Within 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 east of the canal at Stratfield Farm (allocated by Policy PR7b of the Local Plan Part 1 Partial Review).

This bridge is not being proposed as part of this outline planning application and therefore has not been considered as part of this FRA. The bridge will be brought forward in a separate planning application and a FRA will need to be undertaken to assess the impact of the proposed bridge and outline any mitigation required.

4.1.4 Finished Floor Levels

It is noted within the Level 1 SFRA that for new residential development classified as *More Vulnerable* and located within Flood Zone 2 or 3 the following guidance should be considered:

- FFL should be set a minimum of 300mm above the 1 in 100 year with an allowance for climate change.
- Sleeping accommodation should be restricted to the first floor or above.
- Less Vulnerable uses such as commercial spaces within a residential development could be below this level.

Given the above mitigation measures, no development is proposed within the Flood Zone 2 or 3 extents. However, following the principle of setting finished floor levels with appropriate resilience and to ensure that the Development is at a low risk from flooding during the 1 in 100 year + 41%, building FFLs and the access road will be set above the DFE flood level with an allowance of 300mm freeboard. These levels have been considered within the proposed earthworks levels.

4.1.5 Safe Access and Egress

During the 1:100 year + 41% CC event, access and egress via Begbroke Hill will be possible, with the A44 being clear of flooding to the South.

During the 1:1000 year event, a small depth of flood water is shown to cover the access and egress route on Begbroke Hill and along the A44 to the south. However, these depths area <100mm, therefore would not inhibit access for emergency vehicles.

4.2 Surface Water Flooding

A Surface Water Drainage Strategy has been developed for the Proposed Development (see Appendix E for full document). A summary of the key proposals are given below:

- The surface water drainage network collects rainwater at the source. Where falling within plots, these flows will be attenuated within the plot 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. It is also proposed the proposed buildings would incorporate the use of green/blue roofs and various other methods of water capture to help achieve this.
- Where falling on the roadway, it is proposed that rain water 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.
- Plot and roadway flows will then be conveyed to the proposed basins where, again, they will be attenuated and where possible infiltrated. Any flows up to the 1 in 100 year storm (including a 40% climate change allowance) will be discharged into the adjoining water courses at the QBAR flow rate up. This method will

ensure that the Proposed Development does not adversely impact the existing flooding conditions surrounding the site.

- The 1 in 1 year event will be held to the greenfield runoff rate. In all cases this will be done by using a Hydrobrake or other orifice control - as is required by LLFA.

- Flood Risk within the Development:
    - 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.

4.3 Environmental Permits

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, therefore Environmental Permits will be required. It is noted that the Environmental Permitting Regulations (EPR) process is a separate process to Planning and a Flood Risk Activity Permit (FRAP) will be applied for separate to the Planning process.

It is likely that approval will be required from the LLFA for the infilling of the ditch on the Secondary School site, which is classified as an Ordinary Watercourse. Although initial consultation with the LLFA has suggested that these works would be appropriate, it is noted that further coordination and approval should be sought prior to undertaking any modifications to Ordinary Watercourses.

4.4 Groundwater Flooding

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

- In designing surface water drainage attenuation areas in the low-lying areas of the site, consideration has been given to the high ground water table. In these areas, the preference is for the basins to be lined, otherwise, the design surface lifted to a sufficient level above the ground water level. The most appropriate method will be developed as the masterplan is developed further.
- 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 need to 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.

The overall groundwater flood risk is considered Low with the proposed mitigation in place.

5 Summary and Conclusion

This FRA has been carried out on behalf of OUD as part of the Outline Planning Application for the proposed mixed-use development on the current site of Begbroke Science Park, Begbroke, Kidlington. The Proposed Development consists of the expansion of the existing Science Park, residential and associated amenity, education and community uses.

As advised by the EA, Baseline Hydraulic Modelling has been undertaken to produce flood mapping which provides greater detail than the EA flood maps. The majority of the Site is located within Flood Zone 1 and at low risk of flooding. Areas located in Flood Zone 2 and 3, which are at medium to high flood risk are located along the length of Rowel Brook, the parcel of land to the west of the Oxford Canal, in the North-West of the Site and around the Southern drainage ditch.

According to the NPPF, the proposed land uses include Less Vulnerable, More Vulnerable and Essential assets. All assets have been located in accordance with the sequential approach required by NPPF.

There are two locations where the Proposed Masterplan overlaps with the baseline flood extents and therefore potentially at risk of flooding without further mitigation. In the NW of the site, a swale has been proposed which captures, attenuates and diverts overland flows around the development to remove the risk to the development. On the Secondary School Site, regrading has been proposed to ensure no flooding of the school site occurs. Flood storage within the red line boundary to the west of the school site is proposed to provide effective mitigation on a volume-for-volume basis so as to ensure there are no increases in flood risk outside of the red line boundary or to any development on site.

Most of the Site is subject to Very Low surface water flood risk. There are localised areas of ponding on the Site, which are classified as having Medium to High Risk of surface water flooding. These occur around the drainage channels to the south, around the east and southeast of the Site and also on the land adjacent to the Rowel Brook.

The surface water drainage strategy for the Proposed Development will aim to replicate the predevelopment 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 SuDS hierarchy will be used to design the Site drainage in the most sustainable way. Building upon OUD's vision for sustainable places.

All storm events up to the 1 in 100-year storm event + 40% climate change allowance are proposed to be attenuated on site and discharge from the Site to the proposed outlet at the QBAR rate. The 1 in 1-year storm event will be retained to the corresponding greenfield event. In areas of the Site where the ground conditions allow for it, infiltration is promoted to reduce the volumetric discharge of surface water from the site.

There may be a risk of groundwater flooding in the lower lying areas around the perimeter of the Site due to shallow ground water levels. This has been considered in the design of the surface water drainage strategy with regards to the location and design of attenuation ponds and use of infiltration drainage. The ground water flood risk to the Site is therefore Low.

According to the risk of flooding shown on the EA Reservoirs Map, a portion of the Site, mainly to the east/ south-east, is located within the maximum extent of flooding from reservoirs. The SFRA identifies a residual risk of flooding to the Site from overtopping of the Oxford Canal. 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 and therefore risk mitigated against if required for the development. The overall flood risk from artificial sources is Low and no further mitigation is required.

It is concluded that with the mitigation measures outlined within this FRA, the Proposed Development is at Low risk of flooding from all sources.

Appendix A National Planning Policy Framework

Planning Practice Guidance Table 1: Flood Zones

Flood Zone	Definition
Zone 1 Low Probability	Land having a less than 0.1% annual probability of river or sea flooding. (Shown as 'clear' on the Flood Map for Planning – all land outside Zones 2, 3a and 3b)
Zone 2 Medium Probability	Land having between a 1% and 0.1% annual probability of river flooding; or land having between a 0.5% and 0.1% annual probability of sea flooding. (Land shown in light blue on the Flood Map)
Zone 3a High Probability	Land having a 1% or greater annual probability of river flooding; or Land having a 0.5% or greater annual probability of sea. (Land shown in dark blue on the Flood Map)
Zone 3b The Functional Floodplain	This zone comprises land where water from rivers or the sea has to flow or be stored in times of flood. The identification of functional floodplain should take account of local circumstances and not be defined solely on rigid probability parameters. Functional floodplain will normally comprise: • land having a 3.3% or greater annual probability of flooding, with any existing flood risk management infrastructure operating effectively; or • land that is designed to flood (such as a flood attenuation scheme), even if it would only flood in more extreme events (such as 0.1% annual probability of flooding). Local planning authorities should identify in their Strategic Flood Risk Assessments areas of functional floodplain and its boundaries accordingly, in agreement with the Environment Agency. (Not separately distinguished from Zone 3a on the Flood Map)

Note: The Flood Zones shown on the Environment Agency's Flood Map for Planning (Rivers and Sea) do not take account of the possible impacts of climate change and consequent changes in the future probability of flooding. Reference should therefore also be made to the Strategic Flood Risk Assessment when considering location and potential future flood risks to developments and land uses.

Paragraph: 078 Reference ID: 7-078-20220825

Revision date: 25 08 2022

Planning Practice Guidance Table 2: Flood risk vulnerability and flood zone 'incompatibility'

Flood Zones	Flood Risk Vulnerability Classification				
	Essential infrastructure	Highly vulnerable	More vulnerable	Less vulnerable	Water compatible
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	Exception Test required	✓	✓	✓
Zone 3a †	Exception Test required †	**X**	Exception Test required	✓	✓
Zone 3b *	Exception Test required *	**X**	**X**	**X**	✓ *

Key:

✓ Exception test is not required

X Development should not be permitted

Notes to table 2:

- This table does not show the application of the Sequential Test which should be applied first to guide development to the lowest flood risk areas; nor does it reflect the need to avoid flood risk from sources other than rivers and the sea;
- The Sequential and Exception Tests do not need to be applied to those developments set out in National Planning Policy Framework footnote 56. The Sequential and Exception Tests should be applied to 'major' and 'non major' development;
- Some developments may contain different elements of vulnerability and the highest vulnerability category should be used, unless the development is considered in its component parts.

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

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

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

Paragraph: 079 Reference ID: 7-079-20220825

Revision date: 25 08 2022

Essential infrastructure

- Essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk.
- Essential utility infrastructure which has to be located in a flood risk area for operational reasons, including infrastructure for electricity supply including generation, storage and distribution systems; including electricity generating power stations, grid and primary substations storage; and water treatment works that need to remain operational in times of flood.
- Wind turbines.
- Solar farms.

Highly vulnerable

- Police and ambulance stations; fire stations and command centres; telecommunications installations required to be operational during flooding.
- Emergency dispersal points.
- Basement dwellings.
- Caravans, mobile homes and park homes intended for permanent residential use.
- Installations requiring hazardous substances consent. (Where there is a demonstrable need to locate such installations for bulk storage of materials with port or other similar facilities, or such installations with energy infrastructure or carbon capture and storage installations, that require coastal or water-side locations, or need to be located in other high flood risk areas, in these instances the facilities should be classified as 'Essential Infrastructure'.)

More vulnerable

- Hospitals
- Residential institutions such as residential care homes, children's homes, social services homes, prisons and hostels.
- Buildings used for dwelling houses, student halls of residence, drinking establishments, nightclubs and hotels.
- Non–residential uses for health services, nurseries and educational establishments.
- Landfill* and sites used for waste management facilities for hazardous waste.
- Sites used for holiday or short-let caravans and camping, subject to a specific warning and evacuation plan.

Less vulnerable

- Police, ambulance and fire stations which are not required to be operational during flooding.
- Buildings used for shops; financial, professional and other services; restaurants, cafes and hot food takeaways; offices; general industry, storage and distribution; non-residential institutions not included in the 'more vulnerable' class; and assembly and leisure.
- Land and buildings used for agriculture and forestry.
- Waste treatment (except landfill* and hazardous waste facilities).
- Minerals working and processing (except for sand and gravel working).
- Water treatment works which do not need to remain operational during times of flood.
- Sewage treatment works, if adequate measures to control pollution and manage sewage during flooding events are in place.
- Car parks.

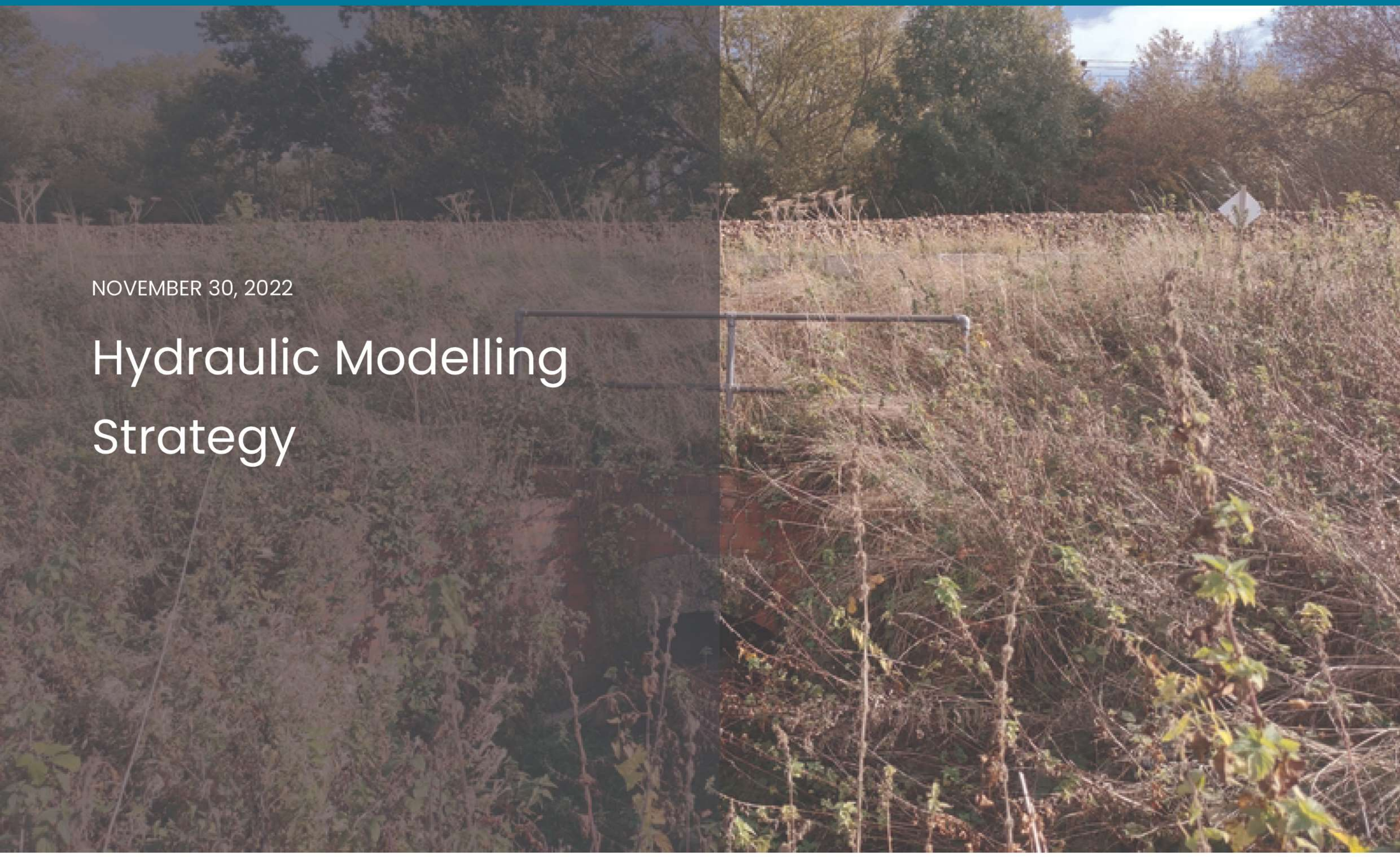
Water-compatible development

- Flood control infrastructure.
- Water transmission infrastructure and pumping stations.
- Sewage transmission infrastructure and pumping stations.
- Sand and gravel working.
- Docks, marinas and wharves.
- Navigation facilities.

- Ministry of Defence installations.
- Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location.
- Water-based recreation (excluding sleeping accommodation).
- Lifeguard and coastguard stations.
- Amenity open space, nature conservation and biodiversity, outdoor sports and recreation and essential facilities such as changing rooms.
- Essential ancillary sleeping or residential accommodation for staff required by uses in this category, subject to a specific warning and evacuation plan.

*Landfill is as defined in Schedule 10 of the Environmental Permitting (England and Wales) Regulations 2010.

Appendix B Hydraulic Modelling Strategy Technical Note



NOVEMBER 30, 2022

Hydraulic Modelling Strategy

Begbroke Innovation District

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A	Buro Happold	November 4th 2022
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Contents

List of Figures

List of Assumptions

SCOPE

1. Introduction

AEP	Epoch	Estimate	Uplift
3.33%	Present		0%
1%	Present		0%
1%	2080s	Central	26%
1%	2080s	Higher	41%
0.1%	Present		0%

Table 1.1: Fluvial events to be simulated

1.1 Project Requirements

Edenvale Young Associates and Buro Happold have been commissioned to undertake hydrological analysis and baseline flood risk modelling of the Begbroke Innovation District site in North Oxford, between Begbroke, Yarnton and Kidlington. The site boundary is shown in figure 1.1.

The purpose of the study is to define the flood extents and map the flood depths and hazards associated with a set of key design events required for the planning process, specifically the 3.33%, 1% and 0.1% AEP present day events and the 1% AEP events with climate change allowances to the 2080s. These events are shown in table 1.1.

1.2 Purpose of this Note

This technical note outlines the proposed approaches to the hydraulic modelling and hydrological analyses in order to gain agreement to these methodologies at the earliest possible stage. This approach was discussed with the Environment Agency (EA) in a meeting of 16th November 2022. It was anticipated in this meeting that the EA would be able to review and comment on the technical detail of this note by late December, unless substantial flood events occurred which might result in a delay.

This note will therefore present the approaches that Edenvale Young Associates and Buro Happold propose to use to meet the above requirements. At each stage, the key assumptions behind each decision will be highlighted and justification will be provided, detailing why the results of the work is not believed to be affected by those assumptions or the actions that will be taken to minimise the impact of each assumption.

Due to the project programme, we are due to commence the hydrological analysis and hydraulic modelling works ahead of receiving the EA's comments on this note. We would appreciate the EA's feedback at your earliest convenience to reduce the risk of abortive work.

1.3 Basic Approach

The flood risk will be assessed through the construction of a baseline hydraulic model using industry-standard software in combination with a hydrological analysis.

Hydraulic modelling of the site has been requested from the Environment Agency and there is no existing model of the site. Current flood mapping is understood to have been derived from JFLOW modelling and therefore is not considered appropriate for a site specific Flood Risk Assessment. Accordingly, as part of this work, it will be necessary to undertake detailed hydrographic survey of the watercourses and build a new hydrological and hydraulic model from scratch.

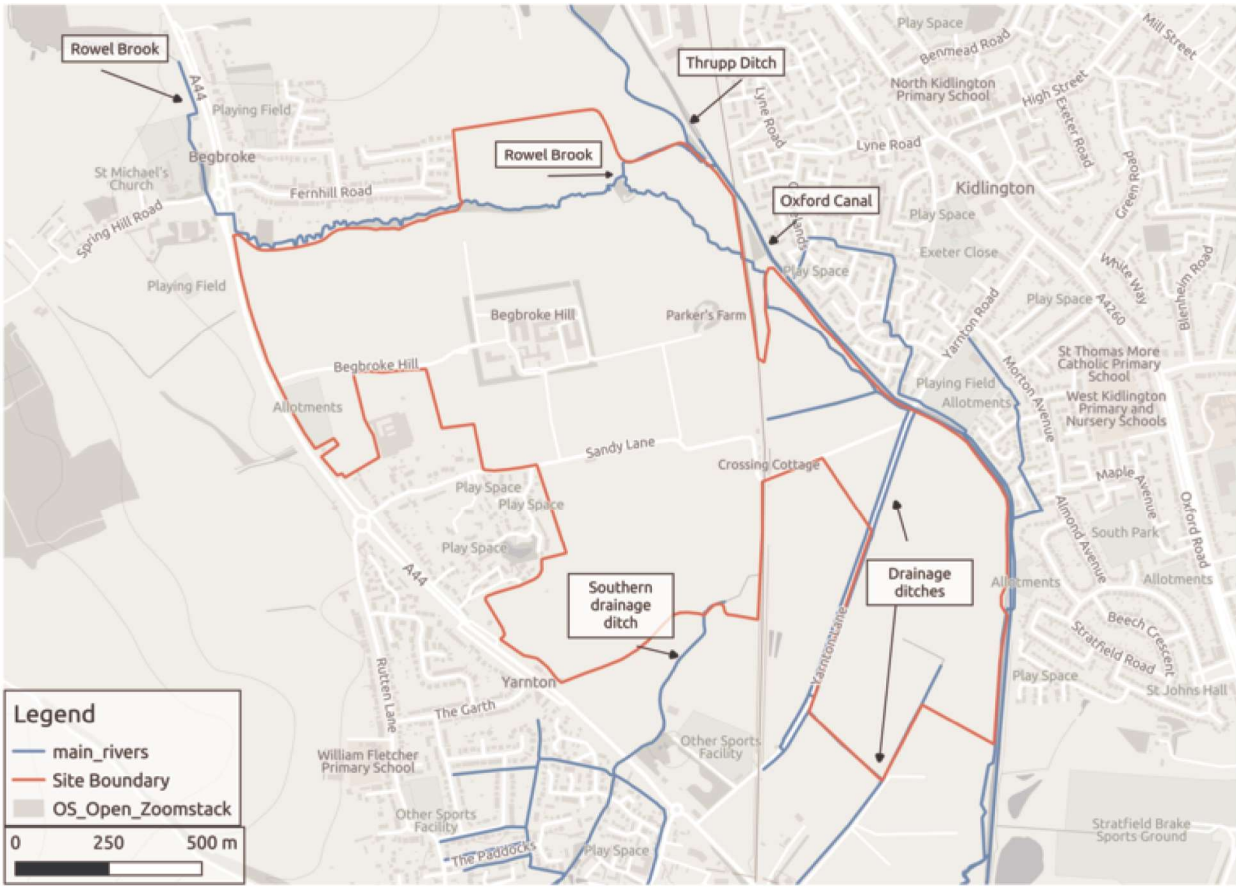

Figure 1.1: Red-line boundary of the site of interest

The hydrological analysis will be undertaken using the FEH methods as updated through the EA's technical guidance (LIT11832) along with the current latest versions of the WINFAP and ReFH2 software. The hydraulic modelling will be undertaken with the latest version of the widely-used TUFLOW software.

1.4 Site Overview

This section of the report provides a brief description of the significant watercourses and flow routes based on an initial desk study of the site and a site visit conducted on 12th October 2022.

There are a number of watercourses on site including the Rowel Brook, the Oxford canal, the Thrupp ditch, the southern drainage ditch and some other field ditches, shown in figure 1.1.

The Rowel Brook originates west of Oxford Airport and drains east to the A44 before turning south towards Begbroke. Once at Begbroke the Rowel Brook is culverted under the road and flows east across the northern boundary and, after bifurcating, through the north western corner of the proposed development site. This watercourse appears to be ephemeral, having no flow or standing water at the time of the site visit.

The watercourse bifurcates in a small wooded area to the north of the proposed development. On the site visit the ground levels in this wooded area appeared quite confused and there was no obvious low-flow connection to the south eastern branch of the bifurcation. A number of ponds in this location did contain water behind a weir that would discharge into the south eastern branch, but there was no obvious connection from these ponds that indicated that they took water from the Rowel Brook. It is anticipated that the proposed detailed survey will resolve the surface water connections in this location.

The north eastern branch from the bifurcation flows north and then east and appears to discharge into the Oxford Canal shortly after its tributary with the Thrupp Ditch. This branch contained standing water during the site visit.

Assumption 1. *Standing water in the Rowel Brook (NE) is maintained by the backwater from the canal.*

It is anticipated that the standing water observed in the Rowel Brook during the site visit is at a constant level matching the pound level of the Oxford Canal. This should be confirmed by the detailed survey. There is a small risk that this is not the case and that this water originates from another source, potentially groundwater, that would have to be identified and modelled.

The south eastern branch of the Rowel Brook flows through the site and, after passing through a culvert under the railway line, along the eastern edge of the site. After crossing under Sandy Lane it flows in a pair of ditches along either side of Yarnton Lane before being routed through field drainage and crossing back under the A44 south of the site. This branch was largely dry during the site visit. The ditches along Yarnton Lane appeared poorly maintained and the connectivity between the ditches was not always clear.

Assumption 2. *There exists an uninterrupted flow route along the Rowel Brook (SE).*

It is assumed from the site visit, the designation of main rivers, and the existing mapping of the watercourses that the ditches along Yarnton Lane are

A. connected to the Rowel Brook at their upstream extent,
B. continuous along both sides of Yarnton Lane,
C. connected to each other at their southern end as shown in the watercourse map,
D. connected to the return crossing under the A44 via field drains,
E. are not connected to allow discharge into the Oxford Canal.

It is anticipated that these assumptions will be confirmed by detailed survey.

The Thrupp ditch drains a catchment north of the site and flows south through an industrial estate, east of Bristol Airport. It runs just west of the Oxford Canal, flowing south, before entering a culvert under a footpath and joins with the Rowel Brook and Oxford Canal on the north eastern boundary of the site.

The Oxford Canal runs in a southerly direction from the northeast of the site, down the eastern edge of the site boundary. There are two pounds that affect the site. The most significant runs from a lock just upstream of the confluence with the Rowel Brook and Thrupp

Ditch along the eastern boundary of the site to a lock near Stratfield Road, Kidlington. The second pound starts here and runs south for a considerable distance, ending a short way upstream of the A40. The lock between these two pounds has a substantial side-spill weir upstream of it to maintain the upper pound level. This discharges into a parallel channel around the lock on the western side and returns to the canal downstream.

The Southern drainage ditch originates to the west of the railway within the site boundary and flows southwest through Yarnton.

Assumption 3. *Field Drainage on site is not fluvially significant*

Except where noted in this section, it is assumed that field drains on the site are not significant for the purposes of delineating fluvial flood risk. The site visit showed that most of the field drains that are not associated with the ditch system along Yarnton Lane (discussed elsewhere) seem to have limited connectivity to the fluvial network. All of the field drains currently designated as main river will be included in the model, regardless of this assumption.

SCOPE

2. General Methods

2.1 Hydrological Analysis

Base catchment

There is no flow or level data available for the catchment of interest, with no known existing studies to review. As such, a standard FEH analysis will be undertaken which will consist of both the Statistical and ReFH methods in order to establish the worst case scenario which will then be applied to the hydraulic model. We believe this will provide a conservative estimate of flood risk for the site.

The site is almost entirely covered by the catchment delineated from the FEH web service shown in figure 2.1 and catchment descriptors and peak flow estimates will be derived for this base catchment.

This catchment is not believed to be well-defined, and it is not reasonable to use this catchment's peak flow estimates directly. In particular, this catchment does not follow the expected flow route for the Rowel Brook to the south west where it is believed to return under the A44 and it ignores a number of significant man-made barriers to flow that constrain this area from functioning as a single hydrological catchment.

Catchment delineation

In order to gain a better understanding of the surface flow routing in this area a broad-scale, 2D-only model will be constructed of the catchment shown in figure 2.1 and a first approximation of the 0.1% AEP design event rainfall will be applied directly to the grid. The results of this Direct Rainfall Model (DRM) will allow

1. the key off-site sub-catchments affecting fluvial flood risk to

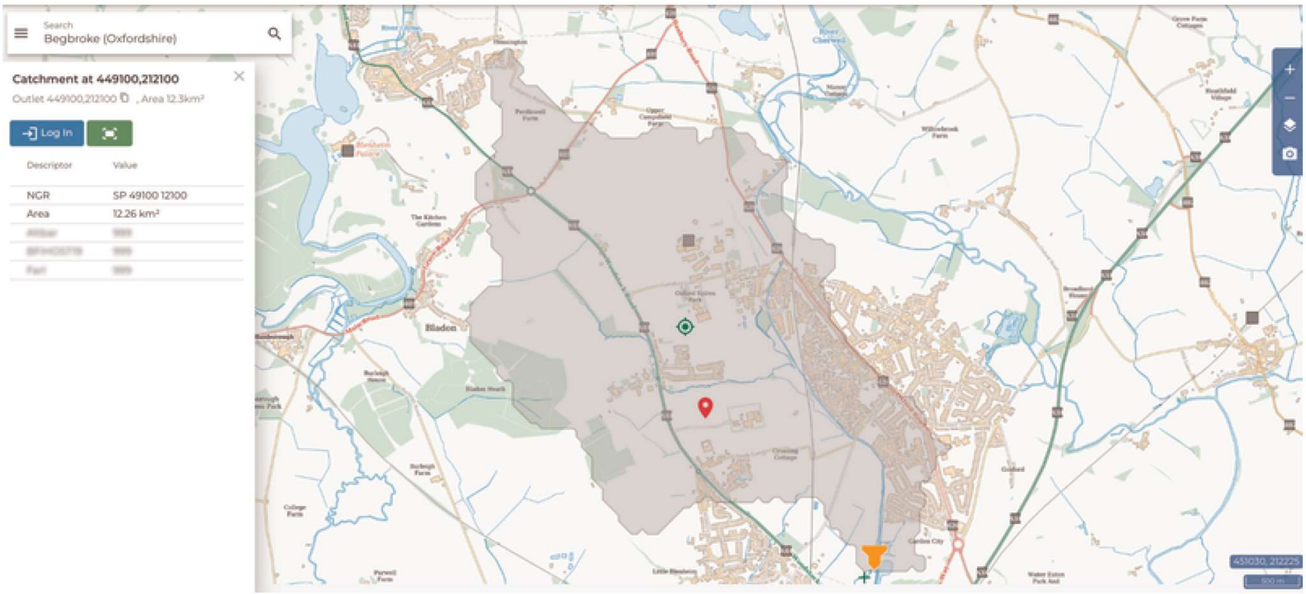

Figure 2.1: Base catchment from the FEH web service

the site to be delineated, and

2. the on-site sub-catchments to be delineated and the flow routes by which these on-site sub-catchments drain to the watercourses to be identified.

It is expected that several adjustments will be made to the base catchment in the light of the results from the DRM. In particular, it is expected that the Oxford Canal will form a hydrological barrier and that the urban area of Kidlington, to the east of the site, will be removed from the base catchment. Conversely, the base catchment on the FEH web service does not include the fields north east of Yarnton, through which it is anticipated the bulk of the site drains and these will need to be added. The base mapping in figure 2.1 also shows several watercourses crossing the supposed catchment boundary, particularly along the western extent, indicating that the catchment is not well delineated in this area.

Assumption 4. *The Oxford Canal is a hydrological barrier.*

The Oxford Canal marks the eastern boundary of the site and it is assumed that the canal forms a barrier to flow, with rain falling east of the canal, in Kidlington, draining south, parallel to the canal, and rain falling west of the canal falling within the Rowel Brook catchment.
This assumption is largely supported by:

- existing surface water and flood risk mapping,
- on-site observations during the site visit that did not reveal any formal discharges into the canal from the left (eastern) bank,
- communication with the Canal & Rivers Trust who have indicated that they have no record of any current outfalls or discharge points between the two locks.

The watercourse map (figure 1.1) does show two watercourses discharging into the canal on the eastern bank, but it was not possible to locate these discharge points or (with the exception of a small reach on the playing field at Kidlington Football Club) watercourses during the site visit. It is therefore expected that normal flows from the urban area of Kidlington drain southwards to the ponds east of the solar farm.

It is possible that urban run-off from Kidlington could enter the canal during very extreme events. The likelihood of this and potential catchment area will be assessed using the DRM and a sensitivity analysis will be undertaken to determine if urban run-off from Kidlington discharging into the canal will significantly affect water levels in the canal and hence water levels on site.

Hydrological Schematisation

The final model is expected to include at least two major inflows representing the off-site catchments of the Rowel Brook and the Thrupp Ditch which will be introduced as point inflows at the model boundary. The expected locations of these inflows are shown in figure 2.2. It is anticipated that catchments for these major inflows will be defined and that individual statistical peak flow analyses will

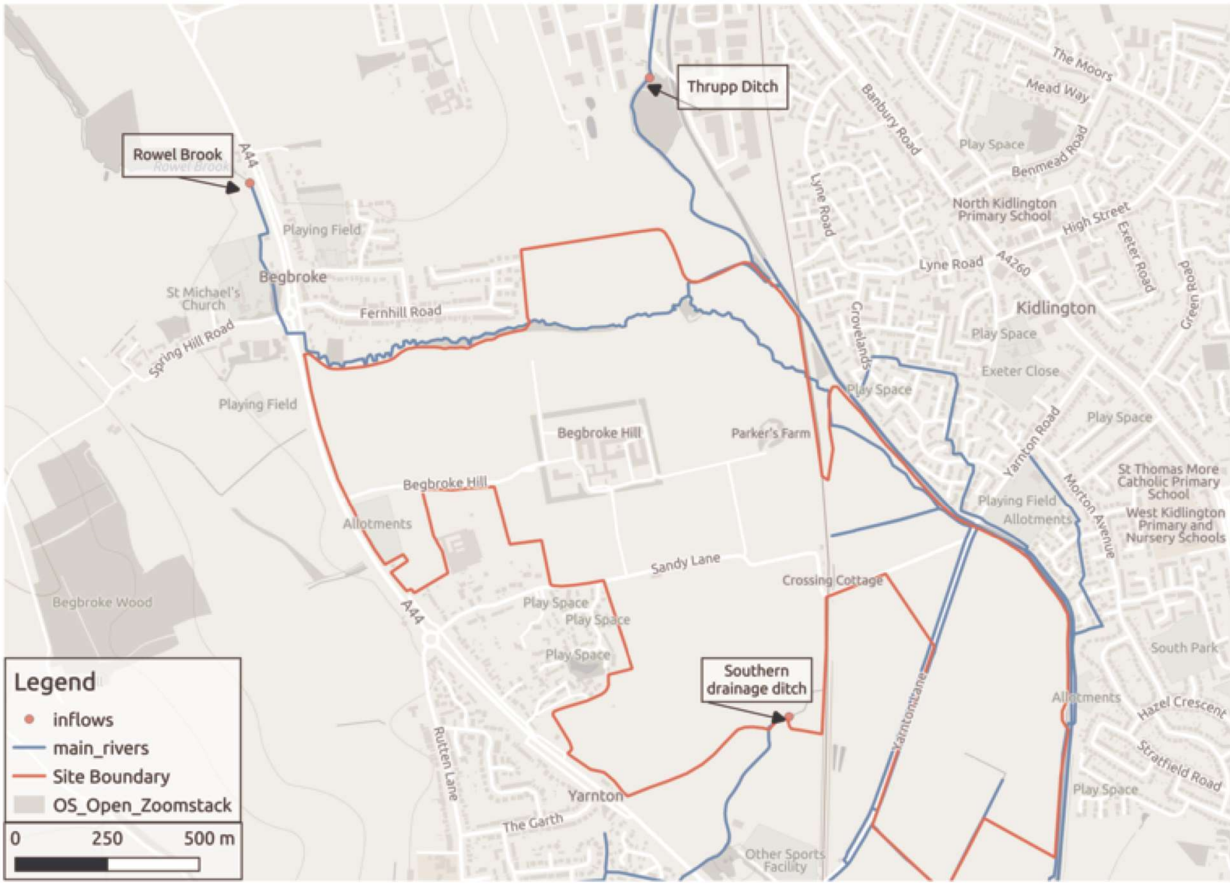

Figure 2.2: Inflow locations

be undertaken for each of these off-site catchments. ReFH2 models will be derived that match these statistical peak flow estimates at their critical storm durations.

The model will also have a number (to be determined) of delineated on-site sub-catchments whose inflows will be introduced in or near the watercourses. It is anticipated that some of these catchments may extend off-site to some limited degree, particularly to capture the areas north of the Rowel Brook, between the two major inflows, and any potential overland flow route approaching the site from the direction of Begbroke Wood, to the west. Catchment descriptors for the newly-derived sub-catchments will be calculated using standard transformations of the descriptors from the overall FEH catchment shown in figure 2.1 and ReFH2 models will be derived for each of these sub-catchments. The distribution of the inflows from the on-site sub-catchments will be informed by the results of the DRM.

Where it is unclear from the DRM whether a catchment would discharge to a watercourse or simply form standing water, that water will be distributed evenly along the watercourse for the purpose of this modelling.

Assumption 5. *All water reaches one of the modelled watercourses.*

For the purposes of flood risk modelling it is assumed that all rainfall and water falling on the site and the catchments upstream will reach one of the modelled watercourses. It is assumed that any rainfall that would form standing surface water not connected to a watercourse will be handled by the surface water drainage scheme and the over-land flow routes associated with this will not be modelled here.
This approach should yield a flood risk map that may, conservatively, include some areas that could be considered surface water flooding, but which is much less likely to erroneously exclude areas of fluvial flood risk.

The on-site catchment feeding the southern drainage ditch will be included as a point inflow at the upstream end of that ditch as shown in figure 2.2. This approach is in line with common flood risk modelling practice and is a conservative representation of the flood risk along this reach.

Design Storm Duration

The design critical storm duration is likely to be longer than the individual critical storm durations of any of the sub-catchments. Accordingly the ReFH2 design critical storm duration and resulting rainfall hyetograph of the base catchment will be applied to all of the sub-catchments to derive design events. It should be noted that the ReFH2 models for each of the sub-catchments for which statistical peak flow estimates are available will have been adjusted to be able to reproduce the statistical peak flows for that sub-catchment's critical storm duration.

Assumption 6. *Single Design Storm*

In line with the FEH methods, a single design storm will be assumed over the modelled catchment. This storm's rainfall totals for each design AEP will be derived using the FEH13 "DDF2" model applied to the base catchment that covers the majority of the site. A rainfall hyetograph will be derived for this storm using the normal approaches in ReFH2 and this single hyetograph will be applied to each sub-catchment for the design events.
For climate change events each sub-catchment's inflow hydrograph will be adjusted individually. Events with an additional storm duration will be run to identify any potential for increased flood risk from the southern drainage ditch in a short-duration event.

2.2 Hydraulic Modelling Approach

Software and Solver

The hydraulic model will be constructed using the latest version of ESTRY-TUFLOW with HPC (currently TUFLOW build 2020-10-AE). The TUFLOW software package has been used extensively in the UK for over 15 years and is a successfully benchmarked and trusted modelling package. ESTRY has been selected due to the meandering, shallow gradient and ephemeral nature of the Rowel Brook and the known limitations with the FMP software for modelling rivers with these characteristics.

The TUFLOW QuadTree solver will be used in order to get high resolution in several critical areas of the model where it is unclear