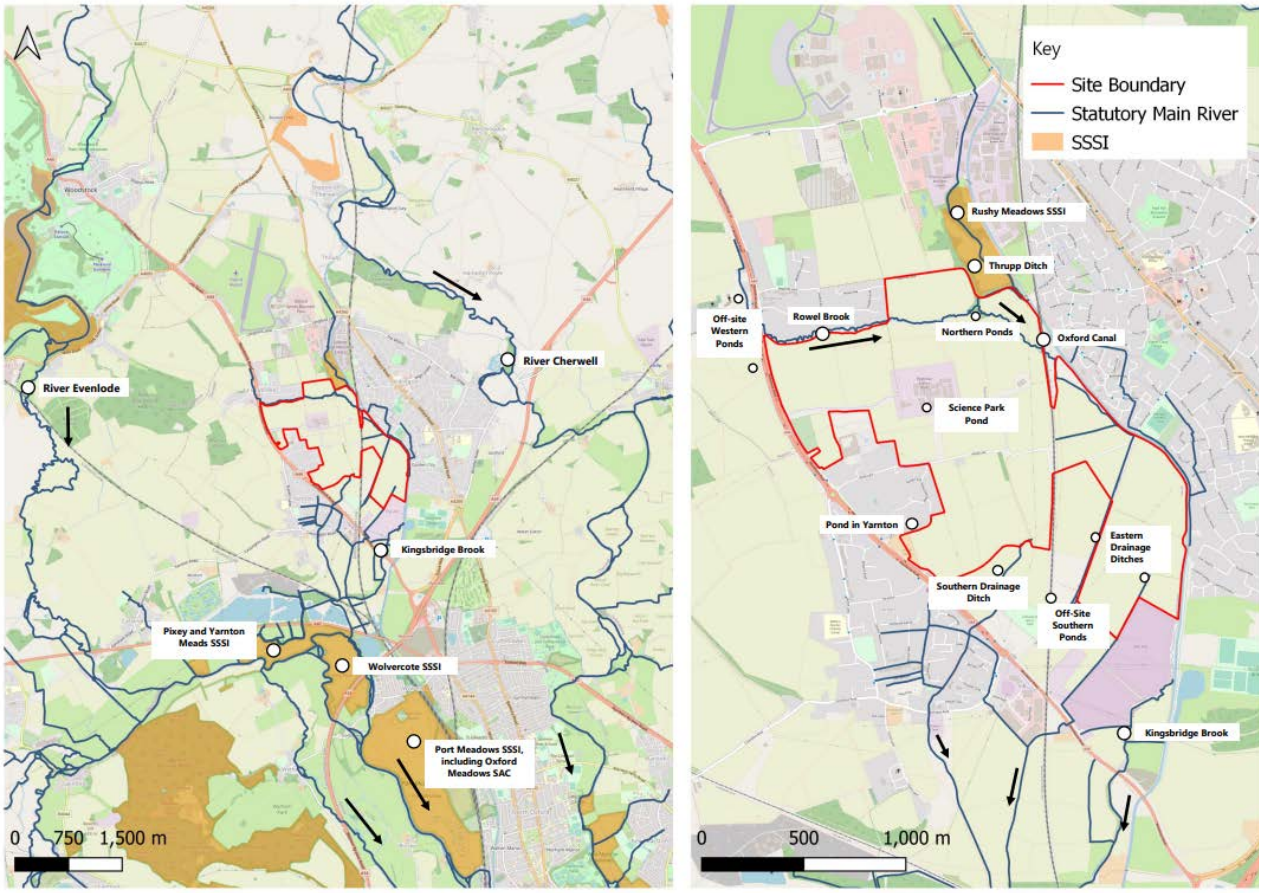
16.5.8 A further ditch/culvert, the Southern Drainage Ditch, also classified as a Main River, runs along the eastern boundary of the Little Marsh Playing Field car park, circa 260m south of the Site.

16.5.9 On-site ponds: The Ecological Baseline Report[41] identifies six ponds within the site, one of the ponds is classified as Habitats of Principal Importance (HPI) in England. The presence of Great Crested Newt (GCN) makes the pond at Begbroke Science Park (referred to in report as Science Park Pond) a HPI, despite the fact that is it is a formal pond with ornamental fish and heavy pumped un ultraviolet filtration. The other five ponds on-site were subject to eDNA survey returned negative results, indicating the absence of GCN. There are three artificial ponds in the northern part of the site (Northern Ponds) with one of them having received excellent suitability score using the Habitat Suitability Index.

16.5.10 Off-site ponds: There is a pond in Yarnton, 45m from the western boundary of the Site (Pond in Yarnton), having received excellent suitability score using the Habitat Suitability Index. There are also two adjacent former settlement ponds between Kidlington Lane and the Cherwell Valley railway line (Off-Site Southern Ponds), approximately 70m south of the Site at its closest point. These ponds have potential ecological connectivity to the Site for GCN but were not accessible for survey due to third-party ownership. There are two ponds on the western part of the site (Off-Site Western Ponds), 190m and 70m north of the Site at its closest point. Although they were not surveyed for the presence of GCN, they received excellent suitability score using the Habitat Suitability Index.

16.5.11 There is another pond 280m to the north of the Site, likely to be former settlement ponds but too far away to be relevant to this assessment.

Figure 16.3: Key Water bodies considered relevant to the assessment




## Existing Surface Water Drainage Features

16.5.12 There are two watercourses on the northern and southern extents of the Site respectively. Both are designated by the EA as 'main rivers'.

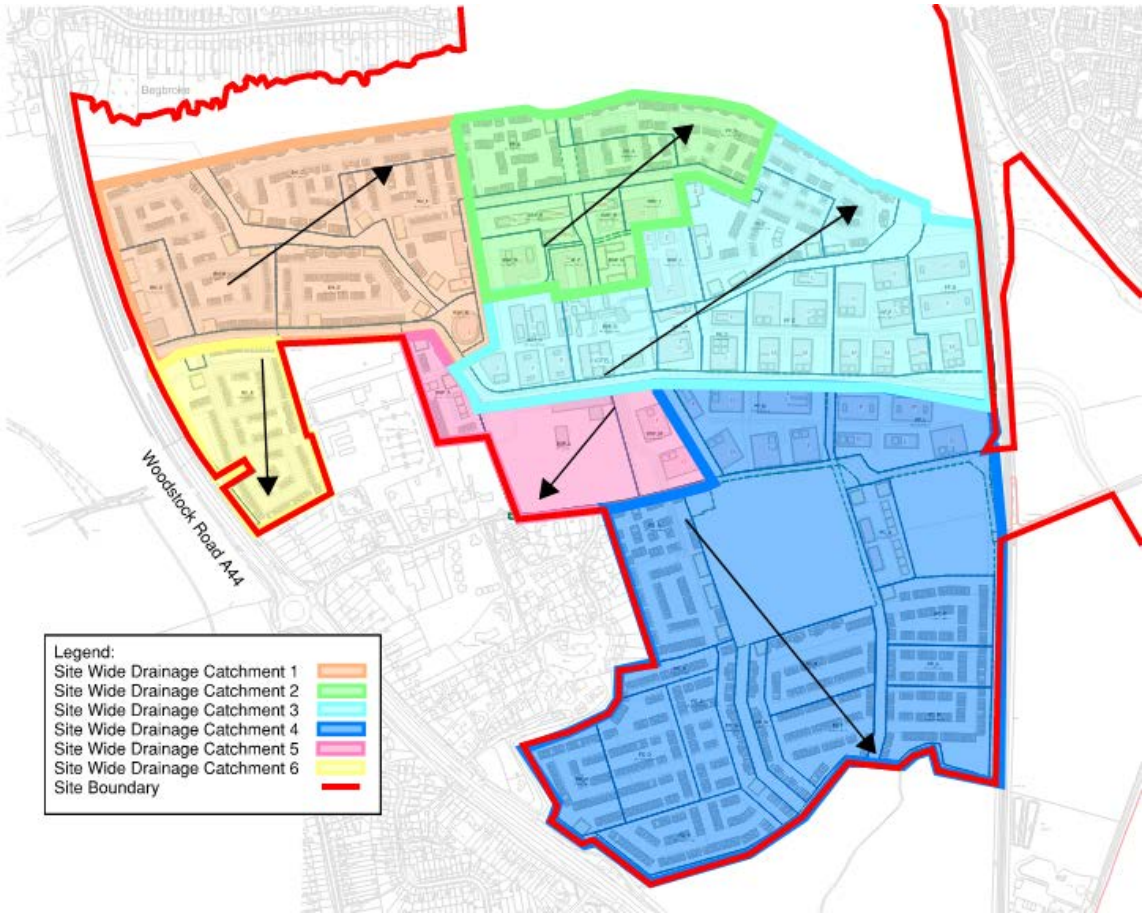
16.5.13 Rowel Brook bounds the northern edge of the Site running west to east before splitting to the north and the south. The northern section continues east to the Oxford Canal. The southern section continues east under the existing railway, through a culvert, then onto grassland further to east.

16.5.14 The Southern Drainage Ditch collects overland flow to the south of Sandy Lane before conveying it under the A44 via a culvert then continues through Yarnton, then further south through ditches and culverts where it eventually discharges into the drainage ditches surrounding the Wolvercote Lakes.

16.5.15 The Oxford Canal is outside of the Site boundary but closely follows the eastern boundary of the Site.

16.5.16 Figure 16.4 shows the existing drainage catchments on site.

Figure 16.4: Overall site drainage catchments




## Existing Foul Drainage Infrastructure

16.5.17 Details of the existing sewer sizes and location of the surrounding network have been taken from Thames Water's (TW) asset plan and compiled by Groundwise. Figure 16.5 shows the location of existing TW sewers within the Site, these include five active rising mains and two abandoned sewers.

Figure 16.5: Existing Foul Water Infrastructure Layout


## Water Quality

16.5.18 The European Water Framework Directive (WFD) was transposed into national law through the WFD Regulations 2003. The aim of this Directive is to provide an integrated, Europe-wide approach to the management of water resources, particularly water quality. As part of the Directive, River Basin Management Plans have been established. This section describes the water quality baseline.

### Oxford Canal

16.5.19 The Oxford Canal, which borders the Site to the east, is considered to be a receptor in the assessment due to its close proximity. Additionally, the drainage strategy proposes surface water discharge into Rowel Brook, which is connected by an outfall to Oxford Canal.

16.5.20 The Oxford Canal at this location, is in the Cherwell Canal's operational catchment and is classified as the Thrupp to Thames section. The Oxford Canal is not a designated Main River by the Environment Agency.

16.5.21 The Oxford Canal at this location is in the Thames River Basin District/Thames AWB Management Catchment/Cherwell Canals Operational Catchment under the WFD. The associated River Basin Management Plan establishes a number of requirements that must be met to comply with the WFD.

16.5.22 When last assessed in 2019, the ecological potential of the Oxford Canal at this location was classified as 'moderate'. The moderate ecological classification is due to the presence of supporting elements. The reasons for not achieving good status can be attributed to agriculture and rural land management.

16.5.23 Chemical status takes into account more polluting substances listed within the European Union Dangerous Substances Directive (and daughter directives) and Annex X of the European Union WFD – Priority List Substances[42]. The chemical status of the Oxford Canal, both in its upper and lower sections, have been classified as "Fail" since 2019. In particular, from 2019 the presence of Polybrominated diphenyl ethers (PBDE) caused the deterioration of the water quality. The production of this chemical is banned in the EU and the UK, thus releases are from historic use in items such as car seats and foam furniture or electrical equipment. Remobilisation of PBDEs buried at depth in sediment, or application of sludge to agricultural land is a significant source of PBDEs to surface waters (EA[43]).

Table 16.6: WFD Cycle 2 classifications for the Oxford Canal for 2015 – 2019

| Classification Item | 2015 | 2016 | 2019 |
|---|---|---|---|
| Ecological | Moderate | Moderate | Moderate |
| Chemical | Good | Good | Fail |

16.5.24 Due to its status under the WFD, the Oxford Canal water body has been classified as 'high' sensitivity for this assessment.

### Rushy Meadows SSSI, including Thrupp Ditch

16.5.25 Rushy Meadows SSSI is located to the north of the Site. The Thrupp Ditch is an EA classified statutory Main River which flows through the SSSI Site from north to south and discharges into the Rowel Brook, which discharges into the Oxford Canal.

16.5.26 The Hydrological & Hydrogeological Desk Top Study 2018, Cherwell District Council)[44] states that:

*'Rushy Meadows comprises unimproved alluvial grassland alongside the Oxford Canal, in which low intensity, traditional management has produced rich meadows with fen communities containing several uncommon species. Meadow habitats of this type are now both rare and under threat in Britain. Rushy Meadows represents one of the few surviving Sites in a district where such grasslands have declined in an area following agricultural improvement and urban development.'*

16.5.27 Based on the groundwater monitoring undertaken as part of the ground investigations (Hydrock, 2023) (Appendix 15.1) groundwater flow in the far north of the Site (adjacent to Rushy Meadows SSSI) is to the south towards Rowel Brook. Consequently, it is unlikely

that any impact from construction and operation of the Proposed Development will extend to the north, past Rowel Brook and be transmitted upgradient to the SSSI as this is 'upstream'.

16.5.28 Due to the Rushy Meadows SSSI categorisation, the Thrupp Ditch is considered to have 'high' sensitivity for this assessment.

### Pixey and Yarnton Meads SSSI, Wolvercote Meadows SSSI, and Port Meadow with Wolvercote Common & Green SSSI (including Oxford Meadows SAC)

16.5.29 There are three additional SSSIs downstream of the Site. These are Pixey and Yarnton Meads SSSI, Wolvercote Meadows SSSI, which are designated for being amongst the best remaining examples of neutral grassland in lowland England; and Port Meadow with Wolvercote Common & Green SSSI, which is designated for the level, the influence of grazing on the balance of species is reflected by characteristics associations of plants. The Pixey and Yarnton Meds SSSI is the closest to the Site, and its closes point to the Site is approximately 2 km from the southern border of the Site.

16.5.30 Water from the Rowel Brook and Oxford Canal discharge into the Dukes Cut after 1.7km this then merges into the Wolvercote Mill Stream, which flows through the Pixey and Yarnton Meads SSSI, and then merges in the Thames at the Oxford Meadows SAC, which is part of the Port Meadow with Wolvercote Common & Green SSSI.

16.5.31 Due to their categorisation, this group of SSSIs is considered to have 'high' sensitivity for this assessment.

### Rowel Brook

16.5.32 The Rowel Brook flows in an easterly direction along the northern boundary of the Site before joining the Oxford Canal. The water quality of Rowel Brook is not classified, but due to its proximity to the Rushy Meadows SSSI, it has been classified as 'high' sensitivity receptor for this assessment.

### Science Park Pond

16.5.33 Due to the presence of the Great Crested Newt, this pond is classified as Habitats of Principal Importance in England. Therefore, this water body is categorised as having 'high' sensitivity for this assessment.

### Northern Ponds

16.5.34 In the context of this assessment, it has been observed that three artificial ponds situated in the northern region of the site, in close proximity to one another, have been collectively designated as the "Northern Ponds." Notably, among these ponds, one has attained an exceptional suitability score as determined by the Habitat Suitability Index. Therefore, the Northern Ponds are considered to have 'high' sensitivity for this assessment.

### Pond in Yarnton

16.5.35 The pond is located near Sandy Lane close to the western border of the Site. The pond appears to be heavily vegetated and could therefore have ecological value. It also has a significant amenity value. Also, it received excellent suitability score using the Habitat

Suitability Index., thus it has therefore been classified as ‘high’ sensitivity for this assessment.

### Off-site Southern Ponds

16.5.36 As described in the Ecology Baseline Report, these ponds were not-subject to any on-site surveys due to a lack of access permission. From Ordnance Survey Maps, they appear to be former settlement ponds, at a disused sewage or water treatment works. And although aerial photography indicates that their potential to provide breeding habitat for GCN is limited, this assessment has used a precautionary approach and assigned this receptor ‘high’ sensitivity.

### Off-site Western Ponds

There are two ponds on the western part of the site (Off-Site Western Ponds), 190m and 70m north of the Site at its closest point. Although they were not surveyed for the presence of GCN, they received excellent suitability score using the Habitat Suitability Index. Thus, they have been classified as ‘high’ sensitivity receptor for this assessment.

### Eastern Drainage Ditches

16.5.37 The two drainage ditches in the eastern part of the Site (‘Eastern Drainage Ditches’) capture and convey surface water run-off from the Site. One of them runs along Kidlington Lane and the surface water in the Southern part of the Site is discharging into this culvert/ditch. While a different culvert/ditch crosses the railway line to the east of the Site, it is understood that this culvert conveys flow from the Rowel Brook towards the Oxford Canal, but the outfall location has not been confirmed.

16.5.38 There are no specific WFD data for these water bodies, however given that these are classified as ‘Main Rivers’ by the EA and as the WFD Regulations applies to all bodies of surface water, including rivers, lakes, and wetlands that are considered ‘water bodies’, a precautionary classification of ‘high’ has been applied to these.

### Southern Drainage Ditch

16.5.39 The Southern Drainage Ditch originates to the west of the railway within the Site boundary and flows south west passing through a culvert under the A44 then continues through Yarnton, then further south through ditches and culverts where it eventually discharges into the drainage ditches surrounding the Wolvercote Lakes.

16.5.40 There are no specific WFD data for this water body, however based on the fact this is a semi-culverted ditch running between agricultural lands, it is not considered to have recreational value, therefore it is for the purpose of the assessment classified as ‘low’ sensitivity.

### **Wider Water Bodies**

16.5.41 The Scoping Report refers to three other watercourses as set out below. However, these water bodies have no direct hydrological connection to the Site – either from surface water runoff or from foul water drainage, thus no significant effects are expected. As such, they are scoped out of the assessment.

### River Cherwell, River Evenlode

16.5.42 To the northeast, on the far side of Kidlington, is the River Cherwell, which is 1.8 km from the Site at its closest point. This is a tributary of the River Thames, which it joins in Oxford. The River Evenlode lies 3.2 km west of the Site where it flows south and merges with the River Thames, which itself flows within 2.1 km of the Site to the south, just before it enters Oxford and where it is joined by its tributary Wolvercote Mill Stream. All of these waterbodies are classified as Main Rivers. No significant effects are expected on these waterbodies due to a lack of any direct hydrological connection to the Site.

### Kingsbridge Brook

16.5.43 The northern part of the Site's surface water discharges into the Rowel Brook, which in turn discharges into the Oxford Canal. The Oxford Canal connects with the Kingsbridge Brook 225m south of the Site boundary to the south-east. Given the limited connectivity, the slow-moving nature of the Oxford Canal and dilution factors over this distance, it is considered the effects of any contaminants from the Site on Kingsbridge Book would be insignificant and is therefore not assessed further.

## Groundwater

16.5.44 A number of Ground Investigation (GI) studies have been undertaken by Hydrock to understand the geology and groundwater on the Site to inform measures which may be required as the design is developed. These include soil infiltration rate test pits, trial pits, dug pits and boreholes. A desk-based review and findings of ground investigation undertaken by Hydrock (2023) is included in Appendix **15.1**. From this information, key information relating to groundwater is as follows:

- Groundwater was encountered at depths between 0.10m bgl and 4.00m bgl during the investigation. Groundwater levels recorded post-fieldwork ranged between 0.03m bgl and 5.83m bgl (57.52m OD to 67.28m OD). Monitoring is ongoing. Sufficient data is available to allow robust assessment.
- The shallow groundwater flow within the superficial deposits is from the west of the site, from the topographic high, to the east and south-east, although in the north of the site groundwater flow is locally towards Rowel Brook (from the north and the south). In the far east of the site (in the floodplain), groundwater flows are to the south and at a shallower hydraulic gradient, but potentially influenced by the Oxford Canal which borders the east of the Site.
- Within the bedrock geology in the north of the site, groundwater flow is shown from west to east although this is likely due to a complicated bedrock outcropping and superficial deposits and temporal limits of the investigation. Groundwater flow is likely to be towards the south following the dip of the strata.

### Abstractions

16.5.45 One abstraction consent is located 960m to the north east of the Site.

## Water Supply

16.5.46 The water provider in the area is TW. The EA has identified this area to be in serious water stress through their 'Water Stressed Areas – Final Classification Report 2021[45]'. It has reached this status through a combination of high population density and relatively low rainfall.

16.5.47 According to TW's Water Resource Management Plan[46] (WRMP), the Swindon and Oxfordshire Resource Zone (SWOX), within which the Site lies, is currently supplied by a combination of sources including groundwater (60%) taken from the upper Kennet Valley and the Cotswolds, the water main at Gatehampton, and the River Thames, via a reservoir at Farmoor, near Oxford.

### On-Site Flood Risk

16.5.48 A detailed assessment of existing flood risk to the Site in relation to flood risk is provided in the FRA. A summary is provided here.

#### Flood Risk Zone Classification

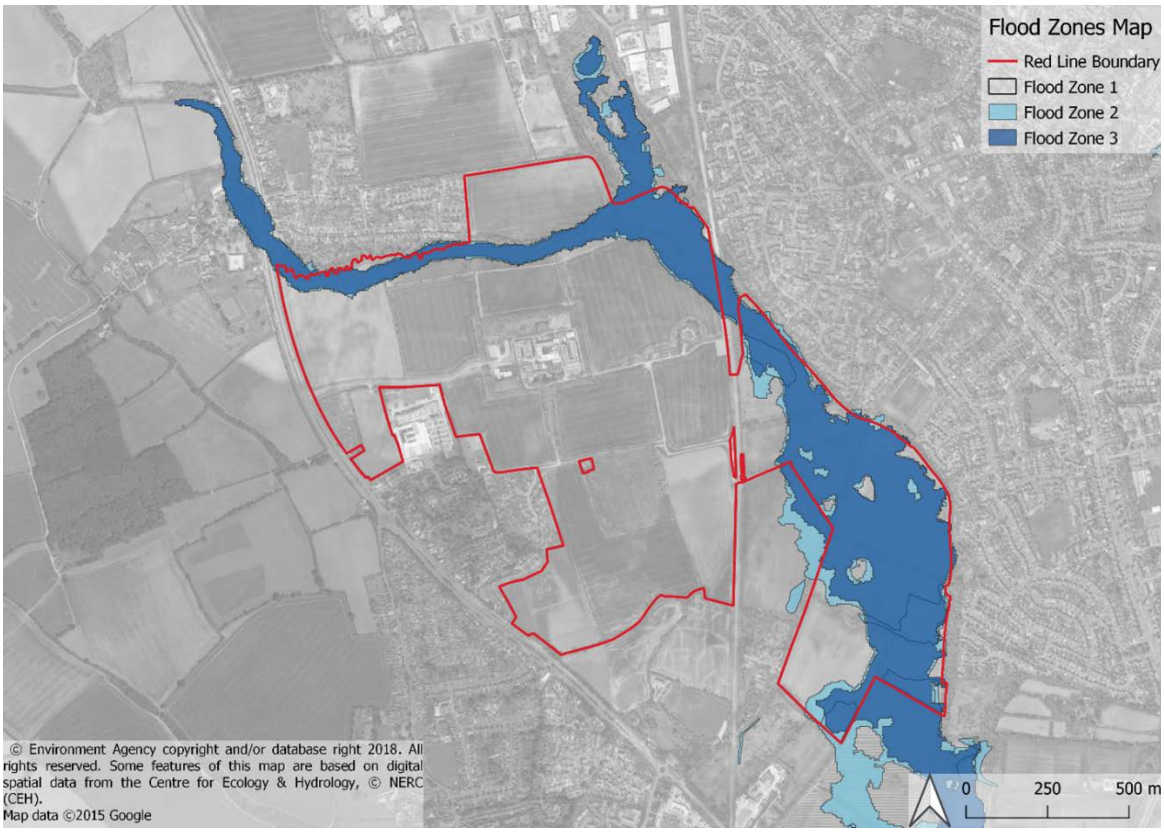
16.5.49 The EA 'Flood Map for Planning (Rivers and Sea)' indicates that the Site lies within the three Flood Zones as shown in Figure 16.6, as follows:

- The majority of the Site is within Flood Zone 1;
- Areas either side of the Rowel Brook across the north of the Site are in Flood Zone 2 and Flood Zone 3a; and
- A large proportion of the east of the Site is in Flood Zone 2 and Flood Zone 3a.

16.5.50 There is no risk of tidal flooding at the Site.

16.5.51 The EA flood maps do not include an allowance for climate change and it is noted in the Level 2 SFRA that the drainage ditch at the south of the Site is unlikely to have been hydraulically modelled if its catchment area is <3km$^2$. This drainage ditch is culverted underneath the A44. There is a potential risk that if this culvert became blocked or the capacity was exceeded, that water could back up onto the Site and create localised flooding.

Figure 16.6: EA flood maps for planning shows present day flood zones




### *Fluvial and Tidal Flooding*

16.5.52 Detailed hydraulic modelling has been undertaken to define the flood extents for the site to provide a more detailed and accurate analysis of flood conditions and risk within and around the Site. Figure 16.7 shows modelled fluvial flooding for a 1-in-30-year flood event, and Figure 16.8 shows the modelled fluvial flooding for a 1-in-100-year flood extent.

Figure 16.7: Baseline Fluvial Modelling Results – 1 in 30 year flood extents

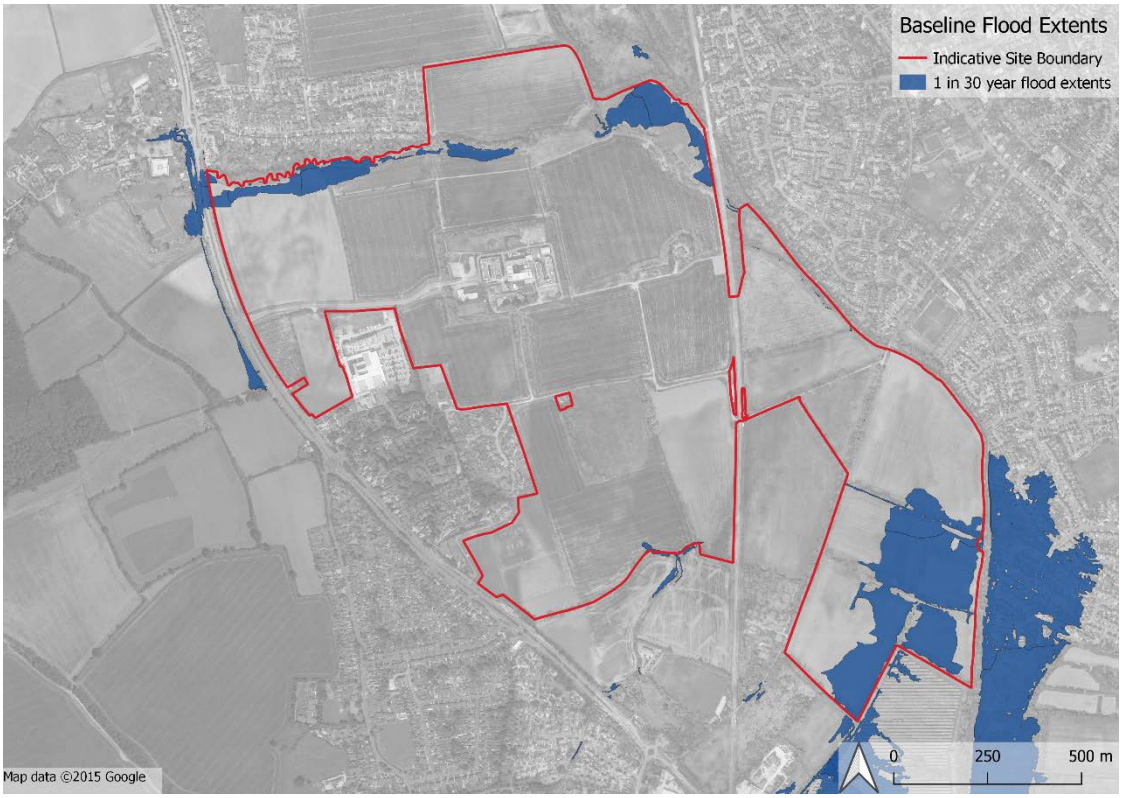
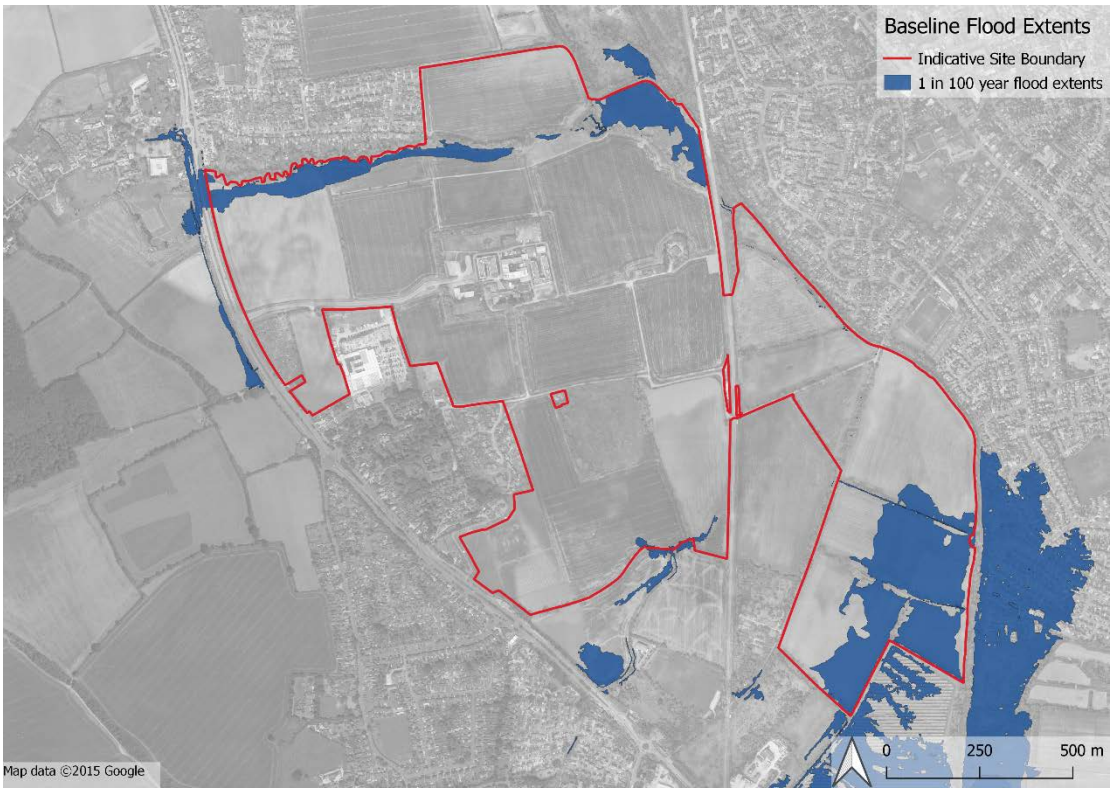



Figure 16.8: Baseline Fluvial Modelling Results – 1 in 100 year flood extents



16.5.53 Full details of the modelling undertaken can be found in Appendix E of the FRA. The baseline flood extents are shown in figures in the FRA along with all the fluvial events stimulated in the baseline modelling.

16.5.54 The modelling indicates that the majority of the Site is outside of all flood events.

16.5.55 The key areas at flood risk in all return events are:

- Sections of the Site along the length of Rowel Brook; and
- The parcel of land immediately to the west of the Oxford Canal.

16.5.56 In the higher order events, flood risk is also present:

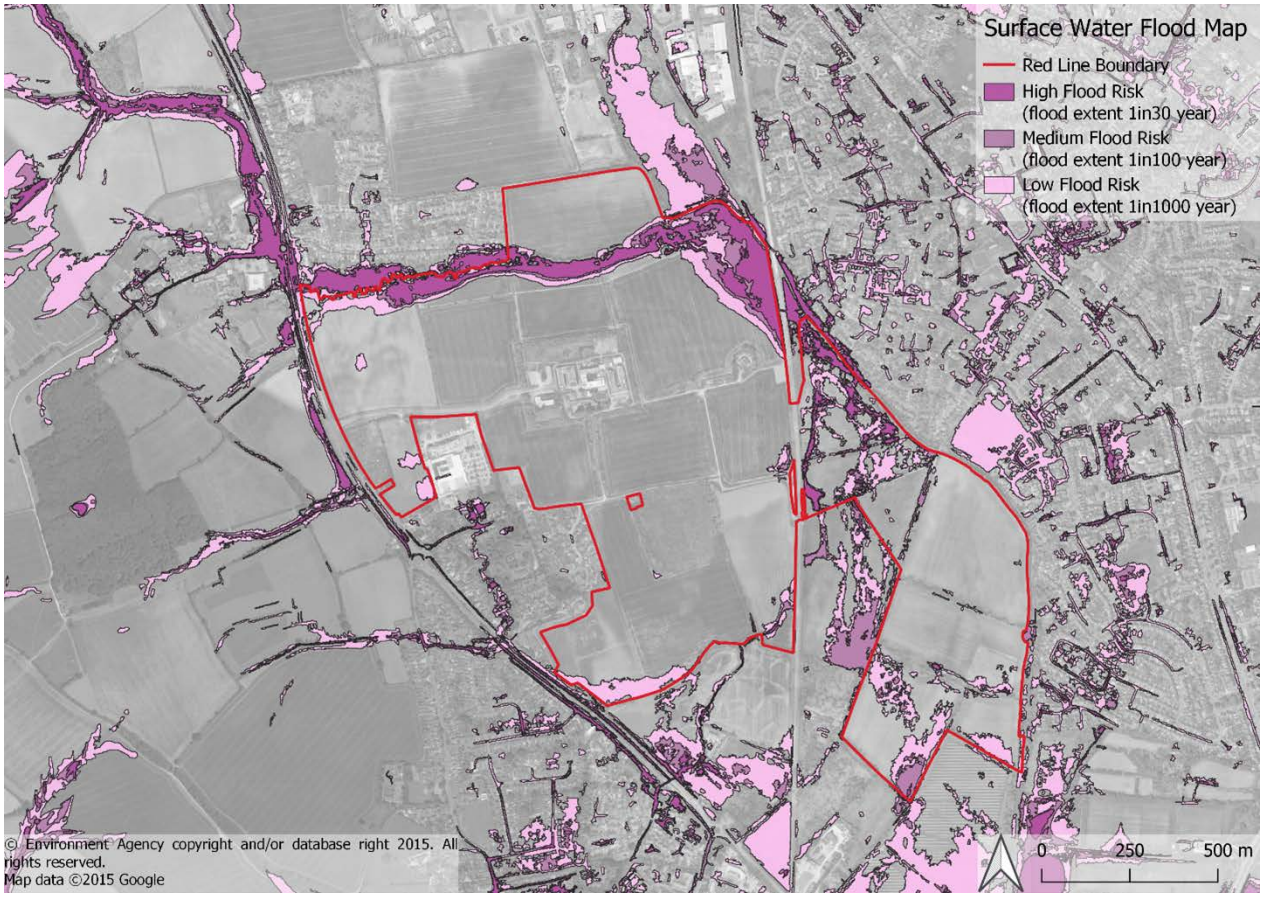
- In the North-West of the Site, owing to water overtopping Woodstock Road and flowing in a north-easterly direction to Rowel Brook;
- Around the Southern Drainage Ditch due to a capacity issue within the ditch; and
- To the east of the site, close to Oxford Canal. This flooding is believed to be due to capacity issues in the Eastern Drainage Ditches. Much of the surface water from the Site is routed through these, however they do not appear to have the capacity to convey the flows in the more extreme events considered.

*Surface Water Flooding*

16.5.57 The EA Surface Water Flood Maps show that the majority of the Site is subject to Very Low (between 0.1% and 1% AEP) surface water flood risk. There are localised areas of ponding on the Site, which are classified as having Medium (between 1% and 3.3% AEP) to High Risk (>3.3% AEP) of surface water flooding. These occur around the drainage channels to the south, around the east and south-east of the Site and also on the land adjacent to Rowel Brook (Figure 16.9).

16.5.58 It is noted that no climate change allowance is considered in the EA surface water flood mapping. Climate change has however been considered in the design of the surface water drainage strategy. The baseline surface water flood risk to the Site is classified as medium.

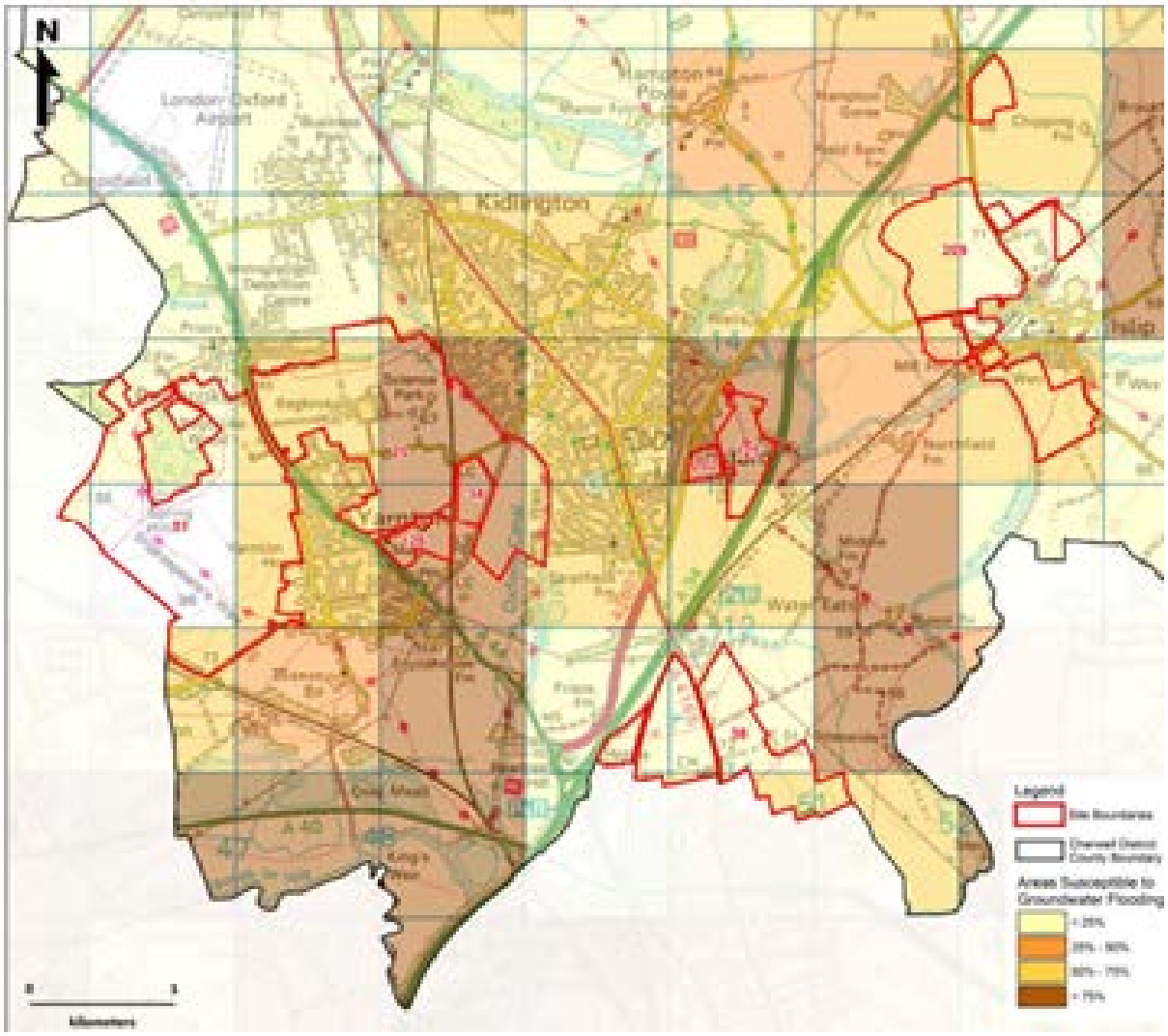
Figure 16.9: Surface water flood risk map




### *Groundwater Flooding*

16.5.59 The EA 'Areas Susceptible to Groundwater Flooding' map (as shown in Figure 16.10) is a coarse data set but illustrates that the western half of the Site lies within 1 km grid squares of which between 50% and 75% of the area is considered to be susceptible to groundwater emergence. This area is classified as having a medium susceptibility to groundwater flooding. The eastern half of the Site lies within a 1km grid square of which >75% of the area is considered to be susceptible to groundwater emergence. This area is classified as being highly vulnerable to groundwater flooding. A small area north of Rowel Brook has low vulnerability to groundwater flooding (SFRA Level 2 Addendum, 2018).

Figure 16.10: Areas susceptible to groundwater flooding Map (SFRA Level 2 Addendum, 2018).




*Flooding from Sewers*

16.5.60 Flooding from sewers may occur during periods of intense rainfall when:

- The rainfall event exceeds the capacity of the sewer system;
- The system becomes blocked by debris or sediment; and,
- The system surcharges due to high water levels in receiving watercourses.

16.5.61 The Level 2 SFRA Addendum notes that the TW DG5 register, which measures the frequency of flooding incidents at external areas, identifies 20-25 recorded incidents of sewer flooding within the postcode area (OX5) covering the Site between 2006 and 2016.

16.5.62 The Level 2 SFRA records two flooding incidents in Kidlington in 2016 because of limited capacity.

*Flooding from Lakes, Reservoirs, and Artificial Sources*

16.5.63 According to the risk of flooding shown on the EA Reservoirs Map (Figure 16.11), a portion of the Site, mainly to the east/south east, is located within the maximum extent of flooding from reservoirs. This is for the scenario when there is concurrent flooding from rivers. The Site is not at risk of reservoir flooding if the water levels within the rivers are at normal level.

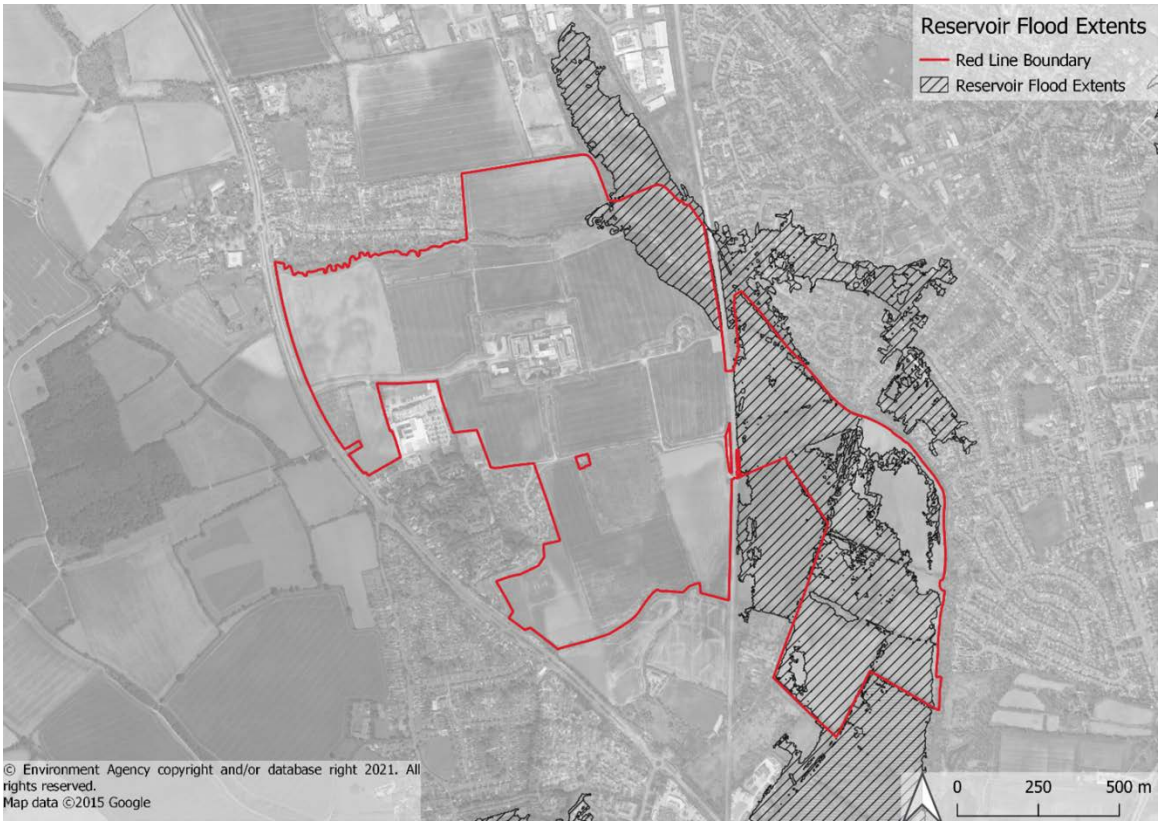
The identified flood risk is from the Banbury Flood Alleviation Scheme, which is located upstream of Banbury. However, as noted above, flood risk to the Proposed Development from reservoirs is classed overall as being low.

16.5.64 The Oxford Canal runs through the east of the Site and is at similar ground level to the Site. It is noted in the Level 2 SFRA Addendum that the only recorded flooding incident from the Oxford Canal in the vicinity of the Site was in January 2003 along the east side and the southernmost part of the Site due to the capacity of the canal being exceeded and overtopping. Details on the locality and extent of flooding have not been provided. However, the report identifies a residual risk of flooding to the Site from overtopping of the canal.

16.5.65 The water levels in the canal are controlled by a series of locks and overflow weirs which look to divert any excess flows into the River Cherwell. It is noted in the Level 1 SFRA that there is a residual risk in Cherwell of overtopping or breach failure of the Oxford Canal. There were breach failures during the 2007 summer floods, however none of these incidents were located in the vicinity of any of the Level 2 SFRA Sites.

16.5.66 The residual risk of canal embankment failure is managed by the Canal and River Trust (CRT) who perform monthly towpath side inspections. The overall flood risk from artificial sources is low. It is noted that once the water overtops the canal in a more extreme event, this will have been captured in the fluvial flood modelling.

Figure 16.11: Reservoir flood extents map




## Storm events

16.5.67 Precipitation plays a vital role in shaping the region's water resources. Oxfordshire County Council experiences a moderate amount of rainfall throughout the year, with an average annual precipitation ranging from 700 to 800 millimetres. Storm events, characterized by

intense and heavy rainfall, occur periodically in the region. These storms contribute significantly to the overall precipitation, especially during the autumn and winter seasons. While the frequency of storm events can vary from year to year, they are generally observed several times annually, leading to localized flooding in certain areas.

## Future Baseline

### Water quality

16.5.68 The future baseline is the year 2033, which represents the year of anticipated completion of the Proposed Development. This future baseline accounts for how the baseline conditions could change if the Proposed Development did not come forward.

16.5.69 If the Proposed Development did not go ahead, conditions of the Oxford Canal could continue to improve, in line with EA WFD objectives. Once these requirements are met, they will need to be maintained. Conditions of other water bodies within the Site and to which the Site drains are not recorded as part of the WFD, however their water quality is dependent on surrounding land use and agricultural practices (assuming the Site remains largely agricultural). It is reasonable to assume that if water quality improvement was realised for Oxford Canal, it would be a proxy for improvement in surrounding water bodies.

### People and property

16.5.70 Begbroke Science Park is located in the centre of the Site and provides employment for researchers, academics and staff of more than 30 external companies. If the Proposed Development didn't come forward, it is anticipated that people and property currently on site would continue to use the site as they currently do until the campus stops being operational with no significant impact or change to the current water regime.

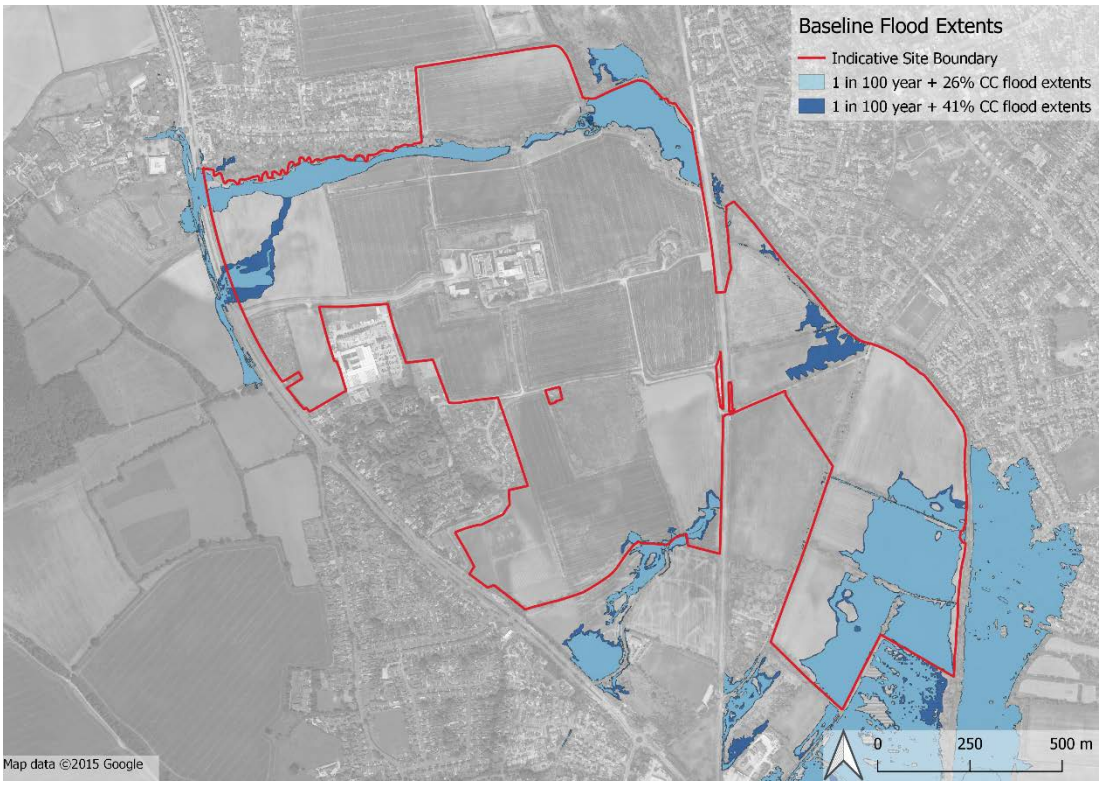
### Climate change and flood risk

16.5.71 It is also prudent to consider the future baseline for the operational lifetime of the project – particularly in terms of climate change and the increased prevalence of extreme rainfall events and associated flooding. While this is built into the modelling work undertaken and the master plan design as described in the Flood Risk 'Baseline' and 'Embedded Mitigation' sections, a summary is described here as it relates to future baseline conditions.

16.5.72 Future climate change impacts are envisaged to result in increased rainfall intensity, which would result in increased surface water runoff within the Site and surrounding area. This may impact the capacity of the existing surface water drainage system.

16.5.73 Hydraulic modelling of the future baseline was undertaken as part of the FRA to define the flood extents of certain key design events in the present and in the future. The modelling shows that the 1-in-100 year + climate change uplift of 26% (moderate scenario) and 41% (high-emissions scenario) increase flood risk with regards the current flood baseline as presented above. Figure 16.12 shows the fluvial flooding including uplift for climate change.

Figure 16.12: Baseline Fluvial Modelling Results – 1 in 100 year + 26% and 41% CC flood extents




### Groundwater

No information on expected future changes to groundwater levels within the area of the Site has been identified from publicly available sources, although there is a national BGS groundwater recharge model for climate change conditions which indicates that recharge seasons will become shorter resulting in flashier groundwater level response and potentially greater drought vulnerability.

## Summary of Receptors and Sensitivity

16.5.74 A description of the receptors identified through the baseline review is summarised in Table 16.7.

Table 16.7: Summary of Receptor Sensitivity

| Receptor | Sensitivity (Value) |
|---|---|
| *Existing* | |
| Oxford Canal | High |
| Rowel Brook | High |
| Rushy Meadows SSSI including Thrupp Ditch | High |
| Pixey and Yarnton Meads SSSI, Wolvercote Meadows SSSI, and Port Meadow with Wolvercote Common & Green SSSI (including Oxford Meadows SAC | High |
| Science Park Pond | High |
| Northern Ponds | High |

| Receptor | Sensitivity (Value) |
|---|---|
| Pond in Yarnton | High |
| Off-site Southern Ponds | High |
| Off-site Western Ponds | High |
| Eastern Drainage Ditches | High |
| Southern Drainage Ditch | Low |
| Water services infrastructure – supply | High |
| Water services infrastructure – surface water capacity | High |
| People and property | High |

## 16.6 Embedded Mitigation (Scheme Design and Management)

### Construction

16.6.1 An Outline Construction Environmental Management Plan (CEMP) is being submitted with the planning application (see Appendix 6.1). The Outline CEMP includes standard mitigation measures to protect the water environment which will be included in detailed CEMPs. The Outline CEMP sets out how construction activities will be undertaken in accordance with good practice guidance, including the Guidance for Pollution Prevention (GPP) documents – specifically 'GPP 1: Understanding your environmental responsibilities – good environmental practices', 'GPP 2: Above ground oil storage', 'GPP 5 Works and maintenance in or near water', and 'GPP 6 Working at construction and demolition sites', and other good construction guidance such as CIRIA 'Guidance C532 control of water pollution from construction Sites'. Detailed CEMP(s) will be prepared by the future construction contractor which will build on the measures in the Outline CEMP and will provide more detail on plant, operations, activities and methods. The detailed CEMP(s) will be secured through planning condition. In addition, a Framework Soil Management Plan has been produced which forms Appendix 14.2 of this ES.

16.6.2 While the nature of potential impacts and effects are described in the assessment section of this chapter, the embedded mitigation measures that are assumed to be included are presented here. These align with the measures set out in the Outline CEMP.

#### Elevated sediment loads in surface water and dewatering of excavations

16.6.3 Detailed CEMP(s) to include the following measures:

- Keep gradients of stored soil and sediments as shallow as possible to prevent large amounts of earth being washed away during periods of heavy rainfall. Areas which are exposed should be reseeded or surfaced as soon as practicable.
- Enforce tight control of Site boundaries including minimal land clearance and restrictions on the use of machinery adjacent to water bodies. Where possible, do not locate stockpiles within 10m of water bodies or drainage lines.
- Wheel wash facilities should be provided at all entry and exits points. Water from wheel wash facilities must not be discharged into water bodies or the on-Site surface water sewerage network.

- Capture Site runoff in perimeter cut off ditches, settlement lagoons and/or settlement tanks where possible. Any dewatering required from Site excavations should be pumped into a settlement tank or lagoon and not discharge direct to a water body or the on-Site surface water sewerage network.
- Sediment should be removed from water pumped during any extractions required. Sediment should be removed prior to discharges to the surface water network through the use of a baffle tank system or equivalent.
- Sediment/soils encountered during construction activities such as boring and other earthworks could be contaminated. This has an associated risk of mobilising pollutants, which could be released to surface waterbodies. The working practices that should be put in place to prevent and manage this issue are described in Chapter 15: Ground Conditions and Contamination and Appendix 15.2.
- Dust suppression measures such as dampening, and wheel washing. See Chapter 11: Air Quality for further details.

Accidental release of hydrocarbons and oils into the on-Site drainage system or directly to water body

16.6.4 Detailed CEMP(s) to include the following measures:

- Appropriate storage of oil and chemical tanks in accordance with Control of Substances Hazardous to Health (COSHH) Regulations 2002 [47] and Control of Pollution (Oil Storage) Regulations 2001 [48].
- A designated location for the storage of fuels and refuelling of operational plant and machines will be identified in the interest of limiting the potential spread of high-risk areas.
- Concrete to be washed out in lined skips or suitably bunded areas, with washout areas located away from drains and watercourses.
- Incorporation of interceptors where appropriate into the Site drainage system at high risk areas, such as parking, unloading and refuelling areas, to remove hydrocarbons and oils from surface water prior to discharge.
- Other measures including drip trays under equipment such as generators, and wheel washing facilities should also be implemented to minimise the risk of pollutants infiltrating groundwater or the surface water drainage network.

Accidental leaks and spillages of significant amounts of hazardous materials migrating into the on-Site drainage system or directly to water body

16.6.5 Detailed CEMP(s) to include the following measures:

- Provision of storage facilities and tanks and conduct refuelling of machinery within bunded areas, which should not be located within 10m of water bodies or drainage lines.
- Storage and bunded areas to be constructed of impervious floors and walls with the capacity for the contents of the storage tank and an additional ten per cent safety margin.
- As a remedial measure, spill containment equipment such as absorbent materials should be stored on Site.

- Mixing of construction materials, such as cement, will be conducted in designated areas located away from water bodies and drainage lines and outside flood zones.

Leak or breakage of temporary sewerage system causing crude sewage to migrate to water

16.6.6 Detailed CEMP(s) to include the following measures:

- Provision and maintenance of temporary septic tank, cesspit and/or sewerage connection for disposal of sewage from the toilet facilities to reduce the likelihood of crude sewage infiltrating groundwater or migrating towards water bodies.
- Any temporary toilet facilities will be positioned at least 10m away from the banks of the Oxford Canal/any on Site water bodies.

Dust and debris blowing into water bodies

16.6.7 Detailed CEMP(s) to include the following measures:

- Record any exceptional incidents that cause dust and/or air emissions, either on- or off-Site, and the action taken to resolve the situation in the Aspects & Impacts register.
- The access road into and out of the Site will be monitored for excessive dust build up. Should surface dust build up, the road will dampened and swept.
- Only use cutting, grinding or sawing equipment fitted or in conjunction with suitable dust suppression techniques such as water sprays or local extraction, e.g. suitable local exhaust ventilation systems.
- Use enclosed chutes and conveyors and covered skips.
- Minimise drop heights from conveyors, loading shovels, hoppers and other loading or handling equipment and use fine water sprays on such equipment wherever appropriate.
- Plan Site layout so that machinery and dust causing activities are located away from receptors and outside flood zones, as far as is possible.
- Erect solid screens or barriers around dusty activities or the Site boundary that are at least as high as any stockpiles on Site.
- Ensure soil stockpiles are dampened down, sealed and/ or seeded to prevent dust becoming airborne or soil erosion occurring and potentially entering sensitive receptors. Also ensure that these are located outside flood zones.
- Damping down to suppress the creation of dust. Mitigation measures typically used for dust management are discussed in Chapter 11: Air Quality.
- Implement good Site practice, perimeter fences and tight control of materials and waste to minimise the risk of debris entering water bodies.

Dewatering of excavations causing sediment and capacity issues in water bodies/foul water network

16.6.8 Detailed CEMP(s) to include the following measures:

- Capture run off from Site in perimeter cut off ditches, settlement lagoons and/or settlement tanks where possible. Any dewatering required from Site excavations

should be pumped into a settlement tank or lagoon and not discharge direct to a water body or the on-Site surface water sewerage network.

- Sediment should be removed from water pumped water during any extractions required. Sediment should be removed prior to discharges to the surface water network through the use of a baffle tank system or equivalent.
- If there is a requirement for discharge to the sewer network, this should be throttled to a flow rate that is agreed with Thames Water prior to commencement of work.

### Increased water demand during construction

16.6.9 All relevant contractors should investigate opportunities to minimise and reduce the use of water, such as:

- Ensure all aspects of Site water consumption are quantified.
- Consider splitting welfare and “Site-based” water consumption.
- Water consumption will be monitored monthly and reported against to track resource efficiency.
- Reduce the risk of uncontrolled water use through selection and specification of equipment.
- Minimise the risk of leakage: Checks will be made across the project for leaks and other wastages of water to prevent unnecessary wastage of resources.
- Leak detection equipment; ensure valves and overflows are visible for early detection of water loss and easy to access for maintenance.
- Implementation of staff-based initiatives such as turning off taps, plant and equipment when not in use both on Site and within Site offices.
- Use of recycling water systems such as wheel washes.
- Use of a rainwater harvesting system for use in equipment and vehicle washing.

### Flood risk to Site workers (and occupants of earlier occupied phases) and downstream areas during construction

- Contractor to prepare a flood emergency and contingency plan including arrangements to make safe any static plant, move any mobile plant, and to evacuate Site operatives in a flood risk emergency.
- Construction workers should be made aware of risks associated with excess surface water caused by overland flows and standing water. For example, risks to deep excavations and damage to plant.
- To minimise any risk from groundwater flooding during excavation of the Site, cut levels should be limited to at least 0.5m above the groundwater level. Where this is not possible, dewatering and other groundwater control measures should be employed. Any such groundwater control measures will also require pollution control measures in accordance with EA guidance.

16.6.10 Of particular relevance to the proposed bridge over Rowel Brook and impacts on the Rushey Meadows SSSI, the following measures should be included in the Outline CEMP:

- Any culverts should be inserted below the existing watercourse bed level to allow for bed formation within the culvert.

- Watercourses should not be deepened or widened up or downstream of the bridge and any new culverts.
- Artificial bank reinforcement should be avoided if possible.
- Open parapets should be used to allow some over-deck flow in the event of the bridge opening becoming blocked in a major flood event.
- Bridge soffit levels and flood spans should be at least 1m above the maximum known flood level to allow floating debris to pass freely through the structure.

### Completed Development

16.6.11 The following embedded design measures represent primary mitigation of relevance to the assessment of water resources and flood risk.

16.6.12 The principles set out in the FRA and Drainage Strategy for the planning application, are considered to form embedded mitigation. The assessment assumes that the design measures specified in these documents are implemented.

#### Proposed Surface Water Drainage Features

16.6.13 In accordance with current good practice and to meet national regional and local planning policies outlined in the Drainage Strategy, the surface water drainage strategy for the Proposed Development will aim to replicate the pre-development surface water runoff regime. This is achieved by capturing, filtering and harvesting (where possible) surface water as close to source as possible through source control SuDS features. The basis of design considered the SuDS hierarchy, water quality, and storm events.

16.6.14 The following SuDS features are currently proposed:

- Permeable paving will be designed in accordance with the best practice to provide pollution prevention measures where this is proposed is on shared spaces within the Site. The permeable paving is to be used as source control and will provide interception. The location and extent of permeable paving implemented will be confirmed at the detail design stage.
- It is proposed to attenuate surface flows that fall within plots to an agreed discharge rate. This controls the flow through the network from the source, in turn, reducing the sizing of required infrastructure downstream. Due to the nature of Site conditions favouring infiltration in higher areas of the Site, this strategy promotes infiltration at the start of the treatment train maximising its effectiveness.
- Swales will be utilised alongside roads within the Proposed Development and connect into a subsurface piped network to convey flows to downstream SuDS features.
- Planted areas and tree pits across the Site can be utilised as rain gardens and other types of bioretention systems.
- Infiltration basins will only be proposed within the Proposed Development where the underlying geology is suitable. The majority of surface water flow these basins will be from upstream SuDS features via a piped network.
- Similar to infiltration basins, the majority of flows into the proposed attenuation basins will be from the upstream network. Attenuation basins will be proposed where surface water storage is required but infiltration is not suitable due to geology or a high groundwater table.

- It is proposed that subsurface geocellular storage be used in conjunction with infiltration basins to maximise infiltration and available network attenuation volume.

### Proposed Site-Wide Surface Water Drainage Network

16.6.15 A Surface Water Drainage Strategy (Appendix 16.1: FRA (Appendix E)) has been developed for the Proposed Development. Surface water management infrastructure will be designed in accordance with CIRIA C753 and guidance set out by the LLFA, such that the surface water run-off regime replicates that existing prior to development.

16.6.16 The principles of the Site-wide surface water network has been designed to collect rainwater at source, follow the existing Site topography and natural flow channels to existing discharge points as far as practically possible.

16.6.17 It is proposed that the surface water drainage strategy will adhere to the following design criteria in accordance with the relevant guidance wherever it is deemed reasonably practicable. Flows will be attenuated before discharge into the above and below ground surface water network at an agreed rate. In areas of the Site where infiltration is possible, this will allow for a reduction in flows being conveyed. The following principles are proposed as part of the Drainage Strategy:

- Peak Flow Control: limit discharge rates for rainfall events up to and including the 1 in 100-year event (including climate change allowances) to the agreed QBAR rate (or 2l/s/ha whichever is greater) and 1 in 1 year event to the corresponding green field event. Any flows up to the 1 in 100 year storm will be discharged into the adjoining water courses at the QBAR flow rate.
- Volume Control: where reasonably practicable, for greenfield runoff development, the runoff volume from the Proposed Development to any highway drain sewer or surface waterbody in the 1 in 100-year, 6-hour rainfall event should never exceed the greenfield runoff volume for the same event.
- Surface water will be confined to the drainage system in a 1 in 30-year (+25% CC) rainfall event.
- The proposed buildings on Site will be protected from flooding in the 1 in 100-year (+40% CC) events.
- Exceedance in the 1 in 100-year rainfall events is to be managed in exceedance routes that minimise the risks to people and property.

16.6.18 The proposed buildings would incorporate the use of green/blue roofs and various other methods of water capture to help achieve these measures. Where falling on the roadway, it is proposed that rainwater flows will be captured by permeable paving to promote infiltration prior to being conveyed by roadside swales. These roadside swales allow for a preliminary treatment and attenuation of the flows. These flows will then be conveyed to the proposed attenuation basins and, where possible, infiltrated. This method will ensure that the Proposed Development does not adversely impact the existing flooding conditions surrounding the Site. In all cases this will be done by using a Hydrobrake or other orifice control - as is required by LLFA.

16.6.19 The proposed surface levels will be designed to allow for the discharge of rainfall exceeding storm events from Site safely overland with the required freeboards to building level.

- The FRA indicated that, at maximum flood levels, the 2 No. proposed surface water outfalls would both be submerged by approximately 0.7m of water. These levels have been incorporated into the Microdrainage Surface Water model when assessing the design. At this stage, given the attenuation provided upstream of these outfalls and proposed throttling of flows from plots, these increased Rowel Brook levels do not cause upstream flooding.

### Proposed Foul Water Drainage Network

16.6.20 The foul water network will split by development phase and will utilise gravity pipework as well as lift pump stations and rising mains, where necessary to convey flows to the proposed point of connection (POC).

16.6.21 The proposed POC for the initial phase of construction works is the existing Thames Water manhole 4804 to the immediate east of the existing pump station in the north of the Site. For later phases, there is a second proposed pump station in the south east of the Site. Flows from the existing pump station are then conveyed via a rising main to the south east corner of the Site where they will converge with flows from the proposed pump station in this area. From here, the foul water will pass beneath the railway line via a proposed rising main and discharged into the existing gravity system.

16.6.22 The capacity of the existing pump station and rising main is critical to the function of the proposed network. Confirmation on the capacity of this infrastructure has been requested from Thames Water. As at the point of submission, this information is still outstanding.

16.6.23 At the outline stage of design, it is estimated that gravity pipework no larger than 300mm diameter will be required to sufficiently convey foul water flows to their required connection points, based on network modelling in Microdrainage. All sewerage assets will be designed in line with the design criteria set out in the Water UK ‘Design and Construction for foul and surface water sewers’ [49] industry guidance and will be put forward for adoption.

16.6.24 More information can be found along with the illustration of the Indicative Site-wide Foul Water Network Layout in the Drainage Strategy (Appendix 16.1: FRA (Appendix E)).

16.6.25 A pumping station will be required as part of the foul water drainage network infrastructure. Details and sizing information can be found in the appended Drainage Strategy.

### Flood Risk

16.6.26 This section outlines the embedded mitigation measures required to remove potential flood risk from proposed locations of sensitive uses within the Proposed Development. For further details, see Appendix 16.1: FRA.

16.6.27 Considering the baseline fluvial flood modelling results, the majority of the Proposed Development is located outside of the key flood event locations.

16.6.28 There are two locations where developable areas of the Proposed Development are within the flood extents and therefore at flood risk. These locations are in the northwest corner and in the south of the Site affecting the playing fields and grounds of the fields of the secondary school, and bespoke mitigation has been identified.

16.6.29 The following sections note the proposed mitigation which has been tested to ensure the Proposed Development is not at fluvial flood risk. These principles will be adopted in the subsequent design stages (Tier 2/3) with details to be approved by the EA.

*North-West Area*

16.6.30 To mitigate the flood risk to the Proposed Development in this location, a swale is proposed within the Site boundary along Woodstock Road that will re-route the flood water along this designated corridor before overtopping and flowing north into Rowel Brook. This swale can be delivered alongside a potential acoustic barrier in this location, if required. Drainage principles are included in the Drainage Strategy (Appendix 16.1: FRA (Appendix E)), and will be confirmed at subsequent stages (Tier 2/3).

*Southern Area - Secondary School Location*

16.6.31 Following the OCC Design Criteria for Secondary Schools[50], no part of the proposed secondary school should be located in an area of Flood Zone 2 or 3, or have any ditches in its extent. To remove any flood extents within this area, it is proposed to re-grade the land within the secondary school Site so that the it is flood free in all events. Further details on flood mitigation at the secondary school location are provided in the FRA (Appendix 16.1: FRA) section 4.1.2 and Figure 22.

Surface Water Flooding

16.6.32 A summary of the key proposals set out in Appendix D of the FRA are given below:

- The surface water drainage network collects rainwater and conveys it through the Site via pipes and swales to attenuation ponds or geocellular storage, encouraging infiltration through this process and providing for controlled discharge off-Site from that point onward.
- The surface water drainage strategy aims to respect the existing catchments and attenuate surface water close to its source before discharging into the three local watercourses.
- In most cases, surface water is anticipated to be captured by areas of permeable and impermeable paving and building roofs before being conveyed to infiltration basins above and below ground.
- Discharge rates will be limited for rainfall events up to and including the 1 in 100-year event (including climate change allowances) to the agreed QBAR rate (or 2l/s/ha whichever is greater) and 1 in 1 year event to the corresponding green field event.
- The SWD network will be sized to store the 1 in 100-year event, including a 40% climate change allowance.
- Where reasonably practicable, for greenfield runoff development, the runoff volume from the development to any highway drain sewer or surface waterbody in the 1 in 100-year, 6-hour rainfall event should never exceed the greenfield runoff volume for the same event. Where practicable, interceptors and silt traps will capture debris from runoff.

Groundwater Flooding

16.6.33 Within the design, groundwater flood risk has been considered in the following ways:

- In designing surface water drainage attenuation areas in the low-lying parts of the Site, consideration has been given to the high ground water table. In these areas it is proposed that these ponds be lifted above ground water level via filling of the ground to raise the pond location and allow more attenuation.
- Infiltration drainage is only proposed in the River Terrace Deposits in the central/ northern plateau area of the Site at topographically high areas of the Site.
- If basements are proposed in higher groundwater flooding areas, they will be designed to be suitably watertight facilities that can withstand the hydraulic loadings, uplift from groundwater.
- The risk of groundwater springing is considered in the surface water drainage strategy, with localised grading away from developments ensuring that this surface water is directed into the surface water network. Exceedance events are to be managed in exceedance routes that minimise the risks to people and property.

### Environmental Permits

16.6.34 All temporary and permanent works within 8m of the Main Rivers requires an Environmental Permit from the Environment Agency. Both the Rowel Brook and the Southern Drainage Ditch are considered Main Rivers. As part of the drainage strategy and flood mitigation measures for the secondary school Site, works within 8m of these watercourses will be required and Environmental Permits will be sought.

## 16.7 Assessment of Effects - Construction Stage

16.7.1 The risks to the water environment during the construction phase include:

- Increased water demand and foul water management requirements from construction Site uses;
- Increase in sediment loads caused by Site run-off containing elevated suspended sediment levels. This can result from land clearance, excavation, dewatering of excavation, stockpiling, bunding, wheel washing and movement of materials to and from the Site;
- The release of hydrocarbons and oils into the on-Site drainage system due to a large number of vehicles accessing the Site, leakage from oil / fuel storage tanks and accidental spillages;
- Accidental leaks and use of hazardous materials, particularly concrete and cement products, which can be contained in uncontrolled wash-down water and surface water run-off;
- Dust and debris caused by poor management of Site;
- Dewatering of excavations; and
- Flood risk associated with excavations.

16.7.2 These effects can be identified as temporary (e.g. construction activities) or permanent (e.g. loss of habitat) relating to the water environment.

### Increased Water Demand

16.7.3 Processes during Site preparation, excavation and the construction phase of the Proposed Development may require significant volumes of water supply including sanitary facilities

for staff, and water supply for wheel washing and washing down of construction areas. Assuming embedded CEMP measures are implemented, the magnitude of change on strategic water supplies will be negligible. This will result in a negligible effect on strategic water supplies.

### Foul water management and sewerage

16.7.4 Foul water will likely be connected initially to a temporary sewerage system before connection to the final sewerage system prior to operation. It is likely to be minimal. Leaks and breakages of sewers from the temporary toilet facilities on-site during construction works may result in crude sewage infiltrating groundwater or being washed into the site drainage system. Sewage contains high levels of nutrients, organic matter, coliforms and suspended solids. These can result in nutrient enrichment and eutrophication, smothering of bottom-dwelling organisms and plants, and significantly reduced oxygen levels. The effect would be temporary as water quality within the affected water body would improve over time as organic matter is dispersed and treated by natural processes.

16.7.5 Any discharge of crude sewage from a temporary system could potentially affect on-Site water features or those that convey runoff such as the Rowel Brook, Oxford Canal or drainage ditches. However, assuming implementation of the embedded mitigation measures set out in the CEMP, the magnitude of impact on water quality and capacity is considered negligible, and the overall significance of effect considered negligible.

### Increased Sediment Loads

16.7.6 Site run-off containing elevated suspended sediment levels can result from land clearance, excavation, dewatering of excavation, stockpiling, bunding, wheel washing and movement of materials to and from the Site. Run-off with high sediment loads can have adverse effects on water bodies through increasing turbidity (thus reducing light penetration and reducing plant growth), and by smothering vegetation and bed substrates (thus effecting on animal communities through the destruction of feeding areas, refuges and breeding/spawning areas).

16.7.7 Indirect adverse effects can also be associated with suspended sediments that have inorganic or organic contaminants (e.g. heavy metals and pesticides respectively). Sediment can additionally cause issues within run-off channels through clogging and blockages resulting in reduced flow capacity.

16.7.8 Increased sediment loads may affect the Oxford Canal, Rowel Brook, the Rushy Meadows SSSI including Thrupp Ditch, Science Park Pond, the Northern Ponds, the Pond in Yarnton, the Off-site Southern Ponds, Off-site Western Ponds, the Eastern Drainage Ditches, and the Southern Drainage Ditch directly through Site run-off. Assuming CEMP mitigation measures are implemented, the likely magnitude of change to these waterbodies is likely to be negligible, resulting in a negligible effect significance for all receptors.

16.7.9 The down-stream SSSIs (Pixey and Yarnton Meads SSSI, Wolvercote Meadows SSSI, and Port Meadow with Wolvercote Common & Green SSSI (including Oxford Meadows SAC)) are not anticipated to be materially affected due in part to their distance from the Site, but in particular the nature of the water bodies and linkages which convey water from the Site to these receptors. Only water from the northern areas of the Site, which discharges to Rowel Brook can has the potential to discharge in to the Oxford Canal. This continues 2.5km south until a small connecting channel (Duke's Cut) connects the Oxford Canal to

Wolvercote Mill Stream around the location of these SSSIs. The nature of the channel and connection would mean only a very small amount of water from the Oxford Canal could reach these sites, and any sediment would already have settled or be heavily diluted. The magnitudes of impact and significance of effects on these receptors is considered to be negligible.

### Hydrocarbons and Oils

16.7.10 The release of hydrocarbons and oils into the environment is a common form of pollution within large development Sites. There is a risk such pollution will increase during construction with greater numbers of vehicles accessing the Site. This increase will likely include a significant number of heavy vehicles. Increased vehicle movements results in a greater likelihood of leakage from oil/fuel storage tanks and accidental spillages.

16.7.11 Hydrocarbons form a film on the surface of water bodies, deplete oxygen levels and can be toxic to freshwater fish. Even at very low concentrations the film can negatively affect the visual appearance of the water body. The effect would be temporary, and water quality within the affected water body would improve over time as pollutants disperse and are treated by natural processes.

16.7.12 Hydrocarbons may affect the Oxford Canal, Rowel Brook, the Rushy Meadows SSSI including Thrupp Ditch, Science Park Pond, the Northern Ponds, the Pond in Yarnton, the Off-site Southern Ponds, Off-site Western Ponds, the Eastern Drainage Ditches, and the Southern Drainage Ditch directly through run-off. Assuming embedded CEMP measures are implemented, the magnitude of effect is considered to be negligible, and therefore the effect significance for all receptors is also considered negligible.

16.7.13 For the same reasons described in the ‘Increased Sediment Loads’ section above, the downstream SSSIs and SAC are not anticipated to be materially affected by this potential impact, with magnitudes of impact and significant effects on these considered as negligible.

### Accidental Leaks of and use of Hazardous Materials

16.7.14 The use of concrete and cement products on-Site can present a pollution risk because of the potential for uncontrolled release of wash-down and surface water run-off. If these activities are not carried out in designated areas, wastewater may enter a water body and adversely affect sewers and aquatic environments. Concrete products are highly alkaline and corrosive; fish can be physically damaged and their gills blocked, and both vegetation and the bed of the water body can be smothered.

16.7.15 During construction there is an elevated risk of potential leaks or accidental spillage of hazardous chemicals infiltrating to groundwater or migrating to surface water bodies. However it is only when large quantities of hazardous substances are spilled, or the spillage is directly into the water body, that a significant risk of acute toxicity will arise in the receiving water body. The magnitude of any change will depend on the scale and nature of any potential incident and thus is difficult to predict.

16.7.16 For the most part, effects are likely to be temporary. Water quality within the affected water body will improve over time as pollutants are dispersed and diluted.

16.7.17 There is the potential for direct spillage into the the Oxford Canal, Rowel Brook, the Rushy Meadows SSSI including Thrupp Ditch, Science Park Pond, the Northern Ponds, the Pond

in Yarnton, the Off-site Southern Ponds, Off-site Western Ponds, the Eastern Drainage Ditches, and the Southern Drainage Ditch. If embedded CEMP mitigation measures are implemented, the magnitude of change on these waterbodies is considered to be negligible resulting in a negligible effect significance for all water receptors.

16.7.18 For the same reasons described in the 'Increased Sediment Loads' section above, the downstream SSSIs and SAC are not anticipated to be materially affected by this potential impact, with magnitudes of impact and significant effects on these considered as negligible.

### Dust and Debris

16.7.19 Construction activities located on-Site have the potential to release dust and debris that may be blown into nearby water bodies. Increased dust levels in water bodies may reduce the levels of light reaching aquatic plant and animal species. Debris blown into water bodies can decrease the recreational and aesthetic quality of the water body. Effects will however be temporary; water quality within the affected water body will improve over time as dust and debris settle or are trapped by vegetation.

16.7.20 The effect of dust blowing directly into water bodies will depend on the distance and Site practices employed. The Oxford Canal, Rowel Brook, the Rushy Meadows SSSI including Thrupp Ditch, Science Park Pond, the Northern Ponds, the Pond in Yarnton, the Off-site Southern Ponds, Off-site Western Ponds, the Eastern Drainage Ditches, and the Southern Drainage Ditch are the main water bodies at risk, however assuming embedded CEMP mitigation measures are implemented, the magnitude of impact is considered to be negligible, resulting in a final effect significance of negligible.

16.7.21 For the same reasons described in the 'Increased Sediment Loads' section above, the downstream SSSIs and SAC are not anticipated to be materially affected by this potential impact, with magnitudes of impact and significant effects on these considered as negligible.

### Dewatering of Excavations

16.7.22 At the time of writing, and due to the outline nature of the application, it is not known if there will be any basements included in the Proposed Development. Excavation of basements can require the need to dewater excavated areas by pumping water out of them, which poses a risk for Site workers. Assessment of this risk has been included in as a precautionary approach in case excavation of basements and subsequent dewatering is required.

16.7.23 The dewatering of excavations would need to be carried out through pumping from the excavation area to a chosen discharge site. A discharge location has not been confirmed at this stage but would likely be one of the surface waterbodies or the surface water sewer network, depending on which part of the Site is being excavated.

16.7.24 Connections and discharges will need to be formally agreed with the sewerage undertaker or the EA as required depending on the location of the connection. If appropriate CEMP mitigation measures are implemented, the impact of pollution, sediment clogging and increased volumes of water to either the sewerage network, or water bodies should be negligible, and therefore the effect significance will also be negligible.

### Flood Risk to Construction Workers and Plant

16.7.25 Flood risk to construction workers is highest where there are areas of excavation above areas where the ground level is naturally close to groundwater levels, or in areas adjacent to water bodies and higher flood risk where stormwater surges could put workers at risk.

16.7.26 Measures should be taken to protect construction workers from residual risks of excavations flooding, surface water flooding and from fluvial flooding. If embedded measures outlined in the CEMP are implemented, then these risks should be reduced to negligible resulting in a negligible risk and effect significance to Site workers.

## Additional Mitigation, Monitoring and Residual Effects

### Additional Mitigation

16.7.27 The mitigation measures relevant to the construction phase are those set out previously in the 'Embedded Mitigation' section, principally relating to the measures to be incorporated in the CEMP. Measures set out in the Framework Soil Management Plan will also help ensure sediments are controlled and do not pose a risk to water quality. These present all the viable mitigation relevant to impacts on water resources and flood risk during the construction phase and therefore no additional mitigation is necessary.

### Monitoring

16.7.28 Monitoring of sediment, dust, debris and water usage are proposed as measures to be specified in the CEMP. In addition to these, no further measures are recommended for the Proposed Development, given that assuming implementation of the embedded mitigation, effects are likely to be insignificant.

### Residual Effects

16.7.29 If the measures outlined in the CEMP are implemented, which includes good Site practice, the residual construction effects to the water environment are considered to be no greater than negligible, and temporary, during the construction period.

## 16.8 Assessment of Effects - Completed Development

16.8.1 The potential effects of the Proposed Development on the water environment during operation include:

- Pollutants contained within surface water run-off contaminating water bodies;
- Changes to flood risk post-development;
- Water services infrastructure being unable to deal adequately with increased water demand; and
- Sewerage infrastructure may not have enough capacity to receive foul discharges to the network and wastewater treatment works.

### Pollutants contained in Surface Water

16.8.2 Pollutants, such as silts and hydrocarbons resulting from activities on-Site such as vehicle storage, vehicle washing and oil/fuels leaks would be discharged to the surface water network through surface water run-off. This can increase water turbidity, deplete oxygen levels and be toxic to the aquatic environment.

16.8.3 The magnitude of change will depend on the activities present and their occurrence. The effect is considered permanent, although certain activities such as accidental spillages would be temporary.

16.8.4 It is envisaged that operational effects on all water bodies will be negligible due to the commitments made in the Drainage Strategy for water quality treatment prior to discharge. Within the Drainage Strategy (Appendix 16.1: FRA (Appendix E)), the surface water attenuation basin key design criteria includes upstream treatment to remove sediment and silt loads to prevent long-term clogging. With this mitigation in mind, the overall significant effect is envisaged to be negligible across all receptors.

### Changes to Flood Risk

#### *On-Site*

16.8.5 With appropriate sizing of the on-Site surface water drainage infrastructure, in-line with the Drainage Strategy, the risk of surface water flooding in developable areas of the Proposed Development due to failure of the surface water system will be negligible. It will be ensured that all Built Development will be set at a level above the 1:100 year + CC with an allowance for freeboard. In addition, an evacuation route needs to be identified to ensure evacuation to Flood Zone 1 can occur.

16.8.6 With regards the proposed secondary school area in the south east of the Site, without the embedded mitigation within the location, the flood risk is considered significant. A modelling identified higher risk of flooding in this area, embedded mitigation described proposes re-grading of this part of the site to raise ground levels and reduce the risk of flooding. This has been modelled within the hydraulic modelling, however this mitigation measure alone still leaves some risk to flooding to people and property. The magnitude of impact after re-grading is considered to be medium, and therefore, the impact significance is major adverse to people and property. Supplementary mitigation is described below.

16.8.7 By implementing these measures, the risk of fluvial flooding is considered negligible.

#### *Off-Site*

16.8.8 The surface water drainage strategy focuses on limiting the discharge rates of the Proposed Development in line with rates agreed the LLFA. With the attenuation and discharge rates proposed, the residual effect to flood risk downstream and outwith the Site boundary is considered to be negligible.

#### *Water Demand*

16.8.9 Due to the scale of the Proposed Development, the water demand once it is operational will result in a large uplift from the current water demand. The SORZ is already under serious water stress, and the increased water demand as a result of the completed Proposed Development may exacerbate the current status and increase demand pressures. Without further measures, there it is anticipated that there could be a moderate adverse effect to strategic water supply.

#### *Foul Water Drainage*

16.8.10 As previously discussed, the capacity of the existing pump station and rising main is currently unknown. Foul water drainage from the Proposed Development are likely to put increasing pressure on the existing system, and if there is insufficient capacity, there is a

risk of the system not being able to accept future foul water discharge from the Proposed Development. Given the nature of the Proposed Development, a precautionary medium magnitude of impact is anticipated. In the absence of further mitigation measures, this would result in a moderate adverse effect to foul water supply.

### Mitigation, Monitoring and Residual Effects

16.8.11 The mitigation measures relevant to the operational phase are those set out previously in the 'Embedded Mitigation' section, principally relating to the early engagement with utilities providers and water efficiency measures. This presents all the viable mitigation relevant to impacts on water resources, capacities and flood risk during the operational phase and therefore with the exception of flood risk in the proposed secondary school area, no additional mitigation is necessary.

16.8.12 In order to reduce the flood risk to non-significant levels in the secondary school area, an area of flood water storage is proposed as per Figure 22 of the FRA (Appendix 16.1). The size of this has been calculated to reduce the flood risk to non-significant levels, however this was not part of the modelling, and so additional hydraulic modelling with this feature is recommended. With this mitigation in place, the flood risk is reduced to a minor adverse and therefore non-significant level.

16.8.13 As no significant residual environmental effects are expected to arise from the Proposed Development, there is no requirement for monitoring.

## 16.9 Cumulative Effects

### Construction

#### Assessment

16.9.1 There is potential for cumulative effects during construction with regard to pollutant loading within Rowel Brook, arising from cumulative schemes acting together with the Proposed Development. This is particularly the case during if the construction of the 'OS Parcel 3673, Adjoining and West of 161 Rutten Lane, Yarnton' scheme (ref: 21/03522/OUT) and 'Former Piggery and Land North of Weedstock Road, Yarnton' scheme (21/00758/SCOP) come forward in parallel with the Proposed Development, given their adjacent site location. Cumulative impacts are, however, not expected to be any more significant than the effects from the Proposed Development . This is because compliance and implementation of the mitigation outlined within a CEMP would be practiced for each scheme, as will be the case for the Proposed Development. Therefore, it is considered that any significant cumulative effects during the construction period are negligible.

16.9.2 There are some proposed developments south of the Oxford Airport site which lies approximately 1km north of the application boundary. Their drainage regimes may prove a higher potential risk of impact to Rushy Meadows SSSI. Given that it has been assessed that the Proposed Development will have a negligible impact on Rushy Meadows SSSI, it is not considered that there will be a cumulative impact as a result of the Proposed Development in combination with other developments, and it will be responsibility of other proposed schemes to ensure their proposals do not pose a significant risk of impact to the SSSI.

### Completed Development

#### Assessment

16.9.3 The completion and operation of the cumulative schemes will see drainage strategies implemented in line with the requirements of the NPPF, the Environment Agency and any requirements that Thames Water request. These developments will result in the management of surface water to abate flood risk and pollution, and potentially aid a reduction in runoff discharge rates for each development. Therefore, it is likely that any cumulative effect to surface water run-off and flood risk within the drainage network and downstream will be significant and moderate beneficial.

16.9.4 Of notable relevance is the adjacent proposal for up to 540 dwellings to the west of the study area, referred to as 'OS Parcel 3673, Adjoining and West of 161 Rutten Lane, Yarnton' in the description of cumulative schemes. This development proposes to include an attenuation basin, which would reduce the runoff from the areas of land west of the Site. Some of this water would be attenuated within the extent of this cumulative scheme, and could help the measures to reduce flood risk within the north western part of the Site, resulting in a net benefit to reducing flood risk for future users in the Proposed Development.

16.9.5 Drainage implemented in line with the NPPF on each Site, and the implementation of SuDS in line with recommendations set out in the Drainage Strategy and FRA, will support the improvement of water quality.

16.9.6 Therefore, it is considered that any potential cumulative effects of the completed Proposed Development with other schemes are no greater than minor adverse with the adequate mitigation and consultation with water authorities.

## 16.10 Summary

16.10.1 As summary of the residual effects of the Proposed Development is provided in Table 16.8.

Table 16.8: Summary of Residual Effects

| Effect | Receptor (Sensitivity) | Geographic & Temporal Scale | Magnitude of Impact | Significance of Effect | Additional Mitigation and Monitoring | Significance of Residual Effect |
|---|---|---|---|---|---|---|
| **Construction** | | | | | | |
| Increased sediment loads | Oxford Canal (High) | Local, temporary | Negligible | Negligible | None required | Negligible |
| | Rowel Brook (High) | | | | | |
| | Rushy Meadows SSSI including Thrupp Ditch (High) | | | | | |
| | Pixey and Yarnton Meads SSSI, Wolvercote Meadows SSSI, and Port Meadow with Wolvercote Common & Green SSSI (including Oxford Meadows SAC (High) | | | | | |
| | Science Park Pond (High) | | | | | |
| | Northern Ponds (High) | | | | | |
| | Pond in Yarnton (High) | | | | | |

| Effect | Receptor (Sensitivity) | Geographic & Temporal Scale | Magnitude of Impact | Significance of Effect | Additional Mitigation and Monitoring | Significance of Residual Effect |
|---|---|---|---|---|---|---|
| | Off-site Southern Ponds (High) | | | | | |
| | Off-site Western Ponds (High) | | | | | |
| | Eastern Drainage Ditches (High) | | | | | |
| | Southern Drainage Ditch (Low) | | | | | |
| Foul water management and sewerage | Oxford Canal (High) | Local, temporary | Negligible | Negligible | None required | Negligible |
| | Rowel Brook (High) | | | | | |
| | Rushy Meadows SSSI including Thrupp Ditch (High) | | | | | |
| | Pixey and Yarnton Meads SSSI, Wolvercote Meadows SSSI, and Port Meadow with Wolvercote Common & Green SSSI (including Oxford Meadows SAC (High) | | | | | |

| Effect | Receptor (Sensitivity) | Geographic & Temporal Scale | Magnitude of Impact | Significance of Effect | Additional Mitigation and Monitoring | Significance of Residual Effect |
|---|---|---|---|---|---|---|
| | Science Park Pond (High) | | | | | |
| | Northern Ponds (High) | | | | | |
| | Pond in Yarnton (High) | | | | | |
| | Off-site Southern Ponds (High) | | | | | |
| | Off-site Western Ponds (High) | | | | | |
| | Eastern Drainage Ditches (High) | | | | | |
| | Southern Drainage Ditch (Low) | | | | | |
| Accidental release of hydrocarbons | Oxford Canal (High) | Local, temporary | Negligible | Negligible | None required | Negligible |
| | Rowel Brook (High) | | | | | |
| | Rushy Meadows SSSI including Thrupp Ditch (High) | | | | | |
| | Pixey and Yarnton Meads SSSI, Wolvercote | | | | | |

| Effect | Receptor (Sensitivity) | Geographic & Temporal Scale | Magnitude of Impact | Significance of Effect | Additional Mitigation and Monitoring | Significance of Residual Effect |
|---|---|---|---|---|---|---|
| | Meadows SSSI, and Port Meadow with Wolvercote Common & Green SSSI (including Oxford Meadows SAC (High) | | | | | |
| | Science Park Pond (High) | | | | | |
| | Northern Ponds (High) | | | | | |
| | Pond in Yarnton (High) | | | | | |
| | Off-site Southern Ponds (High) | | | | | |
| | Off-site Western Ponds (High) | | | | | |
| | Eastern Drainage Ditches (High) | | | | | |
| | Southern Drainage Ditch (Low) | | | | | |
| Accidental leaks of hazardous materials | Oxford Canal (High) | | | | | |
| | Rowel Brook (High) | | | | | |

| Effect | Receptor (Sensitivity) | Geographic & Temporal Scale | Magnitude of Impact | Significance of Effect | Additional Mitigation and Monitoring | Significance of Residual Effect |
|---|---|---|---|---|---|---|
| | Rushy Meadows SSSI including Thrupp Ditch (High) | Local, temporary | Negligible | Negligible | None required | Negligible |
| | Pixey and Yarnton Meads SSSI, Wolvercote Meadows SSSI, and Port Meadow with Wolvercote Common & Green SSSI (including Oxford Meadows SAC (High) | | | | | |
| | Science Park Pond (High) | | | | | |
| | Northern Ponds (High) | | | | | |
| | Pond in Yarnton (High) | | | | | |
| | Off-site Southern Ponds (High) | | | | | |
| | Off-site Western Ponds (High) | | | | | |
| | Eastern Drainage Ditches (High) | | | | | |

| Effect | Receptor (Sensitivity) | Geographic & Temporal Scale | Magnitude of Impact | Significance of Effect | Additional Mitigation and Monitoring | Significance of Residual Effect |
|---|---|---|---|---|---|---|
| | Southern Drainage Ditch (Low) | | | | | |
| Dust and debris (risk of being blown into brook) | Oxford Canal (High) | Local, temporary | Negligible | Negligible | None required | Negligible |
| | Rowel Brook (High) | | | | | |
| | Rushy Meadows SSSI including Thrupp Ditch (High) | | | | | |
| | Pixey and Yarnton Meads SSSI, Wolvercote Meadows SSSI, and Port Meadow with Wolvercote Common & Green SSSI (including Oxford Meadows SAC (High) | | | | | |
| | Science Park Pond (High) | | | | | |
| | Northern Ponds (High) | | | | | |
| | Pond in Yarnton (High) | | | | | |

| Effect | Receptor (Sensitivity) | Geographic & Temporal Scale | Magnitude of Impact | Significance of Effect | Additional Mitigation and Monitoring | Significance of Residual Effect |
|---|---|---|---|---|---|---|
| | Off-site Southern Ponds (High) | | | | | |
| | Off-site Western Ponds (High) | | | | | |
| | Eastern Drainage Ditches (High) | | | | | |
| | Southern Drainage Ditch (Low) | | | | | |
| Dewatering of excavations | Oxford Canal (High) | Local, temporary | Negligible | Negligible | None required | Negligible |
| | Rowel Brook (High) | | | | | |
| | Rushy Meadows SSSI including Thrupp Ditch (High) | | | | | |
| | Pixey and Yarnton Meads SSSI, Wolvercote Meadows SSSI, and Port Meadow with Wolvercote Common & Green SSSI (including Oxford Meadows SAC (High) | | | | | |

| Effect | Receptor (Sensitivity) | Geographic & Temporal Scale | Magnitude of Impact | Significance of Effect | Additional Mitigation and Monitoring | Significance of Residual Effect |
|---|---|---|---|---|---|---|
| | Science Park Pond (High) | | | | | |
| | Northern Ponds (High) | | | | | |
| | Pond in Yarnton (High) | | | | | |
| | Off-site Southern Ponds (High) | | | | | |
| | Off-site Western Ponds (High) | | | | | |
| | Eastern Drainage Ditches (High) | | | | | |
| | Southern Drainage Ditch (Low) | | | | | |
| Increased water demand during construction | Water services infrastructure (supply) (High) | Local, temporary | Negligible | Negligible | None required | Negligible |
| Increased sediment loads | Water services infrastructure – surface water capacity (High) | Local, temporary | Negligible | Negligible | None required | Negligible |
| Dust and debris (risk of being blown into drainage lines and sewer network) | | | | | | |
| Dewatering of excavations | | | | | | |

| Effect | Receptor (Sensitivity) | Geographic & Temporal Scale | Magnitude of Impact | Significance of Effect | Additional Mitigation and Monitoring | Significance of Residual Effect |
|---|---|---|---|---|---|---|
| Flood risks to Site workers (groundwater, surface water and fluvial from Rowel Brook and Oxford Canal) | People and property (High) | Local, temporary | Negligible | Negligible | None required | Negligible |
| **Completed Development** | | | | | | |
| Pollutants contained in surface water | Oxford Canal (High) | Local, permanent | Negligible | Negligible | None required | Negligible |
| | Rowel Brook (High) | | | | | |
| | Rushy Meadows SSSI including Thrupp Ditch (High) | | | | | |
| | Pixey and Yarnton Meads SSSI, Wolvercote Meadows SSSI, and Port Meadow with Wolvercote Common & Green SSSI (including Oxford Meadows SAC (High) | | | | | |
| | Science Park Pond (High) | | | | | |

| Effect | Receptor (Sensitivity) | Geographic & Temporal Scale | Magnitude of Impact | Significance of Effect | Additional Mitigation and Monitoring | Significance of Residual Effect |
|---|---|---|---|---|---|---|
| | Northern Ponds (High) | | | | | |
| | Pond in Yarnton (High) | | | | | |
| | Off-site Southern Ponds (High) | | | | | |
| | Off-site Western Ponds (High) | | | | | |
| | Eastern Drainage Ditches (High) | | | | | |
| | Southern Drainage Ditch (Low) | | | | | |
| Flood risk - Change to runoff rates | Future on-Site water surface infrastructure (capacity) (Medium) | Local, permanent | Small | Minor adverse | | Minor adverse |
| Increased foul water drainage demand | Water services infrastructure - foul (Medium) | Local, permanent | Medium | Moderate adverse | Continued early engagement with Thames Water on the water needs for the Proposed Development and any current restrictions and | Minor adverse |
| Increased potable water demand | Water services infrastructure - supply (Medium) | Local, permanent | Medium | Moderate adverse | | Minor adverse |

| Effect | Receptor (Sensitivity) | Geographic & Temporal Scale | Magnitude of Impact | Significance of Effect | Additional Mitigation and Monitoring | Significance of Residual Effect |
|---|---|---|---|---|---|---|
| | | | | | the need for any upgrades. Water efficiencies measures through design | |
| Flood risk to people and property | People and Property (Medium) | Local, permanent | Large adverse | Major adverse | Proposed area of flood water storage near the school site (Appendix 16.1: FRA) | Minor adverse |
| **Cumulative Assessment** | | | | | | |
| ***Construction*** | | | | | | |
| Poor water quality resulting from construction activities | Water quality - all water bodies (High) | Local, temporary | Negligible | Negligible | None required | Negligible |
| ***Operation*** | | | | | | |
| Pollutants contained in surface water | Water quality - all water bodies (High) | Local, permanent | Negligible | Negligible | None required | Negligible |
| Increased off-Site flood risk | People and property (Medium) | | Small | Minor adverse | None required | Minor adverse |
| Increased potable water demand | Water services infrastructure - supply (Medium) | | Medium | Moderate adverse | Continued early engagement with Thames Water on | Minor adverse |

| Effect | Receptor (Sensitivity) | Geographic & Temporal Scale | Magnitude of Impact | Significance of Effect | Additional Mitigation and Monitoring | Significance of Residual Effect |
|---|---|---|---|---|---|---|
| Increased foul water drainage demand | Water services infrastructure - foul (Medium) | | Medium | Moderate adverse | the water needs for proposed cumulative developments and any current restrictions and the need for any upgrades.<br>Water efficiencies measures through design. | Minor adverse |

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