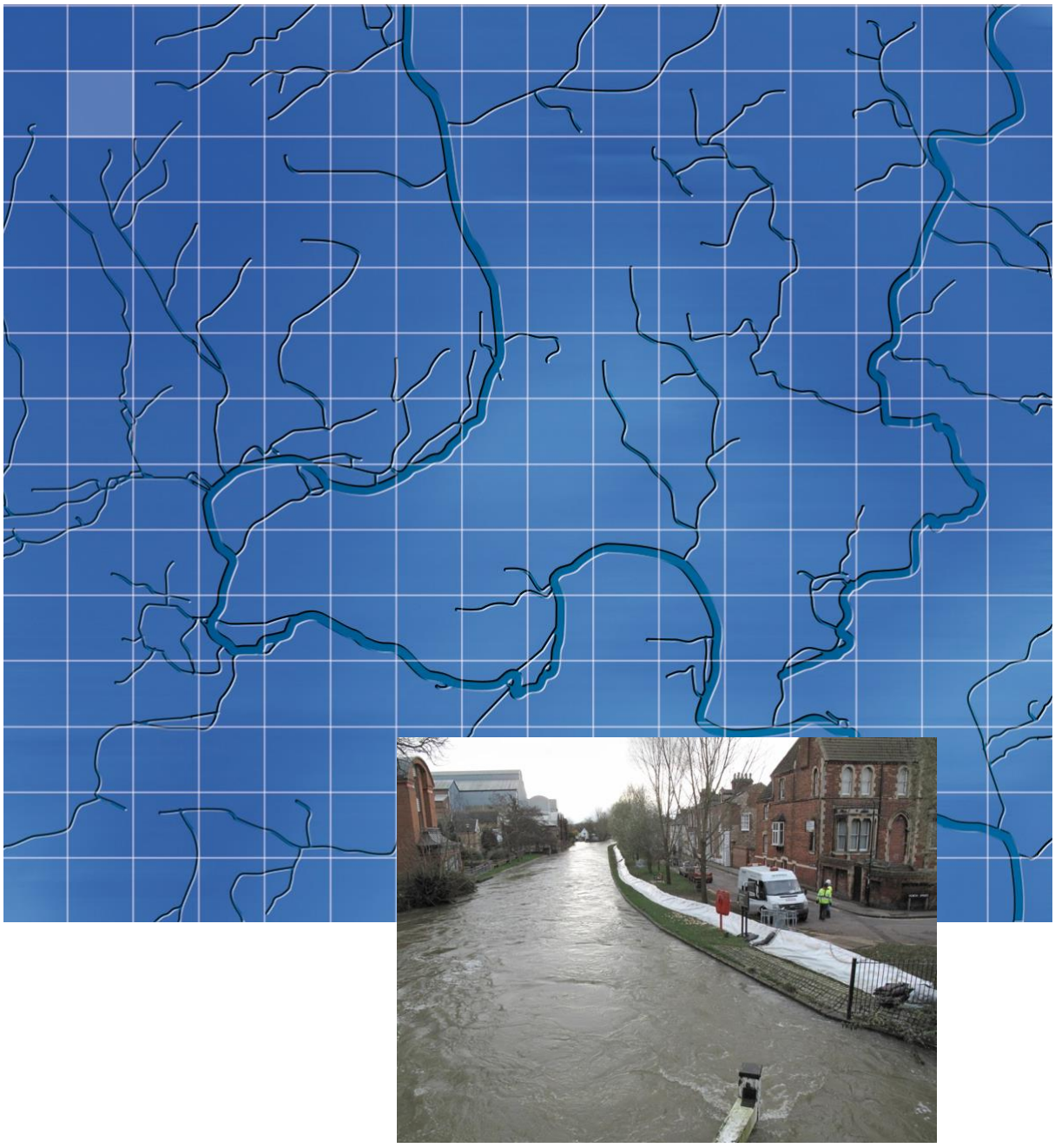
Oxford City Council

July 2018

Level 2 Strategic Flood Risk Assessment



Wallingford HydroSolutions Limited
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Oxford City Council

Level 2 Strategic Flood Risk Assessment

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For and on behalf of Wallingford HydroSolutions Ltd.

The WHS Quality and Environmental Management system is certified as meeting the requirements of ISO 9001:2008 and ISO 14001:2004 for providing environmental consultancy, the development of hydrological software and associated training.

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Contents

1 Introduction

Wallingford HydroSolutions (WHS) Ltd has been commissioned by Oxford City Council (OCC) to undertake a Level 2 Strategic Flood Risk Assessment (SFRA) in accordance with the National Planning Policy Framework (NPPF) and associated guidance from the Environment Agency (EA).

The main analysis and documentation on flood risk for Oxford currently comprises a Level 1 SFRA, completed in 2017. Since completion of the SFRA, the City Council has carried out a sequential test of sites within its administrative area. The results of which show that a number of sites may need to be located in Flood Zone 3a and Flood Zone 3b (developed) for more vulnerable uses such as housing.

A Level 2 SFRA is required to assess the likelihood of the exception test being passed for all relevant sites. The Level 2 SFRA will carry out a detailed assessment of flooding at each of the sites based on available model data, flood defence information, surface water flood mapping and historical flood data. The site-specific assessments will also include guidance for the preparation of site-specific Flood Risk Assessments (FRAs), including information about the use of SuDS and the need for mitigation measures.

This Level 2 SFRA should be read in conjunction with National and Local policy documents, and the Level 1 SFRA.

2 Methodology

2.1 Site Selection

OCC has identified a total of 27 sites to be included in the Level 2 SFRA. Nine of these sites were classed as high-risk sites by OCC, with 20% of their site area in Flood Zone 3. For these sites a detailed assessment of flood risk was required. OCC also asked for a detailed assessment at three sites in the west end of Oxford which were at variable risk of flooding.

For the remaining 15 sites a topographical survey was required. This was to measure the surveyed levels against predicted modelled flood levels by undertaking GIS analysis of the outputs. This sought to confirm whether any additional areas were likely to be in or out of the flood zones. Hence confirming whether OCC's approach to the Sequential Test is still valid and ensuring that a detailed FRA will not produce a different outline for the areas at risk of flooding.

For sites where there was a significant change in the extent of flooding, a detailed assessment identical in scope to the assessments undertaken at the high-risk sites was produced. This was the case for the Summertown Strategic site (003) and Bertie Place (008). Figure 1 shows the location of the sites in Oxford, and the assessment applied.

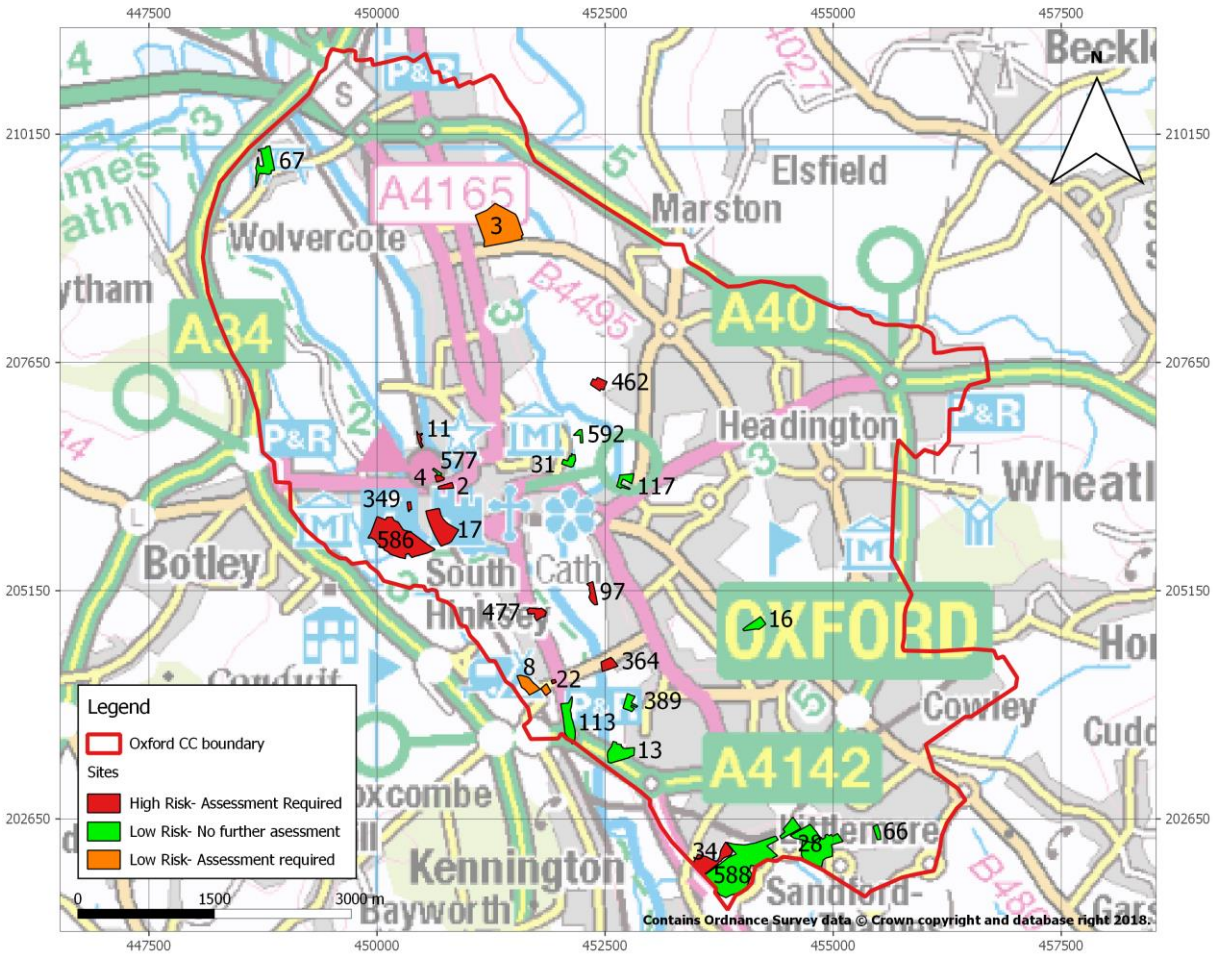

Figure 1- Location and classification of sites in Oxford Level 2 SFRA

2.2 Sources of Data

This SFRA presents an assessment of the risk of flooding from all sources at each of the sites. To inform this, existing information and model data have been identified and collated for different sources of flooding. The latest model data for the Thames catchment and for the Littlemore Brook have been incorporated into the site-specific assessments, along with details on flood defences, surface water flooding and sewer flooding.

The main sources of data used to inform this SFRA include;

- The 2017 Oxford 1D/2D model including the River Thames and River Cherwell to assess fluvial flood risk for the majority of the sites[1]
- Outputs from the 1D/2D model of the Littlemore Brook[2] to assess fluvial flood risk at the Littlemore Park site (034)
- EA Surface Water Flood Mapping[3] to quantify the pluvial flood risk, and flood risk from ordinary watercourses for all of the sites
- EA flood defence structures[4] to assess existing formal and informal flood defences present at each of the sites
- DG5 sewer flooding register[5] to assess the risk of sewer flooding at each of the sites

2.3 Assessment of Flood Risk

For the sites at greater risk of flooding, which included the high-risk sites defined initially by OCC, the west end sites and the lower risk sites identified as being at potential flood risk following site surveys, a detailed assessment of the nature of flood hazard was undertaken. This included using the relevant fluvial modelling data to assess:

- The proportion of the site inundated for a range of return periods
- The speed of onset
- Flood Depth
- Flood Velocity
- Overall Flood Hazard and potential impacts

The sites were assessed against a range of return periods, however the design event, the 100-year (plus 35% climate change[6]) event, was considered most important for planning purposes.

In addition to the analysis of modelling data, the location, standard and condition of existing flood defences was assessed. Other sources of flooding were also reviewed at each site. This included an assessment of surface water flooding and an assessment of sewer flooding based on DG5 sewer flooding register. Potential access/egress routes were identified with respect to the risk posed from all sources of flooding.

Following a review of flood risk, flood defences and the identification of access/egress routes, an assessment was made on whether it is likely that a future FRA would be able to show that the

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[1] EA(2017) Product 6 Thames Model Evenlode to Thame
[2] EA(2011) Product 6 Northfield and Littlemore Brooks model
[3] EA (2018) Flood Map for Planning
[4] EA(2017) Spatial_Flood_Defences_v201608
[5] Thames Water (2016) DG5 Sewer Flooding Register
[6]Environment Agency (2016) Flood risk assessments: climate change allowances, https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances accessed 26/07/18

Exception Test can be passed (see Section 2.4). The assessment also takes into account the NPPF's flood risk vulnerability and flood zone compatibility classifications[7].

In this respect guidance is provided for the preparation of FRAs, including information about the use of SuDS, and requirements to consider at the planning application stage including the need for mitigation measures.

2.4 Exception Test

The NPPF outlines the use of the Exception Test for determining whether a particular development is suitable within areas vulnerable to flooding. Following application of the Sequential Test, if it is not possible or consistent with wider sustainability objectives for the development to be located in zones of lower probability of flooding, the Exception Test needs to be applied.

The Exception Test provides a mechanism for managing flood risk while still allowing necessary development in areas of flood risk to occur. It should not, however be used to justify 'highly vulnerable' development in Flood Zone 3b.

The Exception Test comprises the following two requirements, which the NPPF states must be passed for development to go ahead:

- It must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk.
- A site-specific FRA must demonstrate that the development will be safe for its lifetime taking account of the vulnerability of its users without increasing flood risk elsewhere, and where possible, will reduce flood risk overall.

Both elements of the test will have to be passed for development to be allocated or permitted. This Level 2 SFRA provides high level exception testing for the second part of the test looking at the allocation of sites within areas of medium to high probability of flood risk. A site-specific FRA will need to undertake a more detailed assessment of flood risk and design mitigation measures where required to ensure that the development is safe for its lifetime.

[7] Communities and Local Government (2012), Technical Guidance to the National Planning Policy Framework

3 Results of Site Specific Assessments

3.1 Introduction

This section provides a summary of the findings for the 14 sites for which detailed assessments have been undertaken. It also provides advice for site specific FRAs and an overview of the SuDS guidelines to be followed by developers. Appendix 1 provides a tabulated summary of the findings at each site and the detailed site-specific assessments are provided in Appendix 2.

3.2 Fluvial Flooding

The fluvial flood risk at each of the sites was assessed using modelling data for the Thames and its associated tributaries. Of the 14 sites assessed, 12 were considered to be 'At Risk' from fluvial flooding, with the sites inundated during the design storm event and potential issues with safe access/egress.

The flood hazard at these sites did vary, Abingdon Road (022) and the Donnington Bridge Rd Riversports Centre (364) are both located primarily in Flood Zone 3b, with significant flood depths and velocities modelled for the design storm events. For these sites there are significant obstacles for development (see Section 3.5). At the remaining sites, which include Canalside (011), Jackdaw Lane (097), Littlemore Park (034), Old Power Station (349), Osney Mead (586), Oxford Spires Hotel (477), Park Farm (462), Bertie Place (008), Island Site (004) and Oxpens (017), fluvial flooding is still a significant risk, however development may be permissible. Many of these sites are partially in Flood Zone 3b, however the majority of their area lies outside the 1 in 20-year flood extent, and flood hazard tends to be either 'low' or indicates 'danger to some' in the design flood event.

Two of the sites, Summertown Safeguarded Land (003) and the Fire Station (002) were not considered to be at significant risk of fluvial flooding. These sites were partially inundated in the design storm event; however, the vast majority of the sites remain flood free and safe access/egress was not compromised.

Figure 2 shows a map of the sites and their fluvial hazard.

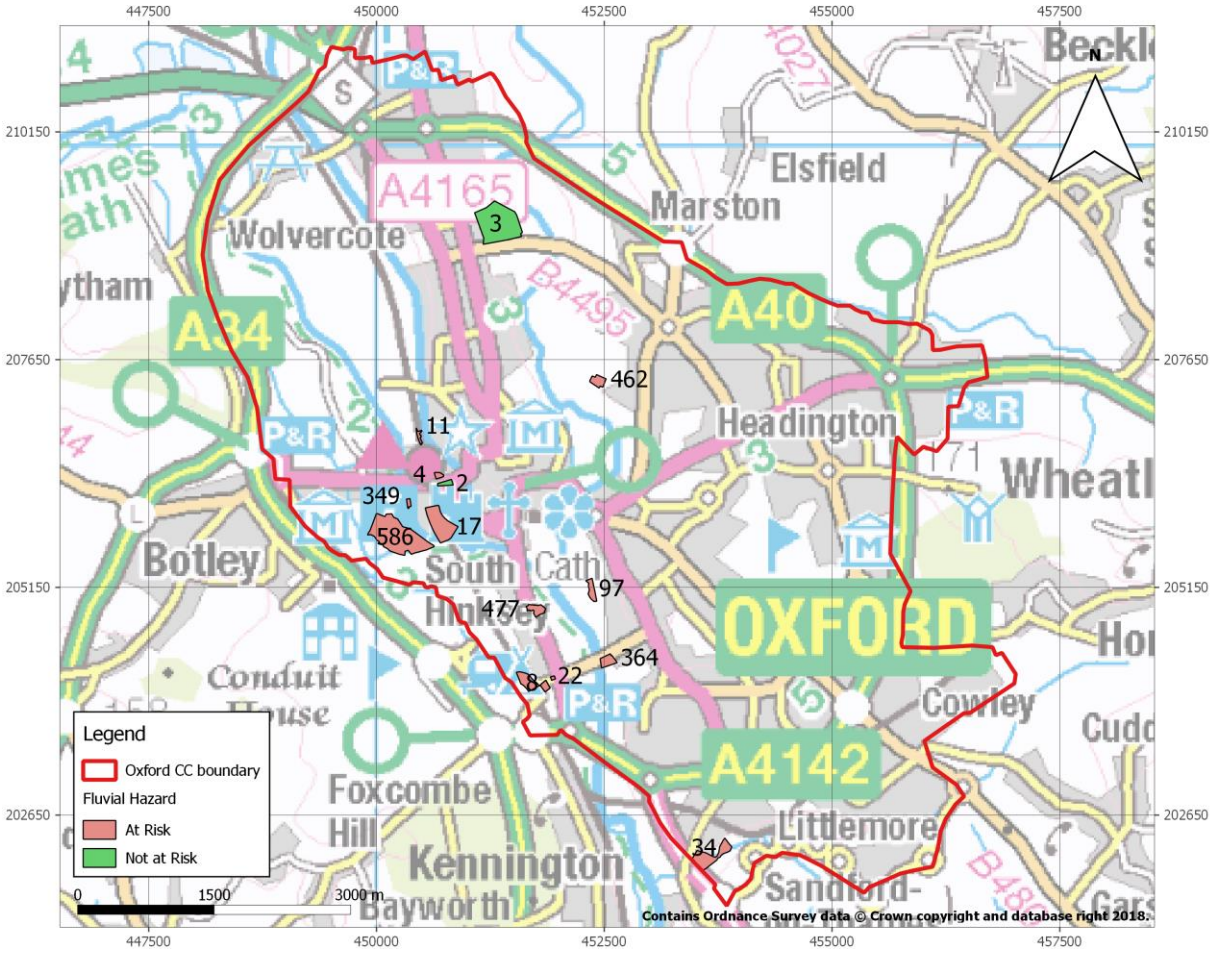

Figure 2- Fluvial Hazard at selected sites in Oxford Level 2 SFRA

3.3 Pluvial & Other Sources of Flooding

The pluvial flood risk at each of the sites was assessed using the EA's surface water flood maps. Of the 14 sites assessed one site was 'At Risk' from pluvial flooding. This was Donnington Bridge Rd Riversports Centre (364). The site is at risk from the 100 year and 1000-year events, with a significant proportion of the site inundated in both events. For the remaining sites pluvial hazard was limited with flooding mostly limited to isolated pooling in the 1000-year event.

Figure 3 shows a map of the sites and their pluvial hazard.

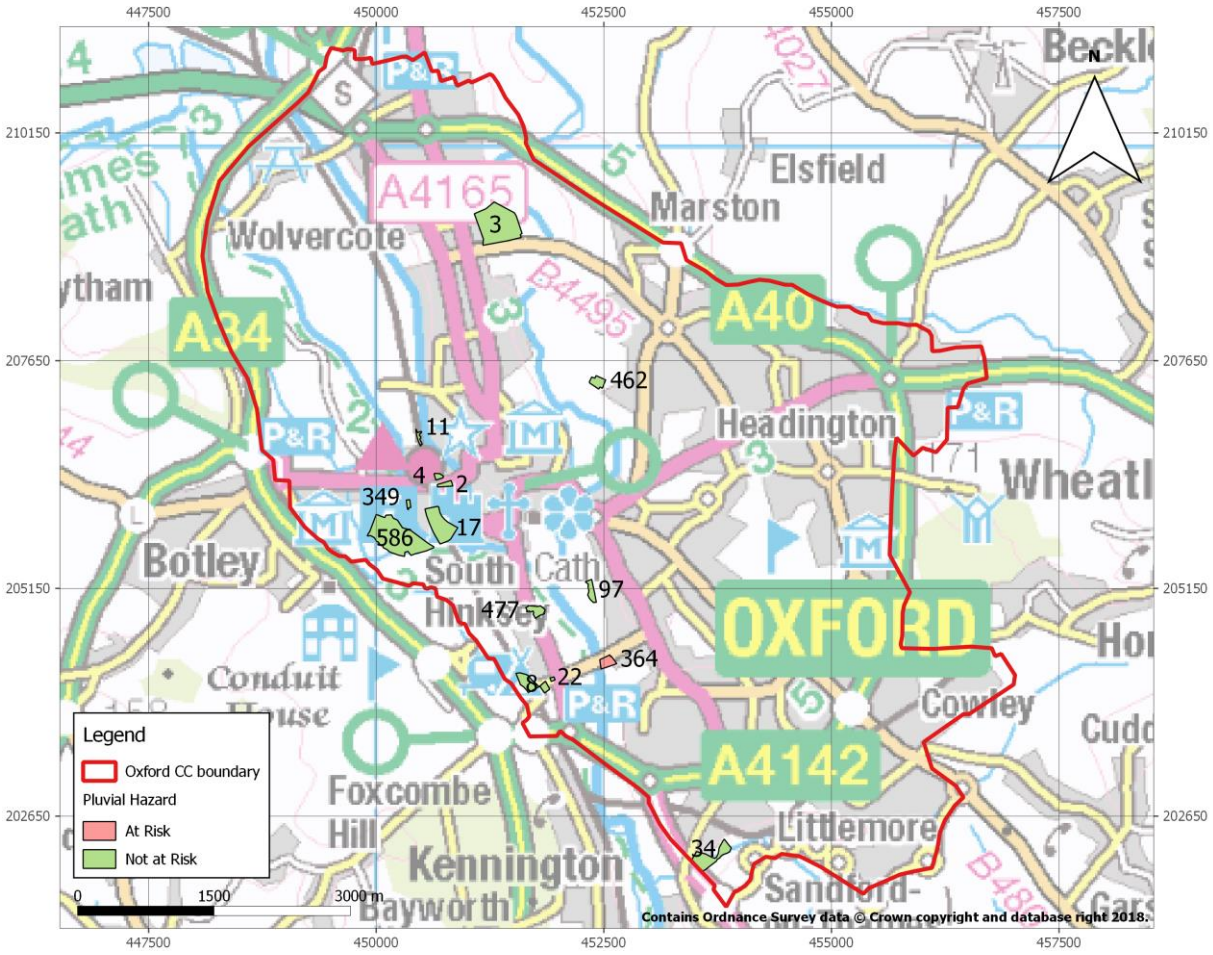

Figure 3- Pluvial Hazard at selected sites in Oxford Level 2 SFRA

Potential flooding from the sewer network due to failure was assessed by reviewing the DG5 sewer register. Six of the sites were in areas where sewer flooding incidents had been recorded, these included Canalside (011), Jackdaw Lane (097), Littlemore Park (034), Old Power Station (349), Osney Mead (586) and Oxpens (017).

Sewer flooding tends to be localised and, provided Thames Water maintain the sewer network to manage inflows from new developments, it should not be a major issue, however it should be considered as part of a site-specific FRA for the sites above.

3.4 Exception Test

To assess the likelihood of a site passing the exception test a traffic light system was used with the three categories defined as follows:

- Red-Proposed development is not appropriate and is unlikely to pass the Exception Test
- Amber- Proposed development is appropriate but may require significant mitigation and/or analysis to demonstrate compliance with the Exception Test
- Green- Proposed development is appropriate and likely to be justified in a site-specific FRA

Two of the sites, Abingdon Road (022) and the Donnington Bridge Rd Riversports Centre (364) were classed as red. These sites are at high risk of flooding and although safe access and egress is possible, it is heavily reliant on early flood warning systems. The proposed developments both consist of more

vulnerable infrastructure which, given the sites are almost exclusively within Flood Zone 3b, cannot be permitted based on the NPPF flood vulnerability classifications. Only water compatible and essential infrastructure can be sited in Zone 3b and the latter requires an Exception Test to justify development.

Nine of the sites, Canalside (011), Littlemore Park (034), Old Power Station (349), Osney Mead (586), Oxford Spires Hotel (477), Park Farm (462), Bertie Place (008), Island Site (004) and Oxpens (017) were classed as amber. For these sites care should be taken in locating different development vulnerability types. Based on the flood vulnerability classification only water compatible infrastructure can be sited in Flood Zone 3b, development is permitted in Flood Zone 3a for less vulnerable infrastructure, however an Exception Test needs to be applied for more vulnerable infrastructure in this zone. For these sites ground raising may be required to raise finished floor levels above the design flood level. If ground raising is required, compensatory storage may need to be considered and mitigation modelling will be required to demonstrate that the development does not increase flood risk elsewhere.

Three of the sites, Jackdaw Lane (097), Summertown (003) and Fire Station (002) were classed as green. Development at these sites should be possible as most of their land is flood free in the design flood event and safe access and egress is available. No Exception Test should be required for these sites, provided more vulnerable infrastructure is located outside of Flood Zone 3a.

Figure 4 shows a map of the sites and their likelihood of passing the Exception Test.

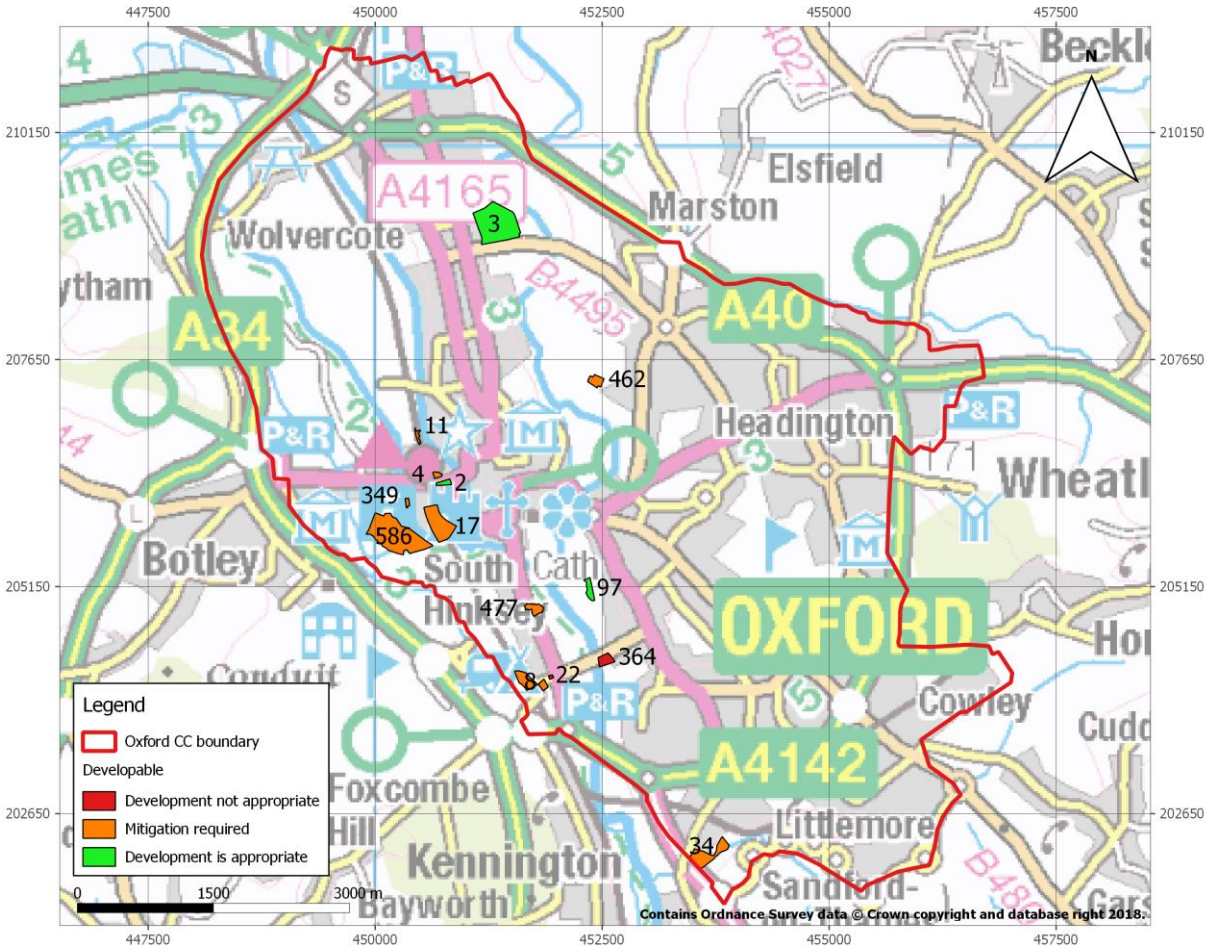

Figure 4- Likelihood of passing exception test at selected sites in Oxford Level 2 SFRA

3.5 SuDS

A site-specific FRA at any of the sites should follow the latest non-statutory guidance for SuDS published by DeFRA (2015) to demonstrate the viability of a SuDS solution. It sets out a range of technical standards. For greenfield developments, the peak runoff rate from the development to any highway drain, sewer or surface water body for the 1 in 1 year and 1 in 100-year rainfall event should never exceed the peak greenfield runoff rate for the same event. For developments which were previously developed, the peak runoff rate from the development must be as close as reasonably practicable to the equivalent greenfield runoff rate over the same area; never exceeding the rate of discharge from the development prior to redevelopment for any event.

Sustainable drainage systems are a vital part of the planning process, the NPPF states that any development should give priority to their use, and local authorities often assess planning proposals based on their ability to mitigate the impacts that development has on surface water runoff rates and volumes. Sustainable drainage systems are also considered to be environmentally beneficial, causing minimal or no long-term detrimental damage. They are often designed to intercept and remove pollutants at the source, managing a development's impact on the water quality of local water bodies.

There are many types of SuDS component, which means that sustainable drainage can be tailored to a range of sites. They are generally split into two categories; infiltration systems and attenuation systems. The use of both systems tends to be determined by the permeability of the soil, and a site's topography. It should be mentioned that the geology in Oxford is primarily composed of Alluvium in the form of Clay, Silt, Sand and Gravel, underlain by a bedrock of either Mudstone or Sandstone. This combined with a naturally high-water table means that the significant use of infiltration SuDS solutions is unlikely to be viable. It is recommended that a geotechnical investigation be undertaken at each site to obtain further information on infiltration rates, this will confirm whether infiltration could be viable in some areas.

If ground conditions cannot support infiltration systems, surface water may need to be attenuated using measures to capture surface water. Attenuation systems do not offer the same range of sustainability benefits as infiltration systems and therefore infiltration SuDS are always preferred where viable.

At a number of sites SuDS designs often include a combination of infiltration and attenuation systems. A central design component for SuDS is the SuDS management train. SuDS should not be thought of as individual components, but as an interconnected system designed to manage, treat and make best use of surface water. The use of a sequence of components that collectively provide the necessary processes to control runoff and water quality is therefore often encouraged.

Runoff rates and volumes for a development site can be derived using the FEH methods specifically the rainfall runoff method implemented in ReFH 2. This is the current recommended method outlined in the CIRIA SuDS manual[8]. Existing run-off rates are estimated by extracting point or catchment data. These data include variables which describe rainfall and runoff characteristics in a particular area. For a development site the runoff characteristics derived can be linearly scaled based on the site area, yielding runoff rates and volumes for that area. The rates derived either need to be maintained or bettered depending on if the site is on green or brownfield land.

[8] CIRIA (2015). *The SuDS Manual.*C753

4 Summary

4.1 Conclusions and Recommendations

4.1.1 OCC identified a total of 27 sites to be included in the Level 2 SFRA, 9 of these were classed as high-risk sites where more than 20% of the sites were in Flood Zone 3. For these sites a detailed assessment of flood risk needed to be undertaken.

4.1.2 Three sites in the west end of Oxford with variable flood risk were also identified by OCC as requiring further detailed assessment.

4.1.3 For the remaining 15 sites a topographical survey was required. These were lower risk sites in Flood Zones 1 and 2. The survey data were used to confirm whether any additional areas were likely to be in or out of the flood zones. Hence confirming whether OCC's approach to the sequential test is valid.

4.1.4 For 13 of these sites, following a review of the topographical survey data a significant change in the existing flood extents was considered unlikely. For these sites the proposed development should be appropriate and is likely to be justified in a site-specific FRA

4.1.5 For two of the lower risk sites a significant change was observed in flood extent when considering the newly available survey data. For these sites a detailed site-specific assessment was undertaken, meaning that a total of 14 sites were assessed in detail.

4.1.6 The detailed site assessments showed 12 of the 14 sites to be at risk of fluvial flood risk, and 1 of the 12 sites to be at risk from pluvial flooding; this site was also at risk from fluvial flooding.

4.1.7 In terms of sewer flooding 6 of the 14 were in areas considered to be at risk based on the DG5 sewer flooding register.

4.1.8 Following a review of flood risk from all relevant sources in respect to site access/egress, development type and access/egress, a high-level review of the Exception Test was undertaken.

4.1.9 For 3 of the 14 sites development is considered appropriate and is likely to be justified in a site-specific FRA; an Exception Test should not be required provided development is located outside of the small at-risk areas.

4.1.10 For 9 of the sites development is considered appropriate however mitigation measures may be required and/or analysis to demonstrate compliance with the Exception Test.

4.1.11 For the remaining 2 sites, the proposed development is not appropriate and is unlikely to pass the Exception Test unless the development type is changed.

4.1.12 Of the 27 sites in total, 16 are considered to be appropriate with respect to flood risk, 9 likely require mitigation to demonstrate compliance, and 2 of the sites are not considered appropriate in their current form.

4.1.13 A site-specific FRA will need to be undertaken at each of the sites, these will need to take into account the latest SuDS guidance, and where an Exception Test is required, show that i). the sustainability benefits of the development to the community outweigh flood risk, and ii). show that the development will be safe for its lifetime; detailing mitigation measures where required.

4.2 A Living Document

This SFRA has been developed with reference to existing data and knowledge with respect to flood risk within Oxford City. The flood maps informing this SFRA are regularly updated with new information and modelling software. This, in addition to observed flooding that may occur throughout a year, will improve the current knowledge of flood risk within the City. Subsequently, the predicted flood extents may be altered in some locations. Furthermore, future amendments to the NPPF are anticipated. Given that this is the case, a periodic review of both the Oxford City Level 1 and 2 SFRA is imperative.

Appendix 1 Summary Table for Site-specific assessments

Appendix 2 Site-specific Assessments