now part of

The Old Power Station, Vastern Road, Reading

Flood Risk Assessment

On behalf of

Project Ref: 47500/4001 | Rev: - | Date: January 2020

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Report Title: **Flood Risk Assessment**

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For and on behalf of Peter Brett Associates LLP				

Revision	Date	Description	Prepared	Reviewed	Approved
A	22/01/20	Updated for new climate change guidance			

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Executive Summary

This Flood Risk Assessment (FRA) has been prepared by Stantec and supports a planning application at 53-55 Vastern Road, Reading, for the demolition of existing structures and erection of a series of buildings ranging in height from 1 to 11 storeys including residential dwellings (C3 use class) and leisure floorspace (A3 use class), together with a new north-south pedestrian link, connecting Christchurch Bridge to Vastern Road.

In accordance with the fundamental objectives of the National Planning Policy Framework (NPPF), the FRA demonstrates that:

(i) The development is safe;

(ii) The development does not increase flood risk; and,

(iii) The development does not detrimentally affect third parties.

The Environment Agency (EA) Flood Zone map shows the northern end of the site is bordered by a corridor of Flood Zone 3 ‘High Probability’ associated with the adjacent River Thames. The site lies partly within Flood Zone 2 ‘Medium Probability’ (as defined in Planning Practice Guidance (PPG) ‘Flood Risk and Coastal Change’ Table 1) as follows:

Flood Zone 2 ‘Medium Probability’ (greater than 1 in 1000 (0.1%) annual probability of river flooding)

The proposals for this residential development constitute a ‘More Vulnerable’ land use (ref: PPG Table 2), which is considered appropriate within Flood Zone 2 subject to passing the Sequential Test (ref: PPG Table 3). The site was allocated for development within Reading Borough Council’s Local Plan, indicating the Sequential Test and Exception Test have been completed and passed.

The PPG ‘Climate Change Allowances’ guidance confirms the site criteria requires consideration of peak river flow allowances ranging from +35% (‘Higher Central’ allowance) to +70% (‘Upper End’ allowance).

The flood risk mitigation strategy for the development consists of the following elements:

- Ground floor levels are set at a minimum 38.60m AOD or above, providing a minimum 300mm freeboard above the design 1 in 100 annual probability +35% allowance for climate change flood level (and above the equivalent +70% scenario flood level);
- Removal of the existing northern boundary wall, and re-grading of the land behind it to provide an improvement in floodplain storage capacity as well as an ecological buffer along the boundary with the River Thames footpath;
- Incorporation of a continuous crest level running east-west across the north side of the site at a minimum of 38.60m AOD, which will tie in to the wider flood defence proposals of the EA Reading and Caversham Flood Alleviation Scheme;
- Safe access during the 1 in 100 annual probability flood event. In more extreme scenarios, allowing for climate change, there will be significant advance warning and the residual risk will be addressed through a Flood Management and Evacuation Plan in line with the requirements of the Reading Strategic Flood Risk Assessment (SFRA);
- A surface water drainage strategy has been prepared demonstrating a significant reduction in peak runoff rates through incorporation of on-site SuDS attenuation measures (provided within a separate document).

In summary, the FRA demonstrates that the proposed development is safe and in accordance with the requirements of national and local planning policy.

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1 Introduction

1.1 Scope of Report

1.1.1 This Flood Risk Assessment (FRA) has been prepared by Stantec, on behalf of our client, Berkeley Homes Ltd. This FRA supports a planning application at 53-55 Vastern Road, Reading, for the for the demolition of existing structures and erection of a series of buildings ranging in height from 1 to 11 storeys including residential dwellings (C3 use class) and leisure floorspace (A3 use class), together with a new north-south pedestrian link, connecting Christchurch Bridge to Vastern Road.

1.1.2 The report is based on the available flood risk information for the site as detailed in **Section 1.2** and prepared in accordance with the planning policy requirements set out in **Section 1.3**. The scope of the FRA is consistent with the 'Site-specific Flood Risk Assessment Checklist' from the National Planning Policy Framework (NPPF) Planning Practice Guidance (PPG).

1.1.3 Stantec has many years of experience in, amongst other areas, the assessment of flood risk, hydrology, flood defence and river engineering. The reviewers of the document are experienced engineers and members of chartered institutions such as the Chartered Institution of Water and Environmental Management (CIWEM) or the Institution of Civil Engineers (ICE).

1.2 Sources of Information

1.2.1 The FRA has been prepared based on the following sources of information:

- Environment Agency (EA) published '**Open Data'** datasets available online, reproduced with OS mapping under licence to Stantec (contains Ordnance Survey data © Crown copyright and database right [2018], contains Environment Agency information © Environment Agency and database right) (see **Appendix A**);
- The **Environment Agency (EA) online flood maps** at https://flood-map-for-planning.service.gov.uk/ and https://flood-warning-information.service.gov.uk/long-term-flood-risk/ ;
- Topographic survey of the site (Drawing reference 16/295/100-A) undertaken by Maltby Surveys Ltd. in October 2016 (see **Appendix B**);
- Development proposals by Berkeley Homes (see **Appendix C**);
- **EA Product 4 data** (THM_107956, December 2018) including historic flood data, flood defence information, modelled flood extents and flood levels from the EA River Thames (Sandford to Mapledurham) 2018 hydraulic model, provided from the 'Abingdon Flood Schemes' mapping study completed June 2017 (see **Appendix D**);
- **EA Product 5, 6 and 7 hydraulic model data** for the EA River Thames (Sandford to Mapledurham) 2018 hydraulic model;
- The Reading Borough Council (RBC) **Preliminary Flood Risk Assessment (PFRA**), June 2011;
- The Reading Borough Council (RBC) **Level 1 Strategic Flood Risk Assessment (SFRA)**, June 2017;
- The Reading Borough Council (RBC) **Level 2 Strategic Flood Risk Assessment (SFRA)**, December 2017.

1.3 Relevant Planning Policy

1.3.1 This FRA has been prepared in accordance with the relevant national, regional and local planning policy and statutory authority guidance as follows:

- National policy contained within the **National Planning Policy Framework (NPPF)** updated June 2019, issued by Communities and Local Government, with reference to Section 14 'Meeting the challenge of climate change, flooding and coastal change';

- The **NPPF Planning Practice Guidance (PPG)** released in March 2014 ('Flood Risk and Coastal Change' section) and updated to incorporate the EA '**Flood Risk Assessments: Climate Change Allowances'** guidance (most recently updated December 2019);

- EA regional guidance contained in the **'Thames Area Climate Change Allowances – Guidance for their use in flood risk assessments'** (January 2017), and 'Thames Guidance Statement – Safe Access/Egress for LPAs' (August 2016).

  It is noted that a pre-application enquiry was made to the EA and the EA response (reference WA/2018/126023/01, dated 30th January 2019 – see **Appendix D**) states that:

  (i) the 2018 modelled flood data is to be obtained and used as a basis for analysis;

  (ii) The 1 in 100 annual probability +35% allowance for climate change flood level is to be considered the 'design' flood level to inform mitigation requirements (i.e. finished floor levels and floodplain compensation);

  (iii) The EA are in favour of maximising the naturalised buffer zone between the development and river bank in accordance with RBC Local Plan Policy EN11.

- Local planning policy contained within the new '**Reading Borough Local Plan',** adopted November 2019, which replaces the Core Strategy, with specific reference to **Policy EN18 'Flooding and Sustainable Drainage Systems'**, which states:

  > *"Development will be directed to areas at lowest risk of flooding in the first instance, following the Sequential and Exceptions Test set out in the NPPF, and taking into account the effects of climate change. It will consider flooding from all sources, including fluvial, surface water, groundwater and sewer flooding. Where development in areas at risk of flooding is necessary, it will not reduce the capacity of the flood plain to store floodwater, impede the flow of floodwater or in any way increase the risks to life and property arising from flooding. Wherever possible, development should be designed to reduce flood risk, both on- and off-site.*
  >
  > *All major developments must incorporate sustainable drainage systems (SuDS) as appropriate and in line with the Government's Technical Standards. Smaller schemes are encouraged to incorporate SuDS, where possible. Runoff rates should aim to reflect greenfield conditions and, in any case, must be no greater than the existing conditions of the site. Schemes should ensure that the movement of water through vertical infiltration as well as horizontal run-off does not worsen contamination effects. Wherever possible, SuDS provision should maximise ecological benefits, link into the existing Green Network, incorporate tree planting and landscaping and avoid damage to existing significant trees, including through changes to the site hydrology. All new developments in areas of flood risk should give priority to SuDS".*

Policy CC3: 'Adaption to Climate Change' is also of relevance and states:

> *"All developments will demonstrate how they have been designed to incorporate measures to adapt to climate change. The following measures shall be incorporated into development…*
>
> - *…All development shall minimise the impact of surface water runoff from the development in the design of the drainage system, and where possible incorporate mitigation and resilience measures for any increases in river flooding levels as a result of climate change."*

Also of relevance - given the northern boundary of the site is adjacent to the River Thames footpath - is **Policy EN11 'Waterspaces',** which states:

> *"Reading's waterspaces will be protected and enhanced, so that they can continue to contribute to local and regional biodiversity and ecology, flood mitigation, local character, heritage and visual amenity, the provision of accessible leisure and recreational opportunities and, where appropriate, navigation. There will be no adverse impact on the functions and setting of any watercourse and its associated corridor.*
>
> *Where development in the vicinity of watercourses is acceptable, it will:-*
>
> - *Provide appropriate, attractive uses and buildings that enhance the relationship of buildings, spaces and routes to the watercourse, including through creating or enhancing views of the watercourse, and create a high quality public realm;*
> - *Make positive contributions to the distinct character, appearance, historic significance, landscape and amenity of the watercourses;*
> - *Provide a strengthened role for watercourses as important landscape features, wildlife corridors, historic features and recreation opportunities;*
> - *Wherever practical and consistent with its biodiversity role, provide good, level access to and along the waterside for all those who want to use it;*
> - *Be set at least ten metres back from the watercourse wherever practicable and appropriate to protect its biodiversity significance;*
> - *Improve the quality of watercourse environment through protecting and enhancing habitats and ensuring that habitat creation is balanced with access and urban uses; and*
> - *Pursue opportunities for deculverting of watercourses."*

1.4 Caveats and Exclusions

1.4.1 This FRA has been prepared in accordance with the NPPF and Local Planning Policy. The proposed flood management (including ground floor level recommendations) and surface water management strategies are based on the relevant British Standards (BS8533), the standing advice provided by the EA or based on common practice.

1.4.2 The Construction (Design and Management) Regulations 2015 (CDM Regulations) will apply to any future development of this site which involves "construction" work, as defined by the CDM Regulations. As such it is the responsibility of the proposed developer (ultimate client) to fulfil its duties under the CDM Regulations.

1.4.3 The approach for the FRA and proposals for the surface water management strategy are respectively based on the requirements of the EA and RBC in its role as Lead Local Flood Authority (LLFA).

1.4.4 The findings of this FRA are based on data available at the time of the study and on the subsequent assessment that has been undertaken in relation to the development proposals as outlined in **Section 5**. As such, the FRA is accurate at time of issue but we would recommend the end user reviews the validity of the flood data on an annual basis with the EA.

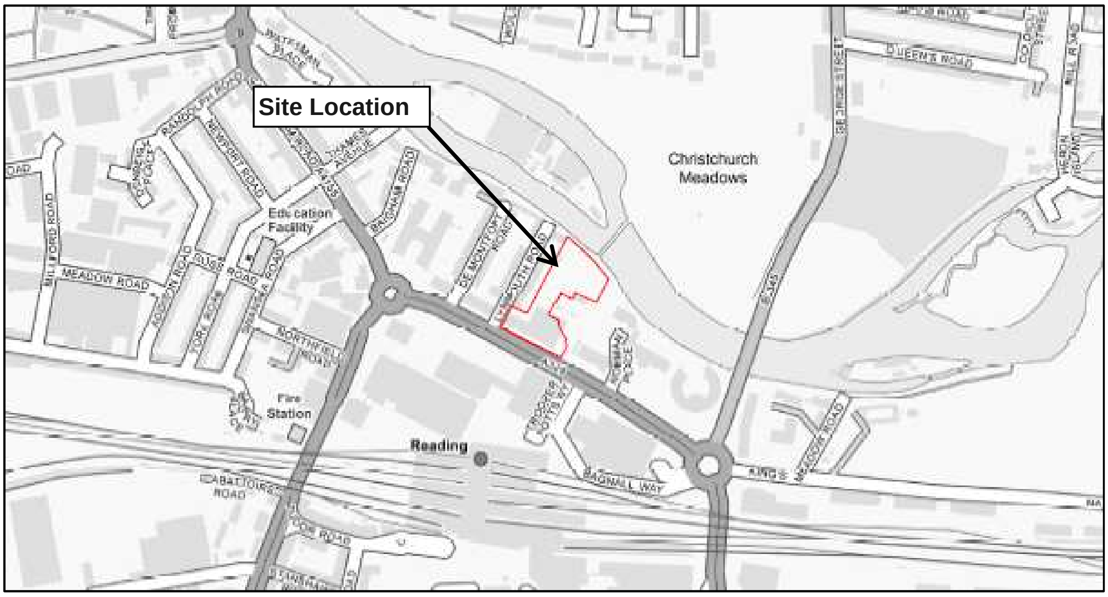
1.4.5 It should be noted that the insurance market applies its own tests to properties in terms of determining premiums and the insurability of properties for flood risk. Those undertaking development in areas which may be at risk of flooding are advised to contact their insurers or the Association of British Insurers (ABI) to seek further guidance prior to commencing development. Stantec does not warrant that the advice in this report will guarantee the availability of flood insurance either now or in the future.

2 Site Setting

2.1 Site Description

2.1.1 The site is located on the north side of Vastern Road in Reading, Berkshire (postcode RG1 8BU, site centre OS grid reference 471,530m E, 174,100m N – see **Figure 2-1**). The site lies within the administrative boundary of Reading Borough Council (RBC).

Figure 2-1: Site Location Plan (not to scale)



2.1.2 The site is currently occupied by SSE, and consists of an electricity sub-station, car parking and offices along the southern boundary. The site is bordered by the River Thames and the Thames footpath to the north (where a boundary wall runs along the back of the footpath), by office buildings on Norman Place to the east, by Vastern Road and a retail estate to the south, and by residential terraced housing on Lynmouth Road to the west.

Figure 2-2: View east along site frontage on Vastern Road

2.1.3 The main access from the site is off Lynmouth Road, close to the junction with Vastern Road.

2.2 Topography

2.2.1 The topographic survey in **Appendix B** by Maltby Surveys Ltd shows that the site is mainly at a level of between 38.0m AOD and 38.7m AOD.

2.2.2 The site is elevated approximately 1 metre above the adjacent Thames Path, accessed by steps at the midpoint of the northern boundary (the bottom of the steps is recorded at 37.3m AOD). and 1.5m above the normal water level of the River Thames (see **Section 2.3**).

2.2.3 EA LIDAR survey data, as shown within **Appendix A**, shows that the site lies at a similar elevation to other surrounding areas on either side of the Thames, with those elevations gradually decreasing eastwards along the corridor of the River Thames. Levels are significantly higher to the south of the site in the centre of Reading city centre, where a nominal ridge separates the Thames from the Kennet catchment to the south-east.

2.3 Hydrological Setting

2.3.1 The River Thames is the dominant watercourse in the area and flows east alongside the northern boundary of the site between Caversham Bridge (upstream of the site) and Reading Bridge (downstream).

2.3.2 Christchurch Bridge, a new public cycle/footbridge connecting Reading with Christchurch Meadows and Caversham to the north, lies directly adjacent to the site. Caversham Lock lies approximately 400m downstream of the site and maintains a Standard Head Water Level (SHWL) for the upstream reach alongside the site, of 36.59m AOD.

Figure 2-3: River Thames, view upstream (west) towards Caversham Bridge (site on left hand side)

2.3.3 The River Kennet flows north-east through the centre of Reading approximately 800m to the south of the site, and its confluence with the River Thames is 1.5km east of the site at Kennetmouth. Downstream of this point are the Caversham Lakes, a series of large lakes on the north side of the River Thames channel.

2.3.4 The other watercourse of relevance to the site is the **Vastern Ditch**, a former land drainage channel that has been subsumed into the surface water sewer network, that flows in a culvert along the southern boundary of the site alongside Vastern Road. The watercourse emerges into a small channel on the south side of Caversham Lock which outfalls to the River Thames immediately downstream of the lock.

2.4 Existing Drainage Arrangements

2.4.1 The current site is almost entirely impermeable, and the SubScan underground utilities survey (Sept 2017) can be summarised as follows (see separate Stantec 'Proposed Drainage Strategy' report, Dec 19, for further details):

- Surface water from the northern part of the site discharges into a 150mm drain that flows north-west within the site, close to the northern boundary wall and is assumed to discharge into the adjacent River Thames.

- Surface water from the western part of the site is conveyed west to the boundary of the site with Lynmouth Road. The sewerage discharges from the site towards Lynmouth Road via a 225mm drain and a 150mm drain. It is assumed that both of these drains outfall to a foul sewer shown on Thames Water asset records in Lynmouth Road.

- The surface water from the southern part of the existing building and northern footway of Vastern Road discharge to the culverted Vastern Ditch below the northern footway of Vastern Road via a number of small connections.

2.5 Geology and Hydrogeology

2.5.1 The British Geological Survey (BGS) Geology of Britain Viewer suggests that the site lies on superficial deposits of the Langley Silt Member.

2.5.2 The 1:50,000 scale geological sheet of the area indicates that the Site is underlain by the White Chalk. Langley Silt Member (Clay and Silt) is recorded across the Site overlying the over bedrock of the Seaford Chalk Formation and Newhaven Chalk Formation (White Chalk). River Terrace Deposits are shown overlying the solid geology on the Site. Alluvium is shown overlying the Terrace Deposits on the line of the River Thames to the north of the site and is possibly present on the site. It is anticipated that the natural strata are overlain by Made Ground associated with the previous and present developments of the site.

2.5.3 From consideration of the geomorphological and topographical setting of the site, it is expected that groundwater level will be consistent with the typical river level at approximately 36.5m AOD, however locally higher water levels may be present following periods of prolonged rainfall and elevated river levels.

2.5.4 The site does not lie within an EA Groundwater Source Protection Zone, however it does lie within a 'Drinking Water Safeguard Zone' for surface water. The site lies on a Principal designated bedrock aquifer, and within an area of Groundwater Vulnerability designated 'Major Aquifer High'.

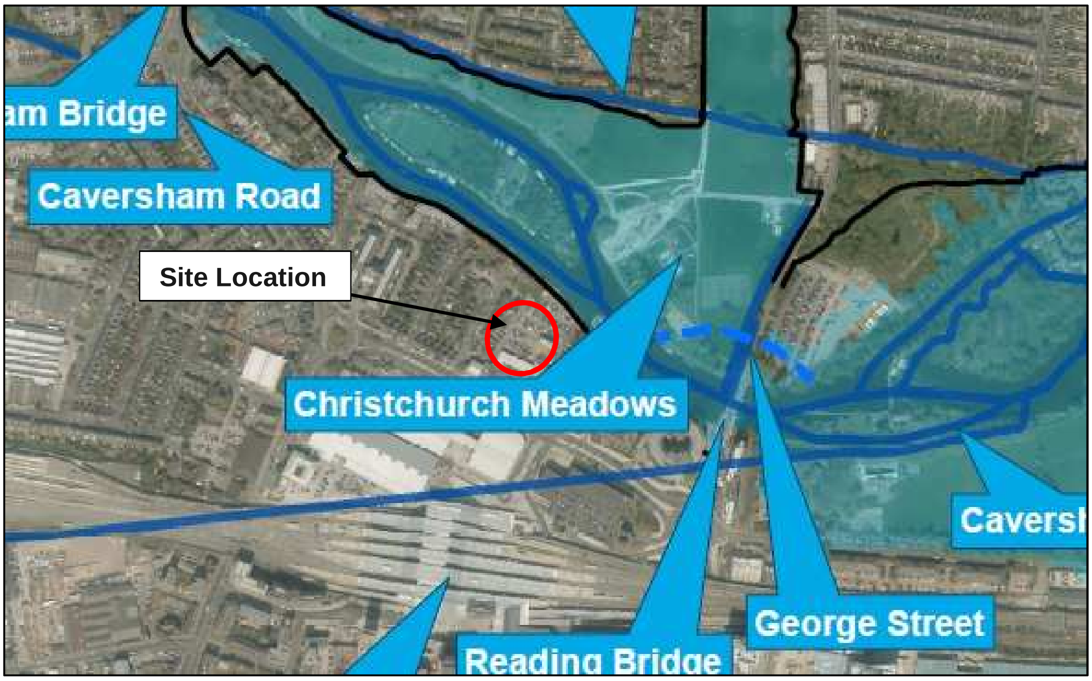
2.6 Reading and Caversham Flood Alleviation Scheme

2.6.1 The EA has indicated in their asset register that informal bank protection on the right bank of the River Thames provides protection to a standard of 1 in 5 years. These 'defences' are considered to be in 'poor' condition and it should be reiterated that this refers to the level of the river bank rather than the masonry wall along the northern boundary of the site; the EA modelled 1 in 5 annual probability flood level in the vicinity of the site is 37.1m AOD (see EA Product 4 data in **Appendix D**), which is lower than the footpath level adjacent to the site (see **Section 2.2**)

2.6.2 The EA is currently developing the design for a Reading and Caversham Flood Alleviation Scheme (FAS) to reduce flood risk to the area from the River Thames, with an intended planning submission in late 2020 and completion by Summer 2023. The current proposed scheme features new and reinforced flood walls and embankments along the edge of the floodplain, and a new flood alleviation channel to be constructed within Christchurch Meadows to the north-east of the site.

2.6.3 The proposed scheme would significantly reduce the extent of flooding affecting the area surrounding the site during the 1 in 200 annual probability flood event, preventing any out of banks flooding on the south bank between Caversham Bridge and Reading Bridge – as shown on **Figure 2-4**.

Figure 2-4: 1 in 200 annual probability flood extents post-FAS (extracted from EA proposals)

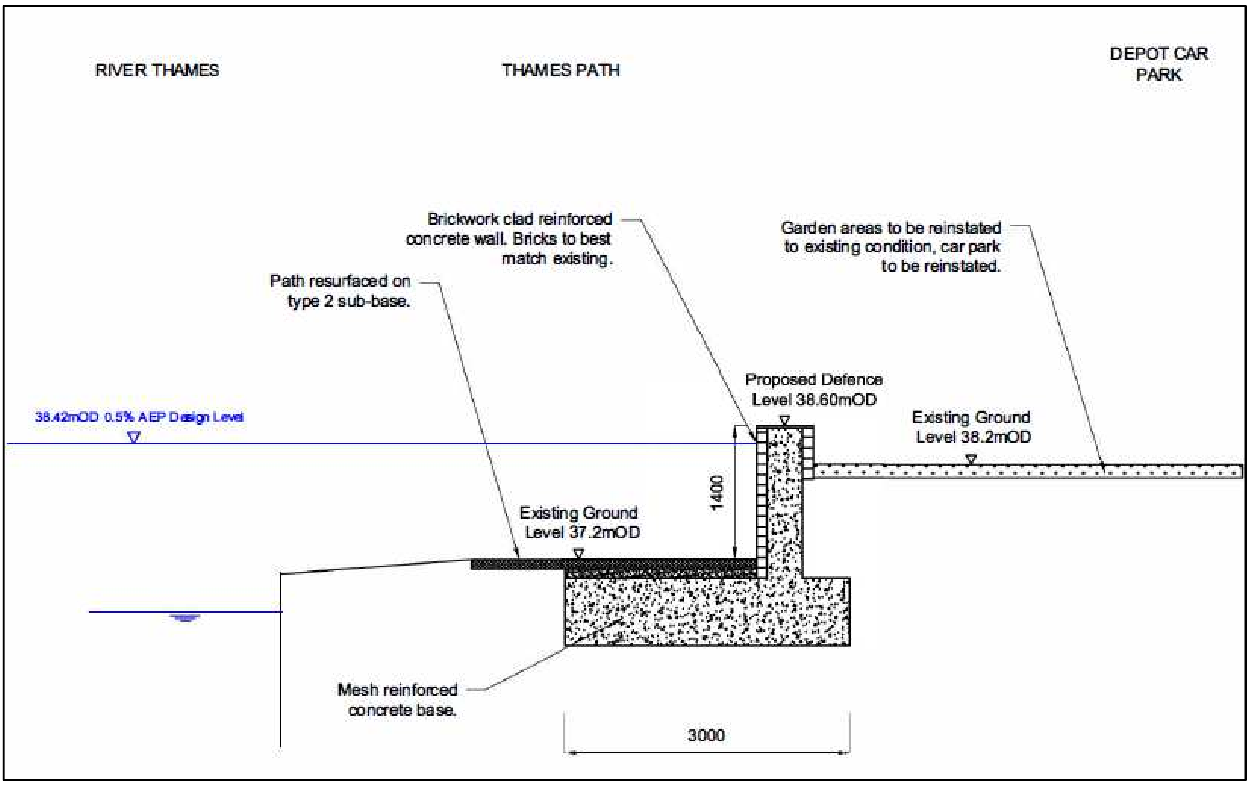


2.6.4 A meeting was held in October 2019 between the EA, Stantec and Berkeley Homes to discuss the site proposals and how these may be modified to ensure they do not compromise delivery of the proposed FAS or require retrospective integration of the two schemes – see meeting minutes dated 7th October 2019 in **Appendix D**.

2.6.5 The EA confirmed that the current FAS design proposes a flood defence wall along the northern boundary of the site, with new brickwork to replace the existing boundary wall and the top of the existing steps off the Thames towpath to be raised. This strategy is based on a design defence level through the site of 38.6m AOD (based on protection to the EA modelled 1 in 200 annual probability+35% allowance for climate change flood level plus appropriate freeboard) and ties in to flood defences upstream and downstream of the site in the north-west and north-east corners of the site respectively – see **Figure 2-5**.

2.6.6 The EA also advised that a new hydraulic model has been developed through the Reading area (Mapledurham to Hurley) to inform the design of the FAS. The provided results from this modelling in the vicinity of the site are provided in **Section 3.5**.

Figure 2-5: EA Flood Defence Proposals at SSE Site



2.6.7 As detailed further in **Section 6.3,** the proposals have been developed in line with the EA to ensure the required defence line is provided through the site.

2.6.8 It should be noted that the benefits afforded to the site through the FAS have not been taken into consideration for the purposes of flood mitigation within this FRA. As such, all benefits provided will be in addition to the proposed mitigation measures described in **Section 6.**

3 Overview of Flood Risk

3.1 EA Flood Maps

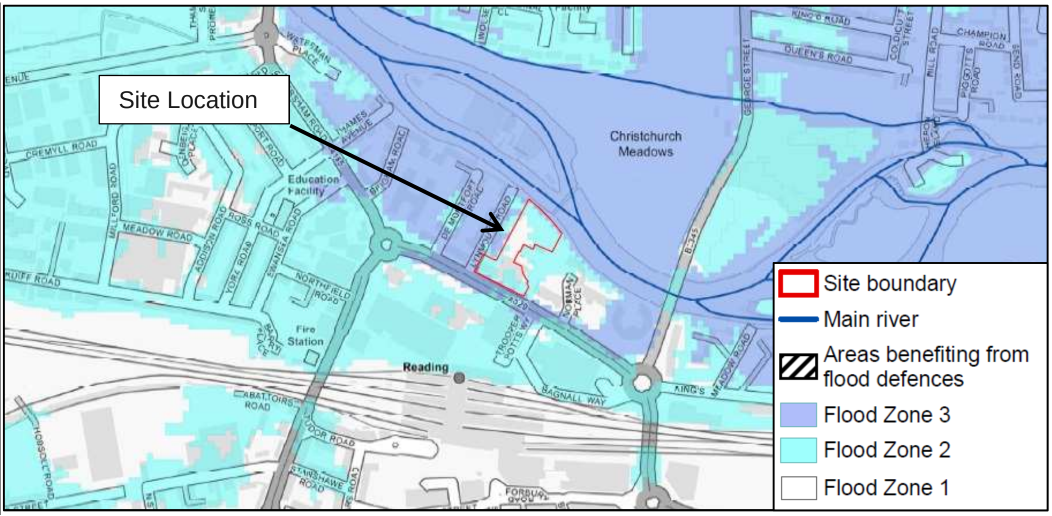
3.1.1 The following maps have been taken from the Stantec GIS flood maps report in **Appendix A** based on the EA Opendata datasets available online and reproduced with OS mapping under licence to Stantec.

Flood Zone Map

3.1.2 The first phase in identifying whether a site is potentially at risk of flooding is to consult the EA's Flood Zone maps, available on the EA's website. This provides an initial indication of the extent of the Flood Zones, which is more detailed site-specific level survey and modelled flood levels. The Flood Zones are defined in Table 1 of the Planning Practice Guidance (PPG) 'Flood Risk and Coastal Change' section as follows:

- **Flood Zone 1 'Low Probability'** – Land at less than 1 in 1000 (0.1%) annual probability of river or sea flooding;
- **Flood Zone 2 'Medium Probability'** – Land between 1 in 100 (1%) and 1 in 1000 (0.1%) annual probability of river flooding, or between 1 in 200 (0.5%) and 1 in 1000 (0.1%) annual probability of sea flooding;
- **Flood Zone 3 'High Probability'** – Land at 1 in 100 (1%) or greater annual probability of river flooding, or 1 in 200 (0.5%) or greater annual probability of sea flooding;

Figure 3-1: EA Flood Zone Map



3.1.3 The EA Flood Zone map indicates the site lies partially within **Flood Zone 2 'Medium Probability',** with central areas within **Flood Zone 1 'Low Probability'**.

Flood Risk from Reservoirs Map

3.1.4 The EA provides maps showing the risk of flooding in the event of a breach from reservoirs, based only on large reservoirs (over 25,000 cubic metres of water). These confirm that the site is not within the predicted flood extents of such an event.

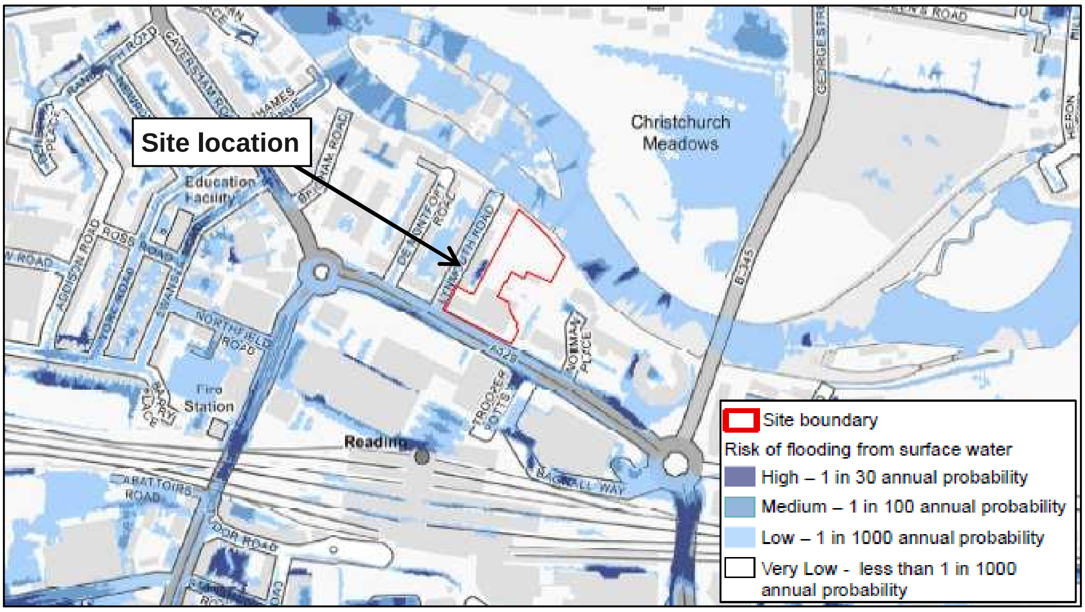
Flood Risk from Surface Water

3.1.5 The EA 'updated Flood Map for Surface Water' ('uFMfSW') shows where areas could be potentially susceptible to surface water flooding in an extreme rainfall event (see **Appendix A**). The latest mapping assesses flooding resulting from severe rainfall events based on the following three scenarios:

- 1 in 30 (3.3%) annual probability rainfall event ('High' risk);
- 1 in 100 (1%) annual probability rainfall event ('Medium' risk);
- 1 in 1000 (0.1%) annual probability rainfall event ('Low' risk).

3.1.6 Land at lower than 1 in 1000 (0.1%) annual probability of flooding is considered to be 'Very Low' risk of flooding

Figure 3-2: EA Updated Flood Map for Surface Water



3.1.7 The Surface Water Flood Map shows that the site is predicted to be at a 'Very Low' risk of surface water flooding, although there are some areas along the boundary of the site which are shown to be at a greater risk.

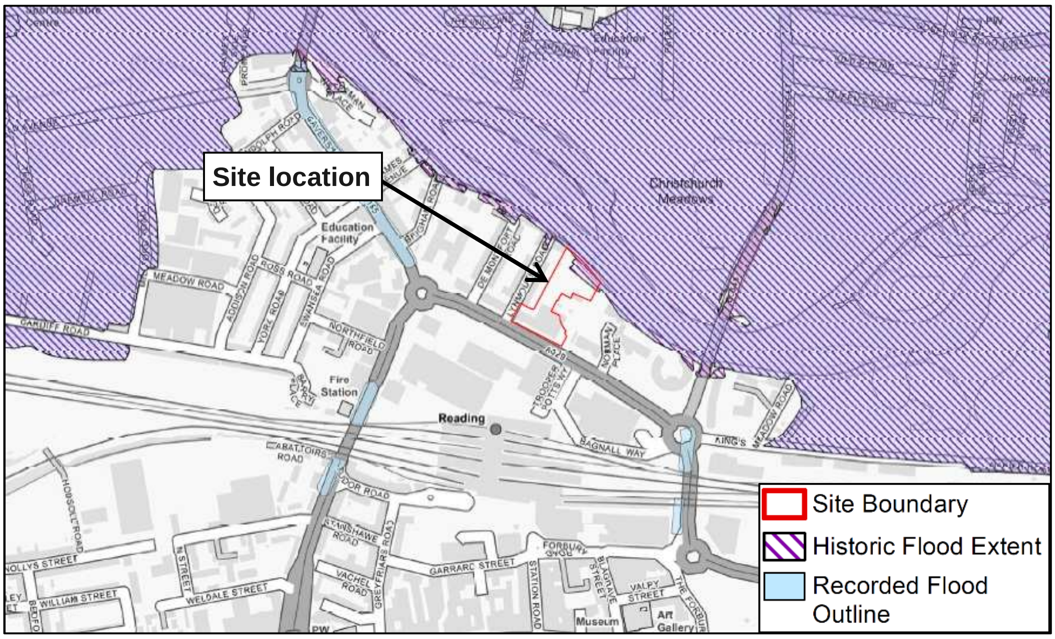
3.1.8 It should be noted that the surface water maps are generated using a generic methodology on a national scale, whereby rainfall is routed over a ground surface model. The analysis does not take account of any specific local information on below-ground drainage infrastructure and infiltration, although an adjustment is included in urban areas to account for the impact of sewerage and a standard infiltration allowance based on soil type. Consequently the mapping provides a guide to potentially vulnerable areas based on the general topography of an area.

Historic Flood Map

3.1.9 The EA 'Historic Flood Map' is a dataset showing the maximum extent of all individual recorded flood outlines from river, the sea and groundwater and shows areas of land that have previously been subject to flooding.

3.1.10 This map indicates that recorded floods on the Thames have affected a small area in the north of the site, however as discussed in **Section 3.3** this is believed to result from mapping precision during a relatively insignificant flood event and the site was not actually affected. Critically, the site did not flood during the March 1947 floods which are generally considered the most severe on record.

Figure 3-3: EA Historic Flood Map



3.2 Preliminary Flood Risk Assessment

3.2.1 The RBC Preliminary Flood Risk Assessment (PFRA) was prepared by Peter Brett Associates LLP (PBA, now Stantec) in 2011 and provides a high-level assessment of flood risk issues within the Borough. This document has been reviewed and key information of relevance to the site has been extracted.

3.2.2 Records within the PFRA indicate that there were two incidences of groundwater flooding in the vicinity of the site between 2000 and 2003, but no other site-specific data is provided.

3.3 Strategic Flood Risk Assessment

3.3.1 The current RBC Strategic Flood Risk Assessment (SFRA) Level 1 and Level 2 reports were prepared by PBA in 2017 and provide advice to RBC on flood risk issues within the Borough. This document has been reviewed and key information of relevance to the site has been extracted.

- **Historic Flooding:** Map F1 provides the EA historic floodplain map, consistent with the data discussed in **Section 3.1.** Maps F2_N1, F1-N2 and F2-N3 show historic flooding records affecting the north of Reading for 9 recorded flood events. These show that the site has largely been unaffected and, critically, did not flood during the March 1947 floods (F2-N2), which is considered to be the worst recorded historic flooding incident affecting the Reading area. The maps indicate that a small area in the north of the site was affected during the 2013-2014 flooding event (F2-N3), however this is assumed to be a result of the map's low precision as this area is significantly elevated behind the northern boundary wall and would require a significantly more extreme event than that which occurred in 2013/14 to affect the site;

- **Flood Zone:** Map F4_N shows the Flood Zone maps across the area, indicating the site is partly in Flood Zone 2. However, the Flood Zones have subsequently been updated to take account of more recent EA River Thames and River Kennet modelling and therefore this SFRA map is superseded by the latest version in **Figure 3.1**;

- **Modelled Flood Extents:** SFRA map series reference F_5 provides modelled present day and climate change flood extents through the Borough. As mentioned above, this mapping has subsequently been updated to take account of the new EA River Thames and River Kennet modelling and therefore this map is superseded by the information discussed in **Section 3.4**;

- **Surface Water**: SFRA map series reference F_6 provides the surface water flood risk through the Borough. These outputs are consistent with the surface water flood maps discussed in **Section 3.1**;

- **Reservoir Breach:** SFRA Map F_7 shows the flood risk associated with reservoir breach in the area (the only reservoir affecting the Borough being Whiteknights Lake at Reading University). The mapping confirms that any flooding as a result of a breach is limited to land to the south-east of Reading and the site is unaffected;

- **Groundwater:** SFRA Map F_8 provides a high level overview of areas susceptible to groundwater flooding, taken from a national dataset and based on underlying geological conditions across 1km grid squares. The site is shown in an area at 'less than 25%' susceptibility;

- **Sewers:** Map F_9 provides a summary of Thames Water sewer flooding incidents by postcode, indicating the site postcode area of the site has 21-50 recorded sewer flooding incidents from both internal and external sources.

3.3.2 The Level 2 assessment includes specific reference to the site (AB005, Local Plan Ref CR11g) as one of the areas receiving a detailed review of flood risk issues. This review largely replicates the data summarised above, indicating the site lies within Flood Zone 2, and also featuring extents which show that some areas around the edge of the site lie within the extent of the 1 in 100 annual probability plus allowance for climate change flood extents.

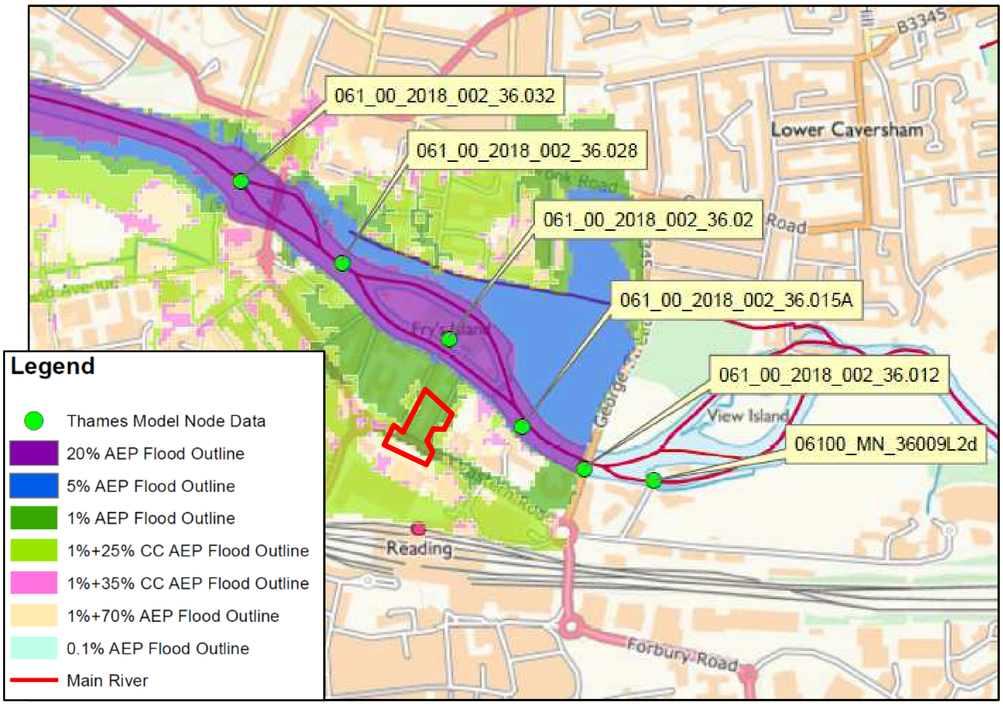
3.3.3 As the site is included in the Level 2 SFRA, it has been identified within the Local Plan and a Sequential Test and Exception Test have already been completed. This is described further in **Section 5**.

3.4 EA River Thames 'Sandford to Mapledurham' Model 2018

3.4.1 The EA has also provided their detailed 'Product 4' flood risk information (EA ref THM_107956). This includes data extracted from the 2018 Thames 'Sandford to Mapledurham' 1D-2D model (also referred to as Abingdon Flood Schemes Mapping 2017), including modelled flood extents, flood levels and flood hazard mapping. The 2018 model has been produced more recently than the model used to generate mapping within the SFRA and forms the basis of the latest EA Flood Zone mapping. This model is therefore considered to be the best available information for assessing flood risk to the site.

3.4.2 **Figure 3.4** below shows flood extents from the 2018 model. These extents indicate the site is outside all present day flood events, up to and including the 1 in 100 annual probability event, but a small area in the north-eastern part of the site lies within the 1 in 100 annual probability +35% allowance for climate change flood extent, and the eastern part of the site is within the equivalent +70% allowance for climate change flood extent. The climate change impacts are discussed further in **Section 4.**

Figure 3-4: EA Modelled Flood Extents – Sandford to Mapledurham 2018 Model



3.4.3 The Product 4 data also includes modelled flood levels for the nodes shown above, however these only represent in-channel levels. To provide modelled flood levels across the site, Stantec has obtained the EA Product 5/6/7 data (i.e. the hydraulic model and outputs) and interrogated this to extract site-specific data.

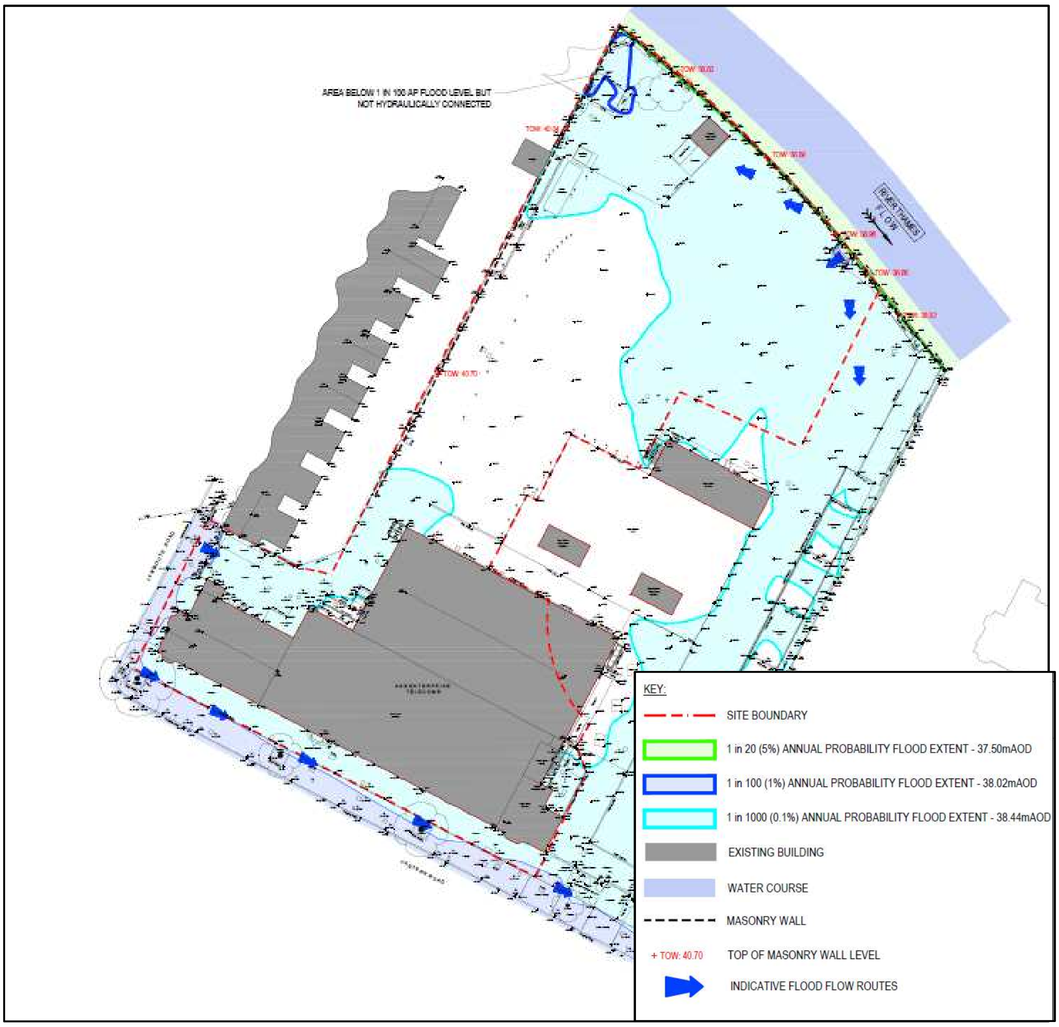
3.4.4 As shown in **Figure 3.5**, the extract of **Stantec drawing 47500/4001/001** (see **Appendix E**) shows the extent of flooding to the site during the 1 in 20, 1 in 100 and 1 in 1000 annual probability flood events, based on these extracted flood levels and the topographic survey by Maltby Surveys.

3.4.5 The modelled flood levels across the site are summarised below:

Table 3.1: EA Modelled Flood Levels – Sandford to Mapledurham 2018 Model

Flood Event (Annual Probability)	Modelled Flood Level, m AOD
1 in 5 (20%)	**37.09 (adjacent river channel only)**
1 in 20 (5%)	**37.50 (adjacent footpath only)**
1 in 100 (1%)	**38.02**
1 in 1000 (0.1%)	**38.44**

Figure 3-5: Modelled Flood Extents (extract of Stantec drawing 47500/4001/001)



3.4.6 The topographic survey in **Appendix B** indicates that the site is mainly at a level of between 38.0m AOD and 38.7m AOD, while the adjacent Thames footpath is at 37.3m AOD. Comparison with the modelled flood levels indicates:

- **1 in 5 annual probability event:** The site is unaffected by flooding. The adjacent Thames footpath remains unaffected (approximately 200mm above flood level at base of northern steps);

- **1 in 20 annual probability event:** The site is unaffected by flooding. The Thames footpath is impacted by flooding up to 200mm depth;

- **1 in 100 annual probability event:** The site is unaffected by flooding. A small area in the north-west corner is below the modelled flood level but is not hydraulically connected to the wider floodplain. The Thames footpath is impacted by flooding up to 700mm depth;

- **1 in 1000 annual probability event:** Areas to the north and south of the site are impacted by flooding, to maximum depths of 400mm. The central area of the site remains outside the floodplain. The Thames footpath is impacted by flooding up to 1,100mm depth.

3.4.7 The potential impacts of climate change over the lifetime of the proposed development have been considered so that mitigation measures can be designed accordingly and are discussed in **Section 4.**

3.5 EA River Thames 'Mapledurham to Hurley' Model 2019

3.5.1 At the EA meeting of 7th October 2019 (see minutes in **Appendix D**) the EA advised that new River Thames modelling through the Reading area (Mapledurham to Hurley model) has been undertaken and used to inform the FAS design. The modelling is still subject to final review/checks and the data provided is therefore provisional.

3.5.2 The modelled flood levels across the site are summarised in **Table 3.2:**

Table 3.2: EA Modelled Flood Levels – Mapledurham to Hurley 2019 Model

Flood Event (Annual Probability)	Modelled Flood Level, m AOD
1 in 100 (1%)	**37.98**
1 in 100 +25% climate change allowance	**38.23**
1 in 200 +25% climate change allowance	**38.35**

3.5.3 Direct comparison between the 1 in 100 annual probability flood level above and the previously advised flood level in **Table 3.1** confirms the previously advised levels are marginally higher and therefore more conservative. As such, and given the status of the above modelling, the previously advised flood levels have been used as a basis for the FRA.

4 Impact of Climate Change

4.1.1 In considering flood risk to the site, it is necessary to fully consider the potential impacts of climate change for the lifetime of the development within the mitigation measures.

4.1.2 In February 2016 the EA released new guidance on the application of climate change allowances in flood risk assessments, which has most recently been updated in December 2019:

https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances.

4.1.3 This guidance provides contingency allowances for potential increases in peak river flow in Table 1, and for potential increases in rainfall intensity in Table 2. The latter requires consideration in any surface water drainage strategy for new development.

4.1.4 The peak river flow allowances table provides a range of allowances based on percentile (i.e. the degree of certainty of an event occurring, based on the range of climate change scenarios assessed through scientific investigations). The provided allowances are also subject to the vulnerability classification of the proposed use and the river basin district of the site.

4.1.5 The conditions at the site and consequent peak river flow allowances to be considered as part of the FRA are as detailed in **Table 4.1.**

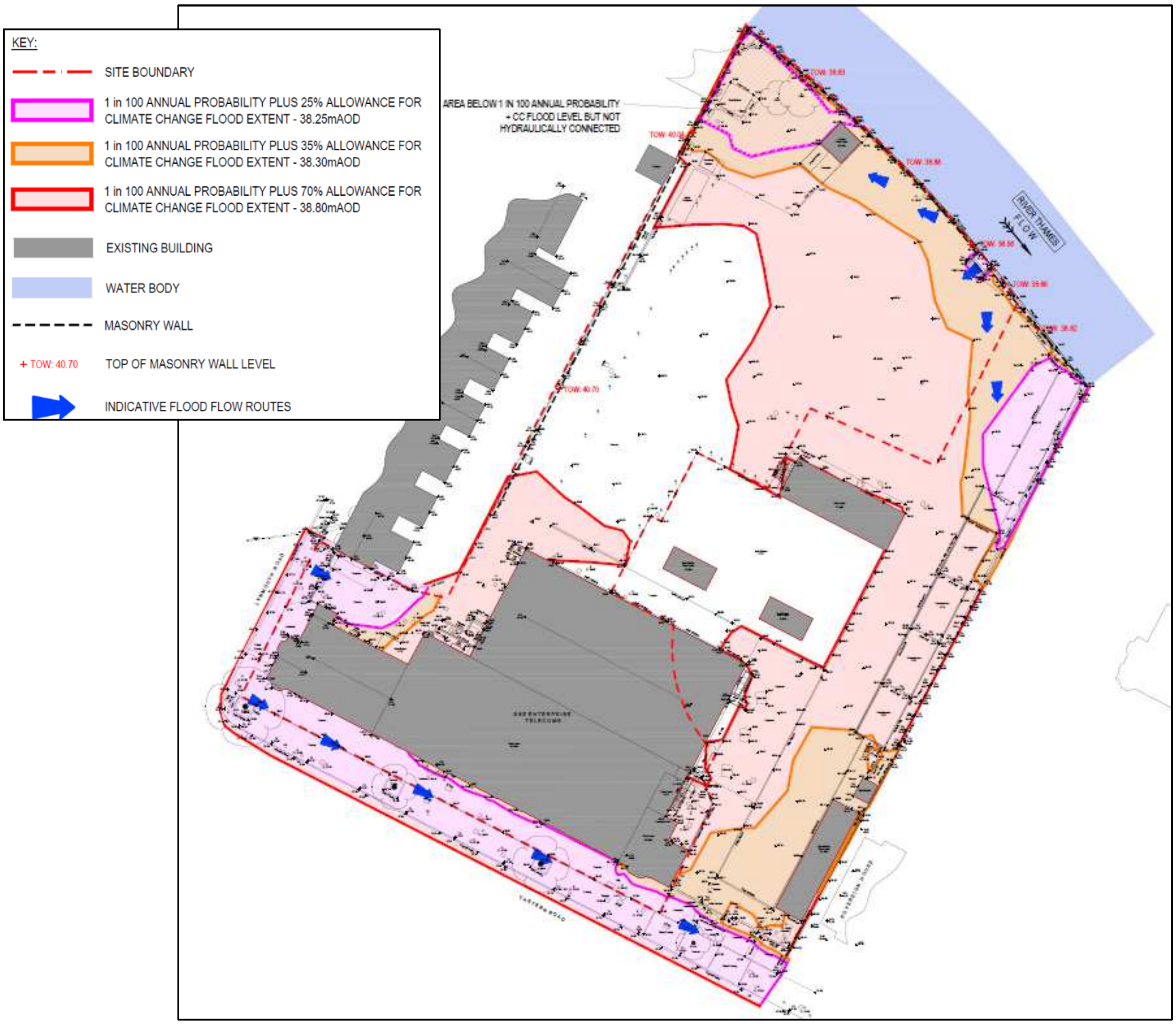
Table 4.1: Climate Change – Peak River Flow Allowances

River Basin District	Flood Zone	Flood Risk Vulnerability Classification	Range of Climate Change Allowances requiring consideration (2070–2115)	
			Higher Central	Upper End
Thames	*2*	*More Vulnerable*	***+35%***	***+70%***

4.1.6 In line with consultation received as part of a pre-application enquiry for the proposed development (see EA letter dated 30th January 2019 in **Appendix D**), the EA has specified that the +35% allowance for climate change is considered to be the baseline for the design of mitigation measures.

4.1.7 Stantec has extracted flood extents across the site from the EA River Thames (Sandford to Mapledurham) 2018 hydraulic model, as shown in **Stantec drawing 47500/4001/002** in **Appendix E** (extract in **Figure 4.1** below).

Figure 4.1: Modelled flood extents with allowance for climate change (extract of Stantec drawing 47500/4001/002)



4.1.8 The flood levels shown in **Figure 4.1** are summarised below:

Table 4.2: EA Modelled Climate Change Flood Levels (m AOD)

Flood Event (1 in 100 Annual Probability plus climate change allowance)	Modelled Flood Level, m AOD (average across site)
+25% climate change	38.25
+35% climate change	**38.30**
+70% climate change	**38.50**

4.1.9 The topographic survey in **Appendix B** indicates that the site is mainly at a level of between 38.0m AOD and 38.7m AOD, while the adjacent Thames footpath is at 37.3m AOD. Comparison of the modelled flood levels with the topographic survey indicates:

- **+25% climate change scenario:** Areas to the north and south of the site are impacted by flooding, to maximum depths of 250mm. The central area of the site remains outside the floodplain. The Thames footpath is impacted by flooding to marginally under 1,000mm depth.

- **+35% climate change scenario:** Areas to the north and south of the site are impacted by flooding, to maximum depths of 300mm. The central area of the site remains outside the floodplain. The Thames footpath is impacted by flooding to 1,000mm depth.

- **+70% climate change scenario:** Areas to the north and south of the site are impacted by flooding, to maximum depths of 500mm. The central area of the site remains outside the floodplain. The Thames footpath is impacted by flooding to 1,200mm depth.

4.1.10 The climate change flood levels have been used as a basis for the design of mitigation measures discussed in **Section 6.**

5 Proposed Development and Sequential Test

5.1 Proposed Development

5.1.1 This FRA accompanies a detailed planning application for the redevelopment of the SSE site at 53-55 Vastern Road, Reading, including the demolition of existing structures and erection of a series of buildings ranging in height from 1 to 11 storeys including residential dwellings (C3 use class) and leisure floorspace (A3 use class), together with a new north-south pedestrian link, connecting Christchurch Bridge to Vastern Road.

5.1.2 Details of the proposals by Berkeley Homes are included in **Appendix C.**

5.1.3 The analysis and proposed mitigation is based on a design life for the development of 100 years, and the climate change allowances described in **Section 4** are also based on this assumption.

5.2 Flood Risk Vulnerability

5.2.1 NPPF PPG 'Flood Risk and Coastal Change' Table 2 confirms the *'Flood risk vulnerability classification'* of a site, depending upon the proposed usage. This classification is subsequently applied to PPG Table 3 to determine whether:

- The proposed development is suitable for the flood zone in which it is located, and;
- Whether an Exception Test is required for the proposed development.

5.2.2 The proposed development is classed as 'more vulnerable' development. As the proposed development is located within Flood Zone 2, it is considered appropriate subject to the Sequential Test.

5.3 NPPF Sequential Test

5.3.1 The NPPF follows a sequential risk-based approach in determining the suitability of land for development in flood risk areas, with the intention of steering all new development to the lowest flood risk areas.

5.3.2 The Sequential Test has been completed for the site as part of a Borough-wide assessment for RBC in December 2017 ('Sequential and Exception Test of Sites in the Pre-Submission Draft Local Plan') – the site, CR11g 'Riverside', is allocated within the Local Plan. The Sequential Test is passed for the site to support current housing targets.

5.4 NPPF Exception Test

5.4.1 Although 'more vulnerable' development within Flood Zone 2 is <u>not</u> required to pass the Exception Test, one has been completed by RBC in the same report as the Sequential Test due to the fact that the site was shown to flood during the 1 in 100 annual probability plus climate change event – in this way, the site has been considered to lie within the future Flood Zone 3a where passing the Exception Test would be a necessity.

5.4.2 The site is considered to be extremely important due to its position adjacent to the Christchurch footbridge as a key link between the city centre/railway to the south and the River Thames/Caversham to the north. As such, redevelopment of this site is essential to improve access between these areas and provide amenities. For this reason, among other sustainability benefits, the Exception Test has been passed.

6 Flood Mitigation Strategy

6.1 Ground Floor Levels

6.1.1 Standard requirements for ground floor levels of new development are set out in BS8533:2017 'Assessing and Managing Flood Risk in New Development – Code of Practice'. This recommends floor levels are set a minimum of 300mm above the modelled 1 in 100 annual probability plus allowance for climate change flood level.

6.1.2 This is also consistent with the guidance from the EA and the recommendations in the RBC SFRA.

6.1.3 Based upon this guidance, the minimum residential floor level of the proposed development is set at **38.60m AOD**, this is based on the 1 in 100 annual probability +35% allowances for climate change flood level as advised by the EA.

6.1.4 Comparison with the 'Upper End' +70% climate change scenario, as a sensitivity test, confirms that floor levels remain above the flood level even in this extreme scenario.

6.1.5 It is also recommended that ground floor levels are set a suitable freeboard above surrounding ground (minimum 150mm) to mitigate the residual flood risk associated with excess surface water runoff in an extreme rainfall event. Similarly, exterior ground levels across the site should also be appropriately contoured to direct surface water away from dwellings in such a scenario.

6.2 Flood Compensation Scheme

6.2.1 Any new development located in the vicinity of a watercourse should be constructed such that it does not detrimentally impact on flow routes or reduce the available floodplain storage over a site; either of which could potentially cause an increase in flood levels on-site or elsewhere. This is considered on a 'level-for-level' basis up to the benchmark of the 1 in 100 annual probability flood event with a 35% allowance for climate change in accordance with EA pre-application advice.

6.2.2 The existing site is fully outside the present day 1 in 100 annual probability floodplain.

6.2.3 In the 1 in 100 annual probability +35% allowance for climate change flood event, parts of the south-west corner of the site are impacted to shallow flood depths (up to 300mm) due to the overland flow routes from the west. Flooding also occurs along the northern boundary as a result of floodwater overtopping the steps off the River Thames footpath (see **Figure 6-1**) and ponding in the lowest lying areas, again to shallow depths of up to 300mm.

6.2.4 The floodplain storage analysis is detailed on **Stantec Drawing 47500/4001/003** in **Appendix E**. As shown on the associated table of calculations, analysis of the 3d ground model confirms that the existing storage capacity over the site, up to the reference climate change level, is 220m^3 and the storage is almost all at the higher level bands between 37.9m AOD and 38.3m AOD, reiterating that the existing site is only impacted in severe flood events and unaffected in lower order scenarios.

6.2.5 It is proposed that the existing brick wall along the northern boundary be removed, and replaced with a shallow landscaped bank from the existing footpath level (typically 37.3m AOD) up to the 1 in 100 annual probability +35% allowance for climate change flood level of 38.30m AOD – see **Stantec Drawing 47500/4001/004** in **Appendix E**. These works will serve to enhance the corridor of land between the site and the River Thames, with the landscaping to incorporate locally native biodiversity enhancements in accordance with the EA 'native species planting list' for the River Thames.

6.2.6 The development does include a café/patio area on the northern side of the site which overhangs this landscaped bank – this is cantilevered decking which is set significantly above the reference flood level and does not have any support structure impacting the floodplain storage area below.

6.2.7 The works will also provide additional floodplain storage capacity over the site; the proposed ground remodelling along the northern boundary – plus some nominal re-grading where access roads/walkways into the site tie into the existing ground along the southern boundary, will provide a total of 340m^3 of floodplain storage up to the 1 in 100 annual probability +35% allowance for climate change flood level, resulting in an overall volume gain of +120m^3.

Figure 6-1: View along existing northern boundary wall

6.2.8 While there is a small loss in the top level band of 7m^3, this is an indication that the existing site only provides storage at upper level bands due to its elevated topography. The proposed floodplain compensation is providing a greater volume, at more frequent events and providing a significant proportion of this storage immediately adjacent to the River Thames, thus providing a more effective distribution of floodplain storage in addition to the ecological and amenity enhancement associated with the landscape improvements. As such, these benefits are considered to outweigh this small loss in a single upper level band.

6.3 Flood Defence Coordination with Reading and Caversham FAS

6.3.1 As detailed in **Section 2.6**, the EA's proposed FAS consists of coordinated flood defence walls along this section of the south bank of the River Thames, preventing flood flow routes through the area and effectively removing the land south of the River Thames between Caversham Bridge and Reading Bridge – including the site - from the floodplain.

6.3.2 The EA had confirmed that their FAS assumes a minimum defence level of 38.60m AOD east-west through the site that needs to link to the adjacent walls in the northern corners. As such, the proposed development incorporates this defence line, through a combination of landscaping, facing walls of proposed buildings, and short sections of wall at each end of the north boundary landscaping to link to the tie-in points in the north-east and north-west corners – see **Figure 6-2**.

6.3.3 Comparison with the 'Upper End' 1 in 100 annual probability +70% climate change flood level of 38.5m AOD confirms that the defence crest remain above the flood level even in this extreme scenario.

6.3.4 Following completion of this proposed FAS, the site would no longer provide any floodplain storage function, so it is clear the proposed landscaping works set out as part of this scheme provide an opportunity to provide ecological and floodplain storage capacity improvements that would otherwise be lost as part of the proposed FAS.

Figure 6-2: Annotation of proposed flood defence crest at 38.6m AOD (to tie in to EA Scheme)

6.4 Safe Access Arrangements

6.4.1 It is necessary to consider and incorporate safe access arrangements as part of the mitigation, to ensure the users/occupants of the development are safe in times of flooding.

6.4.2 Consideration of the safety of any pedestrian route has been based on the guidance in the EA document '*Supplementary Note on Flood Hazard Ratings and Thresholds for Development Planning and Control Purpose – Clarification of the Table 13.1 of FD2320/TR2 and Figure 3.2 of FD2321/TR1*'. Due to the developed nature of the area, it is assumed that velocities would be low or very low, in which case the pedestrian routes would still be considered a 'Very Low Hazard' for depths up to 250mm.

6.4.3 The 'hazard to people' classification has four ratings:

- **Very low hazard** – caution (Flood Hazard Rating ('FHR') less than 0.75)

- **Danger for some** – i.e. children, the elderly and infirm (FHR between 0.75 and 1.25)
- **Danger for most** – includes the general public (FHR between 1.25 and 2.0)
- **Danger for all** – includes the emergency services (FHR greater than 2.0)

6.4.4 The RBC SFRA Level 2 sets out the following hierarchy to be applied when considering the provision of safe access:

More Vulnerable Development:

a) ***The preference is to have a continuous dry route at the 1 in 100 annual probability plus appropriate allowance for climate change event;***

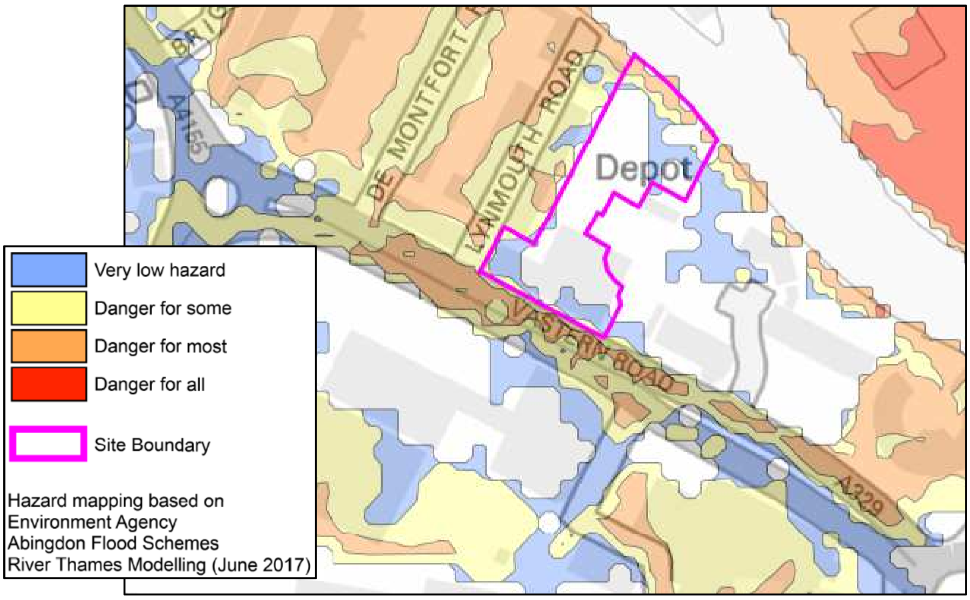
b) ***If (a) is not achievable, then developer should assess if safe access is available at the current 1 in 100 annual probability flood event (in accordance with Defra flood hazard guidance);***

If (b) is achievable, then it is considered safe access in more extreme events could be addressed through provision of a site 'Flood Management and Evacuation Plan', subject to a detailed analysis of the flood hazard along the route and RBC emergency planning department approval;

If (b) is not achievable, it is recommended that the site is not suitable for new (or intensification of) permanent residential development and other uses should be considered (i.e. 'Less Vulnerable' commercial/office development).

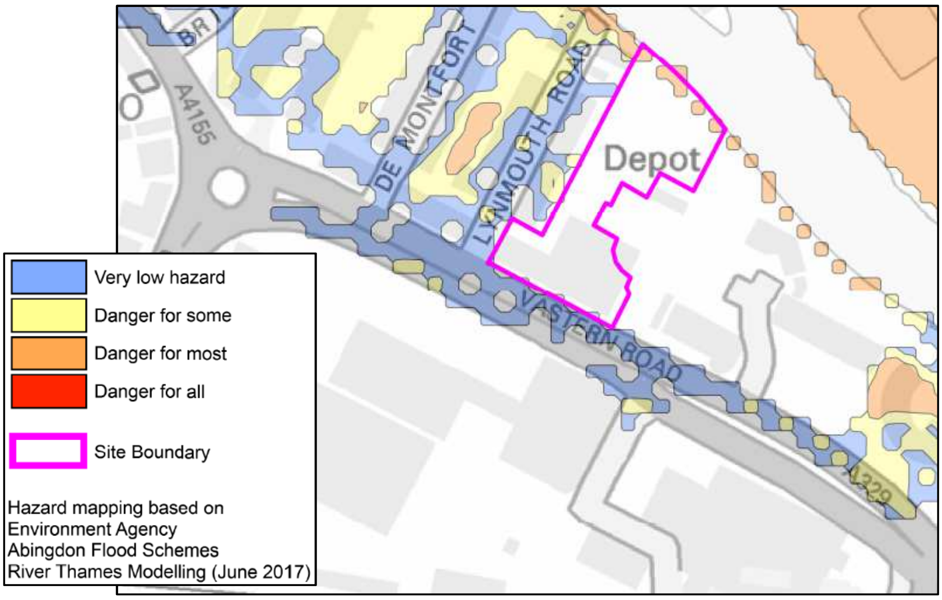
6.4.5 The flood hazard mapping outputs have been extracted from the base EA hydraulic modelling discussed in **Section 3.4** and **Figure 6-3** indicates that, based on the first option (a), when a 35% allowance for climate change has been applied, safe access is not available from the site at the peak of the flood event. There are no routes from the site that can avoid a 'hazard to people' rating of 'Danger for Some' or higher.

Figure 6-3: Flood Hazard - 1 in 100 annual probability +35% climate change allowance flood event



6.4.6 However, as shown on **Figure 6-4** below, at the peak of the present-day 1 in 100 annual probability flood event safe access to and from the site to the wider land (south-west or south-east) is available with – at worst – a maximum hazard rating of 'Very Low Hazard'.

Figure 6-4: Flood Hazard - 1 in 100 annual probability flood event

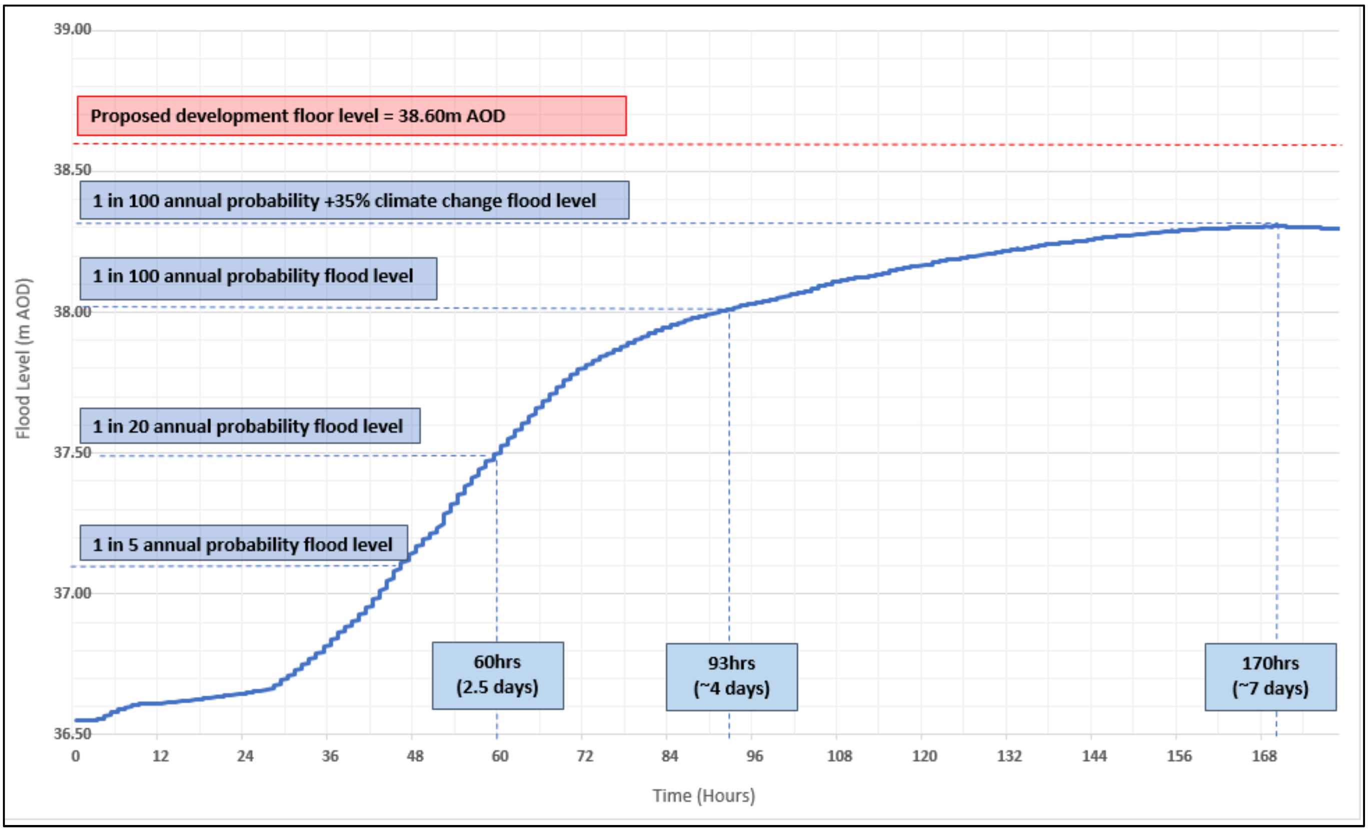


6.4.7 Therefore, it is proposed that a 'Flood Management and Evacuation Plan' is produced in order to ensure that residents are provided with sufficient advance warning to evacuate the site prior to the access routes becoming blocked. As detailed in the Reading SFRA, the River Thames is a slow-responding catchment and there has been widespread public awareness of prior flood events in the area several days before the area was affected, and there would be visual signs of wider flooding and the slowing rising floodwater from the site for a period of days before any access routes are compromised.

6.4.8 The timing of the onset of flooding was considered in further detail to assess the above assumptions on safe access, informed by the hydrograph extracted from the adjacent river node to the site for the reference 1 in 100 annual probability +35% allowance for climate change flood event – see **Figure 6-5**. This provides the following information:

- **T=0hrs**: Model starts - Flood levels begin to rise in the area;
- **T=48hrs (2 days):** River Thames reaches 1 in 5 annual probability flood level. Flooding remains in-banks through Reading and Thames footpath adjacent to site remains unaffected. Continuous dry access remains available;
- **T=60hrs (2.5 days):** River Thames reaches 1 in 20 annual probability flood level. Floodplain extends across Christchurch Meadow to the north of the site, and the Thames footpath adjacent to site floods to shallow depths (~200mm). Continuous dry access remains available;
- **T=93hrs (4 days):** River Thames reaches 1 in 100 annual probability flood level. The floodplain impacts residential areas to the immediate west of the site and wider areas of Reading and Lower Caversham. The site remains unaffected but shallow flooding along Vastern Road. Thames footpath adjacent to site floods to 700mm. Continuous safe access remains available;
- **T=170hrs (7 days):** River Thames reaches 1 in 100 annual probability +35% allowance for climate change flood level. Floodplain impacts wider areas to the west and south of the site. Site remains unaffected but deeper flooding along Vastern Road which prevents safe access. Thames footpath adjacent to site floods to 1000mm. **Continuous safe access unavailable.**

Figure 6-5: River Thames Hydrograph - 1 in 100 annual probability +35% climate change event



6.4.9 It is noted that the overall rate of rise reflects the slow responding nature of the watercourse:

- From start of event to the present day 1 in 100 annual probability flood level – water level rises a total of 1,550mm over 93 hours – an average rate of rise of just under **20mm per hour**;

- Between the present day 1 in 100 annual probability flood level to the peak climate change flood level, this rate of rise reduces significantly to a rise of 290mm over 77 hours – an average of just **4mm per hour**.

6.4.10 Since safe access remains available at the present day 1 in 100 annual probability event, the above analysis suggests that the slow rate of rise once this flood level is exceeded would make allow residents still within the development to be evacuated if required. Should some residents choose not to evacuate, safe refuge above the design flood level is provided for the development.

6.4.11 It should also be noted that the EA's proposed new FAS, as described in **Section 2.6,** would reduce flood risk to the areas surrounding the site and it is therefore likely that safe access arrangements in the vicinity will improve if this scheme is implemented.

6.5 Surface Water Drainage and SuDS

6.5.1 The NPPF recognises that flood risk and other environmental damage can be managed by minimising changes in the volume and rate of surface runoff from development sites, and recommends that priority is given to the use of Sustainable Drainage Systems (SuDS) in new development, this being complementary to the control of development within the floodplain.

6.5.2 As the intention of SuDS is to mimic the natural drainage regime of the undeveloped site, the NPPF PPG states the following (consistent with the Building Regulations H3 hierarchy):

> ***...the aim should be to discharge surface water runoff as high up the following hierarchy of drainage options as reasonably practicable:***
>
> ***- into the ground (infiltration),***
>
> ***- to a surface water body,***
>
> ***- to a surface water sewer, highway drain or another drainage system,***
>
> ***- to a combined sewer***

6.5.3 As such, the feasibility of infiltration should be the initial consideration for disposal of surface water, which is dependent on the ground conditions underlying the site.

6.5.4 If infiltration is to be used as the proposed discharge method then it should be noted that the EA's Groundwater Source Protection Maps show that while the site lies outside a 'Total Catchment' (Zone 3), it lies over major aquifer with a high groundwater vulnerability. This designation indicates that there is a potential for the movement of contaminants through the strata and subsequently pollution of the aquifer. As such a suitable treatment train will be required to protect the aquifer.

6.5.5 If infiltration is not feasible, the second option is provision of on-site attenuation with controlled discharge to the adjacent River Thames, subject to agreement with the EA, or Vastern Ditch.

6.5.6 As of April 2015, the Lead Local Flood Authority (LLFA) has become the statutory consultee for surface water management on planning applications for 'major development'. As the LLFA, RBC are therefore responsible for the approval of surface water drainage systems within such development, based around the key design criteria as set out in the Defra 'Non statutory technical standards for sustainable drainage systems'

6.5.7 The scheme is accompanied by a Stantec 'Proposed Drainage Strategy' report, which sets out the proposed strategy for surface water, summarised as follows:

- The northern part of the site discharges at a controlled rate into the adjacent River Thames via a new 300mm outfall pipe.
- The southern part of the site discharges at a controlled rate into the culverted Vastern Ditch watercourse in the northern footway of Vastern Road via a new 375mm outfall.
- The surface water in both the northern and southern networks will be controlled by hydrobrakes in flow control manholes. The water is attenuated in cellular storage tanks that are located beneath the northern undercroft car park and the southern external car park.

6.5.8 As such, the proposed development will reduce peak runoff rates for a range of return periods – see aforementioned Stantec report for further details.

6.6 Flood Risk Activity Permit Requirements

6.6.1 Proposed works in, over, under or near a main river or a flood defence require a 'Flood Risk Activity Permit' (FRAP) application to be made to the EA (this replaced the previous 'Flood Defence Consent' (FDC) procedure). This is required to demonstrate any new development does not have a detrimental impact on flood risk, either through impacting the integrity of the existing defence or through preventing maintenance access to the defence.

6.6.2 Specifically, the EA requires a FRAP to be completed for any works that occur within the 8m buffer zone of an EA Main River.

6.6.3 The proposed development has been designed such that the residential structures are not located within 8m of the edge of the River Thames, and the scheme provides a significant enhancement along the northern boundary through the incorporation of a landscaped bank which provides an amenity and ecological enhancement to the river corridor, There will be isolated elements within this 8m zone but these are still a significant enhancement compared to the existing masonry wall along the boundary.

6.6.4 A FRAP or exemption is still a requirement for temporary activities (e.g. construction, demolition and some types of survey), for small structures, and for the removal of existing structures (i.e. the removal of the northern boundary wall and associated landscaping works). It is therefore essential that FRAP requirements are reviewed as necessary before any works begin in this area.

7 Residual Risk

7.1.1 It is difficult to completely guard against flooding since extreme events greater than the design standard event are always possible, however, it is practicable to minimise the risk by allowing a substantial freeboard (safety margin) and by using suitable construction and management techniques.

- To minimise residual risks, such as climate change and other uncertainties, floor levels of proposed units will be set a minimum of at 38.60m AOD; 300mm above the modelled 1 in 100 annual probability +35% allowance for climate change design flood level and above the equivalent +70% scenario. They will also be a suitable freeboard above surrounding ground in order to mitigate the residual risk from surface water flooding in an extreme rainfall event.

- Continuous safe access will be available at the present day 1 in 100 annual probability flood event. Continuous safe access is compromised at the peak of the more extreme climate change scenarios and therefore a Flood Management and Evacuation Plan will inform occupants of the measures to take in the event of a flood to the area, in accordance with Reading SFRA requirements. It is noted that the River Thames is slow responding and it would be a period of days before safe access was compromised, and should evacuation not be possible, safe refuge is available across the site above the design flood level.

- The proposed surface water drainage system (detailed in a separate Stantec document) will demonstrate that runoff in exceedance of the design event is directed away from buildings and will not increase flood risk to other sites up to benchmark of the 1 in 100 annual probability plus allowance for climate change rainfall event.

7.1.2 In addition, the development will incorporate a continuous crest level running east-west across the north side of the site at a minimum of 38.60m AOD, which will tie in to the wider flood defence proposals of the EA Reading and Caversham Flood Alleviation Scheme (to continue the proposed standard of defence at the 1 in 200 annual probability plus climate change level)

7.1.3 As such, the residual risk is considered to be acceptable for the lifetime of the development.

8 Conclusions

8.1.1 This Flood Risk Assessment (FRA) has been prepared by Stantec and supports a planning application at 53-55 Vastern Road, Reading for the demolition of existing structures and erection of a series of buildings ranging in height from 1 to 11 storeys including residential dwellings (C3 use class) and leisure floorspace (A3 use class), together with a new north-south pedestrian link, connecting Christchurch Bridge to Vastern Road.

8.1.2 This FRA concludes that:

- EA Flood Zone mapping shows that the site lies within **Flood Zone 2 'Medium Probability'** (land at a 1 in 1000 or greater annual probability of river flooding) and **Flood Zone 1 'Low Probability'** (land at less than 1 in 1000 annual probability of river flooding).

- The proposed residential development is considered 'More Vulnerable', which is considered appropriate in Flood Zone 2 subject to the Sequential Test. Due to the site being allocated within Reading Borough Council's Local Plan, the Sequential Test and Exception Test have already been undertaken and passed.

- National climate change guidance set out in the Planning Practice Guidance (PPG) confirms that the site conditions require consideration of increases in peak river flow of +35% to +70% (Thames River Basin, Flood Zone 2, More Vulnerable development).

- The EA flood model for the River Thames has been obtained by Stantec, and flood data from this model have been extracted around the site, providing a reference 1 in 100 annual probability plus 35% allowance for climate change flood level of 38.30m AOD. The majority of the existing site is outside this floodplain, but areas of flooding occur along the northern boundary and the south-west part of the site – typically to depths of up to 300mm.

- The proposed mitigation strategy demonstrates the development is safe through a number of measures as follows:

    - Ground floor levels are set at 38.60m AOD or above, providing a 300mm freeboard above the design 1 in 100 annual probability +35% allowance for climate change flood level and above the +70% scenario by 100mm;

    - Compensatory floodplain storage is provided through removal of the current masonry wall along the northern boundary of the site, and re-grading of the land to provide a landscaped buffer along the River Thames, resulting in a gain in storage of 120m^3. In addition, further storage is provided around the southern boundary of the site as the site access points grade down to meet adjacent road and footpath levels.

    - Safe access is available during the present day 1 in 100 annual probability event. Provision of a 'Flood Management and Evacuation Plan' will ensure that residents of the proposed development can receive sufficient warning to evacuate the site before flooding begins to affect the area in a more severe climate change scenario in accordance with the Reading Borough Council (RBC) Strategic Flood Risk Assessment (SFRA).

    - Incorporation of a continuous crest level running east-west across the north side of the site at a minimum of 38.60m AOD, which will tie in to the wider flood defence proposals of the EA Reading and Caversham Flood Alleviation Scheme;

    - A surface water drainage strategy has been produced for the site and is provided within a separate report, demonstrating the proposals provide a betterment in terms of surface water runoff rates.

8.1.3 In conclusion, the future occupants and users of the proposed development will be safe from flooding and there will be no detrimental impact on third parties. The proposal complies with the National Planning Policy Framework (NPPF) and local planning policy with respect to flood risk and is an appropriate development at this location.

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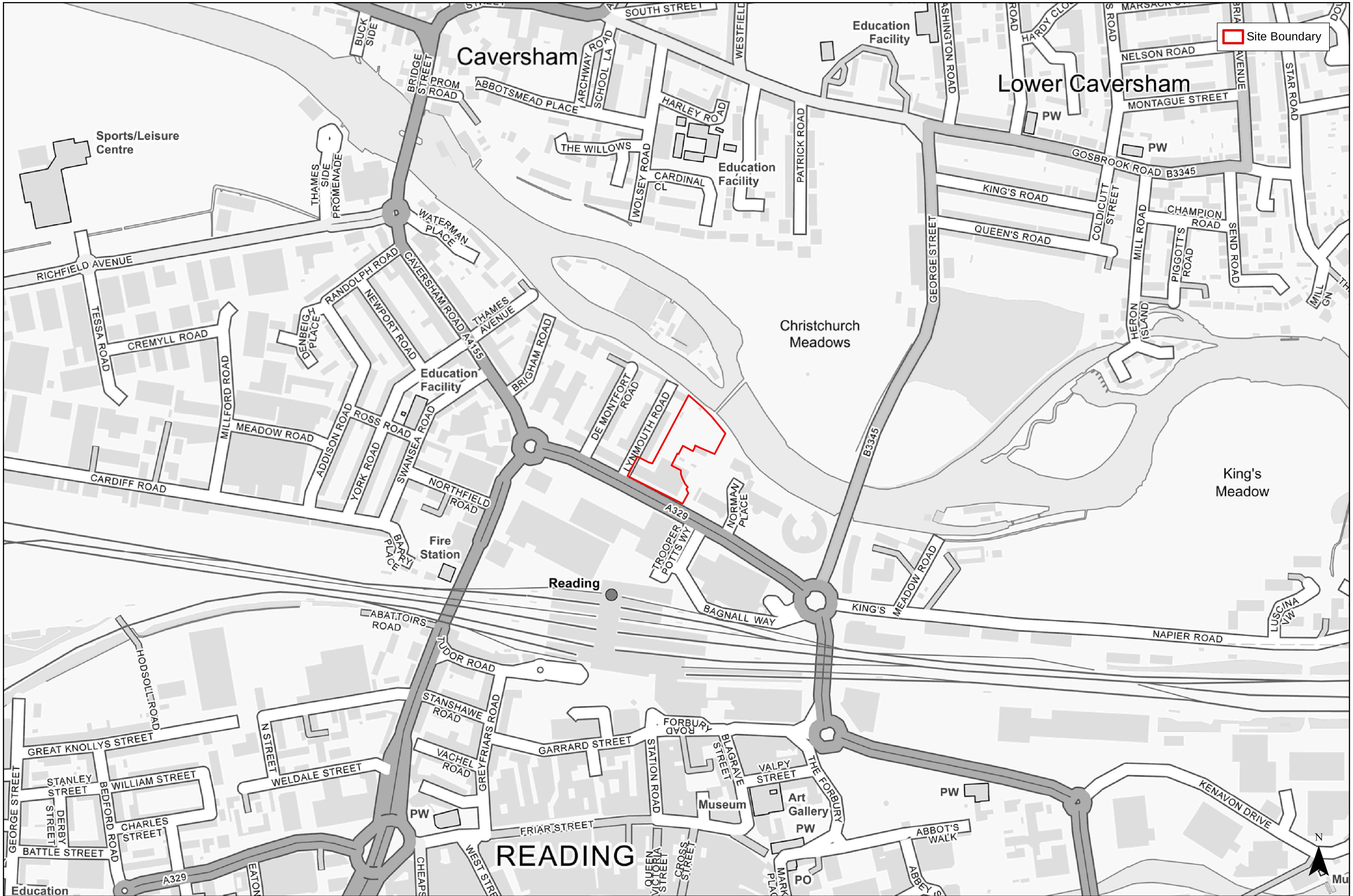
Appendix A OpenData Flood Maps

- Site Location Plan
- Site Location (Aerial Photography)
- Area Topography (LiDAR)
- EA Flood Zone Map
- EA Surface Water Flood Risk
- EA Historic Flood Map



FORMER SSE SITE, VASTERN ROAD	0 — 250 — 500 m Contains Ordnance Survey data (c) Crown copyright and database right 2016.	peterbrett	Client Berkeley Homes (Western) Ltd	1:5,000 @ A3 20/11/18 Drawn: IB Checked: DM	Site Location Figure 001 Rev A

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FORMER SSE SITE, VASTERN ROAD

0 250 500 m

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
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Site Location (Aerial Photography)

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Area Topography

Figure 003 | Rev A

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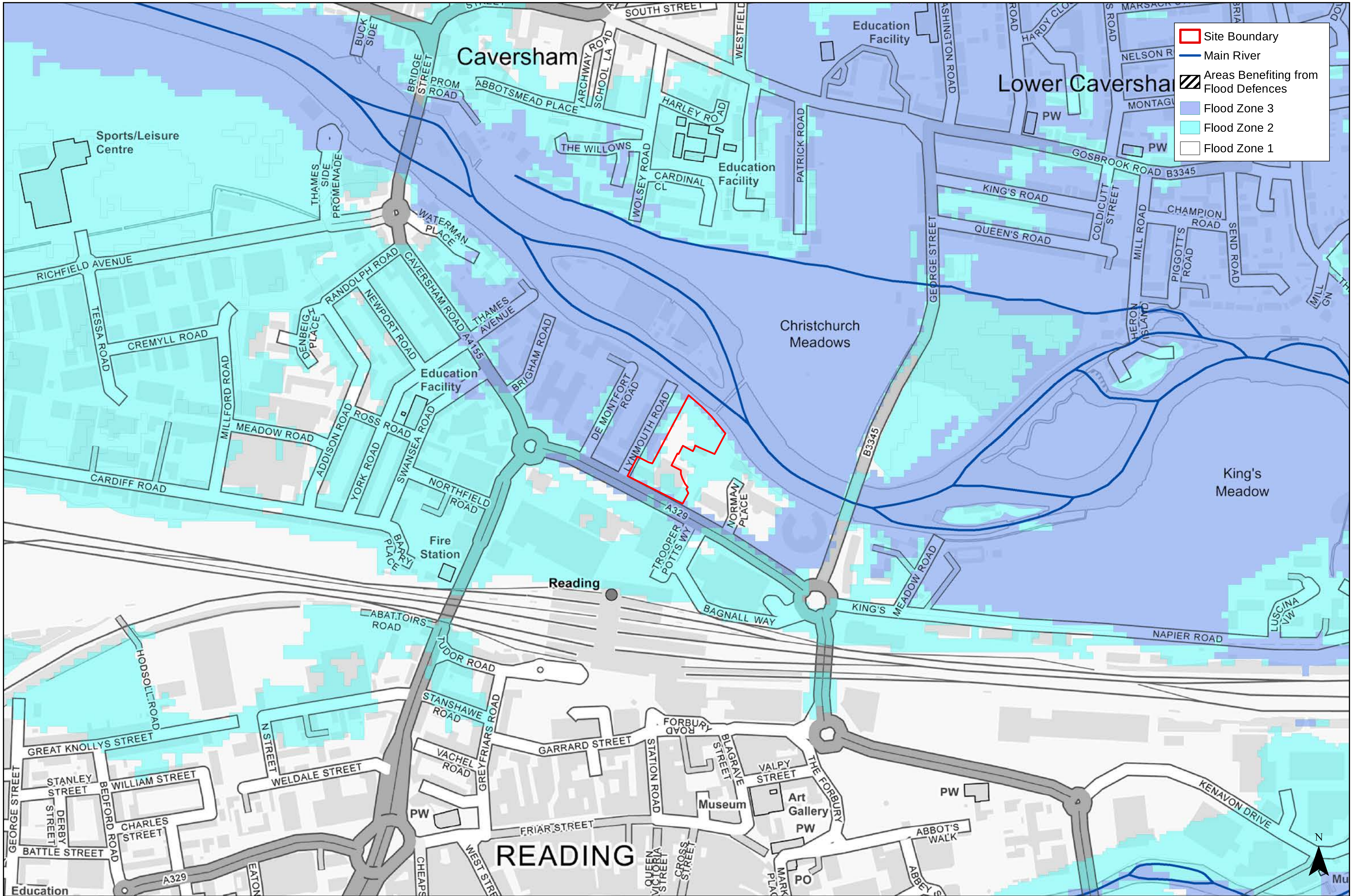

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Flood Zones refer to the probability of river and/or sea flooding, ignoring the presence of defences

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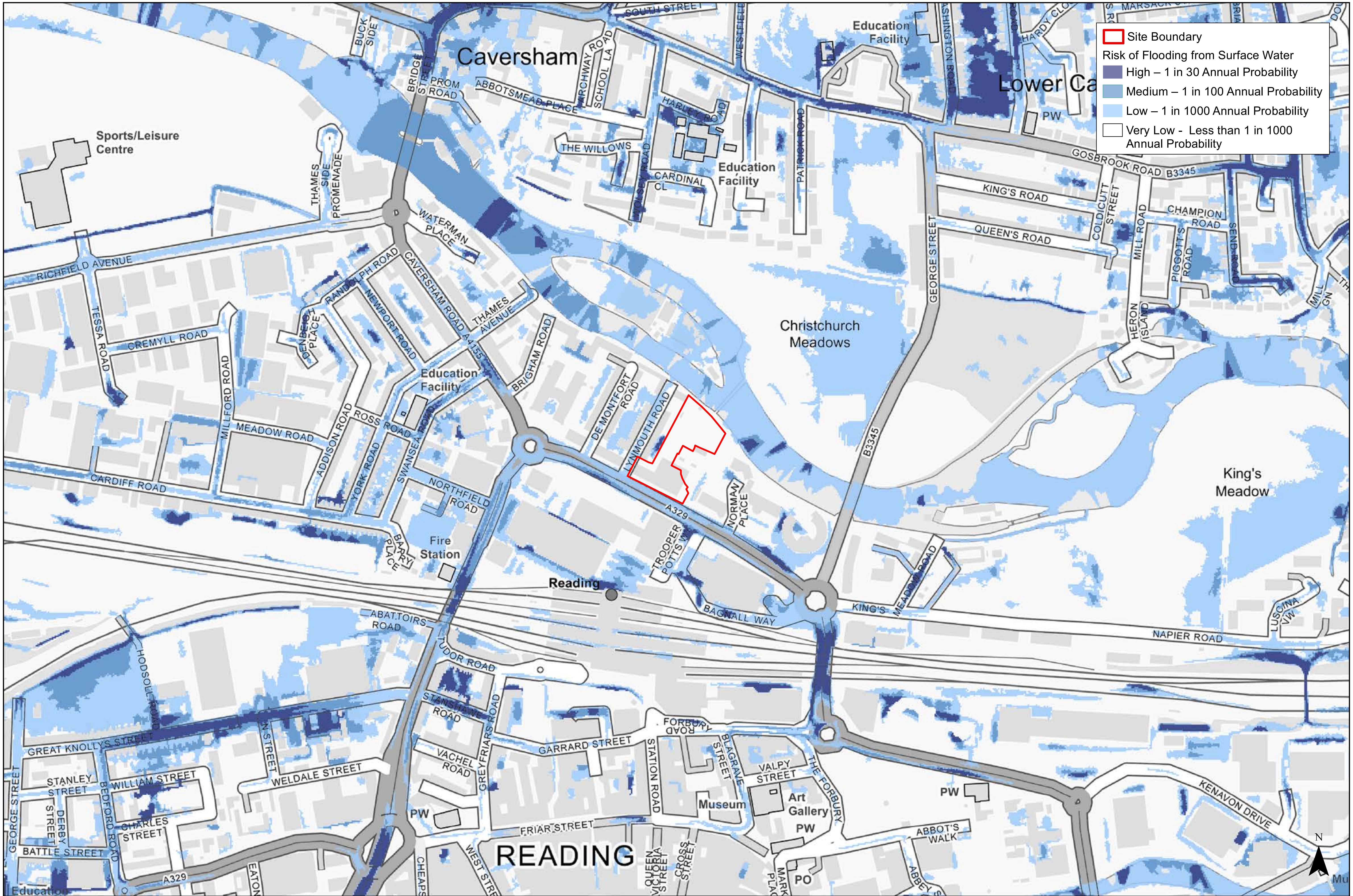

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Maps based on EA updated 'Flood Map for Surface Water' ('uFMfSW') released in 2013 as the latest iteration of a national scale surface water modelling exercise

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EA Surface Water Flood Risk

Figure 005

Rev A

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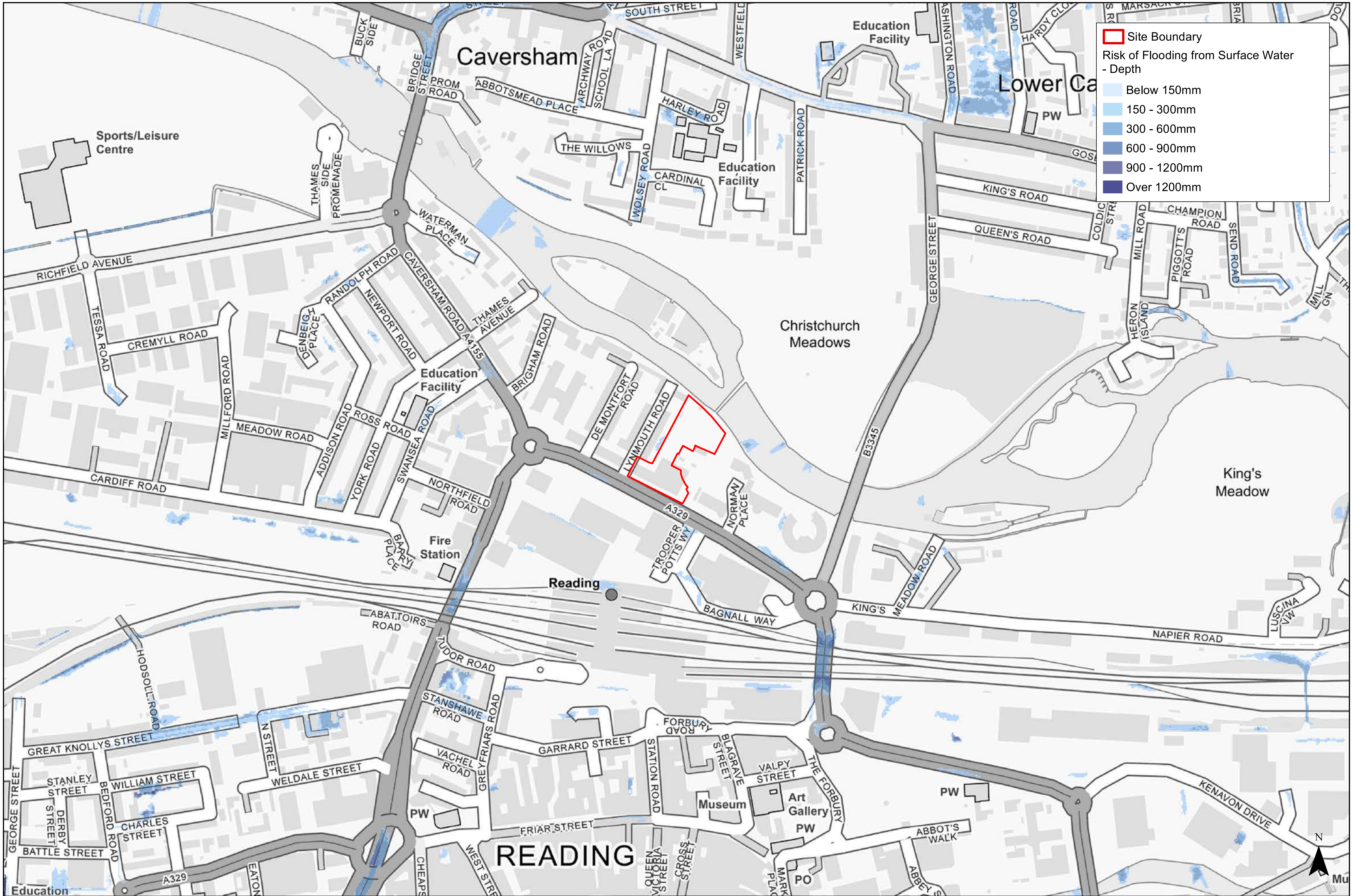

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EA Surface Water Flood Risk - Depth
3.3 Percent Chance

Figure 005a | Rev A

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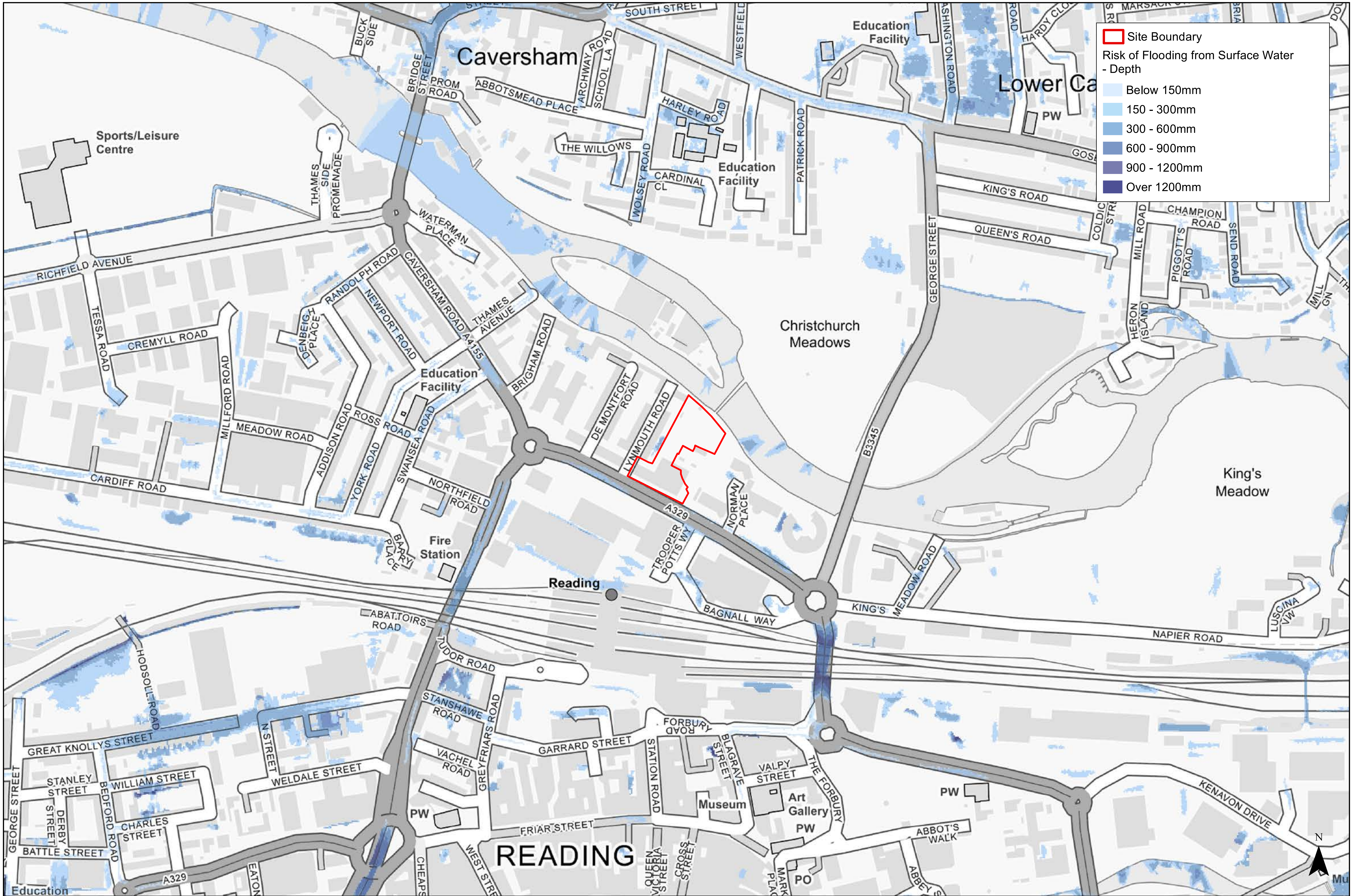

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Maps based on EA updated 'Flood Map for Surface Water' ('uFMfSW') released in 2013 as the latest iteration of a national scale surface water modelling exercise

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EA Surface Water Flood Risk - Depth
1.0 Percent Chance

Figure 005b | Rev A

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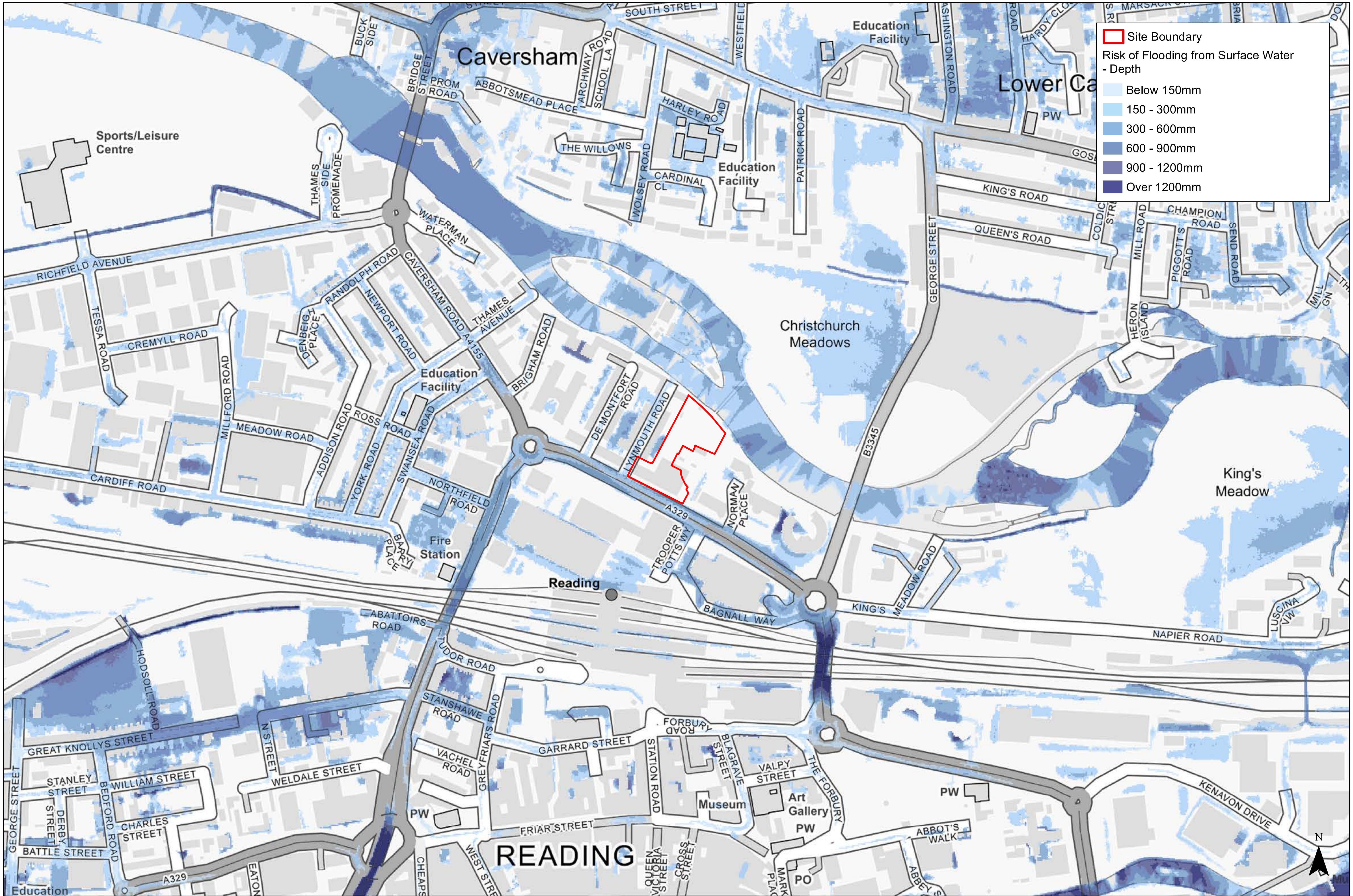

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Maps based on EA updated 'Flood Map for Surface Water' ('uFMfSW') released in 2013 as the latest iteration of a national scale surface water modelling exercise

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EA Surface Water Flood Risk - Depth
0.1 Percent Chance

Figure 005c Rev A

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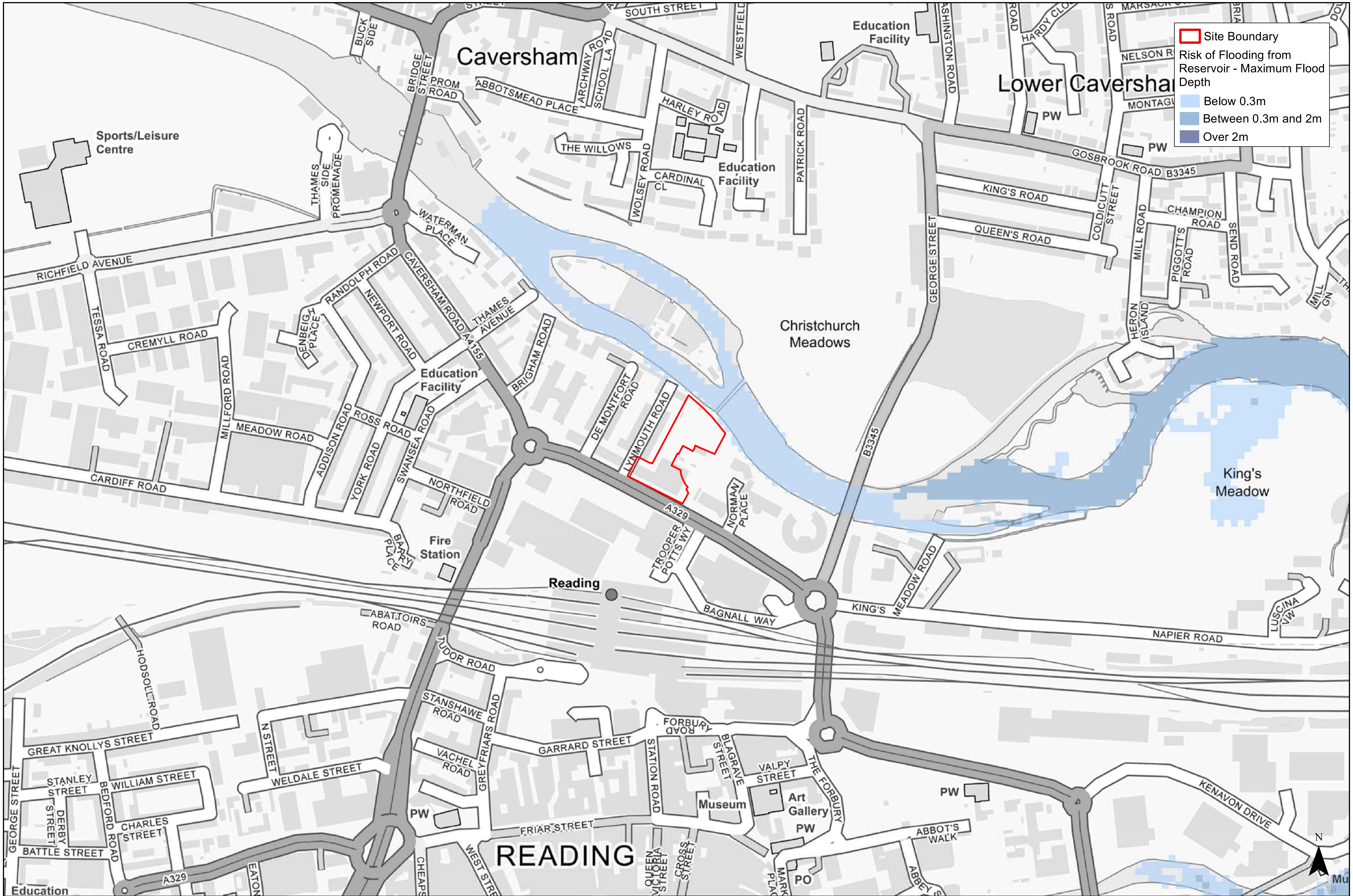

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EA Reservoir Flood Maps (RFMs) showing the potential extent of flooding in the event of a breach from large reservoirs (over 25,000 cubic metres of water) based on a national scale modelling exercise". Key to read 'Area at risk of flooding in reservoir breach

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Reservoir Flood Map

Figure 006 | Rev A

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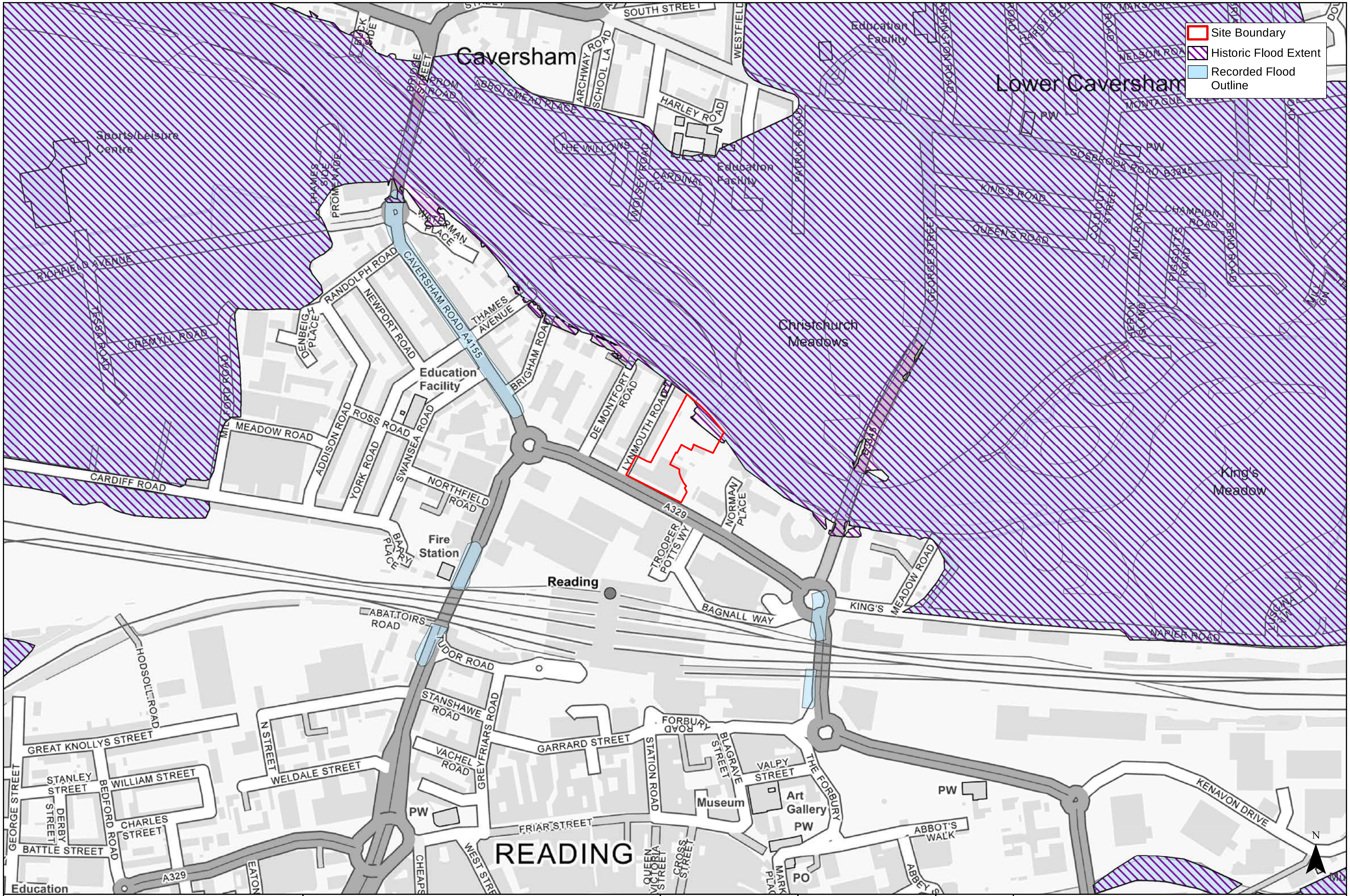

FORMER SSE SITE, VASTERN ROAD	0 250 500 m Contains Environment Agency information © Environment Agency and database right Contains Ordnance Survey data (c) Crown copyright and database right 2016. Historic Flood Map shows the maximum extent of all individual Recorded Flood Outlines from river, the sea and groundwater springs and shows areas of land that have previously been subject to flooding in England. Recorded Flood Outlines shows all EA records of historic flooding from rivers, the sea, groundwater and surface water	pba peterbrett	Client Berkeley Homes (Western) Ltd	1:5,000 @ A3 20/11/18 Drawn: IB Checked: DM	EA Recorded Historic Flood Extents Figure 007 Rev A

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Appendix B Topographic Survey

Maltby Surveys Ltd. Drawing reference 16/295/100-A, October 2016