# London Borough of Newham Level 2 Strategic Flood Risk Assessment

## Final Report

**A1 C02**

**December 2023**

**Prepared for:**

**London Borough of Newham Council**

**www.jbaconsulting.com**

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# Contract

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This report describes work commissioned by London Borough of Newham Council by an email dated 8 December 2022. The Client's representative for the contract was Ellie Kuper Thomas of London Borough of Newham Council. Louise Goode, Freya Nation, Libby Raines, Georgie Troy, Timea Faber, Hannah Booth and Rebecca Lee of JBA Consulting carried out this work.

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## Acknowledgements

We would like to acknowledge the assistance of the following organisation in the production of this SFRA:

- Environment Agency
- London Borough of Newham Council (as LLFA)
- Thames Water
- Canal and River Trust
- London Fire Brigade
- National Highways
- Highways Authority
- Neighbouring authorities:
    i. London Borough of Barking and Dagenham Council
    ii. London Borough of Hackney Council
    iii. London Borough of Redbridge Council
    iv. London Borough of Tower Hamlets Council
    v. London Borough of Waltham Forest Council
    vi. London Legacy Development Corporation (LLDC) Area
    vii. Royal Borough of Greenwich Council


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Abbreviations

| | |
|---|---|
| 1D | One Dimensional (modelling) |
| 2D | Two Dimensional (modelling) |
| AEP | Annual Exceedance Probability |
| BGS | British Geological Survey |
| CC | Climate Change |
| CDA | Critical Drainage Area |
| CFMP | Catchment Flood Management Plan |
| CIRIA | Company providing research and training in the construction industry |
| DEFRA | Department of the Environment, Food and Rural Affairs (formerly MAFF) |
| DTM | Digital Terrain Model |
| DWMP | Drainage and Wastewater Management Plan |
| EA | Environment Agency |
| FMfP | Flood Map for Planning |
| FRA | Flood Risk Assessment |
| FRISM | Flood Risk Metrics [JBA Consulting's impact analysis software] |
| FRM | Flood Risk Management |
| GIS | Geographical Information System |
| ISIS | Hydrology and hydraulic modelling software |
| IWMS | Integrated Water Management Strategy |
| JBA | Jeremy Benn Associates |
| LBN | London Borough of Newham |
| LiDAR | Light Detection And Ranging |
| LFRMS | Local Flood Risk Management Strategies |
| LLDC | London Legacy Development Corporation |
| LPA | Local Planning Authority |
| NFM | Natural Flood Management |
| NPPF | National Planning Policy Framework |
| OS | Ordnance Survey |
| PFRA | Preliminary Flood Risk Assessment |
| PPG | Planning Policy Guidance |
| RBD | River Basin District |
| RBMP | River Basin Management Plan |
| RoFfSW | Risk of Flooding from Surface Water |
| RMA | Risk Management Authority |

| | |
|---|---|
| SFRA | Strategic Flood Risk Assessment |
| SuDS | Sustainable Drainage Systems |
| TE2100 | Thames Estuary 2100 |
| TUFLOW | Two-dimensional Unsteady FLOW (a hydraulic model) |
| UKCP18 | United Kingdom Climate Projections 2018 |

## Definitions

**1D model**: One-dimensional hydraulic model, typically representing a watercourse and structures within the channel (for example bridges and culverts).

**2D model:** Two-dimensional hydraulic model, typically representing the floodplain flows.

**Brownfield:** Previously developed parcel of land.

**Annual Exceedance Probability (AEP):** The probability that a given rainfall total accumulated over a given duration will be exceeded in any one year.

**Critical Drainage Areas:** A discrete geographic area where multiple and interlinked sources of flood risk (surface water, groundwater, sewer, Main River and/or tidal) cause flooding in one or more Local Flood Risk Zones during severe weather thereby affecting houses, businesses and/or local infrastructure.

**Design flood:** This is a flood event of a given annual flood probability, which is generally taken as:

- river flooding likely to occur with a 1% annual probability (a 1 in 100 chance each year); or
- tidal flooding with a 0.5% annual probability (1 in 200 chance each year); or
- surface water flooding likely to occur with a 1% annual probability (a 1 in 100 chance each year),

plus, an appropriate allowance for climate change.

**Exception Test:** Set out in the NPPF, the Exception Test is a method used to demonstrate that flood risk to people and property will be managed appropriately,. The Exception Test is applied following the Sequential Test.

**Flood defence:** Infrastructure used to protect an area against floods such as floodwalls and embankments; they are designed to a specific standard of protection (design standard).

**Flood Map for Planning:** The Environment Agency Flood Map for Planning (Rivers and Sea) is an online mapping portal which shows the Flood Zones in England. The Flood Zones refer to the probability of river and sea flooding, ignoring the presence of defences and do not account for the possible impacts of climate change.

**Flood Risk Area:** An area determined as having a significant risk of flooding in accordance with guidance published by Defra and WAG (Welsh Assembly Government).

**Flood Risk Regulations:** Transposition of the EU Floods Directive into UK law. The EU Floods Directive is a piece of European Community (EC) legislation to specifically address flood risk by prescribing a common framework for its measurement and management.

**Flood and Water Management Act (2010):** Part of the UK Government's response to Sir Michael Pitt's Report on the Summer 2007 floods, the aim of which is to clarify the legislative framework for managing surface water flood risk in England.

**Fluvial Flooding:** Flooding resulting from water levels exceeding the bank level of a river.

**Functional Floodplain:** The land where water has to flow or be stored in times of flood.

**Greenfield:** Undeveloped parcel of land.

**Lead Local Flood Authority (LLFA):** County councils and unitary authorities which lead in managing local flood risks (risks of flooding from surface water, groundwater and ordinary (smaller) watercourses). The London Borough of Newham is a lead local flood authority.

**Local Planning Authority (LPA):** The local government body which is responsible by law to exercise planning functions for a particular area. The London Borough of Newham and the London Legacy Development Corporation are local planning authorities.

**Main River:** A watercourse shown as such on the Main River Map, and for which the Environment Agency has responsibilities and powers.

**Natural Flood Management (NFM):** A wide range of techniques can be used that aim to reduce flooding by working with natural features and processes to store or slow down flood waters before they can damage flood risk receptors (e.g., people, property, infrastructure, etc.).

**Ordinary Watercourse:** All watercourses that are not designated Main River. Local Authorities or, where they exist, IDBs have similar permissive powers as the Environment Agency in relation to flood defence work. However, the riparian owner has the responsibility of maintenance.

**Resilience Measures:** Measures designed to reduce the impact of water that enters property and businesses; could include measures such as raising electrical appliances.

**Riparian owner:** A riparian landowner, in a water context, owns land or property, next to a river, stream or ditch.

**Risk:** In flood risk management, risk is defined as a product of the probability or likelihood of a flood occurring, and the consequence of the flood.

**Risk Management Authority (RMA):** Operating authorities who’s remit and responsibilities concern flood and/or coastal risk management.

**Sequential Test:** Set out in the NPPF, the Sequential Test is a method used to steer new development to areas with the lowest probability of flooding.

**Sewer flooding:** Flooding caused by a blockage or overflowing in a sewer or urban drainage system.

**Standard of Protection (SoP):** Defences are provided to reduce the risk of flooding (typically from a river, sea or surface water).A Standard of Protection is usually described in terms of an AEP flood event. For example, a flood embankment could be described as providing a 1% AEP Standard of Protection.

**Sustainable Drainage Systems (SuDS):** Methods of management practices and control structures that are designed to drain surface water in a more sustainable manner than some conventional techniques.

**Surface water (pluvial) flooding:** Flooding as a result of high intensity rainfall when water is ponding or flowing over the ground surface before it enters the underground drainage network or watercourse or cannot enter it because the network is full to capacity.

# Executive Summary

### Introduction and context

This Level 2 Strategic Flood Risk Assessment (SFRA) document was created with the purpose of supporting the review and update of the London Borough of Newham (LBN) Local Plan to cover the plan period 2018 - 2033. It involves the screening of 61 proposed development sites which have been identified by LBN Council; 44 of these sites were identified as having significant risk of flooding and/or access and egress issues. These were further assessed in 43 detailed site summary tables (Custom House Phase 1 and 2 have been assessed in the same site table as they are adjoining sites). This SFRA incorporates recent changes to national and local planning policy and considers the cumulative impacts of development across the Borough.

### SFRA objectives

The Government's Planning Practice Guidance (PPG) on Flood Risk and Coastal Change advocates a tiered approach to risk assessment involving Level 1 and Level 2 assessments.

The aim of the Level 2 assessment is to build on identified risks from Level 1 for proposed development sites, to provide a greater understanding of fluvial, surface water, groundwater, and reservoir related flooding risks to the site. From this, the Local Council and Developers can make more informed decisions and pursue development in an effective and efficient manner. The Level 2 assessment also identifies sites for further risk analysis at the site-specific Flood Risk Assessment (FRA) stage.

### Level 2 SFRA outputs

The Level 2 assessment includes detailed assessments of the proposed site options. These include:

- Providing an up-to-date Strategic Flood Risk Assessment, taking into account the most recent policy and legislation in the National Planning Policy Framework (2023).
- An assessment of all sources of flooding including fluvial flooding, tidal flooding, surface water flooding, groundwater flooding and the potential increase in fluvial, surface water and tidal flood risk due to climate change, and how these may be mitigated.
- An assessment of existing flood warning and emergency planning procedures, including an assessment of safe access and egress during an extreme event.
- Advice and recommendations on the likely applicability of sustainable drainage systems for managing surface water runoff.
- To provide a comprehensive set of maps presenting flood risk from all sources that can be used as evidence base for use in the emerging Local Plan.
- Advice on whether the sites are likely to pass the second part of the Exception Test and the Sequential Test with regards to flood risk and on the requirements for a site-specific FRA, and outline specific measures or objectives that are required to manage flood risk.

As part of the Level 2 SFRA, detailed site summary tables have been produced for the proposed sites, covering the above. To accompany each site summary table, there are static maps, with all the mapped flood risk outputs.

**Summary of the Level 2 SFRA**

Detailed site summary tables setting out the flood risk to each site and the NPPF requirements for the site, as well as guidance for site-specific FRAs, have been produced. A broadscale assessment of suitable SuDS options has been provided, giving an indication where there may be constraints to certain types of SuDS techniques.

To accompany each site summary table, there are static maps, with all the mapped flood risk outputs per site.

The following points summarise the Level 2 assessment:

Most sites are shown to be at some or significant risk of fluvial and tidal flooding, with the exceptions being located in the centre and north of the Borough.

**Fluvial/Tidal Flooding**: Some areas of the LBN are at greater risk than others. The main watercourses associated with fluvial and or tidal risk are:

- River Lea - the River Lea flows along the western boundary of the LBN before converging with the River Thames in the south-western corner of the Borough. Modelled flood extents suggest that properties in Temple Mills, Stratford and Three Mills are at flood risk from the River Lea, particularly in the areas where there are historic recorded flood outlines.
- River Roding – the River Roding flows along the eastern boundary of the LBN before converging with the River Thames in the south-eastern corner of the Borough. Areas at risk within Newham include the industrial and residential areas of Little Ilford, East Ham and Beckton.
- River Thames – the tidally influenced River Thames flows along the LBN's southern boundary. Due to the flood defences along the River Thames being designed to protect to a 0.1% AEP flood event, the surrounding areas are not at risk of flooding from the Thames. However, breach modelling suggests that if these defences were to fail, the south and west parts, as well as the eastern boundary, of the LBN will be impacted. Areas within these flood extents include the industrial and residential areas of Little Stratford, West Ham, Canning Town, North Woolwich, Cyprus, Beckton and East Ham.
- Ordinary watercourses - there are a number of small ordinary watercourses within the Borough which are not currently modelled but have the potential to cause fluvial flood risk. For this assessment, the surface water mapping has been used to provide an indication of risk; however, modelling of these watercourses will be essential in a Flood Risk Assessment to inform the risk to any development proposals within the vicinity of unmodelled watercourses.

**Surface Water:** Surface water flood risk is widespread across the LBN. Water predominantly flows along topographically low-lying areas, including some roads, and is channelled into watercourses such as the Rivers Lea and Roding.

All the sites with a detailed Level 2 summary table are at surface water flood risk. The degree of flood risk varies, with some sites being only marginally affected, and other sites being more significantly affected. The sites at most significant surface water risk are: Canning Town East 1, Canning Town East 2, Glory House, Custom House Phase 1, East Beckton Town Centre, Former East Ham Gasworks, Greater Carpenter's District, Lyle Park West, Newham 6th Form College, Newham Leisure Centre, Silvertown Way East, Chobham Farm North.

**Access and egress:** Whilst not at significant flood risk within the site boundary, several sites have potential access and egress issues as a result of fluvial and surface water flooding on the surrounding roads. Consideration should be made to these sites as to how safe access and egress can be provided during flood events, both to people and emergency vehicles. Also, consideration should be given to the nature of the risk, for example whether the flooding forms a flow path or bisects the site where access from one side to another may be compromised.

**Effects of climate change:** Fluvial and surface water climate change mapping indicates that flood extents are predicted to increase. As a result, the depths, velocities and hazard of flooding may also increase. The significance of the increase tends to depend on the topography of the site and the climate change percentage allowance used.

- Surface water; The 3.3% AEP +25% and +35% and the 1% AEP +25% and +40% climate change surface water events have been derived from the RoFfSW dataset and ICM modelling as an indication of climate change to surface water flood risk. The RoFfSW and ICM modelled 1% AEP plus 40% climate change surface water events are larger than their respective 1% AEP events, and both similar to their respective 0.1% AEP events, showing the LBN to be relatively sensitive to increases in surface water flooding due to climate change.
- Fluvial; The 3.3%, 0.5% and 1% AEP plus Central, Higher Central and Upper End climate change allowances have been derived from hydraulic modelling of the Rivers Lea and Roding. Both models show the 1% AEP plus Central and Higher Central climate change allowances to be larger than the modelled 1% AEP fluvial events but smaller than the modelled 0.1% AEP fluvial events. However, the 1% AEP plus the Upper End climate change allowance for both the Rivers Lea and Roding (+54% and +64%, respectively) have larger extents than the modelled 0.1% AEP events.
- Tidal; when comparing the present day to the 2100 epoch Thames tidal breach modelling, flood extents increase in the South of the Borough and in the lower reaches of the River Roding and River Lee.
- Sites most sensitive to changes in surface water, fluvial and tidal flood risk due to climate change include: Aldersbrook, Connaught Riverside, Custom House Phase 1, East Beckton Town Centre, Newham Sixth Form, Newham Leisure Centre, Silvertown

Way East, Chobham Farm North, Stratford Town Centre West, Stratford Waterfront South, Greater Carpenter's District, Sugar House Island, Canning Town Riverside, Former East Ham Gasworks, East Ham Industrial Estate, Abbey Mills, Parcelforce, Pudding Mill, Canning Road West, Canning Town East, Royal Albert North and Beckton Riverside.

- Site-specific FRAs should confirm the impact of climate change using latest guidance. It is recommended that the LBN Council work with other Risk Management Authorities (RMAs) to review the long-term sustainability of existing and new development in these areas when developing climate change plans and strategies for the Borough.

**Historic Flooding:** Historic data provided by the LBN Council showed 290 incidences of recorded flooding within the study area since 2011; these incidences were associated with surface water, groundwater or sewer flooding. Details of whether the flooding was internal to properties or affected only highways and curtilage was available for some records.

**Groundwater**: Groundwater emergence mapping indicates that the majority of the Borough is at negligible risk from groundwater emergence due to the nature of the local geological deposits. The GeoSmart Groundwater Flood Risk Map shows there are some localised areas where groundwater levels are low-moderate, and in these areas there may be a risk to subsurface assets, but surface manifestation of groundwater remains unlikely. There have been several records attributed to groundwater flooding within the LBN. For further details of these incidents, please refer to Section 5.7.1 in the Level 1 report.

**Canals:** There are no purpose-built canals within the LBN. However, the tributaries of the River Lea at Stratford are heavily canalised at Bow Back Creek (including the Pudding Mill, Three Mills Wall and Waterworks River) and are managed by the Canal and River Trust. These watercourses are controlled by a series of locks. There have been two recorded flooding incidents at Three Mills on the Bow Back Creek which are detailed in Section 5.1 within the L1 SFRA report.

**Reservoirs**: There are records of flooding from reservoirs in the study area during the 'wet day' and 'dry day' flooding scenarios. The areas not affected within the Borough are the central and northern areas (although the north-eastern and north-western corners of the LBN are within these flood extents, following the paths of the Rivers Lea and Roding). The level and standard of inspection and maintenance required under the Reservoirs Act means that the risk of flooding from reservoirs is relatively low. However, there is a residual risk of a reservoir breach, and this risk should be considered in any site-specific Flood Risk Assessments (where relevant).

**Requirements for Developers:**

- Any sites located where there is Main River (including culverted reaches of Main River) will require an easement of 8m either side of the watercourse from the top of the bank. This may introduce constraints regarding what development will be possible and consideration will also need to be given for access and maintenance at locations where there are culverts. Developers will be required to apply for appropriate permits so the activity being carried out over easements does not increase flood risk.
- A strategic assessment was conducted of SuDS options using regional datasets. A detailed site-specific assessment of suitable SuDS techniques would need to be undertaken at site-specific level to understand which SuDS option would be best.
- In respect of the Cumulative Impact Assessment, the highest ranked catchments are the 'Canning Town', 'Folkstone Road East Ham SPS', 'Plaistow North', 'Plaistow SE' and 'West Ham'. These catchments are classified as high-risk when considering the cumulative impact of development on loss of floodplain storage volume and increase in runoff flow volume. A review of the SWMP, DWMP and Section 19 reports states that local drainage infrastructure has exacerbated recent flooding within Newham. It is recommended that opportunities to deliver improvements to drainage is delivered in any redevelopment. It is also recommended that developers consult with Thames Water when developing the drainage strategy to ensure that this is opportunities for drainage improvements are identified and delivered.
- At the planning application stage, developers may need to undertake more detailed hydrological and hydraulic assessments of the watercourses so that the potential effects of proposals can be evaluated at site level and where there are no detailed hydraulic models present. The modelling should verify flood extent (including latest climate change allowances), inform development zoning within the site and prove, if required, whether the Exception Test can be passed.
- For sites allocated within the Local Plan, the Local Planning Authority should use the information in this SFRA to inform the Exception Test. At planning application stage, the developer must adopt the sequential approach when assessing the feasibility of site allocations. This will ensure that appropriate flood resistance and resilience measures are put in place, which align with the recommendations in National and Local Planning Policy and supporting guidance as well as those set out in this SFRA.
- For developments that have not been allocated in the Local Plan, developers must undertake the Sequential Test followed by the Exception Test (if required) and present this information to the Local Planning Authority for approval. Developers will need to apply the Exception Test and use information in a site-specific Flood Risk Assessment to inform this test at planning application stage. The Exception Test should be applied where there is development which is classed as;
    - More vulnerable in Flood Zone 3a
    - Highly vulnerable in Flood Zone 2 (this is NOT permitted in Flood Zone 3a or 3b)
    - Essential infrastructure in Flood Zone 3a or 3b
    - Any development with significant* risk in the surface water 1% AEP event plus 40% climate change allowance flood extent.

- Any development with significant* risk in the Risk of Flooding from Reservoirs mapping ‘Wet Day’ flood extent.

**Flood risk issues are not always black and white - the significance of issues requires professional judgement, based on the location, topography and nature (including depth, velocity and hazard) of flooding, rather than simply whether part of a site is within a given flood extent. This would be determined as part of a Level 2 assessment.*

The Level 1 SFRA can be used to scope the flooding issues that a site-specific FRA should investigate in more detail to inform the Exception Test for windfall sites.

It is recommended that as part of the early discussions relating to development proposals, developers discuss requirements relating to site-specific FRA and drainage strategies with both the Local Planning Authority and the Lead Local Flood Authority (LLFA), to identify any potential issues that may arise from the development proposals.

# 1 Introduction

*This section outlines the purpose of a Strategic Flood Risk Assessment and their outputs and introduces the study area.*

## 1.1 Purpose of the Strategic Flood Risk Assessment

Paragraph 160 of the National Planning Policy Framework (NPPF) (2023) states that strategic policies should be informed by a Strategic Flood Risk Assessment (SFRA) and should manage flood risk from all sources. They should consider cumulative impacts in, or affecting, local areas susceptible to flooding, and take account of advice from the Environment Agency (EA), and other relevant flood risk management authorities, such as Lead Local Flood Authorities (LLFAs) and Internal Drainage Boards (IDBs).

The Planning Practice Guidance (PPG) (2022) advocates a staged approach to risk assessment and identifies two levels of SFRA:

- Level 1 SFRA (L1): where flooding is not a major issue and where development pressures are low. The assessment should be sufficiently detailed to allow application of the Sequential Test. Level 1 is completed first to understand whether a Level 2 assessment is required.
- Level 2 SFRA (L2): where land outside the EA's Flood Zones 2 and 3 (and land outside areas affected by other sources of flooding as per the Exception Test requirements) cannot accommodate all the necessary development creating the need to apply the NPPF's Exception Test. In these circumstances, the assessment should consider the detailed nature of the flood characteristics within a Flood Zone and assessment of other sources of flooding.

This SFRA report fulfils the requirements for a Level 2 assessment of strategic sites identified for potential allocation within the London Borough of Newham and has been prepared in accordance with the NPPF (2023) and PPG (2022).

This report should be read alongside the London Borough of Newham Level 1 SFRA (2023) and builds upon the information presented in the Level 1 SFRA.

## 1.2 SFRA objectives

The objectives of this Level 2 SFRA are to:

- Provide individual flood risk analysis for site options using the latest available flood risk data, thereby assisting the Council in applying the Exception Test to their proposed site options in preparation of the update to the London Borough of Newham (LBN) Local Plan.
- Using available data to provide information and a comprehensive set of maps presenting flood risk from all sources for each site option.
- Where the Exception Test is required, provide recommendations for making the site safe throughout its lifetime.

- Take into account most recent policy and legislation in the NPPF, PPG and LLFA Sustainable Drainage Systems (SuDS) guidance.
- Update the catchments that are most sensitive to new development in flood risk terms and further review policy and recommendations for these catchments.

## 1.3 Consultation

SFRAs should be prepared in consultation with other risk management authorities. The following parties (external to LBN Council as the Local Planning Authority (LPA)) have been consulted during the preparation of this Level 2 SFRA:

- Environment Agency
- LBN Council (as LLFA)
- Thames Water
- Canal and River Trust
- National Highways
- Highways Authority
- Neighbouring authorities:
    1. London Borough of Barking and Dagenham Council
    2. London Borough of Hackney Council
    3. London Borough of Redbridge Council
    4. London Borough of Tower Hamlets Council
    5. London Borough of Waltham Forest Council
    6. London Legacy Development Corporation (LLDC) Area (Local Planning Authority until December 2024 – for more information please visit their **website**).
    7. Royal Borough of Greenwich Council

## 1.4 How to use this report

Table 1-1 below outlines the contents of this report and how different users can apply this information.

Table 1-1: Outline of the contents of each section of this report and how they should be applied.

| Section | Contents | How to use |
|---|---|---|
| 1. Introduction | Outlines the purpose and objectives of the Level 2 SFRA | For general information and context. |
| 2. The Planning Framework and Flood Risk Policy | Includes information on the implications of recent changes to planning and flood risk policies and legislation, as well as documents relevant to the study. For more detail, please refer to Sections 2 and 3 of the Level 1 SFRA. | Users should refer to this section for any relevant policy which may underpin strategic or site-specific assessments. |

| Section | Contents | How to use |
|---|---|---|
| 3. Sources of Information Used in Preparing the Level 2 SFRA | Summarises the data used in the Level 2 assessments and static mapping.<br><br>Outlines the latest climate change guidance published by the Environment Agency and how this was applied to the SFRA.<br><br>Sets out how developers should apply the guidance to inform site-specific Flood Risk Assessments. | Users should refer to this section in conjunction with the summary tables and static mapping to understand the data presented.<br><br>This section should be used to understand the climate change allowances for a range of epochs and conditions, linked to the vulnerability of a development.<br><br>Developers should refer back to this section when understanding requirements for a site-specific Flood Risk Assessment (FRA). |
| 4. Level 2 Assessment Methodology | Summarises the sites taken forward to a Level 2 assessment and the outputs produced for each of these sites. | This section should be used in conjunction with the site summary tables and static mapping to understand the data presented. |
| 5. Flood Risk Management Requirements for Developers | Identifies the scope of the assessments that must be submitted in FRAs supporting applications for new development.<br><br>Refers back to relevant sections in the L1 SFRA for mitigation guidance. | Developers should use this section to understand requirements for FRAs and what conditions/ guidance documents should be followed. Developers should also refer to the L1 SFRA for further information on flood mitigation options. |
| 6. Surface Water Management and SuDS | Refers back to relevant sections in the L1 SFRA for information on SuDS and surface water management. | Developers should use this section to understand the suitability of SuDS across the study area and refer to the L1 SFRA for further information on types of SuDS, the hierarchy and management trains information. |
| 7. Summary of Level 2 Assessment and Recommendations | Summarises the results and conclusions of the Level 2 assessment, and signposts to the L1 SFRA for planning policy recommendations. | Developers and planners should use this section to see a summary of the Level 2 assessment and understand the key messages from the site summary tables.<br><br>Developers should refer to the Level 1 SFRA recommendations when considering requirements for site-specific assessments. |

| Section | Contents | How to use |
|---|---|---|
| Appendix A: Static Mapping and Site Summary Tables | Provides a detailed summary of flood risk for sites requiring a more detailed assessment. The section considers flood risk, emergency planning, climate change, broadscale assessment of possible SuDS, exception test requirements and requirements for site-specific FRAs.<br><br>Provides static mapping for each Level 2 assessed site displaying flood risk at and around the site. | Planners should use this section to inform the application of the Sequential and Exception Tests, as relevant.<br><br>Developers should use these tables to understand flood risk, access and egress requirements, climate change, SuDS, and FRA requirements for site-specific assessments.<br><br>Planners and developers should use these maps in conjunction with the site summary tables to understand the nature and location of flood risk. |
| Appendix B: Sites Carried Forward to a Level 2 Assessment | Provides a table which lists all the sites that were screened for the Level 2 assessment and have been deemed as having significant flood risk.<br><br>The table details fluvial and surface water flood risk from EA datasets (FMfP and RoFfSW) and hydraulic modelling. | Developers should use this table to understand flood risk for site-specific assessments. |
| Appendix C: JBA Hydraulic Modelling Technical Notes | Provides details on the methodology used to re-run the hydraulic models as part of this SFRA. | Developers should use this information to understand how each model has been simulated to provide accurate results. |

## 1.5 SFRA study area

Covering an area of 36 km$^2$, the London Borough of Newham is an inner London Borough with a population of 351,000 **(Census, 2021).** Figure 1:1 below displays the SFRA study area alongside its neighbouring authorities.

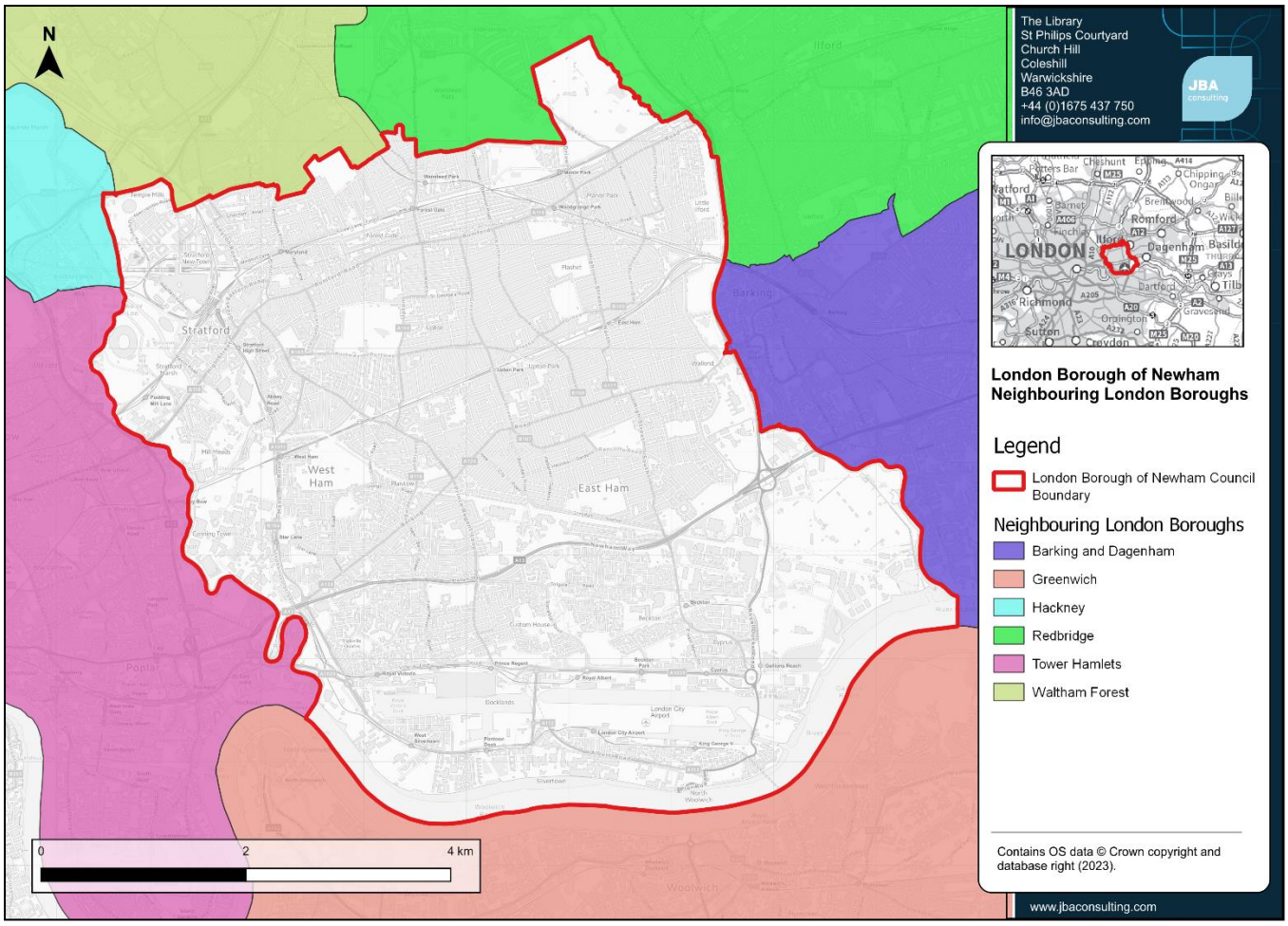



Figure 1:1: The SFRA study area (London Borough of Newham) alongside its neighbouring London Boroughs.

A number of principal watercourses (classed as Environment Agency Main Rivers) are present within the district (Figure 1:2), and include the:

- River Thames
- River Roding and its tributary (Alders Brook).
- River Lee or Lea (hereafter named the River Lea) and tributaries (Bow Creek, Channelsea River, City Mill River, Pudding Mill River, Three Mills Wall River and Water Works River).

The River Thames is tidally influenced and flows along the entire width of the southern boundary of the LBN in an easterly direction. It then continues to flow through the southern boundaries of Barking and Dagenham as well as Havering before eventually discharging into the North Sea. The Thames Barrier is located within the LBN, stretching between Silvertown (LBN) and New Charlton (Royal Borough of Greenwich).

The River Lea flows from north to south along the western boundary of LBN, discharging into the Thames in the south-western corner of Newham. The final 3.5km of the River Lea is also called Bow Creek.

The River Roding flows from north to south adjacent to the eastern boundary of LBN. Part of the River Roding is within the London Borough of Barking and Dagenham. The last 1.5km of the River Roding are known as the Barking Creek (also known as Warpools Reach), which discharges into the River Thames in the south-eastern corner of the LBN.

The Royal Docks are also located in the south of the Borough on historical River Thames riverside marshes and collectively enclosed docks.

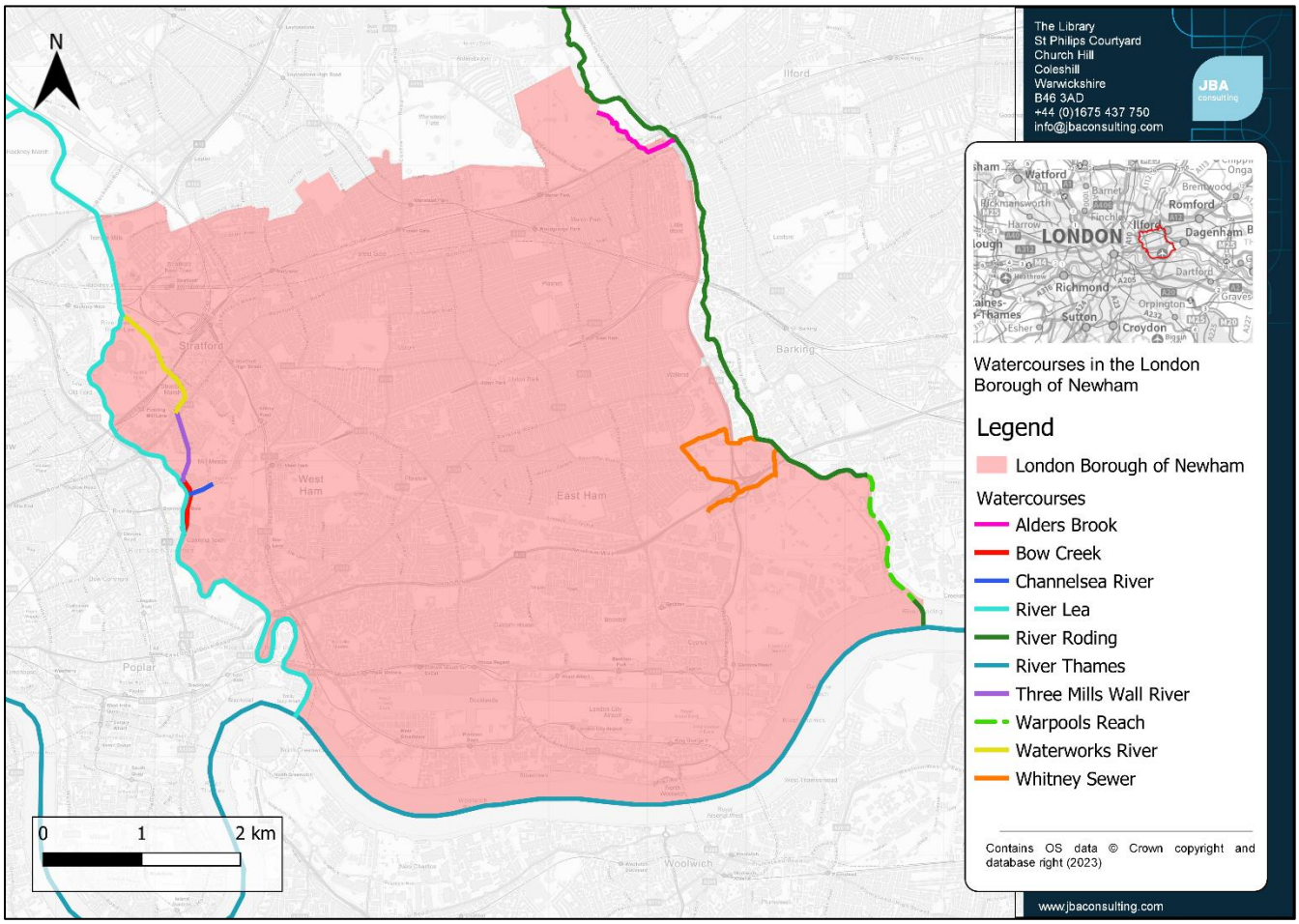



Figure 1:2: Principal watercourses present within the London Borough of Newham.

# 2 The Planning Framework and Flood Risk Policy

*This section of the Level 2 SFRA provides an overview of the planning framework, flood risk policy and flood risk responsibilities. In preparing the subsequent sections of this SFRA, appropriate planning and policy amendments have been acknowledged and considered.*

## 2.1 National Planning Policy Framework and Guidance

The Revised **National Planning Policy Framework** (NPPF) was last updated in September 2023. The NPPF sets out Government's planning policies for England and how these are expected to be applied. The Framework is based on core principles of sustainability and forms the national policy framework in England, also accompanied by a number of **Planning Practice Guidance** (PPG) notes. It must be taken into account in the preparation of local plans and is a material consideration in planning decisions.

### 2.1.1 Planning Practice Guidance

An updated version of the PPG was published in August 2022. This advises on 'how to take account of and address the risks associated with flooding and coastal change in the planning process'. The guidance outlines the steps required when preparing strategic policies. Further details regarding the PPG can be found in the Level 1 SFRA.

### 2.1.2 The Sequential Test

The Sequential Test aims to ensure that areas of little or no flood risk are prioritised for development over areas at a higher risk of flooding. This means areas at a medium or high risk of flooding from any source, now or on the future should be avoided for development where possible.

### 2.1.3 The Exception Test

It may not always be possible for all new development to be allocated on land that is not at risk from flooding. To further inform whether land should be allocated, or Planning Permission granted, a greater understanding of the scale and nature of the flood risks is required. In these instances, the Exception Test will be required.

The Exception Test should only be applied following the application of the Sequential Test. It applies in the following instances, where it is not possible for development to be located in areas with a lower risk of flooding:

- More vulnerable in Flood Zone 3a
- Highly vulnerable in Flood Zone 2 (this is NOT permitted in Flood Zone 3a or 3b)
- Essential infrastructure in Flood Zone 3a or 3b
- Any development with significant* risk in the surface water 1% AEP event plus 40% climate change allowance flood extent.

- Any development with significant* risk in the Risk of Flooding from Reservoirs mapping ‘Wet Day’ flood extent.

**Flood risk issues are not always black and white - the significance of issues requires professional judgement, based on the location, topography and nature (including depth, velocity and hazard) of flooding, rather than simply whether part of a site is within a given flood extent. This would be determined as part of a Level 2 assessment. This is ultimately decided by the RMAs just as the LPA and EA, which are informed by site specific FRAs and the SFRAs.*

It is noted that the EA’s Flood Map For Planning Flood Zones represent undefended fluvial outputs. In this SFRA, modelled defended fluvial events for the River Roding and River Lee are used due to the presence of flood defences in Newham. There are no defended tidal modelled outputs for the River Thames, as this is defended up to and including the 0.1% AEP event so there is no out of bank flooding. Developers will need to show that any residual risk to sites can be safely managed.

Flood Zone 3b, the functional floodplain, is based on the fluvial defended modelled 3.3% AEP event extent for the River Roding and River Lee (where necessary). More information on the parameters used to run and uplift the models can be found in Appendix C of the Level 1 SFRA. In the 3.3% AEP event, the tidal Thames remains within bank due to defences, so there is no Flood Zone 3b associated with the River Thames.

## 2.2 Use of SFRA data

This SFRA has been developed using the best available information, supplied at the time of preparation. This relates both to the current risk of flooding from rivers, the sea, surface water and groundwater and, where available, the potential impacts of future climate change.

Datasets used to inform this SFRA may be updated following the publication of this SFRA and new information on flood risk may be produced by Risk Management Authorities. This new information (such as updated mapping and modelling) may supersede the information included in this SFRA. Guidance should be sought from LBN Council and the Environment Agency as appropriate to check the most up to date source of information is used for future flood risk assessment.

## 2.3 Roles and responsibilities for Flood Risk Management

Risk Management Authorities (RMAs) are comprised of different organisations that have responsibilities for flood risk management. The RMAs in and around the LBN are displayed below in Table 2-1, alongside a summary of their responsibilities.

Table 2-1: Roles and responsibilities of different organisations for Flood Risk Management

| Risk Management Authority | Strategic Level | Operational Level | Planning Role |
|---|---|---|---|
| Environment Agency. | Strategic overview for all sources of flooding, national strategy, reporting and general supervision. | Main rivers, reservoirs and tidal flooding. | Statutory consultee for development in Flood Zones 2 and 3 for coastal and fluvial extents. |
| London Borough of Newham Council as Lead Local Flood Authority (LLFA). | Preliminary Flood Risk Assessment and Local Flood Risk Management Strategy. | Surface water, groundwater and ordinary watercourses (consenting, enforcement and works). | Statutory consultee for all major developments. |
| London Borough of Newham Council as Local Planning Authority (LPA).<br><br>London Legacy Development Corporation (LLDC) as LPA.* | Local Plan production. | Determination of Planning Applications and managing open spaces under Council ownership. | Determination of Planning Applications. |
| Water Companies: Thames Water. | Asset Management Plans supported by Periodic Reviews (business cases) and Develop Drainage and Wastewater Management Plans (DWMPs). | Public sewers. | Non-statutory consultee for all major developments. Also provides comments below this threshold where a specific request is received from Council Adoption of SuDS under Sewerage Sector Guidance. |

| Risk Management Authority | Strategic Level | Operational Level | Planning Role |
|---|---|---|---|
| Highways Authorities: National Highways (for motorways and trunk roads)<br>London Borough of Newham as Local Highway Authority (for other adopted roads). | Highway drainage policy and planning. | Highway drainage Local Highway Authority can adopt some highway drainage features. | Internal planning consultee regarding highways and design standards and options. |

*At the time of writing this SFRA, the **London Legacy Development Corporation (LLDC)** acts as the Local Planning Authority (LPA) for development within the Queen Elizabeth Olympic Park and its surrounding areas. Please visit the **LLDC's website** to see the location in which this LPA presides. The LLDC's planning powers and functions will be returned back to the four Boroughs it was originally composed of (London Boroughs of Newham, Hackney, Tower Hamlets and Waltham Forest) on the 1st December 2024. Planned developments within the LLDC area should follow the guidance outlined in the **LLDC's Local Plan** and **evidence base** until the LPA's planning powers and functions are returned. For development within the London Borough of Newham, the new Newham Local Plan will supersede the **original LLDC's Legacy Corporation Local Plan (2020).**

## 2.4 Relevant legislation

The following legislation is relevant to development and flood risk in LBN:

- **Flood Risk Regulations (2009)** - These transpose the European Floods Directive (2000) into law and require the Environment Agency and LLFAs to produce Preliminary Flood Risk Assessments and identify where there are nationally significant Flood Risk Areas. For the Flood Risk Areas, detailed flood maps and a Flood Risk Management Plan is produced; this is done in a six-year cycle. At the time of writing this SFRA (September 2023) it is understood that the UK Government intends to scrap the Flood Risk Regulations 2009 as part of a review into retained EU legislation. It is proposed to scrap this by 31st December 2023, as the Flood Risk Regulations duplicate existing domestic legislation, namely the Flood and Water Management Act 2010.
- **Town and Country Planning Act (1990), Water Industry Act (1991), Land Drainage Act (1991), Environment Act (1995), Flood and Water Management Act (2010)** – as amended and implemented via secondary legislation. These set out the roles and responsibilities for organisations that have a role in FRM.
- The **Land Drainage Act (1991, as amended)** and **Environmental Permitting Regulations (2018)** also set out where developers will need to apply for additional permission (as well as planning permission) to undertake works to an Ordinary Watercourse or Main River.
- **The Water Environment Regulations (2017)** – these transpose the European Water Framework Directive (2000) into law and require the Environment Agency to produce River Basin Management Plans (RBMPs). These aim to ensure that the water quality of

aquatic ecosystems, riparian ecosystems and wetlands reaches 'good' status. Note that this secondary UK legislation, which implements EU Directives, is subject to repeal/ amendment following the UK exit from the EU. At the time of publishing this report the references here were correct.

- Other environmental legislation such as the Habitats Directive (1992), Environmental Impact Assessment Directive (2014) and Strategic Environmental Assessment Directive (2001) also apply as appropriate to strategic and site-specific developments to guard against environmental damage.

## 2.5 Relevant Flood Risk Policy and Strategy Documents

This section highlights policies and other relevant documents for the LBN area at the time of writing. Hyperlinks are provided to external documents:

- **London Borough of Newham Local Flood Risk Management Strategy (LFRMS)** (2015, update currently in the process of being finalised) – sets out how LBN Council will manage flood risk from surface water runoff, groundwater and ordinary watercourses for which they have a responsibility as LLFA.
- **London Borough of Newham Preliminary Flood Risk Assessment (PFRA)** (2011) – a high level overview of flood risk within the LBN from all sources within a local area, including consideration of surface water, groundwater, ordinary watercourses and canals.
- **London Regional Flood Risk Appraisal** (2018) – a strategic overview of flood risk from all sources of flooding in London and a revised set of monitoring recommendations to manage and prepare for flood risk.
- **Subregional Integrated Water Management Strategy (IWMS) – East London** (2023) – the IWMS provides a holistic and integrated assessment of future water demand scenarios, flood risk, and water infrastructure including water supply, foul and surface water drainage. This provides a framework to support the planning process and activities of infrastructure providers, such as water companies and developers.
- **Royal Docks and Beckton Riverside Integrated Water Management Strategy** (2023) – this IWMS is provided at a more detailed spatial scale than the East London strategy, specifically focusing on the Royal Docks and Beckton Riverside.
- **Surface Water Management Plan (SWMP) for the London Borough of Newham** (2011, last updated 2019) – outlines the preferred surface water management strategy for the Borough.
- **Thames Catchment Flood Management Plan (CFMP)** (2009) – a high-level strategic plan providing an overview of flood risk across the Thames Catchment. The Environment Agency use CFMPs to work with other key decision makers to identify and agree long-term policies for sustainable flood risk management.
- **Thames Estuary 2100 (TE2100) Action Plan** (last updated 2023) – A long-term adaptive strategy for how flood risk management authorities (e.g., the Environment Agency, local councils and utility companies) can manage the increasing risk of tidal

flooding across the Thames Estuary as a result of climate change. The 'Isle of Dogs and Lea Valley' and 'Royal Docks' Policy Unit are both located within the LBN.

- **Thames River Basin District Flood Risk Management Plan** (2022) – this plan identifies what flood risk activities are occurring across the river basin district (RBD) as well as those in locally important areas, referred to as 'Strategic Areas.'
- **Thames River Basin District River Basin Management Plan (RBMP)** (updated 2022) – legally binding locally specific environmental objectives that underpin water regulation (such as permitting) and planning activities.
- **Thames Water Drainage and Wastewater Management Plan (DWMP)** (2023) – long term plan which outlines how Thames Water plans to approach and manage sewerage and wastewater over the next 25 years.
- The LBN Development Management Policies Document is part of the Local Plan and sets out the policies that are used to determine whether development proposals should be accepted. It highlights how development should avoid areas subject to flooding and consider flood risk policy. Sustainable drainage and water management is another key theme, with the encouragement of sustainable drainage systems (SuDS) being incorporated into the design of new developments.

## 2.6 LLFAs, Surface Water and SuDS

The NPPF (2023) states that:

- 'Major developments should incorporate sustainable drainage systems unless there is clear evidence that this would be inappropriate' (paragraph 169)

When considering planning applications, local planning authorities should consult the LLFA on the management of surface water in order to satisfy that:

- The proposed minimum standards of operation are appropriate.
- Through the use of planning conditions or planning obligations there are clear arrangements for on-going maintenance over the development's lifetime.

For proposed development within the LBN, reference should be made to LBN Council's SuDS requirements and guidance for new developers which are set out in the:

- **London Borough of Newham Council Sustainable Drainage Design and Evaluation Guide** (2020)
- **London Borough of Newham Lead Local Flood Authority Flood Risk and Sustainable Drainage: requirements and guidance for Planning Applications** (2020)
- **London Sustainable Drainage Action Plan** (2016)

The NPPF (2023) states that:

- 'All plans should apply a sequential, risk-based approach to the location of development' and should achieve this by 'using opportunities provided by new development […] to reduce causes and impacts of flooding.' (paragraph 161)

As such, the LBN Council expects SuDS to be incorporated on minor development as well as major development and, if possible, development in areas at material risk of flooding should be avoided. Masterplans should be designed to ensure that space is made for above ground SuDS features and that the requirements of existing surface water flow paths and storage volumes are appropriately accommodated. Underground tanks should only be used on sites as a last resort.

## 2.7 Updated Strategic Flood Risk Assessment Guidance

There have been several updates (the latest being in March 2022) to the **'How to prepare a Strategic Flood Risk Assessment'** guidance including a new section on setting up governance arrangements when preparing your SFRA which lists who to consult and when, and what to include in Level 1 SFRAs. It also includes links to various nature strategies, management plans and local design guidance. There is also guidance on improving the clarity on the sequential test and use of SuDS. This Level 2 assessment is undertaken in accordance with this guidance.

# 3 Sources of Information Used in Preparing the Level 2 SFRA

*This chapter describes the key sources of flood risk information used in the preparation of this SFRA. An assessment of the information mentioned in this section is included within the mapping and site tables for each site.*

## 3.1 Topography, geology, soils and watercourses

Topography, geology, soils and watercourses data were obtained from the following sources:

- Topography data was obtained from the Environment Agency's **1m LiDAR Composite Digital Terrain Model (DTM) 2022.**
- Bedrock Geology and Superficial Deposits data was procured from the **British Geological Society's (BGS) 50K mapping** dataset.
- Soils data was sourced from **Cranfield University Soilscapes mapping.**
- Watercourses data – main rivers were mapped using the Environment Agency's **Statutory Main River Map** dataset, and ordinary watercourses from the Environment Agency's (Partner Only) Detailed River Network (DRN) dataset. Caution should be taken when using these layers to identify culverted watercourses which may appear as straight lines but in reality, are not.

## 3.2 Historic flooding

The historic flood risk within LBN Council's administrative area has been assessed using the following:

- The Environment Agency's **'Recorded Flood Outlines'** have been used to understand whether historic flooding has been recorded at all sites. The dataset takes into account the presence of defences, structures and other infrastructure, where they existed at the time of flooding.
- Recorded flooding incidents provided by the LBN Council (flood incidents database and Section 19 investigations).
- Canal and Rivers Trust recorded flooding incidents.
- Thames Water historic sewer flooding incidents.

It is important to note that the absence of historic flood records does not mean than an area has never flooded, only that records are not held. For previously undeveloped sites, it is likely that historic flooding incidents may have gone unreported due to a lack of site use or interest. In addition, it is also possible that flooding mechanisms have changed since the date of a recorded flooding incident, making it more or less likely for flooding to occur on site.

## 3.3 Flood defences

For sites where existing flood defences provide a reduction in the flood risk to the site, it is important to understand the standard of protection these structures and measures provide. It is also necessary to understand how this level of protection changes over time, considering the implications of climate change.

If flood defences are required to protect a development site, evidence will be required to show that the new development does not adversely impact and increase flood risk to other areas, for example that there is no net loss in floodplain storage in circumstances where this is a material consideration. It will need to be established that these defences can be appropriately managed and maintained during the lifetime of the development. In some cases, it will be a requirement to demonstrate that there is an appropriate level of commitment to the maintenance of the standard of protection afforded by existing defences, where reliance is placed on the standard they provide.

Current flood defences have been taken from the Environment Agency's Asset Information Management System (AIMS) Spatial Defences dataset. Their current condition and standard of protection are based on those recorded in the tabulated shapefile data. The Council's asset register was also obtained in the Level 1 SFRA.

Flood defences along the River Thames, and tidally influenced reaches of the River Lea and River Roding, are held to the standards of protection as outlined within the **TE2100 plan**.

Flood defence structures along the Thames have a design standard of protection up to and including the 0.1% AEP flood event (this can be used as a proxy for the 0.5% AEP plus climate change flood event), therefore there is no functional floodplain/Flood Zone 3b for the tidal Thames.

### 3.4 Flood Zones from the EA's Flood Map for Planning

Flood Zones are discrete areas of land identified to be at risk from flooding from rivers and sea. They represent the undefended scenario. Table 3-1 outlines the definition of Flood Zones as per the PPG.

Table 3-1: Definition of the Flood Zones as per the Planning Practice Guidance

| Flood Zone | Definition |
|---|---|
| Zone 1 – Low probability | Land having a less than 0.1% annual probability of river or sea flooding. |
| Zone 2 – Medium probability | Land having between a 1% and 0.1% annual probability of river flooding; or land having between a 0.5% and 0.1% annual probability of sea flooding. |
| Zone 3a – High probability | Land having a 1% or greater annual probability of river flooding; or Land having a 0.5% or greater annual probability of sea. |

Flood Zones 1, 2 and 3a have been taken from the Environment Agency's **'Flood Map for Planning'** and do not take into account flood defences. As previously mentioned in Section 3.3 of this report, there is no functional floodplain/Flood Zone 3b across the entirety of the LBN due to it being defended up to and including the 0.1% AEP flood event. This is important for planning long term developments as long-term policy and funding for maintaining flood defences over the lifetime of a development may change over time.

The Flood Map for Planning is based on generalised modelling to provide an indication of flood risk. Planning is based on generalised modelling to provide an indication of flood risk. Whilst the generalised modelling is typically suitable for use on a large scale, they are not provided for specific sites or for land where the catchment of the watercourse is less than 3km$^2$.

For watercourses with smaller catchments, the Risk of Flooding from Surface Water (RoFfSW) map provides an indication of the floodplain of small watercourses and ditches. It is more accurate in upper to mid river valley locations than lower valley locations near the coast. This is because it does not represent the floodplain for small watercourses as well in topographically flat areas where the flow routes are not as well defined.

Even where more detailed models of Main Rivers have been used by the Environment Agency to inform the Flood Map for Planning, they will be largely based on remotely detected ground model data and not topographic survey.

Also, the Flood Map for Planning does not take into account surface water, sewer or groundwater flooding or the impacts of canal or reservoir failure or climate change. Hence there could still be a risk of flooding from other sources and the level of flood risk will change over time during the lifetime of a development.

For these reasons, the Flood Map for Planning is not of a resolution to be used as application evidence to provide the details of possible flooding for individual properties or sites and for any sites with watercourses on, or adjacent to the site. Accordingly, for site-specific assessments it will be necessary to perform more detailed studies in circumstances where flood risk is an issue.

## 3.5 Climate change

The Environment Agency published updated **climate change guidance** in 2019 on how allowances for climate change should be included in both strategic and site-specific FRAs. The guidance adopts a risk-based approach considering the vulnerability of the development.

In 2018 the government published new UK Climate Projections (UKCP18). The Environment Agency have used these to further update their climate change guidance for new developments with regards to updated fluvial, rainfall, and tidal allowances. The **new climate change allowances** were released in July 2021 for peak river flows, May 2022 for peak rainfall allowances, and December 2019 for sea level allowances. These should be used when undertaking a detailed Flood Risk Assessment.

To apply the climate change guidance, the following information needs to be known:

- The vulnerability of the development.
- The likely lifetime of the development – in general at least 75 years is used for commercial development (depending on the development's characteristics) and 100 years for residential, but this needs to be confirmed in an FRA.
- The River Basin in which the site is located.

**For tidal flood risk:**

- Likely depth, speed, and extent of flooding for each allowance of climate change over time considering the allowances for the relevant epoch (2020s, 2050s and 2080s).
- The 'built in' resilience measures used, for example, raised floor levels.
- The capacity or space in the development to include additional resilience measures in the future, using a 'managed adaptive' approach.

The Climate Change Act 2008 creates a legal requirement for the UK to put in place measures to adapt to climate change and to reduce carbon emissions by at least 80% below 1990 levels by 2050.

The NPPF sets out that flood risk should be managed over the lifetime of a development, taking climate change into account.

## 3.6 Flooding from rivers

### 3.6.1 Fluvial modelling

Updated fluvial modelling has been undertaken for the River Lea and River Roding as displayed in Table 3-2. This provides a more accurate representation of actual flood risk within the LBN than the Environment Agency's Flood Map for Planning, as it accounts for the presence of flood defence structures along both rivers. Further information about the models used is available in Appendix C.

Table 3-2: Details regarding the fluvial flood risk modelling used to inform this SFRA.

| Model name | Software |
|---|---|
| River Lee (2014) | ISIS-TUFLOW |
| Shonks Mill Lower Roding (2018) | ESTRY-TUFLOW |

The following Annual Exceedance Probability events for the defended fluvial scenarios have been assessed:

- 3.3% AEP (1 in 30-yr) defended fluvial*
- 1% AEP (1 in 100-yr) defended fluvial
- 0.5% AEP (1 in 200-yr) defended fluvial**
- 0.1% AEP (1 in 1000-yr) defended fluvial

*Areas within the modelled 3.3% AEP defended extent should be considered as Flood Zone 3b. Where modelled results are not available, Flood Zone 3a should be considered as a proxy for Flood Zone 3b (the functional floodplain) is defined as land having a 3.3% or greater annual probability of flooding, with any existing flood risk management

infrastructure operating effectively, or land that is designed to flood (such as a flood attenuation scheme), even if it would only flood in more extreme events.

**The 0.5% AEP event was assessed for this SFRA due to the Rivers Lea and Roding being tidally influenced.

### 3.6.2 Impacts of climate change on fluvial flood risk

Climate change is expected to increase the peak flows of rivers, meaning that flows which were previously thought to be extreme will now be considered far more possible. Areas benefiting from flood defences will find the standard of protection changes over time with overtopping of defences more likely unless they are upgraded.

Peak river flow climate change allowances developed by the Environment Agency are divided into a series of Management Catchments, two of which fall within the LBN. The London Management Catchment covers land to the west and south of the LBN, including the Royal Docks (Table 3-3). The Roding, Beam and Ingrebourne Management Catchment is located to the east of the LBN and includes Beckton, Custom House and Manor Park (

Table 3-4). This information provides a strategic assessment of climate change risk; developers should undertake detailed modelling of climate change allowances as part of a site-specific FRA, following the **Climate Change Guidance** set out by the Environment Agency.

Table 3-3: Peak river flow allowances for the London Management Catchment in the London Borough of Newham

| Management Catchment | Allowance category | Total potential change anticipated for '2020s' (2015 to 39) | Total potential change anticipated for '2050s' (2040 to 2069) | Total potential change anticipated for '2080s' (2070 to 2115) |
|---|---|---|---|---|
| London | Upper end | 26% | 30% | 54% |
| | Higher central | 14% | 14% | 27% |
| | Central | 10% | 7% | 17% |

Table 3-4: Peak river flow allowances for the Roding, Beam and Ingrebourne Management Catchment in the London Borough of Newham

| Management Catchment | Allowance category | Total potential change anticipated for '2020s' (2015 to 39) | Total potential change anticipated for '2050s' (2040 to 2069) | Total potential change anticipated for '2080s' (2070 to 2115) |
|---|---|---|---|---|
| Roding, Beam and Ingrebourne | Upper end | 31% | 38% | 64% |
| | Higher central | 20% | 21% | 36% |
| | Central | 15% | 14% | 26% |

### 3.6.3 Climate change uplifts for fluvial hydraulic modelling

Representation of climate change within this SFRA was agreed with the EA. The following model outputs were used to represent climate change:

- River Lee model (2014) – 3.3%, 1% and 0.5% AEP events (+17%, +27%, +54%).

Conservative proxy donor events have been used for some River Lee climate change events due to model instabilities. This is further discussed in Appendix C

- Lower Roding (2018 and JBA 2017 extension) model – 3.3%, 1% and 0.5% AEP events (+26%, 36%, 64%).

It should be noted that both the River Lea and River Roding hydraulic models are in the process of being updated by the EA and developers should contact the EA to see if these are available when assessing flood risk to sites.

The London, and Roding, Beam and Ingrebourne Management Catchments peak river flow allowances have been applied to the River Lea and Lower Roding, respectively.

## 3.7 Flooding from the sea

### 3.7.1 Tidal modelling

Flood defence structures along the tidal Thames are designed to protect to a 0.1% AEP flood event, so during the defended scenario there is no out of bank flooding from the Thames (including and up to the 0.1% AEP event). Therefore, modelling of the defended scenario for the River Thames has not been undertaken for this study.

The Environment Agency's **Reduction in Risk of Flooding from Rivers and Sea due to Defences** dataset extent can be used to visualise the area of the LBN located within this extent. The dataset shows the area where there is a reduction in risk of flooding from rivers and sea due to flood defences, taking into account the condition they are in.

### 3.7.2 Impacts of climate change on tidal flood risk

For tidal flooding, allowances are given in the form of total sea level rise based on a 1981 to 2000 baseline. Table 3-5 shows the relevant sea level allowances for the management catchments considered in this study.

Table 3-5: Sea level allowances in the Thames Area

| River Basin district | Cumulative Rise to 2125 (m) |
|---|---|
| Higher Central | 1.2 |
| Upper end | 1.6 |
| H++ | 1.9 |

The Thames Tidal Breach modelling has been used within this SFRA to assess site's residual risk of flooding from the tidal river Thames. The 'into the future' epoch modelled

events have been assessed to understand the impact of climate change on tidal breaches within the LBN.

Climate change adaptation along the Thames Estuary is outlined in the TE2100 plan, which details how the risk of climate change will be managed.

For any development within close proximity to the Thames Estuary and within the area covering the City of London Riverside Strategy that benefits from defences located within the site, developers should seek and follow advice from the TE2100 plan as part of a site-specific FRA. Councils should ensure that riverside development incorporates future flood defence requirements. Throughout much of the estuary, flood walls and embankments will need to be a metre or more higher by 2100. It is also noted that any existing development needs to include Thames Estuary 2100 height and deadline requirements for upgrading flood defences (by 2030).

## 3.8 Surface water flooding

### 3.8.1 Present day Risk of Flooding from Surface Water (RoFfSW)

Mapping of surface water flood risk in the LBN has been taken from the Environment Agency's Risk of Flooding from Surface Water (RoFfSW) mapping. Surface water flood risk is subdivided into the following four categories:

- **High**: An area has a chance of flooding greater than 3.3% AEP (1 in 30-yr) each year.
- **Medium**: An area has a chance of flooding between 1% AEP (1 in 100-yr) and 3.3% AEP (1 in 30-yr) each year.
- **Low**: An area has a chance of flooding between 0.1% AEP (1 in 1,000-yr) and 1% AEP (1 in 100-yr) each year.
- **Very Low**: An area has a chance of flooding of less than 0.1% AEP (1 in 1,000-yr) each year.

The results should be used for high-level assessments. If a particular site is indicated in the Environment Agency mapping to be at risk from surface water flooding, a more detailed assessment should be required to illustrate the flood risk more accurately at a site-specific scale. Such an assessment should use the RoFfSW in partnership with other sources of local flooding information to confirm the presence of a surface water risk at that particular location.

Detailed modelling based on site survey will be necessary where there is a significant risk of surface water flooding. It is the intention that the Environment Agency will prepare updated and improved surface water mapping in the course of updating the National Flood Risk Assessment (NaFRA). It is anticipated that this data will be available in 2024 and at that time it is recommended that the surface water risk assessment is reviewed. It is not anticipated that the updated mapping will fundamentally change the locations identified to be at risk from surface water flooding, but the improved analysis techniques will reduce some of the uncertainties associated with the assessment.

### 3.8.2 Present day surface water modelling

The LBN Council has also provided surface water models that cover three extents within the LBN. The models (simulated using InfoWorks ICM software) listed below were run to produce the following scenarios:

- Little Ilford: 3.3%, 1% and 0.1% AEP events
- Silvertown: 3.3%, 1% and 0.1% AEP events
- Newham Central: 3.3%, 1% and 0.1% AEP events

### 3.8.3 Impacts of climate change on surface water flood risk

Climate change is predicted to result in wetter winters and increased summer storm intensity in the future. This increased rainfall intensity will affect land and urban drainage systems, resulting in surface water flooding, due to the increased volume of water entering the systems. The potential impacts of surface water plus climate change will likely need to be considered at site-specific assessment stage.

In May 2022, the Environment Agency updated the surface water climate change projections, which are now based on management catchments – the London Management Catchment and the Roding, Beam and Ingrebourne Management Catchment. Table 3-6 shows the peak rainfall intensity allowances that apply in LBN for both management catchments when considering surface water flood risk. Both the central and upper end allowances should be considered to understand the range of impact.

Table 3-6: Peak rainfall intensity allowance in the London Management Catchment and the Roding, Beam and Ingrebourne Management Catchment

| Allowance category | Total potential change anticipated for '2050s' (2040 to 69) | Total potential change anticipated for '2070s' (2061 to 2125) |
|---|---|---|
| 3.3% AEP Central | 20% | 20% |
| 3.3% AEP Upper end | 35% | 35% |
| 1% AEP Central | 20% | 25% |
| 1% AEP Upper end | 40% | 40% |

### 3.8.4 Climate change uplifts for surface water hydraulic modelling

As part of this SFRA, the Little Ilford, Newham Central, and Silvertown ICM models were run for the 3.3% and 1% AEP events for the 2070s epoch.

### 3.8.5 Critical Drainage Areas

A critical drainage area (CDA) is defined by the **Drain London Tier 2 Technical Specification** as *"a discrete geographic area (usually a hydrological catchment) where multiple and interlinked sources of flood risk (surface water, groundwater, sewer and/or*

*river) often cause flooding in a Flood Risk Area during severe weather thereby affecting people, property or local infrastructure."* These can cover wide areas within both rural and urban environments and are typically where manmade drainage infrastructure has been identified as at critical risk of failure, resulting in flooding. An absence of CDAs does not mean there are no areas with potential drainage problems.

There are several areas within the LBN that are in a CDA. These are most notably situated in the north and centre of the Borough, where the majority follow the routes of railway lines. Elsewhere, there are CDAs along roads and areas where surface water is impounded behind an embankment.

## 3.9 Sewer flooding

Historical incidents of flooding are detailed by Thames Water through their Sewer Flood Risk Register. The sewer flooding register records incidents of flooding relating to public foul, combined or surface water sewers, and identifies where properties have suffered flooding.

Thames Water is the water company responsible for the management of the drainage networks across the LBN. Thames Water provided details of 7,138 recorded incidents of sewer flooding which have occurred in the Borough. These were provided using four-digit postcode areas for the period between January 1957 and December 2022.

Records show sewer flooding is widespread across the Borough, with recorded incidents on 3,057 separate dates and 25 different postcodes. The most incidents occurred on 12 September 1989, with 441 separate incidents reported. There are spatial clusters of sewer flooding in East Ham, Manor Park and Forest Gate. Some of these spatial clusters (e.g. East Ham) correspond with the CDAs (Section 3.8.5) although there are notable exceptions (e.g. the Royal Docks). For further information on sewer flooding within the LBN, please refer to Section 5.6 of the Level 1 SFRA which includes Figure 5-7, a map displaying the aforementioned recorded sewer flooding incidents.

### 3.9.1 Impact of climate change on sewers

Surface water and fluvial flooding with climate change have the potential to impact the sewerage system, so careful management of these is needed for development. Due to differing ages of settlements, there will be drainage systems consisting of different types of sewers. Increasing pressures from climate change, urban creep and infill development could impact the performance of the sewerage system.

## 3.10 Groundwater

In comparison to fluvial flooding, current understanding of the risks posed by groundwater flooding is limited and mapping of flood risk from groundwater sources is in its infancy. Groundwater level monitoring records are available for areas on Major Aquifers; however, for lower lying valley areas, which can be susceptible to groundwater flooding caused by a

high-water table in mudstones, clays, and superficial alluvial deposits, very few records are available. Additionally, there is an increased risk of groundwater flooding where long reaches of watercourse are culverted as a result of elevated groundwater levels not being able to naturally pass into watercourses and be conveyed to less susceptible areas.

To assess groundwater flooding emergence within the LBN, the Groundwater Flood Map 5m Resolution GW5 V2.2 (GeoSmart licensed product) has been provided by the LBN Council. The GeoSmart Groundwater Flood Risk Map shows areas of potential groundwater emergence during a 1% AEP flood event, and highlights areas where there is sufficient evidence to suggest that flooding may occur. This data cannot form part of the Sequential Test as it is not directly comparable to other datasets (e.g. Flood Zones), and therefore cannot categorise an area as high, medium or low risk on its own. The map should be interpreted as an initial indicative tool to assess groundwater flood risk at preliminary stages of planning/site allocation.

The V2.2 model categorises four different features classes (1-4), as set out in the GeoSmart Groundwater Flood Risk Map User guide. A detailed description of each individual class is detailed below in Table 3-7.

Table 3-7: GeoSmart groundwater risk screening categories

| Risk Class | Description |
|---|---|
| Class 1: High | There is a high risk of groundwater flooding in this area with a chance of greater than 1% annual probability of occurrence or more frequent. |
| Class 2: Moderate | There is a moderate risk of groundwater flooding in this area with a chance of greater than 1% annual probability of occurrence. |
| Class 3: Low | There is a low risk of groundwater flooding in this area with a chance of greater than 1% annual probability of occurrence. |
| Class 4: Negligible | There is a negligible risk of groundwater flooding in this area and any groundwater flooding incidence has a chance of less than 1% annual probability of occurrence. |

There have been several records attributed to groundwater flooding within the LBN. For further details of these incidents, please refer to Section 5.7.1 in the Level 1 report.

### 3.10.1 Impact of climate change on groundwater flooding

The impact of climate change is uncertain for groundwater flooding associated with rivers and land catchments and those watercourses where groundwater has a large influence on winter flood flows. There is no technical modelling data available to assess climate change impacts on groundwater. It would depend on the flooding mechanism, historic evidence of known flooding and geological characteristics, for example prolonged rainfall in a chalk catchment. Flood risk could increase when groundwater is already high or emerged, causing additional overland flow paths or areas of still ponding.

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

In the coastal floodplain it is possible that the rise in mean sea level could affect the influence of groundwater and affect the capacity of watercourses and drainage systems. In circumstances where such effects could be material over the lifetime of development, more detailed assessment should be performed to identify and address any matters that could affect the proposed development.

## 3.11 Reservoirs

The risk of inundation due to reservoir breach or failure of reservoirs within the area has been assessed using the **Environment Agency's Risk of Flooding from Reservoirs dataset**.

This dataset displays a prediction of the credible worst-case scenario. The dataset gives no indication of the likelihood or probability of reservoir flooding. The Reservoir Flood Maps do not describe the risk of flooding (simply a credible worst case) and data includes layers for:

- 'Dry days' – Individual flood extents for all large, raised reservoirs in the event that they were to fail and release the water held on a "dry day" when local rivers are at normal levels.
- 'Wet days' – Individual flood extents for all large, raised reservoirs in the event that they were to fail and release the water held on a "wet day". A wet day is assumed to be a failure at the same time as experiencing a river flood with a 1 in 1000 chance of occurring in any year.
- 'Fluvial contribution' – The extent of river flooding added to the reservoir model to determine the impacts of failure on a wet-day.

## 3.12 Residual risk

The residual flood risk to sites is identified as where potential blockages or overtopping/ breach of defences could result in the inundation of a site, with the sudden release of water with little warning.

Potential culvert blockages that may affect a site were identified on OS Mapping and the Environment Agency's Detailed River Network Layer to determine where watercourses flow into culverts or through structures (i.e. bridges) in the vicinity of the sites. Any potential locations were flagged in the site summary tables. These will need to be considered by the developer as part of a site-specific Flood Risk Assessment.

### 3.12.1 Breach modelling

Residual risk from breaches to flood defences, whilst rare, needs to be considered in Flood Risk Assessments. Considerations include the location of a breach, when it would occur and for how long, the depth of the breach (toe level), the loadings on the defence and the potential for multiple breaches. There are currently no national standards for breach

assessments and there are various ways of assessing breaches using hydraulic modelling. Work is currently being undertaken by the Environment Agency to collate and standardise these methodologies. It is recommended that the Environment Agency are consulted if a development site is located near to a flood defence to understand the level of assessment required and to agree the approach for the breach assessment, if required.

Parts of the LBN are potentially vulnerable to flooding of this type given the low-lying topography and the reliance on flood defences.

The EA's Thames Estuary Downriver and Upriver Breach Assessment modelling has been assessed as part of this SFRA to understand the risk of potential tidal breaches to the proposed development sites. However, should these sites be taken forward, detailed modelling should be undertaken to inform the flood risk assessments. The following breach scenarios provided by the EA were modelled for current and future conditions of the Thames:

- Thames Tidal Downriver Breach Inundation Modelling (2018):
    - 2005 epoch 0.5% & 0.1% AEP events
    - 2115 epoch 0.5% & 0.1% AEP events
- Thames Tidal Upriver Breach Inundation Modelling (2017):
    - 2005 epoch 0.5% AEP event
    - 2100 epoch 0.5% AEP event

### 3.13 Adapting to climate change

The NPPG Climate Change guidance contains information and guidance for how to identify suitable mitigation and adaptation measures in the planning process to address the impacts of climate change. Examples of adapting to climate change include:

- Considering future climate risks when allocating development sites to ensure risks are understood over the development's lifetime.
- Considering the impact of and promoting design responses to flood risk and coastal change for the lifetime of the development.
- Considering availability of water and water infrastructure for the lifetime of the development and design responses to promote water efficiency and protect water quality.
- Promoting adaptation approaches in design policies for developments and the public realm for example by building in flexibility to allow future adaptation if needed, such as setting new development back from watercourses; and
- Identifying no or low-cost responses to climate risks that also deliver other benefits, such as green infrastructure that improves adaptation, biodiversity and amenity, for example by leaving areas shown to be at risk of flooding as public open space.
- Considering the standard of protection of defences and sites for future development, in relation to sensitivity to climate change. The Council and developers will need to work with RMAs and use the SFRA datasets to understand whether development is

affordable or deliverable. Locating development in such areas of risk may not be a sustainable long-term option.

It is recommended that the differences in flood extents from climate change are compared by the Council when allocating sites, to understand how much additional risk there could be, where this risk is in the site, whether the increase is marginal or activates new flow paths, whether it affects access/ egress and how much land could still be developable overall.

### 3.14 Depth, velocity and hazard to people

The Level 2 assessment seeks to map the probable depth and velocity of flooding as well as the hazard to people during the defended fluvial 1% AEP event plus an allowance for climate change. The 1% AEP plus climate change flood event has been investigated in further detail because the Level 2 assessment helps inform the Exception Test and usually flood mitigation measures and access/ egress requirements focus on flood events lower than the 0.1% AEP event (e.g. the 1% AEP plus climate change event).

Where detailed model outputs were available, i.e. along the River Lea and Lower Roding, the 1% AEP plus climate change depth, velocity and hazard data has been used. This data is only present where models have a 2D element, representing the floodplain in detail. In the absence of detailed hydraulic models (or models with detailed 1D-2D outputs), the Flood Map for Planning dataset has been used, as well as the Risk of Flooding from Surface Water dataset. The depth, hazard, and velocity of the 1% AEP (100-year) surface water flood event has also been mapped and considered in this assessment. Hazard to people has been calculated using the below formula as suggested in Defra's FD2321/TR2 "Flood Risk to People." The different hazard categories are shown in Table 3-8. Developers should also test the impact of climate change depths, velocities, and hazard on the site, at Flood Risk Assessment stage.

Table 3-8: Defra's FD2321/TR1 "Flood Risks to People" classifications

| Degree of Flood Hazard | Flood Hazard Rating | Description |
|---|---|---|
| Very Low Hazard | < 0.75 | Caution *"Flood zone with shallow flowing water or deep standing water"* |
| Moderate | 0.75 – 1.25 | Dangerous for some (i.e. children) *"Danger: flood zone with deep or fast flowing water"* |
| Significant | 1.25 – 2.00 | Danger for most people *"Danger: flood zone with deep fast flowing water"* |
| Extreme | >2.00 | Danger for all *"Extreme danger: flood zone with deep fast flowing water"* |

*Please note these hazard ratings are due to be updated soon. These classifications are based on the guidance of TR1.*

As part of a site-specific FRA, developers will need to undertake more detailed hydrological and hydraulic assessments of the watercourses to verify flood depth, velocity and hazard based on the relevant 1% AEP plus climate change event, using the relevant climate change allowance based on the type of development and its associated vulnerability

classification. Not all this information is known at the strategic scale and the level of resolution may not be appropriate to enable site scale assessment of proposed development schemes.

### 3.15 Note on SuDS suitability

The hydraulic and geological characteristics of each site were assessed to determine the factors that potentially constrain schemes for surface water management. This assessment is designed to inform the early-stage site planning process and is not intended to replace site-specific detailed drainage assessments.

The assessment is based on catchment characteristics and additional datasets such as the GeoSmart Groundwater Flood Risk Map and British Geological Survey (BGS) Soil maps of England and Wales which allow for a basic assessment of the soil characteristics on a site-by-site basis. LIDAR data was used as a basis for determining the topography and average slope across each development site. Other datasets were used to determine other factors. These datasets include:

- Historic landfill sites
- Groundwater Source Protection Zones
- Detailed River Network
- The Flood Map for Planning

This data was then collated to provide an indication of particular groups of SuDS systems which might be suitable at a site. SuDS techniques were categorised into five main groups, as shown in Table 3-9. This assessment should not be used as a definitive guide as to which SuDS would be suitable but used as an indicative guide of general suitability. Further site-specific investigation should be conducted to determine what SuDS techniques could be used on a particular development, informed by detailed ground investigations.

Table 3-9: Summary of SuDS categories

| SuDS Type | Technique |
|---|---|
| Source Controls | Green Roof, Rainwater Harvesting, Pervious Pavements, Rain Gardens |
| Infiltration | Infiltration Trench, Infiltration Basin, Soakaway |
| Detention | Pond, Wetland, Subsurface Storage, Shallow Wetland, Extended Detention Wetland, Pocket Wetland, Submerged Gravel Wetland, Wetland Channel, Detention Basin |
| Filtration | Surface Sand filter, Sub-Surface Sand Filter, Perimeter Sand Filter, Bioretention, Filter Strip, Filter Trench |
| Conveyance | Dry Swale, Under-drained Swale, Wet Swale |

The suitability of each SuDS type for the site options has been described in the summary tables, where applicable. The assessment of suitability is broadscale and indicative only;

more detailed assessments should be carried out during the site planning stage to confirm the feasibility of different types of SuDS.

Further SuDS guidance and design requirements for the LBN are available in Section 2.6.

# 4 Level 2 Assessment Methodology

*This chapter outlines how sites were screened against flood risk datasets to determine which sites needed a Level 2 assessment. It also identifies other sites at lower risk with general recommendations for developers.*

## 4.1 Site screening

The London Borough of Newham Council provided 61 sites for assessment. These sites were screened against a suite of available flood risk information and spatial data to provide a summary of risk to each site, including:

- The proportion of the site in each Flood Zone derived from the Level 1 SFRA, which includes modelling data
- Whether the site is shown to be at risk from surface water flooding in either the RoFfSW dataset or modelling data and, if so, the lowest return period from which the site is at surface water flood risk
- The proportion of the site in the reservoir 'wet' and 'dry' day extents

The screening was undertaken using JBA's in-house software called "FRISM". FRISM is an internal JBA GIS package that computes a range of flood risk metrics based on flood and receptor datasets.

The results of the screening provide a quick and efficient way of identifying sites that are likely to require a Level 2 Assessment, assisting the LBN Council with Sequential Test decision-making so that flood risk is taken into account when considering allocation options.

The screening also provides an opportunity to identify sites which may show to be 100% in Flood Zone 1, but upon visual inspection in GIS, have an ordinary watercourse flowing through or adjacent to them but for which no Flood Zone information is currently available.

*Note: although there are no Flood Zone maps available for these watercourses, it does not mean the watercourse does not pose a risk, it just means no modelling has yet been undertaken to identify the risk.*

The Flood Zones are not provided for specific sites or land where the catchment of the watercourse falls below 3km$^2$. For this reason, the Flood Zones are not of a resolution to be used as application evidence to provide the details of possible flooding for individual properties or sites and for any sites with watercourses on, or adjacent to the site. The Risk of Flooding from Surface Water has been used in these cases because this provides a reasonable representation of the floodplain of such watercourses to use for a strategic assessment.

## 4.2 Sites taken forward to a Level 2 assessment

Out of the 61 sites provided by LBN Council, 44 sites were carried forward to a Level 2 assessment.

A Red-Amber-Green system was applied to the sites on the basis, that:

- Red sites needed a Level 2 assessment and have significant obstacles or challenges for development which will need consideration going forward for development. These sites will need the Exception test to show that the site can be developed safely from a flood risk perspective.
- Amber sites did not need a Level 2 assessment but are flagged in this report for developer considerations (recommendations provided in Section 4.3), but these are likely to be able to be addressed at the planning application stage. These sites are included within this report as they may have some surface water issues relative to access and egress to the site.
- Green sites that had no significant obstacles for development. However, it is noted sites may need an FRA and drainage strategy depending on the location of the site.

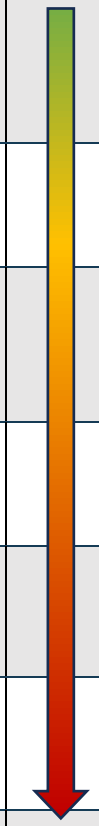
In order to categorise the sites in this system, a flood risk criteria was applied to the ranking assessment as shown in Table 4-1. This categorisation is tailored to Newham and based on professional judgement and categories were agreed with LBN. It is noted that Newham is defended up to and including the 0.1% AEP tidal event from the Thames. Groundwater flood risk should be considered as part of the site-specific assessments, but there is no equivalent national mapping or datasets to directly compare with fluvial/tidal/pluvial risk for allocation purposes. Rather, once sites have been assessed for other sources, a groundwater assessment should be undertaken. The same also applies to reservoir flooding.

It is noted that there are some sites that may be upgraded or downgraded in this assessment. For example, a site may show as Amber, but if there was an area of deep ponding, a prominent flow route bisecting a site, immediate constraints to site access at the boundary, potential for highly vulnerable types of development to occupy a site, it may be moved up to the Red category.

For other sites with less significant but still noteworthy surface water issues, these have been highlighted in Table 4-2 and the LLFA expect the developer to take these into account at an early stage when planning the form and layout of the site, the surface water drainage system and any surface water mitigation measures that may be necessary.

Appendix B provides a summary of the sites which have been taken forward to the Level 2 assessment on this basis.

Table 4-1: Site categories used for site flood risk assessment

| Category | | Site Table required? | Undefended Fluvial/Tidal Risk | Modelled Defended Fluvial Risk* | Surface Water Risk** | Residual Risk (Tidal Breach)requirement for Flood Warning and Evacuation Plan |
|---|---|---|---|---|---|---|
| Green |  | No site table required - no significant flood risk. Most preferrable for allocation. | Site is within Flood Zone 1 | None/negligible | 1% AEP event plus 40% cc RoFfSW extent covers <15% of the site area, likely to be manageable with through site layout and SuDS | None/negligible |
| Amber | | No site table required - but mentioned in L2 report, risk can be managed at FRA stage | | | 1% AEP event plus 40% cc RoFfSW extent covers <25% of the site area, likely to be manageable with through site layout and SuDS | May be necessary depending on the nature or location of the risk |
| Amber | | | Site is mostly within Flood Zone 1 and <15% of site in Flood Zone 2 | | 1% AEP event plus 40% cc RoFfSW extent covers <15% of the site area, likely to be manageable with through site layout and SuDS | |
| Red | | Site table required - some flood risk, some obstacles for development | Site is within Flood Zone 1 | 1% AEP plus central cc allowance extent covers <25% of site area | 1% AEP event plus 40% cc RoFfSW extent covers <15% of the site area, likely to be manageable with through site layout and SuDS | Should demonstrate that the site can be safely evacuated in the event of a breach or overtopping of defences during the 0.5% or 0.1% AEP event in the present day and into the future epoch, whichever is greater |
| Red | | | Site is within Flood Zone 2 and 3 | 1% AEP plus central cc allowance extent covers <20% of site area | 1% AEP event plus 40% cc RoFfSW extent covers <15% to 25% of the site area, likely to be manageable with through site layout and SuDS | |
| Red | | Site table required - significant flood risk and obstacles for development | Site is within Flood Zone 2 and 3 | 1% AEP plus central cc allowance extent covers >25% to 40% of the site area | 1% AEP event plus 40% cc RoFfSW extent covers >25% to 40% of the site area, potential to be manageable through SuDS | |
| Red | | | | 1% AEP plus central cc allowance extent covers >40% of the site area | 1% AEP event plus 40% cc RoFfSW extent covers >40% of the site area | |

*Fluvial flood risk applies to the River Lea and Roding models only. This table is based on the Central climate change allowances for residential development, which is classified as 'More Vulnerable' development. This assessment of climate change would change to the Higher Central allowance if the development included 'Essential Infrastructure'. It is noted that the River Lea and Roding are in different management catchments, so have different peak river flow climate change allowances.

**Surface water assessment requires the Upper End peak rainfall intensity climate change allowance. In this case for residential development for the 2070s epoch, the 1% AEP plus 40% climate change allowance is the design event.

### 4.3 Recommendations for sites not taken forward to a Level 2 assessment

The 'amber' sites identified as having some challenges to development, but not requiring a Level 2 assessment, are shown in Table 4-2 below. The risk posed to these sites is from surface water flooding (or an ordinary watercourse that does not present in the EA's Flood Zones due to catchment size). Although not used to categorise sites as per Table 4-1. These sites also have some reservoir flooding and groundwater flooding.

None of these sites are at risk of fluvial flooding from the Rivers Lea or Roding, except for Bridgewater Road. This flood risk is detailed in Table 4-2.

Table 4-2: Sites flagged at lower flood risk

| Site name | % of site in RoFfSW 3.3% AEP extent | % of site in RoFfSW 1% AEP extent | % of site in RoFfSW 0.1% AEP extent | % of site in 'Dry Day' reservoir extent | % of site in 'Wet Day' reservoir extent | Geosmart Groundwater flood risk |
|---|---|---|---|---|---|---|
| Dulcia Mills | 5.0 | 5.0 | 7.8 | 0.0 | 27.2 | Moderate |
| Queen's Market | 2.8 | 6.3 | 10.3 | 0.0 | 0.0 | Negligible |
| Grove Crescent | 0.0 | 0.0 | 2.5 | 1.3 | 2.8 | Moderate |
| Esk Road | 0.0 | 0.0 | 6.7 | 0.0 | 98.7 | Moderate |
| Balaam Leisure Centre | 0.0 | 0.7 | 11.8 | 0.0 | 99.9 | Moderate |
| Rear of 30-34 Plashet Grove | 0.0 | 0.0 | 24.2 | 0.0 | 0.0 | Negligible |

| Site name | % of site in RoFfSW 3.3% AEP extent | % of site in RoFfSW 1% AEP extent | % of site in RoFfSW 0.1% AEP extent | % of site in 'Dry Day' reservoir extent | % of site in 'Wet Day' reservoir extent | Geosmart Groundwater flood risk |
|---|---|---|---|---|---|---|
| East Ham Industrial Estate 2 | 0.8 | 2.3 | 18.4 | 0.0 | 0.0 | Negligible |
| Bridgewater Road | 0.1 | 0.3 | 0.5 | 5.7 | 10.4 | Negligible |
| Alpine Way | 1.4 | 4.0 | 12.5 | 8.7 | 96.7 | Negligible |

All the sites listed in Table 4-2 are at minor surface water risk. Access and egress may be impacted in the 3.3%, 1% and 0.1% AEP surface water events. Safe access and egress must be demonstrated in the 1% AEP surface water and fluvial events, including an allowance for climate change. Raising of access routes should not impede surface water flows.

Although East Ham Industrial Estate 2 is at high risk of surface water flooding during the 0.1% AEP event, this risk may not be accurately represented by the EA's RoFfSW dataset due to the impoundment of water beneath the railway line.

If flows are likely to limit access/egress to the sites, this should be considered further as part of a site-specific flood-risk assessment. Developers will need to demonstrate safe access and egress is possible during the 1% AEP surface water event, including an allowance for climate change.

All sites that are affected by significant flooding during the 0.1% AEP surface water event have impermeable surfaces and areas of ponding. Where proposed development results in a change in building footprint, the developer should ensure that it does not impact upon the ability of the floodplain to store or convey water and, due to strict SuDS measures that will be put in place, seek opportunities to provide floodplain betterment.

Dulcia Mills, Esk Road, Balaam Leisure Centre and Bridgewater Road are all at high risk of reservoir flooding during the 'Wet Day' event. Despite the risk being residual, in the very unlikely event that the reservoirs fail, it is predicted that there is a risk to life. Developers will need to produce flood warning and evacuation plans for these sites in consultation with the LPA emergency planning team.

Dulcia Mills, Grove Crescent, Esk Road and Balaam Leisure Centre are all at moderate risk of groundwater flooding. There will be a significant possibility that incidence of groundwater flooding could lead to damage to property or harm to other sensitive receptors at, or near, these locations. There may also be basement flooding, but flooding should pose no significant risk to life. Further consideration of the local level of risk and mitigation, by a suitably qualified professional, is recommended in consultation with the LPA. This will

impact which SuDS are appropriate for the sites, for example, liners will be needed on filtration, detention and conveyance SuDS to prevent the egress of groundwater.

Bridgewater Road is also at risk from several other sources of flooding which are detailed in Table 4-3.

Table 4-3: Other flood risks to Bridgewater Road

| % of site in FMfP Flood Zone 3 | % of site in FMfP Flood Zone 2 | % of site in 0.5% (2005) Thames Upriver breach extent | % of site in 0.5% (2100) Thames Upriver breach extent | % of site in 0.1% AEP River Lea extent | Nature of low flood risk/ considerations for the developer |
|---|---|---|---|---|---|
| 4 | 4 | 1.1 | 2.3 | 4.4 | Development should be steered away from areas of the site that are within Flood Zones 2 and 3. The site is at residual risk if the Thames were to breach its banks and defences were to fail. The risk posed by all these sources of flooding remain along the boundaries of the site, mainly affecting access and egress routes. |

As well as the flood risks to the site listed in Table 4-2, Alpine Way is at risk from other sources which are detailed in Table 4-4.

Table 4-4: Other flood risks to Alpine Way

| % of site in FMfP flood Zone 3 | % of site in FMfP Flood Zone 2 | % of site in 0.5% (2115) Thames Downriver tidal breach extent | % of site in 0.1% (2115) Thames Downriver breach extent | Nature of low flood risk/ considerations for the developer |
|---|---|---|---|---|
| 7 | 12 | 6.9 | 9.7 | Development should be steered away from areas of the site that are within Flood Zones 2 and 3. The site is at residual risk if the Thames were to breach its banks and defences were to fail. The risk posed by all these sources of flooding remain along the |

| % of site in FMfP flood Zone 3 | % of site in FMfP Flood Zone 2 | % of site in 0.5% (2115) Thames Downriver tidal breach extent | % of site in 0.1% (2115) Thames Downriver breach extent | Nature of low flood risk/ considerations for the developer |
|---|---|---|---|---|
| | | | | boundaries of the site, mainly affecting access and egress routes. |

Further recommendations relating to managing the cumulative impacts of development are stated in Appendix F (Cumulative Impact Assessment) of the Level 1 SFRA and in Appendix D of this report for consideration at the site-specific Flood Risk Assessment stage.

### 4.4 Site summary tables

As part of the Level 2 SFRA, detailed site summary tables have been produced for the sites listed in Appendix B. The summary tables can be found in Appendix A.

Where available, the results from existing detailed Environment Agency hydraulic models were used in the assessment to provide depth, velocity, and hazard information. For more information on these models, please refer to sections 3.6 and 3.12 of this report.

The Environment Agency's Risk of Flooding from Surface Water mapping has also had Central and Upper End climate change uplifts applied to it in order to indicate the future risk of surface water flooding during the 3.3% AEP and 1% AEP events.

Using the model information combined with the Flood Zones, climate change, Risk of Flooding from Surface Water (RoFfSW) extents and Reservoir mapping, detailed site summary tables have been produced for the site options (see Appendix A). Each table sets out the following information:

- Basic site information
- Location of site in the catchment
- Area, type of site, current land use (greenfield/ brownfield), proposed site use
- Sources of flood risk
- Existing drainage features
- Fluvial – proportion of site at risk including description from FMfP mapping and modelling including extent, depth, velocity and hazard information
- Surface Water – proportion of site at risk including description from RoFfSW mapping/modelling including extent, depth, velocity and hazard information
- Reservoir
- Flood History
- Flood risk management infrastructure

- Description of residual risk including breach of defences, specifically the River Thames Upriver and Downriver breach assessment models including extent, depth, velocity and hazard information
- Emergency Planning
    i. Flood Warning Areas
    ii. Access and egress
- Climate change
- Summary of climate change allowances and increase in flood extent compared to Flood Zones/modelling for fluvial, surface water, and breach of the Thames defences
- Requirements for drainage control and impact mitigation
- Broadscale assessment of possible SuDS to provide indicative surface water drainage advice for each site assessed for the Level 2 SFRA.
    i. Groundwater Source Protection Zone
    ii. Historic Landfill Site
- NPPF Planning implications
    i. Exception Test requirements
- Requirements and guidance for site-specific FRA (including consideration of opportunities for strategic flood risk solutions to reduce flood risk)
- Key messages – summarising considerations for the Exception Test to be passed
- Mapping information – description of data sources for the following mapped outputs:
    i. Flood Zones
    ii. Climate change
    iii. Fluvial depth, velocity and hazard mapping
    iv. Surface water
    v. Surface water depth, velocity and hazard mapping

### 4.4.1 Static mapping

To accompany each site summary table, there is a static map, with all the mapped flood risk outputs per site.

Flood risk information in the static maps include:

- Site boundary and Council boundary
- Title bar showing site name, name of mapped dataset and legend
- Each legend contains:
    - Site boundary,
    - Main River, and;
    - Dataset information.
- Mapped datasets:
    - EA's Flood Warning and Flood Alert Area
    - Geosmart Groundwater
    - EA's Recorded Flood Outlines

- Thames Tidal Breach Inundation Modelling (Upriver and Downriver) with extent, depth, velocity and hazard
- Topography
- EA's Flood Map for Planning and Reduction in Risk Due to Defences
- EA's ROFfSW with extent, depth, velocity and hazard
- EA's ROFfSW with climate change uplifts with extent, depth, velocity and hazard
- Surface Water ICM models (Silvertown, Little Ilford, Newham Central) with extent, depth, velocity and hazard
- Surface Water ICM models (Silvertown, Little Ilford, Newham Central) with climate change uplifts with extent, depth, velocity and hazard
- Fluvial modelling – River Roding and River Lee with extent, depth, velocity and hazard
- Fluvial modelling – River Roding and River Lee (with climate change uplifts) with extent, depth, velocity and hazard
- EA's Reservoir Inundation Mapping – 'wet day' and 'dry day'
- Flood Defences with standardised attributes

# 5 Flood Risk Management Requirements for Developers

*This chapter provides guidance on site-specific Flood Risk Assessments (FRAs). These are carried out by (or on behalf of) developers to assess flood risk to and from a site. They are submitted with Planning Applications and should demonstrate how flood risk will be managed over the development's lifetime, considering climate change and vulnerability of users.*

## 5.1 Introduction

The report provides a strategic assessment of flood risk in the London Borough of Newham. Prior to any construction or development, site-specific assessments will need to be undertaken so all forms of flood risk and any defences at a site are considered in more detail. Developers should, where required, undertake more detailed hydrological and hydraulic assessments of the watercourses to verify flood extent (including latest climate change allowances), to inform the sequential approach within the site and prove, if required, whether the Exception Test can be satisfied.

## 5.2 Principles for new developments

**Apply the Sequential and Exception Tests**

Developers should refer to the Level 1 SFRA for more information on how to consider the Sequential and Exception Tests. For allocated sites, LBN Council will need to carry out the Sequential and Exception Tests. For windfall sites, a developer must undertake the Sequential Test, which includes considering reasonable alternative sites at lower flood risk. Only if it passes the Sequential Test should the Exception Test then be applied if required. The Sequential and Exception Tests in the NPPF apply to all developments and an FRA should not be seen as an alternative to proving these tests have been met.

Developers should also apply the sequential approach to locating development within the site. The following questions should be considered:

- Can risk be avoided through substituting less vulnerable uses or by amending the site layout?
- Can it be demonstrated that less vulnerable uses for the site have been considered and reasonably discounted? and
- Can layout be varied to reduce the number of people or flood risk vulnerability or building units located in higher risk parts of the site?

**Consult with the statutory consultees at an early stage to understand their requirements**

Developers should consult with the Environment Agency, LBN Council as LLFA and Thames Water as the water and sewerage company, at an early stage to discuss flood risk

including requirements for site-specific FRAs, detailed hydraulic modelling and drainage assessment and design.

**Consider the risk from all sources of flooding and that they are using the most up to date flood risk data and guidance**

The SFRA can be used by developers to scope out what further detailed work is likely to be needed to inform a site-specific Flood Risk Assessment. At a site level, Developers will need to check before commencing on a more detailed Flood Risk Assessment that they are using the latest available datasets. Developers should apply the 2019 Environment Agency climate change guidance and ensure the development has taken into account climate change adaptation measures.

**Ensure that development does not increase flood risk elsewhere and in line with the NPPF, seeks to reduce the causes and impacts of flooding**

Chapter 8 of the Level 1 SFRA report sets out these requirements for taking a sustainable approach to surface water management. Developers should also ensure mitigation measures do not increase flood risk elsewhere and that floodplain compensation is provided where necessary.

**Ensure the development is safe for future users**

Consideration should first be given to minimising risk by planning sequentially across a site. Once risk has been minimised as far as possible, only then should mitigation measures be considered. Developers should consider both the **actual and residual risk of flooding** to the site.

Further flood mitigation measures may be needed for any developments in an area protected by flood defences, where the condition of those defences is ‘fair’ or ‘poor’, and where the standard of protection is not of the required standard.

**Enhance the natural river corridor and floodplain environment through new development**

Developments should demonstrate opportunities to create, enhance and link green assets. This can provide multiple benefits across several disciplines including flood risk and biodiversity/ ecology and may provide opportunities to use the land for an amenity and recreational purposes. Development that may adversely affect green infrastructure assets should not be permitted. Where possible, developers should identify and work with partners to explore all avenues for improving the wider river corridor environment. Developers should open up existing culverts and should not construct new culverts on site except for short lengths to allow essential infrastructure crossings.

**Consider and contribute to wider flood mitigation strategy and measures in LBN and apply the relevant local planning policy**

Wherever possible, developments should seek to help reduce flood risk in the wider area e.g., by contributing to a wider community scheme or strategy for strategic measures, such as defences or natural flood management or by contributing in-kind by mitigating wider

flood risk on a development site. Developers must demonstrate in an FRA how this has been considered at a site level.

## 5.3 Requirements for site-specific Flood Risk Assessments

### 5.3.1 When is an FRA required?

Site-specific FRAs are required in the following circumstances:

- Proposals of 1 hectare or greater in Flood Zone 1.
- Proposals for new development (including minor development such as non-residential extensions, alterations which do not increase the size of the building or householder developments and change of use) in Flood Zones 2 and 3.
- Proposals for new development (including minor development and change of use) in an area within Flood Zone 1 which has critical drainage problems (as notified to the LPA by the Environment Agency).
- Where proposed development or a change of use to a more vulnerable class may be subject to other sources of flooding.

An FRA may also be required for some specific situations:

- If the site may be at risk from the breach of a local defence (even if the site is actually in Flood Zone 1); the Environment Agency should be contacted to agree the breach assessment approach.
    - EA guidance states Finished Floor Levels of developments that will be impacted by a Thames tidal defence breach should be raised to 300mm above the 0.5% AEP plus climate change event. In the case of tidal breaches, the climate change allowance here is referring to the 2100 or 2115 epoch.
    - EA guidance also states that any defences within the planning area need to be raised to the 2100 or 2115 epoch breach flood level.
- Where evidence of historical or recent flood events have been passed to the LPA.
- In an area where surface water flood risk is a material consideration.
- If a basement property falls within a Critical Drainage Area, an FRA is required for surface water and sewer flooding.
- Land identified in an SFRA as being at increased risk in the future.

### 5.3.2 Objectives of site-specific FRAs

Site-specific FRAs should be proportionate to the degree of flood risk, as well as appropriate to the scale, nature, and location of the development. Site-specific FRAs should establish:

- whether a proposed development will be at risk of flooding, from all sources, both now and in the future, taking into account climate change
- whether a proposed development will increase flood risk elsewhere
- whether the measures proposed to deal with the effects and risks are appropriate

- the evidence, if necessary, for the local planning authority to apply the Sequential Test; and
- whether, if applicable, the development will be safe and pass the Exception Test.

FRAs should follow the approach recommended by the NPPF (and associated guidance) and guidance provided by the Environment Agency and LBN Council (as listed in Section 2.5) and Section 2 in the Level 1 SFRA report. Guidance and advice for developers on the preparation of site-specific FRAs include:

- **Standing Advice on Flood Risk** (Environment Agency);
- **Flood Risk Assessment for Planning Applications** (Environment Agency);
- **FRA Guidance Note** (Environment Agency SHWG area);
- **Site-specific Flood Risk Assessment: CHECKLIST** (NPPF PPG, Defra).

Guidance for local planning authorities for reviewing Flood Risk Assessments submitted as part of planning applications has been published by Defra in 2015 – **Flood Risk Assessment: Local Planning Authorities.**

## 5.4 Local requirements for mitigation measures

The Level 1 SFRA provides details on the following mitigation measures in Section 7.2, and should be referred to alongside this report:

- Site layout and design (7.2.3)
- Modification of ground levels (7.2.3.1)
- Raised floor levels (7.2.3.2)
- Safe access and egress (7.2.3.3)
- Development and raised defences (7.2.3.4)
- Developer contributions (7.2.3.5)
- Buffer strips (7.2.3.6)
- Making space for water (7.2.3.7)

## 5.5 Flood warning and emergency planning

Section 7.5 of the Level 1 SFRA discusses NPPF requirements and what a Flood Response Plan (also known as an Emergency Plan) will need to consider and other relevant information on emergency planning. Further information is provided by the **London Resilience Forum** in reducing flood risk from other sources.

Section 7.4 of the Level 1 SFRA discusses how to reduce flood risk from other sources, such as groundwater, surface water and sewer flooding.

## 5.6 Reservoirs

The risk of reservoir flooding is extremely low. However, there remains a residual risk to development from reservoirs and the allocation of proposed new development downstream of a reservoir can have implications for the risk designation of the reservoir. This can trigger

the need for substantive investment in the reservoir assets so that a flood can be safely passed. Accordingly, care should be taken when allocating development downstream of a reservoir so that the implications with respect to risk designation and any necessary investment to improve the safety of the asset are appropriately addressed. In addition, developers should consider the following during the planning stage:

- Developers should contact the reservoir owner for information on:
    i. the Reservoir Risk Designation
    ii. reservoir characteristics: type, dam height at outlet, area/volume, overflow location
    iii. operation: discharge rates/maximum discharge
    iv. discharge during emergency drawdown; and
    v. inspection/maintenance regime.
- The EA and Natural Resources Wales online Reservoir Flood Maps contain information on the extents, depths and velocities following a reservoir breach (note: only for those reservoirs with an impounded volume greater than 25,000 cubic metres are governed by the Reservoir Act 1975). Consideration should be given to the extent, depths and velocities shown in these online maps.
- The GOV.UK website on **Reservoirs: owner and operator requirements** (https://www.gov.uk/guidance/reservoirs-owner-and-operator-requirements) provides information on how to register reservoirs, appoint a panel engineer, produce a flood plan and report an incident.

Developers should consult the **London Resilience Forum** about emergency plans for reservoir breach.

Developers should use the above information to:

- Apply the sequential approach to locating development within the site.
- Consider the impact of a breach and overtopping, particularly for sites proposed to be located immediately downstream of a reservoir. This should consider whether there is sufficient time to respond, and whether in fact it is appropriate to place development immediately on the downstream side of a reservoir.
- Assess the potential hydraulic forces imposed by a sudden reservoir failure event and check that the proposed infrastructure fabric could withstand the structural loads.
- Develop site-specific Emergency Plans and/ or Off-site Plans if necessary and ensure that future users of the development are aware of these plans. This may need to consider emergency drawdown and the movement of people beforehand.

### 5.7 Duration and onset of flooding

The duration and onset of flooding affecting a site depends on a number of factors:

- The position of the site within a river catchment, with those at the top of a catchment likely to flood sooner than those lower down. The duration of flooding tends to be longer for areas in lower catchments.

- Upstream reservoirs in these catchments will provide some online flood storage that reduce the flood risk downstream and delays the onset of flooding. At the confluence of the larger watercourses and smaller tributaries, there may be different timings of peak flows, for example smaller tributaries would peak much earlier than the larger catchments.
- The principal source of flooding: where this is surface water, depending on the intensity and location of the rainfall, flooding could be experienced within 30 minutes of the heavy rainfall event e.g., a thunderstorm. Typically, the duration of flooding for areas at risk of surface water flooding or from flash flooding from small watercourses is short (hours rather than days).
- The preceding weather conditions prior to the flooding: wet weather lasting several weeks will lead to saturated ground. Rivers respond much quicker to rainfall in these conditions.
- Whether a site is defended, noting that if the defences were to fail, a site could be affected by very fast flowing and hazardous water within 15 minutes of a breach developing (depending on the size of the breach and the location of the site in relation to the breach), causing danger to life.
- Catchment geology, for example chalk catchments take longer to respond than typical clay catchments.

Table 5-1: Guidelines on the duration and onset of flooding

| Principal source of flooding | Duration | Onset |
|---|---|---|
| Surface water | Up to 4 hours | Within 30 minutes |
| Fluvial | 4 – 24* hours | Within 2 – 8 hours |

**Depending on where in the catchment a site is located, flooding could be rapid and flashy in the upper catchment (e.g. small tributaries), and slower responding and longer in duration in the lower catchment.*

It is recommended that a site-specific Flood Risk Assessment refines this information, based on more detailed modelling work where necessary.

# 6 Surface Water Management and SuDS

*This chapter provides guidance and advice on managing surface water runoff and flooding.*

The Level 1 SFRA summarises guidance and advice on managing surface water runoff and flooding in Section 8. Below is a guide to what is included in sections not expanded on here, for reference alongside this Level 2 SFRA:

- Section 8.1 – Role of the LLFA and LPA in surface water management
- Section 8.2 – Sustainable Drainage Systems (SuDS)

## 6.1 Sources of SuDS guidance

### 6.1.1 C753 CIRIA SuDS Manual (2015)

The **C753 CIRIA SuDS Manual** (2015) provides guidance on planning, design, construction and maintenance of SuDS. The manual is divided into five sections ranging from a high-level overview of SuDS, progressing to more detailed guidance with progression through the document.

### 6.1.2 Non-statutory Technical Guidance, Defra (March 2015)

**Non-Statutory Technical guidance** provides non-statutory standards on the design and performance of SuDS. It outlines peak flow control, volume control, structural integrity, flood risk management and maintenance and construction considerations.

### 6.1.3 Non-statutory Technical Guidance for Sustainable Drainage Practice Guidance, LASOO (2016)

The Local Authority SuDS Officer Organisation produced their **Practice guidance** in 2016 to give further detail to the Non-statutory technical guidance.

### 6.1.4 Groundwater Vulnerability Zones

The Environment Agency have published new groundwater vulnerability maps in 2015. These maps provide a separate assessment of the vulnerability of groundwater in overlying superficial rocks and those that comprise of the underlying bedrock. The map shows the vulnerability of groundwater at a location based on the hydrological, hydro-ecological and soil propertied within a one-kilometre grid square.

The groundwater vulnerability maps should be considered when designing SuDS. Depending on the height of the water table at the location of the proposed development site, restrictions may be placed on the types of SuDS appropriate to certain areas. Groundwater vulnerability maps can be found on **Defra's Interactive MagicMap** website.

### 6.1.5 Groundwater Source Protection Zones (GSPZ)

The Environment Agency also defines Groundwater Source Protection Zones (SPZs) near groundwater abstraction points. These protect areas of groundwater used for drinking water. The Groundwater SPZ requires attenuated storage of runoff to prevent infiltration and contamination. Groundwater Source Protection Zones can be viewed on the **Defra Interactive MagicMap** website.

Parts of northern LBN are located in zones 1, 2 and 3 of the Groundwater Source Protection Zones.

### 6.1.6 Nitrate Vulnerable Zones

Nitrate Vulnerable Zones (NVZs) are areas designated as being at risk from agricultural nitrate pollution. Nitrate levels in waterbodies are affected by surface water runoff from surrounding agricultural land entering receiving waterbodies. The level of nitrate contamination will potentially influence the choice of SuDS and should be assessed as part of the design process. The NVZ coverage can be viewed on **Defra's Interactive MagicMap** website. Parts of LBN are located within the Roding (Cripsey Brook to Loxford Water) and Lea surface water NVZs.

## 6.2 SuDS suitability across the study area

The suitability of SuDS techniques is dependent upon many variables, including the hydraulic and geological characteristics of the catchment.

The permeability of the underlying soils can determine the infiltration capacity and percolation capacities. As such, a high-level review of the soil characteristics has been undertaken using British Geological Survey (BGS) soil maps of England and Wales which allow for a basic assessment of the soil characteristics and infiltration capacity. A high-level assessment of the suitability of SuDS is included in the site tables in Appendix A.This is based on national datasets and it should be assessed in more detail when designing SuDS.

This strategic assessment should not be used as a definitive site guide as to which SuDS would be suitable but rather as an indicative guide of general suitability based solely on soil type. Several other factors can determine the suitability of SuDS techniques including land contamination, the depth and fluctuation of the water table, the gradient of local topography and primary source of runoff etc. When considering NVZs and if areas have pollutants, infiltration may only be suitable where treatment measures are provided, prior to any discharge to surface or groundwaters.

Further site-specific investigation should be conducted to determine what SuDS techniques could be utilised at a particular development. The result of this assessment does not remove the requirements for geotechnical investigation or detailed infiltration testing and does not substitute the results of site-specific assessments and investigations. The LLFA should be consulted at an early stage to ensure SuDS are implemented and designed in response to site characteristics and policy factors.

# 7 Summary of Level 2 Assessment and Recommendations

## 7.1 Assessment methods

As part of the Level 2 SFRA, 43 detailed site summary tables have been produced for the 44 Level 2 sites assessed.

The summary tables set out the flood risk to each site, including Flood Zone coverage, maps of extent, depth, and velocity of flooding as well as hazard mapping for the 1% AEP plus an allowance for climate change defended event, where available. Climate change mapping has also been produced to indicate the impact which different climate change allowances may have on the site (where models are available) or using Flood Zone 2 as an indication of climate change. Each table also sets out the NPPF requirements for the site as well as guidance for site-specific FRAs.

A broadscale assessment of suitable SuDS options has been provided giving an indication where there may be constraints to certain sets of SuDS techniques. This assessment is indicative and more detailed assessments should be carried out during the site planning stage to confirm the feasibility of different types of SuDS. It may be possible that those SuDS techniques highlighted as possibly not being suitable can be designed to overcome identified constraints.

Static mapping is shown in Appendix A and should be viewed alongside the detailed site summary tables. There are outline hydraulic models available for the River Lea and Lower Roding as well as the Thames Tidal Downriver and Upriver, but where models are unavailable, the Environment Agency's Flood Zones and Risk of Flooding from Rivers and Sea datasets have been used. Also, where the watercourses are smaller and not represented in the Flood Zones, the Risk of Flooding from Surface Water mapping datasets and the ICM surface water hydraulic models have been used.

Consideration has also been given to the safety implications for development with respect to surface water flood risk. This reflects the requirement to consider the application of the Exception Test in circumstances where flood risk cannot be avoided. The Level 2 SFRA also identifies the need to consider the implications of allocating land that could potentially be affected by reservoir flood risk.

## 7.2 Summary of key site issues

The LBN Council provided 61 sites for assessment. These were chosen through a combination of a site's potential for allocation and its flood risk as determined through the site assessment process. These sites were screened against flood risk datasets to assess how many were to be carried forward to a Level 2 SFRA assessment. In total, 44 sites were carried forward to a Level 2 assessment. These have been detailed in 43 site summary tables (Custom House Phase 1 and 2 have been assessed in the same site table as they

are adjoining sites). Additional sites which may have flood risk issues with access and egress are also flagged in this report.

Detailed site summary tables setting out the flood risk to each site and the NPPF requirements for the site, as well as guidance for site-specific FRAs, have been produced. A broadscale assessment of suitable SuDS options has been provided, giving an indication where there may be constraints to certain types of SuDS techniques.

To accompany each site summary table, there are static maps, with all the mapped flood risk outputs per site.

The following points summarise the Level 2 assessment:

Most sites are shown to be at some or significant risk of fluvial and tidal flooding, with the exceptions being located in the centre and north of the Borough.

**Fluvial/Tidal Flooding**: Some areas of the LBN are at greater risk than others. The main watercourses associated with fluvial and or tidal risk are:

- River Lea - the River Lea flows along the western boundary of the LBN before converging with the River Thames in the south-western corner of the Borough. Modelled flood extents suggest that properties in Temple Mills, Stratford and Three Mills are at flood risk from the River Lea, particularly in the areas where there are historic recorded flood outlines.
- River Roding – the River Roding flows along the eastern boundary of the LBN before converging with the River Thames in the south-eastern corner of the Borough. Areas at risk include Little Ilford, East Ham and Beckton.
- River Thames – the tidally influenced River Thames flows along the LBN's southern boundary. Due to the flood defences along the River Thames being designed to protect to a 0.1% AEP flood event, the surrounding areas are not at risk of flooding from the Thames. However, breach modelling suggests that if these defences were to fail, the south and west parts, as well as the eastern boundary, of the LBN will be impacted. Areas within these flood extents include Stratford, West Ham, Canning Town, North Woolwich, Cyprus, Beckton and East Ham.
- Ordinary watercourses - there are a number of small ordinary watercourses within the Borough which are not currently modelled but have the potential to cause fluvial flood risk. For this assessment, the surface water mapping has been used to provide an indication of risk; however, modelling of these watercourses will be essential in a Flood Risk Assessment to inform the risk to any development proposals within the vicinity of unmodelled watercourses.

**Surface Water:** Surface water flood risk is widespread across the LBN. Water predominantly flows along topographically low-lying areas, including some roads, and is channelled into watercourses such as the Rivers Lea and Roding.

All the sites with a detailed Level 2 summary table are at surface water flood risk. The degree of flood risk varies, with some sites being only marginally affected, and other sites

being more significantly affected. The sites at most significant surface water risk are: Canning Town East 1, Canning Town East 2, Glory House, Custom House Phase 1, East Beckton Town Centre, Former East Ham Gasworks, Greater Carpenter's District, Lyle Park West, Newham 6th Form College, Newham Leisure Centre, Silvertown Way East, Chobham Farm North.

**Access and egress:** Whilst not at significant flood risk within the site boundary, several sites have potential access and egress issues as a result of fluvial and surface water flooding on the surrounding roads. Consideration should be made to these sites as to how safe access and egress can be provided during flood events, both to people and emergency vehicles. Also, consideration should be given to the nature of the risk, for example whether the flooding forms a flow path or bisects the site where access from one side to another may be compromised.

**Effects of climate change:** Fluvial and surface water climate change mapping indicates that flood extents are predicted to increase. As a result, the depths, velocities and hazard of flooding may also increase. The significance of the increase tends to depend on the topography of the site and the climate change percentage allowance used.

- Surface water; The 3.3% AEP +25% and +35% and the 1% AEP +25% and +40% climate change surface water events have been derived from the RoFfSW dataset and ICM modelling as an indication of climate change to surface water flood risk. The RoFfSW and ICM modelled 1% AEP plus 40% climate change surface water events are greater than their respective 1% AEP events (and both similar to their respective 0.1% AEP events). As the 1% AEP plus 40% climate change surface water extent is greater than the 1% AEP surface water flooding extent, this indicates that the LBN is relatively sensitive to increases in surface water flooding due to climate change.
- Fluvial; The 3.3%, 0.5% and 1% AEP plus Central, Higher Central and Upper End climate change allowances have been derived from hydraulic modelling of the Rivers Lea and Roding. Both models show the 1% AEP plus Central and Higher Central climate change allowances to be larger than the modelled 1% AEP fluvial events but smaller than the modelled 0.1% AEP fluvial events. However, the 1% AEP plus the Upper End climate change allowance for both the Rivers Lea and Roding (+54% and +64%, respectively) have larger extents (cover a greater spatial area) than the modelled 0.1% AEP events.
- Tidal; when comparing the present day to the 2100 epoch Thames tidal breach modelling, flood extents increase in the South of the Borough and in the lower reaches of the River Roding and River Lee.
- Sites most sensitive to changes in surface water, fluvial and tidal flood risk due to climate change include: Aldersbrook, Connaught Riverside, Custom House Phase 1, East Beckton Town Centre, Newham Sixth Form, Newham Leisure Centre, Silvertown Way East, Chobham Farm North, Stratford Town Centre West, Stratford Waterfront South, Greater Carpenter's District, Sugar House Island, Canning Town Riverside, Former East Ham Gasworks, East Ham Industrial Estate, Abbey Mills, Parcelforce,

Pudding Mill, Canning Road West, Canning Town East, Royal Albert North and Beckton Riverside.

- Site-specific FRAs should confirm the impact of climate change using latest guidance. It is recommended that the LBN Council work with other Risk Management Authorities (RMAs) to review the long-term sustainability of existing and new development in these areas when developing climate change plans and strategies for the Borough.

**Historic Flooding:** Historic data provided by the LBN Council showed 290 incidences of recorded flooding within the study area since 2011; these incidences were associated with surface water, groundwater or sewer flooding. Details of whether the flooding was internal to properties or affected only highways and curtilage was available for some records.

**Groundwater**: Groundwater emergence mapping indicates that the majority of the Borough is at negligible risk from groundwater emergence due to the nature of the local geological deposits. The GeoSmart Groundwater Flood Risk Map shows there are some localised areas where groundwater levels are low-moderate, and in these areas there may be a risk to subsurface assets, but surface manifestation of groundwater remains unlikely. There have been several records attributed to groundwater flooding within the LBN. For further details of these incidents, please refer to Section 5.7.1 in the Level 1 report.

**Canals:** There are no purpose-built canals within the LBN. However, the tributaries of the River Lea at Stratford are heavily canalised at Bow Back Creek (including the Pudding Mill, Three Mills Wall and Waterworks River) and are managed by the Canal and River Trust. These watercourses are controlled by a series of locks. There have been two recorded flooding incidents at Three Mills on the Bow Back Creek which are detailed in Section 5.1 within the L1 SFRA report.

**Reservoirs**: There are records of flooding from reservoirs in the study area during the ‘wet day’ and ‘dry day’ flooding scenarios. The areas not affected within the Borough are the central and northern areas (although the north-eastern and north-western corners of the LBN are within these flood extents, following the paths of the Rivers Lea and Roding). The level and standard of inspection and maintenance required under the Reservoirs Act means that the risk of flooding from reservoirs is relatively low. However, there is a residual risk of a reservoir breach, and this risk should be considered in any site-specific Flood Risk Assessments (where relevant).

**Requirements for Developers:**

- Any sites located where there is Main River (including culverted reaches of Main River) will require an easement of 8m either side of the watercourse from the top of the bank. This may introduce constraints regarding what development will be possible and consideration will also need to be given for access and maintenance at locations where

there are culverts. Developers will be required to apply for appropriate permits so the activity being carried out over easements does not increase flood risk.

- A strategic assessment was conducted of SuDS options using regional datasets. A detailed site-specific assessment of suitable SuDS techniques would need to be undertaken at site-specific level to understand which SuDS option would be best.
- In respect of the Cumulative Impact Assessment, the highest ranked catchments are the 'Canning Town', 'Folkstone Road East Ham SPS', 'Plaistow North', 'Plaistow SE' and 'West Ham'. These catchments are classified as high-risk when considering the cumulative impact of development on loss of floodplain storage volume and increase in runoff flow volume. A review of the SWMP, DWMP and Section 19 reports states that local drainage infrastructure has exacerbated recent flooding within Newham. It is recommended that opportunities to deliver improvements to drainage is delivered in any redevelopment. It is also recommended that developers consult with Thames Water when developing the drainage strategy to ensure that this is opportunities for drainage improvements are identified and delivered.
- At the planning application stage, developers may need to undertake more detailed hydrological and hydraulic assessments of the watercourses so that the potential effects of proposals can be evaluated at site level and where there are no detailed hydraulic models present. The modelling should verify flood extent (including latest climate change allowances), inform development zoning within the site and prove, if required, whether the Exception Test can be passed.
- For sites allocated within the Local Plan, the Local Planning Authority should use the information in this SFRA to inform the Exception Test. At planning application stage, the developer must adopt the sequential approach when assessing the feasibility of site allocations. This will ensure that appropriate flood resistance and resilience measures are put in place, which align with the recommendations in National and Local Planning Policy and supporting guidance as well as those set out in this SFRA.
- For developments that have not been allocated in the Local Plan, developers must undertake the Sequential Test followed by the Exception Test (if required) and present this information to the Local Planning Authority for approval. Developers will need to apply the Exception Test and use information in a site-specific Flood Risk Assessment to inform this test at planning application stage. The Exception Test should be applied where there is development which is classed as;
    - More vulnerable in Flood Zone 3a
    - Highly vulnerable in Flood Zone 2 (this is NOT permitted in Flood Zone 3a or 3b)
    - Essential infrastructure in Flood Zone 3a or 3b
    - Any development with significant* risk in the surface water 1% AEP event plus 40% climate change allowance flood extent.
    - Any development with significant* risk in the Risk of Flooding from Reservoirs mapping 'Wet Day' flood extent.

**Flood risk issues are not always black and white - the significance of issues requires professional judgement, based on the location, topography and nature (including depth,*

*velocity and hazard) of flooding, rather than simply whether part of a site is within a given flood extent. This would be determined as part of a Level 2 assessment.*

The Level 1 SFRA can be used to scope the flooding issues that a site-specific FRA should investigate in more detail to inform the Exception Test for windfall sites.

It is recommended that as part of the early discussions relating to development proposals, developers discuss requirements relating to site-specific FRA and drainage strategies with both the Local Planning Authority and the Lead Local Flood Authority (LLFA), to identify any potential issues that may arise from the development proposals.

### 7.2.1 Considering the Exception Test for the proposed sites in LBN

In principle, it is possible for the majority of sites assessed in the Level 2 SFRA to satisfy the flood risk element of the Exception Test, for example by:

- siting development away from the highest areas of risk,
- considering safe access/ egress in the event of a flood (from all parts of the site, if say the site is severed by a flood flow path),
- using areas in Flood Zone 2 for the least vulnerable parts of the development in accordance with Table 2 in the NPPF. Residential development should not be permitted in Flood Zone 3 and no development at all should be permitted in Flood Zone 3b (aside from essential infrastructure, such as a bridge crossing the lowest points of a site),
- testing flood mitigation measures if these are to be implemented, to ensure that they will not displace water elsewhere (for example, if land is raised to permit development in one area, compensatory flood storage will be required in another),
- considering space for green infrastructure in the areas of highest flood risk where this is appropriate.

In some areas of the LBN, more detailed fluvial modelling has been carried out in recent years, providing a more accurate representation of the Flood Zones within specific catchments. For the purposes of this SFRA, the River Lea and River Roding hydraulic models have been re-run to provide more accurate fluvial flood risk data than the current EA's FMfP.

Consideration should be given to the surface water risk within the LBN as this must also be addressed by the Exception Test. Care should be taken with use of the national surface water mapping as it does not account for culverts, structures, channel hydraulics or detailed sewer capacity, and therefore can provide an overestimated risk, reducing the confidence in this dataset. In some areas of the LBN, more detailed surface water modelling has been carried out in recent years, providing a more accurate representation of surface water flooding within the Borough. For the purposes of this SFRA, the Little Ilford, Silvertown and Newham Central hydraulic models have been re-run to provide more accurate surface water flood risk data than the current EA's RoFfSW. It is recommended that developers investigate surface water risk in more detail at the planning application stage and may need to consider undertaking additional integrated modelling.

If larger sites are split in future into smaller land parcels for development, and some of those parcels are in areas of flood risk, the Exception Test may need to be re-applied by the Developer at the planning application stage.

## 7.3 Planning policy recommendations

The planning policy recommendations in Chapter 9 of the Level 1 SFRA still stand for the site allocations and any windfall development that comes forward. Recommendations in the L1 are made as follows:

- Developers should consider flood resilience measures for new development, including raised thresholds, self-sealing UPVC doors, non-return valves and air brick covers.
- Combine infiltration (e.g. permeable surfaces) and attenuation (e.g. balancing ponds and flood storage reservoirs) SuDS techniques to overcome constraints to the area of a site set aside for infiltration systems caused by development pressures.
- Where appropriate, opportunities for betterment should be sought where surface water flooding issues are present, which could be implemented through Supplementary Planning documents for individual settlements.
- Encourage the use of permeable surfacing in gardens and use measures to optimise drainage and reduce runoff.
- Consider opportunities for water conservation through rainwater harvesting and water butts where appropriate for new and existing development.
- Promote land management practices where appropriate to attenuate runoff and alleviate potential issues downstream.

Further site-specific recommendations have been made in Appendix F (Cumulative Impact Assessment) of the Level 1 SFRA and in Appendix D of this report.

## 7.4 Guidance for windfall sites and sites not assessed in the L2 SFRA

- For sites not represented in the Environment Agency's Flood Zones, or where Flood Zones do exist, but no detailed hydraulic modelling is present, it is recommended that developers construct detailed hydraulic models at these sites as part of a site-specific FRA using channel, structure and topographic survey, to confirm flood risk. Site-specific flood modelling will probably need to be developed in locations where it is necessary to understand the effects of proposed development schemes on the existing flood flow paths and flood volume storage.
- If a site's extents either include or borders with a Main River (including a culverted reach of Main River), an easement of 8m is required from either bank for access and maintenance. Any future development will require a flood risk permit from any activity within 8m of a Main River.
- If an ordinary watercourse is within or immediately adjacent to the site area, consultation with the Lead Local Flood Authority should be undertaken. If alterations or discharges are proposed to the watercourse, a land drainage consent will be required.
- Where necessary, blockages of nearby culverts may need to be simulated in a hydraulic model to confirm residual risk to the site.

- Surface water risk should be considered in terms of the proportion of the site at risk in the 3.3% AEP (30-year), 1% AEP (100-year) or 0.1% AEP (1,000-year) events, whether the risk is due to isolated minor ponding or deeper pooling of water, or whether the risk is due to a wider overland flow route.
- Surface water risk and mitigation should be considered as part of a detailed site-specific Flood Risk Assessment and Surface Water Drainage Strategy.
- Access and egress should be considered at the site, but also in the vicinity of the site, for example, a site may have low surface water risk, but in the immediate locality, access/ egress to and from the site could be restricted for vehicles and/ or people.
- Sites where there is a canal within or immediately adjacent to the site area, developers should consult the Canals and Rivers Trust. Any proposed alterations to the canal or discharges must be agreed with the Canals and Rivers Trust.
- If a site is located within 250m of a landfill site, there could be amenity, dirt and contamination issues. Sites could be sensitive from the perspective of controlled waters and therefore any redevelopment must ensure there is no pollution risk to the water environment.

## 7.5 Use of SFRA data and future updates

It is important to recognise that the SFRA has been developed using the best available information at the time of preparation. This relates both to the current risk of flooding from rivers, and the potential impacts of future climate change.

The SFRA should be a 'living document', and as a result should be updated when new information on flood risk, flood warning or new planning guidance or legislation becomes available. New information on flood risk may be provided by LBN Council, Greater London Authority, the Highways Authority, Thames Water and the Environment Agency. Such information may be in the form of:

- New hydraulic modelling results
- Flood event information following a future flood event
- Policy/ legislation updates
- Environment Agency flood map updates
- New flood defence schemes, or alleviation schemes.

The Environment Agency regularly reviews their flood risk mapping, and it is important that they are approached to determine whether updated (more accurate) information is available prior to commencing a detailed Flood Risk Assessment. It is recommended that the SFRA is reviewed when there are significant updates to the Environment Agency's Flood Zone mapping. This will ensure the latest data is still represented in the SFRA, allowing a cycle of review and a review of any updated data by checking with the above bodies for any new information.

### 7.5.1 Neighbourhood Plans

Flood risk should be fully addressed in the plan preparation and in bringing forward policies for the allocation of land and therefore the SFRA findings should be used in the production of Neighbourhood Plans.

Neighbourhood planners can use the information in the Level 1 and Level 2 SFRA on the sources of flood risk across LBN and the flood risk mapping, to assess the risk of flooding to sites within their community. The SFRA will also be helpful for developing community level flood risk policies in high flood risk areas.

The Level 1 LBN SFRA highlights on a broad scale where flood risk from fluvial, surface water, groundwater and the effects of climate change are most likely. The maps are useful to provide a community level view of flood risk but may not identify if an individual property is at risk of flooding or model small scale changes in flood risk. Local knowledge of flood mechanisms will need to be included to complement this broadscale mapping.

# A Static Mapping and Site Summary Tables

All access to static mapping, which has been produced for this study, is to be requested from the LBN Council. A summary of the maps provided as part of this Level 2 SFRA is detailed in the below tables. All the maps listed have been produced for each individual site, with each also showing the main rivers where appropriate.

| General Mapping |
|---|
| Flood Alert and Warning Areas |
| Flood defences standardised attributes |
| Flood Map for Planning |
| Geosmart groundwater flood risk |
| Recorded flood outline |
| Reduction in risk of flooding from rivers and sea |
| Reservoir wet day |
| Reservoir dry day |

| Surface Water – Present Day | | | | |
|---|---|---|---|---|
| | RoFfSW | ICM Silvertown | ICM Newham Central | ICM Little Ilford |
| Extent | 3.3% | 3.3% | 3.3% | 3.3% |
| | 1% | 1% | 1% | 1% |
| | 0.1% | 0.1% | 0.1% | 0.1% |
| Depth | 3.3% | 3.3% | 3.3% | 3.3% |
| | 1% | 1% | 1% | 1% |
| | 0.1% | 0.1% | 0.1% | 0.1% |
| Velocity | 3.3% | 3.3% | 3.3% | 3.3% |
| | 1% | 1% | 1% | 1% |
| | 0.1% | 0.1% | 0.1% | 0.1% |
| Hazard | 3.3% | 3.3% | 3.3% | 3.3% |
| | 1% | 1% | 1% | 1% |
| | 0.1% | 0.1% | 0.1% | 0.1% |

| Surface Water – Climate Change | | | | |
|---|---|---|---|---|
| | RoFfSW | ICM Silvertown | ICM Newham Central | ICM Little Ilford |
| Extent | 3.3% +20%CC | 3.3% +20%CC | 3.3% +20%CC | 3.3% +20%CC |
| | 3.3% +35%CC | 3.3% +35%CC | 3.3% +35%CC | 3.3% +35%CC |
| | 1% +25%CC | 1% +25%CC | 1% +25%CC | 1% +25%CC |
| | 1% +40%CC | 1% +40%CC | 1% +40%CC | 1% +40%CC |
| Depth | 3.3% +20%CC | 3.3% +20%CC | 3.3% +20%CC | 3.3% +20%CC |
| | 3.3% +35%CC | 3.3% +35%CC | 3.3% +35%CC | 3.3% +35%CC |
| | 1% +25%CC | 1% +25%CC | 1% +25%CC | 1% +25%CC |
| | 1% +40%CC | 1% +40%CC | 1% +40%CC | 1% +40%CC |
| Velocity | 3.3% +20%CC | 3.3% +20%CC | 3.3% +20%CC | 3.3% +20%CC |

| Surface Water – Climate Change | | | | |
|---|---|---|---|---|
| | 3.3% +35%CC | 3.3% +35%CC | 3.3% +35%CC | 3.3% +35%CC |
| | 1% +25%CC | 1% +25%CC | 1% +25%CC | 1% +25%CC |
| | 1% +40%CC | 1% +40%CC | 1% +40%CC | 1% +40%CC |
| Hazard | 3.3% +20%CC | 3.3% +20%CC | 3.3% +20%CC | 3.3% +20%CC |
| | 3.3% +35%CC | 3.3% +35%CC | 3.3% +35%CC | 3.3% +35%CC |
| | 1% +25%CC | 1% +25%CC | 1% +25%CC | 1% +25%CC |
| | 1% +40%CC | 1% +40%CC | 1% +40%CC | 1% +40%CC |

| Tidal Breach Thames Model | | | | |
|---|---|---|---|---|
| | Downriver 2005 epoch | Downriver 2115 epoch | Upriver 2005 epoch | Upriver 2100 epoch |
| Extent | 0.5% | 0.5% | 0.5% | 0.5% |
| | 0.1% | 0.1% | - | - |
| Depth | 0.5% | 0.5% | 0.5% | 0.5% |
| | 0.1% | 0.1% | - | - |
| Velocity | 0.5% | 0.5% | 0.5% | 0.5% |
| | 0.1% | 0.1% | - | - |
| Hazard | 0.5% | 0.5% | 0.5% | 0.5% |
| | 0.1% | 0.1% | - | - |

| Fluvial – River Roding | | |
|---|---|---|
| | Present Day | Climate Change |
| Extent | 3.3% Defended | 3.3% +26%CC |
| | | 3.3% +36%CC |
| | | 3.3% 64%CC |
| | 1% Defended | 1% +26%CC |
| | | 1% +36%CC |
| | | 1% +64%CC |
| | 0.5% Defended | 0.5% +26%CC |
| | | 0.5% +36%CC |
| | | 0.5% +64%CC |
| | 0.1% Defended | - |
| Depth | 3.3% Defended | 3.3% +26%CC |
| | | 3.3% +36%CC |
| | | 3.3% 64%CC |
| | 1% Defended | 1% +26%CC |
| | | 1% +36%CC |
| | | 1% +64%CC |
| | 0.5% Defended | 0.5% +26%CC |
| | | 0.5% +36%CC |
| | | 0.5% +64%CC |

| Fluvial – River Roding | | |
|---|---|---|
| | 0.1% Defended | - |
| Velocity | 3.3% Defended | 3.3% +26%CC |
| | | 3.3% +36%CC |
| | | 3.3% 64%CC |
| | 1% Defended | 1% +26%CC |
| | | 1% +36%CC |
| | | 1% +64%CC |
| | 0.5% Defended | 0.5% +26%CC |
| | | 0.5% +36%CC |
| | | 0.5% +64%CC |
| | 0.1% Defended | - |
| Hazard | 3.3% Defended | 3.3% +26%CC |
| | | 3.3% +36%CC |
| | | 3.3% 64%CC |
| | 1% Defended | 1% +26%CC |
| | | 1% +36%CC |
| | | 1% +64%CC |
| | 0.5% Defended | 0.5% +26%CC |
| | | 0.5% +36%CC |
| | | 0.5% +64%CC |
| | 0.1% Defended | - |

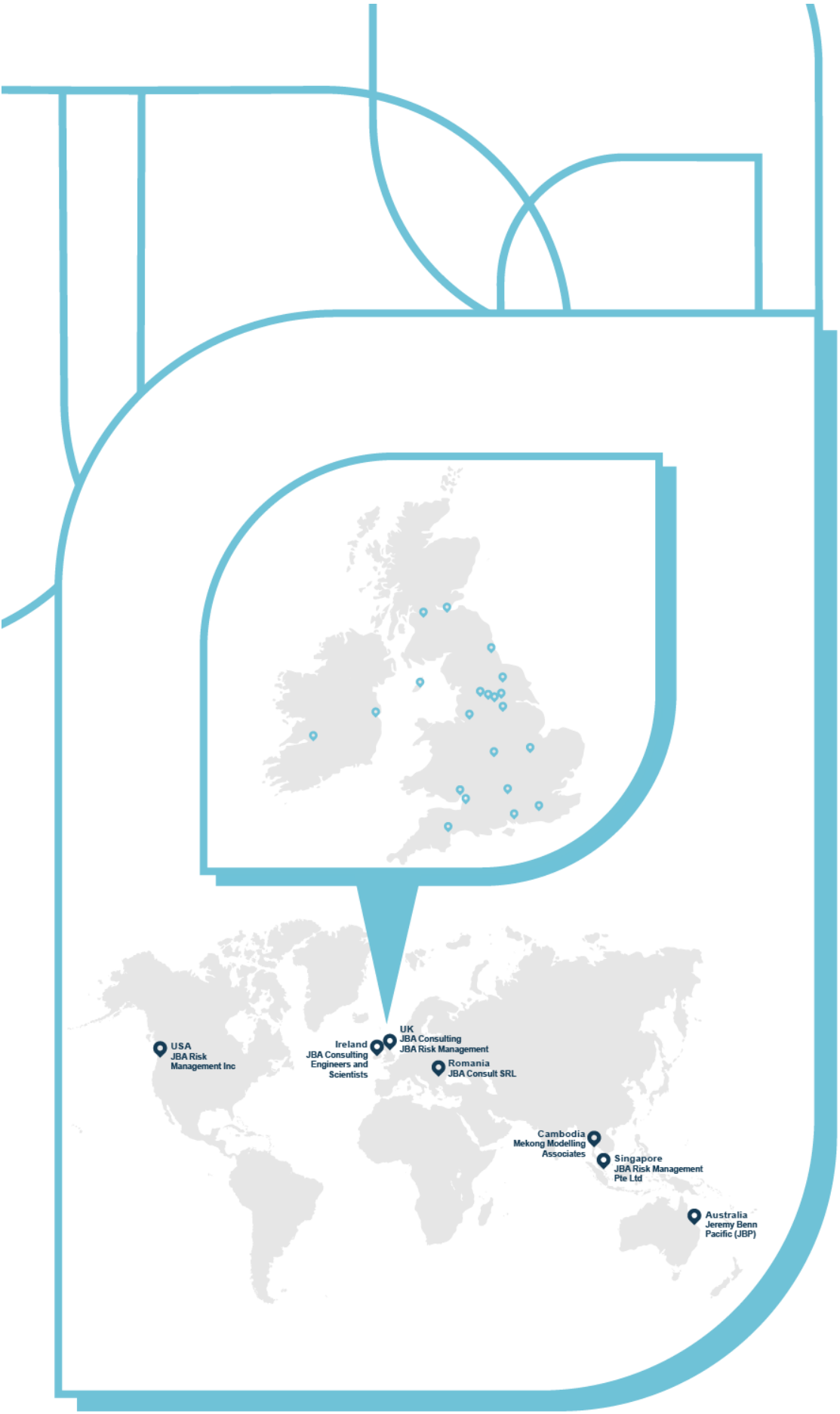
| Fluvial – River Lee | | |
|---|---|---|
| | Present Day | Climate Change |
| Extent | 3.3% Defended | 3.3% +17%CC |
| | | 3.3% +27%CC |
| | 1% Defended | 1% +17%CC |
| | | 1% +54%CC |
| | 0.5% Defended | 0.5% +17%CC |
| | | 0.5% +27%CC |
| | 0.1% Defended | - |
| Depth | 3.3% Defended | 3.3% +17%CC |
| | | 3.3% +27%CC |
| | 1% Defended | 1% +17%CC |
| | | 1% +54%CC |
| | 0.5% Defended | 0.5% +17%CC |
| | | 0.5% +27%CC |
| | 0.1% Defended | - |
| Velocity | 3.3% Defended | 3.3% +17%CC |
| | | 3.3% +27%CC |
| | 1% Defended | 1% +17%CC |

| Fluvial – River Lee | | |
|---|---|---|
| | | 1% +54%CC |
| | 0.5% Defended | 0.5% +17%CC |
| | | 0.5% +27%CC |
| | 0.1% Defended | - |
| Hazard | 3.3% Defended | 3.3% +17%CC |
| | | 3.3% +27%CC |
| | 1% Defended | 1% +17%CC |
| | | 1% +54%CC |
| | 0.5% Defended | 0.5% +17%CC |
| | | 0.5% +27%CC |
| | 0.1% Defended | - |

# B Sites Carried Forward to a Level 2 Assessment

# C JBA Hydraulic Modelling Technical Notes

# D Cumulative Impact Assessment Review

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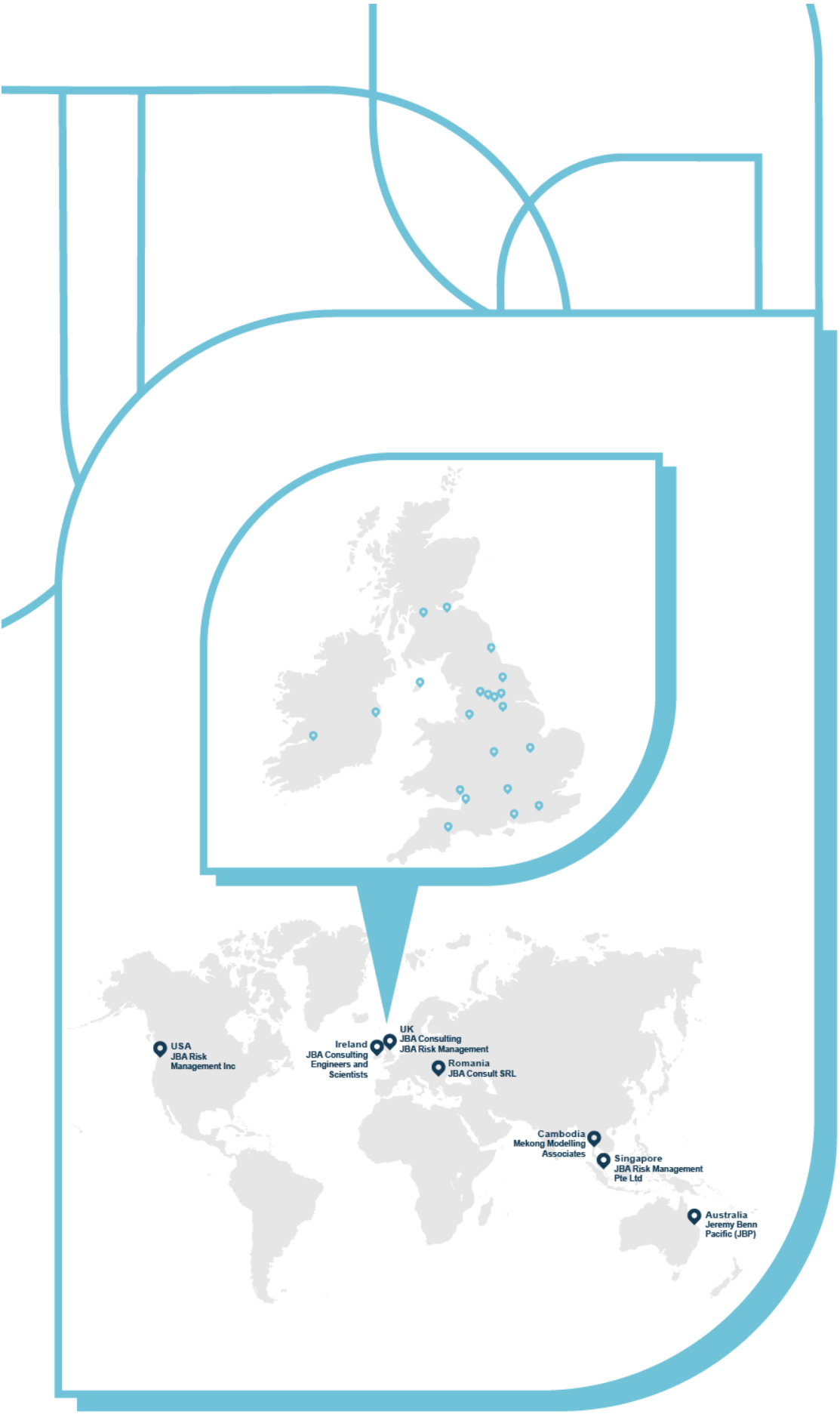


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