London Borough of Tower Hamlets
Strategic Flood Risk Assessment

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Quality information

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Contents

Executive Summary

The National Planning Policy Framework (NPPF) and accompanying Planning Practice Guidance emphasise the responsibility of Local Planning Authorities (LPAs) to ensure that flood risk is understood and managed effectively and sustainably throughout all stages of the planning process.

This Strategic Flood Risk Assessment (SFRA) aims to facilitate this process by identifying the spatial variation in flood risk across London Borough of Tower Hamlets (LBTH) thus allowing an area-wide comparison of future development sites with respect to flood risk considerations.

The Borough is bounded to the south by the River Thames and to the East by the River Lee. Whilst the Thames poses a potential risk of flooding to properties within the Borough, all property is currently protected from combined tidal and fluvial flooding by the Thames Tidal Defences (TTD) up to the 1 in 1000 year event. This protection is effective provided the Thames Barrier is operated to protect against storm surges from the North Sea and that there is sufficient storage behind the barrier to accommodate the River Thames when the Thames Barrier is shut during extreme fluvial events at high tides. The River Lee is also defended; however, small sections of the Borough are at risk of flooding from this source around the area of Hackney Wick, for events above a 1 in 50 year return period (2% Annual Exceedance Probability (AEP)).

Potential risk of flooding from other sources exists throughout the Borough, including sewer surcharge, and surface water flooding as a result of heavy rainfall and limited capacity of drainage infrastructure. This is known to be an issue within Critical Drainage Areas (CDAs), in particular, the Isle of Dogs (Map 006).

Areas throughout the Borough are also suggested (by geological indicators) to be susceptible to elevated groundwater levels (Map 007), which may additionally interact with and exacerbate other flood risk sources. It is expected that changing climate patterns will have a substantial impact on the level of flood risk from all sources within the Borough.

This SFRA identifies the tidal and fluvial floodplains associated with the River Thames and Lee and presents Flood Zone Maps that delineate the flood zones outlined in the NPPF (Map 005). Given the level of protection provided by defences across the Borough, there are deemed to be no Functional Floodplain (Flood Zone 3b) areas within LBTH.

The mapping contained in Appendix A illustrates the spatial distribution of flood risk from all sources across the Borough.

As a large inner city Borough, Tower Hamlets is experiencing rapid rates of high density development resulting in limited open space and significant basement areas. There is additionally an emerging precedent for new development encroaching on existing water spaces across the Borough. Tower Hamlets is underlain by varying geology and hydrogeology, which is additionally influenced by regional groundwater extraction. Without adequate mitigation, development of this spatial distribution and typology has the potential to impact upon the sensitive hydrology and hydrogeology across LBTH, leading to exacerbation of flood risk.

In the future, climate change is anticipated to have an impact on all sources of flood risk within the Borough. It is important that planning decisions recognise the potential risk that increased runoff poses to property and plan development accordingly so that future sustainability can be assured.

The maps and supporting information presented in this SFRA are intended to inform and facilitate the decision making process by LBTH with regards to the NPPF risk-based approach to planning. This is based upon determining compatibility of various types of development within each Flood Zone, subject to the application of the Sequential Test and Exception Test (when needed).

The findings of the SFRA have additionally been used to undertake a more detailed assessment of each of the allocated development sites across the Borough.

Key Recommendations

Flood risk should be an early and primary consideration in strategic planning for development across the Borough. A sequential approach should be taken to allocating strategic development areas in regions of lowest flood risk, taking into account vulnerability of land use. Consideration should also be given to strategic allocation of open space and preserving and expanding river corridors to create space for flooding to be managed effectively. In consulting on and determining development applications, LBTH must ensure that all new developments have considered flood risk management from the planning stage, including site specific flood risk assessment, where required.

Given the position of the Borough adjacent to the River Thames and River Lee, it is highly reliant on flood defences. Ongoing maintenance of these defences is critical, and priority should be given to safeguarding the Standard of Protection (SoP) provided by defences over the lifetime of any development. Additionally, consideration should be given to the specific recommendations of the Thames Estuary 2100 (TE2100) plan in requiring reduction of current and future flood risk through raising, maintaining and enhancing flood defences. Existing corridors of land along the river frontage should be safeguarded and opportunities taken to set back development to enable sustainable and cost effective flood risk management, including upgrading of river walls and embankments and landscape, amenity and habitat improvements

Despite the high SoP provided by to the Borough, there is a residual risk through breaching or overtopping of defences. This should be managed through flood resistant and resilient design and protection measures. Flood awareness and robust emergency planning and response will additionally be critical to sustainable ongoing flood risk management.

Given the rate and nature of development anticipated across the Borough, robust surface water management, including the use of Sustainable Drainage Systems (SuDS), will be critical to ensuring sustainability. It is recommended that runoff rates from new development be restricted to greenfield runoff rates, wherever possible, and managed in line with the SuDS hierarchy. Existing water spaces, including dock areas, should be safeguarded, and their flood management functionality enhanced where possible. Further consideration should additionally be given to hydrogeological conditions across the Borough and managing the impacts of subterranean development through site-specific impact assessments.

Abbreviations

Acronym	Definition
AEP	Annual Exceedance Probability
CDA	Critical Drainage Area
CFMP	Catchment Flood Management Plan
EA	Environment Agency
FCERM	Flood and Coastal Erosion Risk Management
FWMA	Flood and Water Management Act
FRA	Flood Risk Assessment
FRMI	Flood Risk Management Infrastructure
GIS	Geographical Information Systems
LBTH	The London Borough of Tower Hamlets
LFRMS	Local Flood Risk Management Strategy
LFRZ	Local Flood Risk Zone
LiDAR	Light Detection and Ranging
LLFA	Lead Local Flood Authority
LPA	Local Planning Authority
m AOD	Metres Above Ordnance Datum.
MLWL	Maximum Likely Water Level
NPPF	National Planning Policy Framework
PFRA	Preliminary Flood Risk Assessment
RFRA	Regional Flood Risk Appraisal
SFRA	Strategic Flood Risk Assessment
SoP	Standard of Protection
SPG	Supplementary Planning Guidance
SuDS	Sustainable Drainage Systems
SWMP	Surface Water Management Plan
TE2100	Thames Estuary 2100 Plan
TTD	Thames Tidal Defences

Glossary

Term	Definition
Annual Exceedance Probability (AEP)	In flood risk terms, the AEP represents the probability of a particular return period event occurring in any given year. (e.g. 1 in 100 year return period event = 1% AEP – there is a 1% chance every year that this event will take place).
Aquifer	A source of groundwater comprising water-bearing rock, sand or gravel capable of yielding significant quantities of water.
Areas Benefiting from Defences	The area that is protected by a defence or defence system against flooding from a 1% (1 in 100) annual probability fluvial event and 0.5% (1 in 200) annual probability tidal event, assuming all defences remain intact and function perfectly.
Blue-green infrastructure	Combining green spaces and surface water management infrastructure within the urban environment to facilitate natural hydrological processes whilst minimising flooding, enhancing biodiversity, facilitating recreation and assisting adaption to climate change.
Brownfield Land	Previously developed land.
Catchment	The land (and its area) which drains (normally naturally) to a given point on a river, drainage system or other body of water.
Catchment Flood Management Plan	A high-level planning strategy through which the Environment Agency works with key decision makers within a river catchment to identify and agree policies to secure the long-term sustainable management of flood risk.
Critical Drainage Area	A discrete geographic area where multiple and interlinked sources of flood risk (surface water, groundwater, sewer, main river and/or tidal) cause flooding during severe weather, affecting people, property or local infrastructure.
Culvert	A channel or pipe that carries water below the level of the ground.
Exception Test	The Exception Test is required for certain development sites following application of the Sequential Test. The Exception Test must demonstrate that the development provides wider sustainability benefits to the community that outweigh flood risk, and that the site is safe from flood risk for its lifetime.
Flood Defence	Flood defence infrastructure, such as flood walls and embankments, intended to protect an area against flooding to a specified Standard of Protection.
Flood Map	A map produced by the Environment Agency providing an indication of the likelihood of flooding within all areas of England and Wales, assuming there are no flood defences.
Flood Risk Assessment	A study to assess the risk to an area or site from flooding from all sources, now and in the future, and to assess the impact that any changes or development on the site or area will have on flood risk to the site and elsewhere. It may also identify, particularly at more local levels, how to manage those changes to ensure that flood risk is not increased.
Flood Risk Management	The activity of understanding the probability and consequences of flooding, and seeking to modify these factors to manage flood risk to people, property and the environment in line with agreed policy objectives.
Flood Warning	If a flood warning is issued in an area, it means flooding is expected and will cause disruption.

Term	Definition
Flood Zone	A geographic area within which the flood risk is in a particular range as defined within NPPF and its Practice Guidance.
Flood Zone 1	Land where flooding from rivers and the sea is very unlikely. There is less than a 0.1 per cent (1 in 1000) chance of flooding occurring each year.
Flood Zone 2	Land which has between a one in 100 and one in 1000 annual probability (chance) of river flooding (1% -0.1%); or between a one in 200 and 1 in 1000 annual probability (chance) of sea flooding (0.5%-0.1%).
Flood Zone 3	Land which has a greater than one in 100 annual probability (chance) of river flooding (>1%); or greater than one in 200 annual probability (chance) of sea flooding (>0.5%).
Flood Zone 3a (High probability)	This is a subset of Zone 3 (above), which is not within the functional floodplain (Flood Zone 3b), as defined below. Therefore this land is typically expected to have an annual probability of flooding between 1 in 20 and 1 in 100 or (from fluvial sources) or 1 in 200 (from tidal sources) in any year.
Flood Zone 3b (Functional Floodplain)	Land where water has to flow or be stored in times of flood. Specifically, this land would flood with an annual probability of 1 in 20 (5 %) or greater in any year, or as otherwise agreed by the Local Authority and the Environment Agency.
Flooding Hotspot	Also known as flood prone areas. These are locations where concentrations of flooding incidents within a limited geographical context have appeared over time.
Floodplain	Area of land that borders a watercourse, an estuary or the sea, over which water flows in time of flood, or would flow but for the presence of flood defences where they exist.
Flood Resilience	Flood resilience involves design and construction of buildings and structures to reduce the impact of flooding so that, although flood water may enter the building, its impact is minimised, structural integrity is maintained, and repair, drying & cleaning are facilitated.
Flood Resistance	Flood resistance involves design and construction of buildings or other structures to prevent entry of flood water or minimising the amount that may enter.
Functional Floodplain	Refer to Flood Zone 3b definition.
Greenfield Runoff Rate	The greenfield runoff rate is the rate at which rainfall would runoff from an undeveloped, naturally permeable catchment.
Main River	A watercourse designated on a statutory map of Main Rivers, maintained by DEFRA, on which the Environment Agency has permissive powers to construct and maintain flood defences.
National Planning Policy Framework	The NPPF is a framework which aims to simplify and accentuate accessibility on current policy in planning of development of an area, particularly for local planning authorities and decision makers.
Ordinary Watercourse	All rivers, streams, ditches, drains, cuts, dykes, sluices, sewers (other than public sewers) and passages through which water flows which do not form part of a Main River. Local authorities and, where relevant Internal Drainage Boards, have similar permissive powers on Ordinary Watercourses as the Environment Agency has on Main Rivers.
Overtopping	The process of water rising over the top of a barrier intended to contain it (e.g. sea defence).

Term	Definition
Pathway	A route that enables a hazard to move from a 'source' to a 'receptor', as in the 'source-pathway-receptor' concept. A pathway must exist in order for a hazard to be realised. Pathways can be constrained in order to mitigate the risks.
Planning Practice Guidance	This document provides additional technical guidance to ensure the effective implementation of the planning policy set out in the National Planning Policy Framework.
Reservoir	A large raised structure, raised lake or other area capable of storing at least 25,000 cubic metres of water above natural ground level, created artificially or enlarged. This is defined by the Reservoirs Act, 1975.
Residual risk	The risk which remains after all risk avoidance, reduction and mitigation measures have been implemented.
Return Period	The long-term average period between events of a given magnitude which have the same annual exceedance probability of occurring.
Run-off	The flow of water from an area caused by rainfall.
Sequential Test	Aims to steer vulnerable development to areas of lowest flood risk.
Site Allocation	Location identified by the Local Planning Authority as likely to experience change or development in the short to medium term.
Standard of Protection	The design event or standard to which a building, asset or area is protected against flooding, generally expressed as an annual exceedance probability.
Strategic Flood Risk Assessment	An area-wide study, undertaken by one or more local authorities, to assess the risks that all sources of flooding poses to a Borough or district, both now and in the future. It incorporates the impacts of further land changes and climate change in the development of an area and if these factors impact the risk of flooding.
Surface Water Flooding	In this context, surface water flooding describes flooding from sewers, drains, groundwater, and runoff from land, small water courses and ditches that occurs as a result of heavy rainfall.
Sustainability Appraisal	An integral part of the plan-making process which seeks to appraise the economic, social and environmental effects of a plan in order to inform decision-making that aligns with sustainable development principles.
Sustainable Drainage Systems	A sequence of management practices and control structures, often referred to as SuDS, designed to drain water in a more sustainable manner than some conventional techniques.
Tidal Surge	A local high rise in sea level caused by climatic conditions, creating wind and low atmospheric pressure. Tidal flooding is of greatest risk when tidal surges combine with high tides.
Vulnerability Classes	NPPF provides a vulnerability classification to assess which uses of land may be appropriate in each flood risk zone.

1 Background

1.1 Introduction

1.1.1 The National Planning Policy Framework (NPPF) and accompanying Planning Practice Guidance emphasise the responsibility of Local Planning Authorities (LPAs) to ensure that flood risk is understood and managed effectively using a risk-based approach throughout all stages of the planning process. As such, LPAs are required to undertake Strategic Flood Risk Assessments (SFRAs) to support the preparation of their Local Plan.

1.1.2 AECOM has been commissioned by the London Borough of Tower Hamlets (LBTH) to review and revise the existing SFRA for the Borough, which was completed in 2012. The methodology followed in the study has been designed to comply with the NPPF and the accompanying Planning Practice Guidance as well as guidelines from the Environment Agency (EA). The SFRA has been carried out in collaboration with a range of officers from LBTH, the EA and Thames Water. The results of this assessment are described in this report and are intended to inform strategic land use planning and decision making, from a flood risk perspective.

1.2 SFRA Aims and Objectives

1.2.1 The aim of this SFRA is to collate and analyse the most up-to-date flood risk information, from all sources, to provide an overview of flood risk issues across Tower Hamlets. The resulting report and mapping is intended to be used by the LBTH as evidence to inform the emerging Local Plan, ensuring flood risk is taken into account when considering development options and in the preparation of strategic land use policies.

1.2.2 In addition to providing an evidence base to support the Local Plan, the SFRA will enable LBTH to:

- Determine the spatial variations in flood risk from all sources across the Borough;
- Prepare broad policies for the management of flood risk;
- Steer development towards areas of lowest flood risk, through the application of the Sequential Test and, where necessary, the Exception Test;
- Assist the decision making process on flood risk issues;
- Consider opportunities to reduce flood risk to existing communities through better management of surface water, provision for conveyance and storage for flood water;
- Identify the level of detail required for site-specific Flood Risk Assessments (FRAs); and
- Determine the acceptability of flood risk in relation to emergency planning capability.

1.2.3 This SFRA has been undertaken as a staged Level 1 and Level 2 study, with the outputs consolidated into an integrated report. Based upon EA guidance, the key objectives for each stage of this SFRA are described below.

- Level 1 SFRA:
  - Provide maps showing the LPA area including main rivers, ordinary watercourses and flood zones, including the functional floodplain;
  - Assess and map the distribution of flood risk from all sources across the Borough, including an assessment of the potential implications of climate change;
  - Identify relevant flood risk management measures, including the location and standard of infrastructure and the coverage of flood warning systems; and
  - Provide advice on appropriate mitigation measures, including the likely applicability of Sustainable Drainage Systems (SuDS) techniques for managing surface water run-off.

- Provide advice on the preparation of site-specific FRAs for sites of varying risk across the flood zones, including information about the use of sustainable drainage techniques;

· Level 2 SFRA:

- Undertake an appraisal of the current condition of flood defences and likely future flood management policy with regard to its maintenance and upgrade;
- Undertake an appraisal of the probability and consequences of overtopping or failure of Flood Risk Management Infrastructure (FRMI), including an appropriate allowance for climate change;
- Identify policies and practices required to ensure development satisfies the Exception Test; and
- Provide meaningful recommendations to inform policy, development control and technical issues.

1.2.4 The Level 2 SFRA study additionally undertook an assessment of development within the Borough (contained in Chapter 4), including analysis of flood risk at key allocated development sites (Appendix F).

1.3 Using this SFRA

1.3.1 This SFRA is broadly divided into 6 sections, as described below:

· *Chapter 1* (this chapter) includes an overview of the aims and objectives of the updated SFRA, provides contextual background information about the Borough and summarises the methodology used to undertake this assessment;

· *Chapter 2* provides a brief overview of the legislative as well as national, regional and local planning policy context relevant to LBTH and referenced in the preparation of this SFRA;

· *Chapter 3* presents a broad overview of flood risk from all sources across Tower Hamlets, including flood history and the anticipated impact of climate change;

· *Chapter 4* provide a high level examination of development within the Borough, including considerations of typology and spatial distribution, and how these characteristics interact with existing and expected levels of flood risk;

· *Chapter 5* summarises the NPPF risk-based approach to managing flood risk through planning, including step-by-step guidance on the application of the Sequential Test and the Exception Test. This is followed by specific recommendations to inform local planning policy, development control and emergency planning;

· *Chapter 6* provides guidance to developers in undertaking site-specific FRAs and measures available for appropriately managing and mitigating flood risk; and

· *Chapter 7* summarises the key findings of the SFRA, including the primary recommendations for flood risk management in Tower Hamlets.

1.3.2 A number of appendices are also attached within this SFRA, as summarised below:

· *Appendix A* contains mapping summarising contextual information for Tower Hamlets and illustrating the spatial variability of flood risk across the Borough;

· *Appendix B* provides more detailed information on commonly utilised SuDS techniques and their applicability;

· *Appendix C* provides a summary of the datasets collated throughout the SFRA preparation and describes each of the datasets contained within the SFRA maps;

· *Appendix D* presents a management guide, detailing recommendations for maintaining and updating the SFRA to ensure it remains relevant;

· *Appendix E* summarises the known historical flooding records across the Borough; and

- *Appendix F* contains a brief assessment of flood risk at the allocated development sites within Tower Hamlets. While it is generally recommended that this SFRA be considered holistically, the key sections deemed to be most relevant to various parties are summarised below.

Development Control

1.3.3 A key objective of the SFRA is to collate, assess and map all forms of flood risk across LBTH and use this information to steer new development towards areas of lowest flood risk, through the Sequential Test process. The spatial distribution of different sources of flood risk across the Borough is illustrated in the mapping contained in Appendix A, and further described in Chapter 3. These sections will provide a broad indication of the sources of flood risk impacting on any potential development sites, and the flood zone in which they are situated. A high level assessment of impact of development within the Borough is contained in Chapter 4.

1.3.4 Section 5.1 summarises the Sequential Test process to be followed when establishing the compatibility of certain developments types within each flood zone, describing how the mapping and associated information should be used to assess planning applications. Further recommendations for managing flood risk through Development Control are provided in Section 5.2.

1.3.5 Appendix F contains an assessment of the allocated development sites within the Borough, summarising key considerations with respect to flood risk mitigation and requirement for development justification, in line with the NPPF. This will be used to inform the Sequential Testing of site allocations during the Local Plan formulation process.

Strategic Planning

1.3.6 The maps contained within Appendix A illustrate the spatial distribution of flood risk across Tower Hamlets, and are intended to inform strategic land use planning and development allocation. Greater detail on each source of flood risk is contained in Chapter 3.

1.3.7 Chapter 4 provides a high level assessment of emerging development characteristics and spatial distribution across the Borough, highlighting associated flood risk concerns and recommendations.

1.3.8 Chapter 5 provides an overview of the NPPF risk based approach to sequential planning, which should inform development planning and site allocations. This is followed by specific recommendations for the Borough, intended to inform planning policy, development control and emergency planning.

Guidance for Developers

1.3.9 When considering proposed development, it is recommended that developers refer to the mapping contained in Appendix A to obtain an overall understanding of the different sources and level of flood risk which may affect their site. Further detail on any relevant sources of flooding can be found in Chapter 3.

1.3.10 Chapter 6 provides detailed guidance in undertaking site-specific FRAs, depending on the Flood Zone and the type of development. This chapter also describes common measures which are available for appropriately managing and mitigating flood risk. Further detail on the applicability and use of different types of SuDS is provided in Appendix B.

1.3.11 Developers should also refer to Chapter 5 in order to understand the compatibility between different types of development and levels of flood risk, and how LBTH will apply the Sequential Test to assess planning applications.

1.4 Study Area

Location

1.4.1 The study area is defined by the administrative boundary of LBTH, illustrated in Map 001, Appendix A. The Borough covers an area of approximately 20 km^2 and is located to the East of the City of London, between the London Borough of Newham to the east and the London Borough of Hackney to the north. The River Thames runs along the southern boundary of the Borough for over 10 km, and the River Lee flows from north to south along the extent of the eastern boundary, before discharging into the River Thames.

1.4.2 The study area falls into the Thames River Basin District and is located in the EA Thames Region. The water utility provider is Thames Water Utilities Ltd.

Land Use

1.4.3 As a large inner city Borough, Tower Hamlets is heavily urbanised, with a variety of commercial, residential and industrial land uses. The Borough accommodates a rapidly growing population, estimated at 284,000, as of June 2014[1].

1.4.4 The financial centre of Canary Wharf is located on the Isle of Dogs and the historic Tower of London is situated in the south west corner of the Borough. A network of strategic transport infrastructure traverses the Borough, including the Docklands Light Railway, London Underground and Overground, Network Rail and major road routes controlled by Transport for London (TfL).

Topography

1.4.5 The topography of the Tower Hamlets generally slopes in a south-easterly direction, towards the River Lee and the River Thames. The highest areas of the Borough are adjacent to the boundary with the London Borough of Hackney to the north-east, and the lowest are along the River Thames frontage, particularly in the Isle of Dogs, Wapping and Bromley by Bow.

1.4.6 The general topography of the Borough is illustrated in Map 002, Appendix A.

River Network

1.4.7 The Borough is bounded by the River Thames to the South and the River Lee to the East, with the confluence of these waterways forming the south-eastern corner of the Borough. These are both Main Rivers, as defined by the EA.

1.4.8 The River Lee originates near Luton, flowing through Bedfordshire, Hertfordshire and London in a south easterly direction, draining a catchment area of approximately 1400 km^2. It is a part of the Bow Back River System and has a connection to a network of canals which run through the Borough. These include:

- The Limehouse Cut and the River Lea Navigation Canal, which are designated as Main Rivers;
- The Grand Union Canal, which flows from the London Borough of Hackney and bisects the Borough from north to south, discharging in the Limehouse Basin; and
- Hertford Union Canal, which flows in an east-westerly direction between the River Lee and the Grand Union Canal.

1.4.9 All of these watercourses are artificial and managed by the Canal and Rivers Trust.

[1] Office for National Statistics https://www.ons.gov.uk/

1.4.10 There are additionally a series of docks and basins present across Tower Hamlets, predominately connected to the River Thames by lock gates, as described in Section 3.3.40.

1.4.11 The River Network within the Borough is illustrated in Map 001, Appendix A.

Geology

1.4.12 The majority of the Borough is underlain by the fossil rich and impermeable London Clay, excepting the Isle of Dogs and areas along the frontage of the River Thames and Lee, which is underlain by the Lambeth Group, with a small area of Thanet Sand Formation to the south. This solid geology has been formed by drift deposits from river terraces, including Silts, Gravels and an area of Alluvium.

1.4.13 The underlying geology across Tower Hamlets is illustrated in Map 003, Appendix A.

1.5 Methodology and Approach

1.5.1 This SFRA is a desk-based study undertaken using readily available information and existing datasets to enable the assessment of flood risk across the Borough. The information is presented in a suitable graphical format to facilitate the decision making process by LBTH. The SFRA will be used to inform the application of the Sequential Test to local development sites and to identify if any require the application of the Exception Test.

1.5.2 The main activities undertaken in the preparation of this SFRA are summarised below:

- Organise and attend an inception meeting with LBTH as well as a steering group meeting with key stakeholder organisations to establish the main objectives of the study (from each organisation's perspective), aid collaborative working and discuss available information and datasets;
- Liaise with LBTH to request relevant datasets and information from stakeholders;
- Interrogate received data and review against the objectives of the SFRA to identify any gaps in the required information;
- Consult with key stakeholders to agree approach, and define datasets to be included within the SFRA;
- Assess flood risk from all sources, including sea, rivers (fluvial), land (overland flow and surface water), groundwater, sewers and artificial sources; and
- Produce strategic flood risk maps, GIS deliverables and a technical report.

1.5.3 The key datasets selected for inclusion within this SFRA are summarised in Appendix C.

Consultation

1.5.4 The following stakeholders were engaged to provide data and information during this SFRA.

- *London Borough of Tower Hamlets* – LBTH is the Local Planning Authority (LPA), with responsibility for strategic planning of future development, determination of planning applications and emergency planning, as well as development control within the Borough. Additionally, LBTH have a role as the Lead Local Flood Authority (LLFA), responsible for leading the management of flood risk from surface water, groundwater and ordinary watercourses. In particular, officers from the areas of Planning and Flood Risk and Drainage were closely involved in the preparation of this SFRA.
- *Environment Agency* – The EA is responsible for taking a strategic overview of the management of all sources of flooding and erosion. The study area falls entirely in the EA's Thames Region. The EA has discretionary powers under the Water Resources Act (1991) for all Main Rivers and their associated flood defences.

- *Thames Water* – Thames Water is responsible for management of the sewer system across the study area. This includes managing the risk of flooding from surface water, foul and combined sewer systems. In addition, private individuals may be responsible for drainage systems that operate prior to discharge either into a watercourse or into a public sewer.
- *Canals and Rivers Trust* - The canals and docks within Tower Hamlets are owned and managed by CRT, who must be consulted in relation to any development next to the canals or docks.

1.5.5 There are a number of other organisations which play a role in effectively managing flood risk across the London Borough of Tower Hamlets. These include The Greater London Authority, Neighbouring London Boroughs, the London Fire Brigade, Network Rail, London Underground, Transport for London, the Highways Agency and Natural England, among others.

2 Legislative and Planning Policy Framework

2.1 Introduction

2.1.1 This section provides a brief overview of the legislative and national, regional and local planning policy context relevant to the Borough and referenced in the preparation of this SFRA. Hyperlinks providing further detail on each of the described documents are contained in the footnote references where possible.

2.2 National Policy

Flood and Water Management Act (2010)

2.2.1 The Flood and Water Management Act (FWMA)[2] was enacted in 2010, with the intention of enabling the provision of more comprehensive and effective flood risk management. The act formalises flood risk management responsibilities across a range of organisations including the EA, water companies and highways authorities, and requires cooperation across all groups. Unitary authorities, including LBTH, are designated as LLFAs, with responsibility to lead and co-ordinate local flood risk management. As such, LBTH's responsibilities include:

- Coordinate management of flooding from surface water, ground water and ordinary watercourses;
- Develop, maintain and implement Flood Risk Management Strategies;
- Investigate and record local flood events; and
- Establish and maintain a Flood Risk Asset Register.

2.2.2 The Act further required the preparation of a number of other studies and strategies, as described in the following sections.

National Strategy for Flood and Coastal Erosion Risk Management

2.2.3 In accordance with the Act, the EA has developed a National Strategy for Flood and Coastal Erosion Risk Management (FCERM) in England[3]. Developed around the notion of understanding risks, empowering communities and building resilience, this Strategy provides a framework for the work of all FCERM authorities.

Flood Risk Regulations

2.2.4 As well as the duties under the FWMA, LBTH have legal obligations under the EU Floods Directive, which was transposed into UK Law through the Flood Risk Regulations 2009 ('the Regulations')[4].

2.2.5 The regulations set out duties for the EA and LLFAs in the preparation of a range of studies and mapping outputs. As such, LBTH was required to produce a Preliminary Flood Risk Assessment (PFRA), Flood Risk Maps showing the extents and hazards of flooding in their area and Flood Risk Management Plans. These studies are summarised in the following sections.

[2] Flood and Water Management Act (2010) http://www.legislation.gov.uk/ukpga/2010/29/contents
[3] National Flood and Coastal Erosion Risk Management Strategy for England https://www.gov.uk/government/publications/national-flood-and-coastal-erosion-risk-management-strategy-for-england
[4] Flood Risk Regulations (2009) http://www.legislation.gov.uk/uksi/2009/3042/contents/made

National Planning Policy Framework and Planning Practice Guidance

2.2.6 The NPPF[5] was published in March 2012, and present a structure and context for planning within England, providing a framework for local authorities and residents to produce local and neighbourhood plans that reflect the needs and priorities of their communities.

2.2.7 Within the core principles of NPPF, set out in Paragraph 17, it is stated that planning should: "Support the transition to a low carbon future in a changing climate, taking full account of flood risk and coastal change."

2.2.8 Section 10 of the NPPF, titled Meeting the Challenge of Climate Change, Flooding and Coastal Change, establishes the principles for assessing and managing flood risk through the planning and development process.

2.2.9 The overall approach of the NPPF to flood risk is broadly summarised in Paragraph 103:

2.2.10 "When determining planning applications, LPAs should ensure flood risk is not increased elsewhere and only consider development appropriate in areas at risk of flooding where, informed by a site-specific FRA following the Sequential Test, and if required the Exception Test, it can be demonstrated that:

- Within the site, the most vulnerable development is located in areas of lowest flood risk unless there are overriding reasons to prefer a different location, and
- Development is appropriately flood resilient and resistant, including safe access and escape routes where required, and that any residual risk can be safely managed, including by emergency planning; and it gives priority to the use of sustainable drainage systems."

2.2.11 This is achieved by delineating the probability of flooding in any area into three main Flood Zones, as defined by the NPPF. Flood Zone 3 is additionally delineated into Flood Zone 3a (high probability area) and Flood Zone 3b (known as the functional floodplain, where water has to flow or be stored in times of flood). Each of these Flood Zones is described in Table 1.

Table 1 - *Flood Zone Definitions (as defined in the NPPF)*

Flood Zone	Definition	Probability of Flooding
Flood Zone 1	At risk from flood event greater than the 1 in 1000 year event (greater than 0.1% annual probability of each year)	Low Probability
Flood Zone 2	At risk from a tidal flood event between the 1 in 200 and 1 in 1000 year event (between 0.5% and 0.1% annual probability of flooding each year), or a fluvial flood event between the 1 in 100 and 1 in 1000 year event (between 1% and 0.1% Annual flooding probability of flooding each year).	Medium Probability
Flood Zone 3a	At risk from a tidal flood event less than or equal to the 1 in 200 year event (greater than 0.5% annual probability of flooding each year), or a fluvial flood event less than or equal to the 1 in 100 year event (greater than 1% annual probability of flooding each year).	High Probability
Flood Zone 3b	At risk from a flood event less than or equal to the 1 in 20 year event or otherwise agreed between the LPA and the EA.	Functional Floodplain

[5] The NPPF (2012) https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/6077/2116950.pdf

2.2.12 Each LPA is responsible for preparing an SFRA to inform the allocation of development sites within their administrative areas in accordance with their established Sustainability Appraisal. The policy levels of this process in the context of flood risk and the position of the SFRA within the planning framework are shown in Figure 1 below.

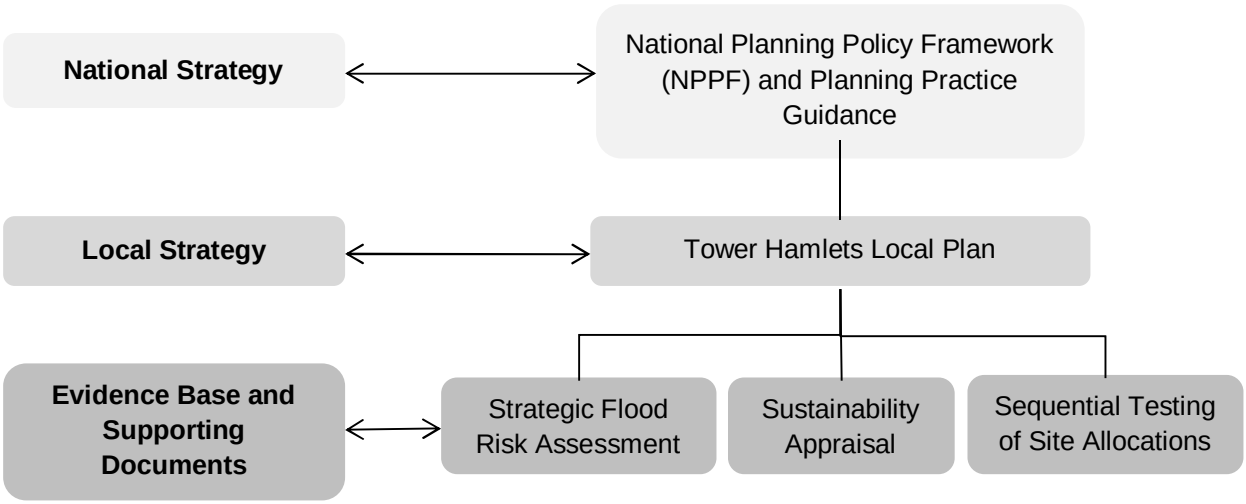

***Figure 1**: Overview of Policy Levels and Documents in the context of Flood Risk*

2.2.13 The NPPF is supported by the Planning Practice Guidance[6], which provides additional guidance to ensure the effective implementation of the planning policy, with particular emphasis on managing flood risk.

2.2.14 Further detail regarding the application of the Sequential and Exception Tests is included in Section 5.1.

2.3 Regional Flood Risk Policy

London Plan

2.3.1 The London Plan[7], updated in March 2015, is the core planning and development guidance document for all of Greater London. Flood risk is considered in the London Plan under the section dealing with response to climate change. Policy statements 5.12 and 5.13 require developers to follow the guidance of NPPF, TE2100 and the SFRA in undertaking a site specific FRA. It also requires developers to follow the Sustainable Urban Drainage Scheme (SuDS) hierarchy when devising surface water management strategies, ensuring where possible surface water is attenuated and stored at source. A key recommendation is that all developments should aim to achieve Greenfield runoff rates where possible.

2.3.2 Supplementary Planning Guidance (SPG) has been published to provide further guidance on policies within the London Plan, which cannot be addressed in sufficient detail within the main Plan. The SPG for Sustainable Design and Construction[8] was published in April 2014, and provides further practical detail on flood risk and sustainable drainage.

2.3.3 To ensure clarity for stakeholders, it is important that LBTH local policy is aligned with the recommendations of the London Plan, particularly with respect to SuDS requirements.

[6] Planning Practice Guidance (2014) http://planningguidance.communities.gov.uk/
[7] The London Pan (March 2015) and London Regional Flood Risk Appraisal http://www.london.gov.uk/priorities/planning/london-plan
[8] Supplementary Planning Guidance for Sustainable Design and Construction https://www.london.gov.uk/what-we-do/planning/implementing-london-plan/supplementary-planning-guidance/sustainable-design-and

London Regional Flood Risk Appraisal

2.3.4 The first review of the London Regional Flood Risk Appraisal (RFRA) was released for public consultation in January 2014, providing underpinning evidence to the London Plan. The RFRA provides a broad overview of the different types of flood risk in London and provides a spatial analysis of tidal, fluvial and surface water flood risk against major development locations, key infrastructure assets and services. The RFRA contains 14 recommendations to be implemented by the EA and other agencies.

Thames Catchment Flood Management Plan

2.3.5 The Thames Catchment Flood Management Plan (CFMP)[9], was published by the EA in December 2009, and is the overarching flood risk management policy document for the Thames River Basin. It provides an overview of flood risk within the catchment and presents the EA's key strategic policy for sustainable flood risk management over the next 50 to 100 years.

2.3.6 The Thames CFMP only covers the fluvial and non-tidal part of Thames region, with the tidal section covered by the Thames Estuary 2100 (TE2100) plan, discussed below. However, the non-tidal downstream extent of the River Lee encroaches into Tower Hamlets and is therefore influenced by the CFMP. Under the Plan, Tower Hamlets falls into the Lower Lee and Lower Lee tributaries Policy Unit. The policy for this area is to "Take further action to reduce flood risk. This could mean lower the probability of exposure to flooding and/or the magnitude of the consequences of a flood, and hence the risk."

2.3.7 The Thames CFMP's vision for managing flood risk in the Lower Lee catchment is:

- To maintain existing flood defences whilst they continue to be effective;
- To reduce, where possible, future costs for maintaining defences by adapting them (for example by replacing moveable structures with fixed structures such as weirs);
- To work with local authorities to achieve a common understanding of future land use within the floodplain, to achieve a net reduction in flood risk from redevelopment, in line with national planning policy;
- To raise public awareness of flooding and how to be better prepared;
- To bring about a growing proportion of housing that is resilient or resistant to all forms of flooding; and
- To respond to climate change by ensuring that the natural floodplain retains it's potential to store floodwater.

Thames Estuary 2100 Plan

2.3.8 The EA's Thames Estuary 2100 Plan (TE2100) covers the Thames estuary from Teddington in the west to the mouth of the estuary at Shoeburyness and Sheerness. It provides a plan for improving the tidal flood defence system for the period to 2100 so that current standards of flood protection are maintained or improved taking account of sea level rise. This plan is of particular relevance to Tower Hamlets, due to the significant level of dependence on the Thames Defences for flood protection.

2.3.9 This study indicates that the present system of flood risk management for tidal flooding can continue to provide an acceptable level of risk management up to 2030 without major alterations. However, beyond 2030 more actions will be needed, and the plan sets out recommendations and a timeline for these.

2.3.10 Tower Hamlets contains most of the TE2100 Isle of Dogs and Lea Valley policy unit and part of the London City policy unit. Both of these policy units have been designated TE2100 policy 5, "to take

[9] Thames Catchment Flood Management Plan https://www.gov.uk/government/publications/thames-catchment-flood-management-plan

further action to reduce the risk of flooding (now or in the future)". This advocates an increase in the level of flood protection from the current 1 in 1000 year level to 1 in 10,000; justified by the unique commercial, economic and historic value of London, as well as the potential for loss of life in the unlikely event of an extreme flood event.

2.3.11 Specific actions in the TE2100 Plan that refer to the Borough are as follows:

- To maintain, enhance or replace the existing river defence walls/banks and flood control structures;
- To implement a programme of defence raising through Central London in about 2065;
- To incorporate the Riverside Strategy concept into local plans, strategies and guidance documents;
- To agree a programme of managing flooding from other sources in the defended tidal floodplain;
- To inform the development and revision of local council SFRAs and flood plans;
- To agree partnership arrangements and principles to ensure that new development in the tidal flood risk area is safe and where possible applies the NPPF to reduce the consequences of flooding; and
- To agree partnership arrangements and a programme for floodplain management.

2.3.12 The implications of the TE2100 Plan are of integral importance to flood risk management in Tower Hamlets and should be closely considered in the formulation of local planning policy. Further recommendations on the translation of the Plan findings to strategic planning and development control within the Borough are contained in Section 5.2.

Thames River Basin District Flood Risk Management Plan

2.3.13 Under the EU Floods Directive and UK Flood Risk Regulations, the EA is required to prepare FRMPs for all of England covering flooding from main rivers, the sea and reservoirs. The updated Thames River Basin District FRMP[10] was published by the EA in March 2016, setting out the proposed measures to manage flood risk within the District from 2015 to 2021 and beyond. The measures in the Thames FRMP have been formulated in line with agreed social, economic and environmental objectives and are grouped under 4 categories, summarised below.

- Preventing risk
  - Working with local planning authorities to ensure development takes place in the areas with the lowest risk of flooding;
  - Maintaining existing flood defences so that they continue to protect properties in future; and
  - Carrying out a prioritised programme of mapping and modelling to ensure flood risk information remains up to date and fit for purpose.
- Preparing for risk:
  - Working with communities to help them understand their risk and how to prepare effectively, improving emergency response; and
  - Continuing to invest in improving real-time data and information to provide a quality flood warning service.
- Protecting from risk:
  - Reducing the likelihood of flooding affecting people and property in specific locations or in locations that have flooded in the past; and
  - Continuing to maintain watercourses that pose the most significant flood risk, responding quickly to incidents and clearing obstructions from screens and culverts during heavy rainfall.

[10] Thames River Basin District Draft Flood Risk Management Plan https://www.gov.uk/government/publications/thames-river-basin-district-flood-risk-management-plan

- Recovery and review:
  - Continuing to carry out investigations after flooding, produce recommendation reports and help communities to recover from floods more quickly.

Thames River Basin District Management Plan

2.3.14 The Thames River Basin District Management Plan[11] was updated in 2015, and has been prepared under the European Water Framework Directive. The plan describes the river basin district, the pressures impacting the state of the water environment, and proposed actions to address these. The waterbodies within Tower Hamlets are covered by two separate catchments within the plan. This includes the London - Lower Lee South catchment and the Thames Tidal catchment.

2.3.15 The plan highlights several water management issues across the Basin, including physical river modification, flow regulation and a lack of natural river processes. This has led to a loss of habitat diversity and barriers for fish migration throughout the catchment. Water quality is also a significant issue across the catchments, with pollution pressures due to increased surface water run-off, storm sewage overflows, misconnections and effluent discharge. The plan identifies a series of actions to assist in improving water body status by addressing the water management issues highlighted.

Lower Lee Strategy

2.3.16 The EA has developed a detailed strategy for the Lower Lee Catchment, summarised in the 2014 publication "Managing flood risk in the Lower Lee catchment, today and in the future"[12]. The policy considers the overarching Thames CFMP agreed policies for fluvial flooding and providing a basis for implementing these policies specifically in the Lower Lee region. The proposals particularly relevant to Tower Hamlets are associated with ongoing maintenance and improvement of the River Lee Flood Relief Channel, and associated hydraulic control structures.

2.4 Local Planning Policy and Flood Risk Strategies

Local Plan

2.4.1 LBTH is currently in the process of preparing a new Local Plan, which will set out the spatial vision, planning strategy and policies for the Borough over the next 15 years. The emerging planning process has identified key topics to focus the local plan:

- *Town centres* - Vibrant and varied town centres which bring communities together, as places for retail, leisure and social enjoyment;
- *Housing* - New homes, in particular affordable and family homes which meet the needs of existing and future residents.
- *Economy and jobs* - Strong and diverse employment base, which delivers our regional role and with a focus on small and medium sized enterprises (SMEs), which provides employment opportunities for local residents.
- *Community facilities* - Mixed community neighbourhoods supported by high quality and accessible education, health, leisure and community facilities, to help promote community cohesion.
- *Design and historic environment* - Distinct and high quality built environment which protects and enhances the places and assets that make the Borough unique and promotes high quality and safe public spaces.

[11] Thames River Basin District River Basin Management Plan https://www.gov.uk/government/publications/thames-river-basin-district-river-basin-management-plan

[12] Managing flood risk in the Lower Lee catchment, today and in the future https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/288611/Managing_flood_risk_in_the_Lower_Lee_catchment_3131d9.pdf

- *Transport and connectivity* -An improved and sustainable transport network to ensure people living, working and visiting the Borough are able to get around easily.
- *Open space and green grid* -- Improved existing open spaces so they are better connected, more accessible and of higher quality. Provide more open spaces, to meet the needs of our growing population.
- *Environmental sustainability* - Protecting, enhancing and promoting sustainable development to achieve wider social, economic and environmental benefits. Including waste management, reducing flood risk, enhancing biodiversity, improving air quality and decreasing carbon emissions.

Core Strategy and Development Management Document

2.4.2 The current LBTH Local Plan consists of the Core Strategy[13] and Managing Development Document[14]. These two documents provide spatial and development management polies to guide and manage development across the Borough.

2.4.3 The Core Strategy was adopted in 2010 and sets out the vision for growth and development within the Borough until 2025. Within the Core Strategy, flood risk is primarily addressed within Policy SP04 Part 5. This policy states that the Borough will "*Reduce the risk and impact of flooding through:*

- Using the Sequential Test to assess and determine the suitability of land for development based on flood risk.
- All new development that has to be located in a high risk flood zone must demonstrate that it is safe and passes the Exception Test (in accordance with PPS25).
- Ensuring that all new development across the Borough does not increase the risk and impact of flooding.
- Ensuring the application of flood-resilient design of all new developments in areas of Flood Risk 2 and 3a.
- Protecting and where possible increasing the capacity of existing and new water spaces to retain water.
- All new developments must aim to increase the amount of permeable surfaces, including SUDS, to improve drainage and reduce surface water run-off.
- Seeking to maintain existing flood defences to the appropriate standards and, in the case of riverside development, improve the standard, lifetime and access to such defences.
- Ensuring effective emergency-planning practices are in place
- Working closely with the Environment Agency to keep up-to-date information about flood risk in the Borough."

2.4.4 This policy is complemented by a number of other sub-policies within SP04, which aim to promote green corridors and infrastructure and enhance water spaces across the Borough.

2.4.5 These Core Strategy policies are supported by the policies within the subsequent Managing Development Document, adopted in 2013. Notably this includes Policy DM13 for *Sustainable Drainage* and DM12 *Water Space*, supported by DM11 *Living Buildings and Biodiversity.* These policies generally emphasise the importance of SuDS to manage surface water, and promote the conservation of blue-green spaces.

2.4.6 A review of these policies has been undertaken, in light of the findings of this SFRA, and is contained in Section 4.7.

[13] Tower Hamlets Core Strategy http://www.towerhamlets.gov.uk/Documents/Planning-and-building-control/Strategic-Planning/Local-Plan/Core-Strategy-and-MDD/Core-Strategy-low-resolution.pdf

[14] Tower Hamlets Managing Development Document http://www.towerhamlets.gov.uk/Documents/Planning-and-building-control/Strategic-Planning/Neighbourhood-Planning/Managing-Development-Document-April-2013.pdf

Local Flood Risk Management Strategy

2.4.7 As a LLFA, LBTH has a statutory duty to develop, maintain, apply and monitor a strategy for local flood risk management. Tower Hamlets has published a Draft Local Flood Risk Management Strategy[15] (LFRMS), which provides guidance and information for residents, businesses and developers regarding managing flood risk. The document outlines LBTH's responsibilities as a LLFA and also clarifies the role of other organisations in managing flooding across the Borough. The LFRMS further provides an overview of the sources of flood risk across the Borough and outlines options for dealing with flooding.

2.5 Other Local Studies

Tower Hamlets Surface Water Management Plan

2.5.1 A Surface Water Management Plan (SWMP)[16] was produced for LBTH as part of the Drain London Study. This study undertook an assessment of flooding from sewers, drains, groundwater and runoff from land, small watercourses and ditches that occurs as a result of heavy rainfall. The plan outlines the preferred surface water management strategy for the Borough and includes an Action Plan that has been developed in conjunction with both LBTH and other relevant Risk Management Authorities.

2.5.2 As part of the Phase 2 Risk Assessment, direct rainfall modelling has been undertaken across the entire Borough for five specified return periods. The results of this modelling have been used to identify Local Flood Risk Zones (LFRZs) where flooding affects people, property or local infrastructure. Those areas identified to be at more significant risk have been delineated into Critical Drainage Areas (CDAs) representing one or several LFRZs as well as the contributing catchment area and features that influence the predicted flood extent. The SWMP identified 14 CDAs in Tower Hamlets. However, it should be noted that subsequent studies have further refined the understanding of surface water flood risk in the Borough, superseding the CDA's defined during the SWMP (as further described in Section 3.3.31).

2.5.3 The main outputs of the Tower Hamlets SWMP have been considered in the preparation of this SFRA.

Preliminary Flood Risk Assessment

2.5.4 Under the Flood Risk Regulations, all LLFAs were required to prepare a PFRA. This study provides a high level summary of areas of significant flood risk, describing both the probability and consequences of past and future flooding.

2.5.5 The Tower Hamlets PFRA[17] was produced in June 2011 as part of the Drain London study, drawing upon the data and information available from the SWMP. The assessment gives an overview of all local sources of flood risk. Boroughs must review the PFRA every six years and therefore the next update of this document is due in 2017.

Tower Hamlets SuDS Guidance

2.5.6 The LBTH SuDS Guidance[18] was published in 2016 and is aimed at developers, council officers and other bodies within the Borough who play a role in the planning and installation of SuDS. The

[15] Tower Hamlets Local Flood Risk Management Strategy http://www.towerhamlets.gov.uk/Documents/Environmental-protection/Monitoring/Draft-Local-Flood-Risk-Management-Strategy.pdf

[16] Tower Hamlets Surface Water Management Plan http://www.towerhamlets.gov.uk/Documents/Environmental-protection/Monitoring/DLT2-GP4-TowerHamlets-SWMP-V2.0-Merged.pdf

[17] Tower Hamlets Preliminary Flood Risk Assessment
http://www.southwark.gov.uk/downloads/download/4298/preliminary_flood_risk_assessment_pfra
http://www.towerhamlets.gov.uk/Documents/Environmental-protection/Monitoring/DLT2-GP4-TowerHamlets-PFRA.pdf

[18] Tower Hamlets SuDS Guidance http://www.towerhamlets.gov.uk/Documents/Environmental-protection/Monitoring/LBTH-SuDS-Guidance-up-to-date.pdf

document summarises the legislative and local policy background to SuDS and further explains the purpose and nature of the attenuation requirements across the Borough. The guidance provides practical advice to developers on SuDS measures which are likely to be suitable within Tower Hamlets and details relevant calculation and design methodologies.

London Borough of Newham Strategic Flood Risk Assessment

2.5.7 The neighbouring London Borough of Newham is updating their SFRA in line with the latest policy and flood risk information. This includes utilising updated hydraulic modelling to assess the risk of fluvial flooding from the River Lee, considering the latest climate change allowances. Due to the transboundary nature of the watercourse, the findings of the assessment are relevant to LBTH. As such, LBTH have engaged with London Borough of Newham to coordinate with respect to this updated hydraulic modelling.

3 Flood Risk in Tower Hamlets

3.1 Overview

3.1.1 The Borough is bounded to the south by the River Thames and to the east by the River Lee. Whilst the tidal Thames poses a potential risk of flooding to properties within the Borough, the Thames Tidal Defences (TTD) provide substantial protection from this source, up to the 1 in 1000 year event (0.1% AEP). This protection is effective provided the Thames Barrier is operated to protect against storm surges from the North Sea and that there is sufficient storage behind the barrier to accommodate the River Thames when it is shut during extreme fluvial events at high tides. The River Lee is also defended; however, small areas to the north-east of the Borough are at actual risk of fluvial flooding from this source, due to overtopping of defences during the 1 in 100 year return period event and above (1% AEP) (Map 013A - 013C).

3.1.2 A potential risk of flooding from other (non-river related) sources exists throughout the Borough, including sewer surcharge and surface water flooding as a result of heavy rainfall. This is known to be an issue within CDAs, in particular, the Isle of Dogs (Map 006).

3.1.3 Areas throughout the Borough (Map 007) are also thought to be susceptible to elevated groundwater levels, which may additionally interact with and exacerbate other sources of flood risk. It is expected that changing climate patterns will have a substantial impact on the level of flood risk from all sources within the Borough.

3.1.4 The various sources of flooding with the potential to affect the Borough have been analysed in this Chapter. Mapping indicating the spatial distribution of all sources of flood risk is contained in Appendix A.

3.2 Historic Flooding

3.2.1 Information on known and recorded historic flooding events within the Tower Hamlets is shown in Map 004, Appendix A and broadly summarised below.

3.2.2 Limited records are available for localised flooding incidents across LBTH. This is likely due to a historical lack of centralised recording of such flood incidents across the UK, and should not be interpreted as indicating a low probability of future flooding. Conversely, some of the recorded historical events might have been as a result of issues that have now been addressed and, therefore, an indication of historical flooding affecting a particular location does not necessarily mean that the locality affected remains prone to flooding.

3.2.3 A site specific FRA will be required to confirm whether any historical issues have been addressed and development in previously flooded sites can take place.

Historic Flooding from the Sea

3.2.4 Severe flooding affected central London in 1928 when the defences along the River Thames were breached, causing inundation of much of the Isle of Dogs and the other areas of the Thames frontage.

3.2.5 A further notable historic tidal flooding event occurred in 1953, when a storm surge impacted the east coast of the UK, causing high tidal levels to breach flood defences and resulting in extensive flooding across London and the Thames Estuary. Within Tower Hamlets, the event predominantly impacted the confluence of the River Lee and River Thames, causing flooding in the Docklands area.

Historic Flooding from Rivers

3.2.6 The Borough was severely impacted by flooding in March 1947, when a combination of rainfall and snowmelt caused a rise in water levels within the River Lee and its tributaries. The subsequent flooding inundated areas across the East India Docks Basin, South Bromley and Canning Town.

3.2.7 Following this event, defences were implemented along the Lower Lea. Since this time, flooding has occurred in 1968, 1978, 1983 and 2000; however, this has been largely confined to the upper catchment and therefore did not have a significant impact on the Borough.

Historic Flooding from Surface Water

3.2.8 Limited historic surface water flooding events have been recorded across the Borough, with only two events listed in the Tower Hamlets local flood incident records, both recorded in August 2014. This is representative of historically sporadic recording of localised flooding incidents across London. The lack of recorded incidents in the Borough should not be interpreted as a sign of low probability of flooding from this source in the future.

Historic Groundwater Flooding

3.2.9 Limited records of groundwater flooding incidents across the Borough have been sourced, with only one incident recorded by the EA to date. However, it should be noted that there has not been a statutory obligation to record incidences of groundwater flooding in the past, and it is therefore likely that this list is not exhaustive.

Historic Sewer Flooding

3.2.10 General information on sewer flooding history has been provided by Thames Water, and is contained within Map 004, Appendix A. This data indicates the total number of properties which have been impacted by sewer flooding (both externally and internally), per postcode area, over the previous decade.

3.2.11 It should be noted that the flood records provided by Thames Water may not provide a complete and/or accurate account of flood events from this source in the city over the last 10 years. Some minor flooding incidents may go unreported, particularly if no property is affected.

Historic Flooding from Artificial Sources

3.2.12 There is no known history of flooding from artificial sources within the Borough.

3.3 Flood Risk from all Sources

Tidal Flood Risk

3.3.1 Tower Hamlets is bounded to the South by the lower reaches of the River Thames, which drains a catchment area of 5,000 square miles as it flows towards the sea. The primary flood risk mechanisms associated with the River Thames are summarised below:

- Daily tidal fluctuation, occurring when the freshwater Thames is met by the incoming tide from the North Sea;
- Surge tides, which occur due to climatic conditions creating bands of low pressure in the Atlantic and North Sea. This causes a surge of water to move across the Atlantic, travelling southwards into the North Sea and becoming compressed as it travels towards and through the narrow English Channel, between Great Britain and mainland Europe. This causes a rapid rise in sea levels, which can be exacerbated by strong northerly winds; and

- Fluvial mechanisms, due to prolonged rainfall within the upper reaches of the Thames catchment during times of high tide.

3.3.2 The greatest overall flood risk from the River Thames occurs when tidal surges coincide with particularly high tide levels and/or fluvial flooding in the upper reaches of the catchment. As the flood risk associated with fluvial mechanisms is relatively minor, compared to the tidal influence, the risk from this source is defined as tidal and addressed as such within this SFRA. Fluvial influences on this tidal risk have, however, been considered within this analysis.

3.3.3 The Thames Tidal Defence system, including the Thames Barrier and Thames River Walls provide the Borough with a significant Standard of Protection (SoP) against tidal flooding, up to the 1 in 1000 year event (0.1% AEP). The current and future River Thames Defences are described in further detail in Section 3.4.

3.3.4 Whilst these defences provide a significant SoP to the Borough, it is essential to appreciate that they are engineered structures which can only protect to a certain point, may malfunction and have a finite design life. There will always therefore be a residual risk of flooding from this source, associated with:

- Overtopping of the defences, during a larger event than has been planned for; or
- Breach of the defences, due to structural/operational failure.

3.3.5 The likelihood of such residual risks are very small; however, the scale of consequences from rapid inundation and deep water in heavily urbanised areas mean that these residual risks must be considered (as further expanded in the following sections).

3.3.6 The risk of flooding from Rivers and the Sea across the Borough is illustrated in Map 005, Appendix A. This map delineates the probability of flooding into the Flood Zones, defined previously in Table 1 (Section 2.2.11). There are three main areas at risk of tidal flooding in Tower Hamlets, as indicated by the mapped Flood Zones. This includes the Isle of Dogs, extending into Poplar, Wapping and Blackwall. All of these areas are located within Flood Zone 3, with additional areas of Poplar located in Flood Zone 2.

3.3.7 It should be noted that these Flood Zones are defined based on an undefended scenario not taking into account the influence of defences, including the Thames Barrier and river walls. Therefore the actual risk of flooding from these sources is much lower.

3.3.8 The floodplain areas associated with the River Thames do not have a Flood Zone 3b or functional floodplain associated with them, as they are classed as defended and would not flood during a 1 in 20 year event. Therefore, the functional floodplain has been defined as the area situated on the river side of the raised defence line.

3.3.9 For the purposes of applying the Sequential Test combined fluvial and tidal Flood Zones are illustrated in Map 005, Appendix A.

Overtopping

3.3.10 The TTD provide a 1 in 1000 year level of protection. Overtopping occurs when flow exceeds the capacity of the channel to convey that flow, and water passes over a flood defence. Low levels of overtopping may arise even when the defence crest level is higher than the water level due to the actions of winds, wave and spray.

3.3.11 No assessment of risk associated with overtopping has been made as part of this study. Development proposals adjacent to The River Thames flood defences should include a FRA containing assessment of overtopping risk.

Breaching

3.3.12 The tidal floodplain areas associated with the River Thames and classified as defended. Therefore, the associated flood risk within these areas is that of a residual nature, resulting from a failure or breach in the flood defences. To provide further detail on the variation of the residual risk, hydraulic breach modelling was commissioned by the EA along the extent of the Tidal Thames frontage, from Teddington to Dartford Creek.

3.3.13 This modelling was completed in 2014 using TuFlow software, simulating breach of the tidal defences in 113 critical breach locations, focused on those which are likely to result in the most severe flooding, including 15 locations within the Borough. These breach locations are shown in Map 012, Appendix A, and further detailed in Table 2 below.

Table 2 - *Breach locations*

Breach Name	Description	Coordinates	
		Eastings	Northings
City01	Tower Bridge Wharf	534075	180235
City02	Watsons Wharf	534430	180065
City03	St. Johns Wharf / Phoenix Wharf	534910	180080
City04	Pelican Wharf	535365	180495
City05	Riverside Gardens	534800	180010
Dog01	Limekiln Wharf	536832	180691
Dog02	Hutchings Wharf	537035	179615
Dog03	Sir John Mc Dougall Gardens	537050	179410
Dog04	Cyclops Wharf	537165	178700
Dog05	Island Gardens	538430	178335
Dog06	Isle Of Dogs Pumping Station	538385	179725
Dog07	Raleana Wharf	538500	180350
Dog08	Blackwall Yard Reuter Plc	538735	180605
Dog09	Trinity Buoy Wharf	539500	180685
Dog10	Poplar Gas Works	538623	181692

3.3.14 The modelling simulated a breach in the river defences, occurring at the same time as a defined Maximum Likely Water Level (MLWL). These MLWLs were determined using combinations of flow and tide, consistent with the water levels used in the TE2100 plan, and modelled under present day conditions (2015) in addition to two climate change scenarios (2065 and 2100). The breach locations have been largely defined by previous studies, and have been selected based on floodplain topography behind the flood defences and property density, in order to represent expected worst case scenarios. As such, the modelling did not take into account the conditions of the defences or the expected probability of localised breaches. For the purposes of the hydraulic analysis, breach width was assumed as a uniform 20 m, across all modelled breaches.

3.3.15 The potential maximum extent of inundation resulting from defence breaching for each of the considered scenarios is shown in Map 012A, Appendix A. The maximum modelled water depth, velocity and hazard resulting from these breaches is illustrated in Map 012B, Map 012C and Map 012D respectively. These maps indicate the modelled breach characteristics, including allowance for anticipated climate change impacts in the year 2100.

3.3.16 When considering these maps, it is essential to consider the limitations and assumptions of the modelling. In particular, not all possible breach locations have been considered in this study. As such, the illustrated flood velocity, depth and hazard represent the expected conditions arising from one or more of the specific breach locations and, as such, will vary spatially if the breach location is in a different local area.

3.3.17 All proposed development sites in Flood Zone 2 and Flood Zone 3 (and sites over a hectare in Flood Zone 1) would be subject to a site specific FRA. Therefore, it is recommended that if any proposed development is located within the breach extent of the Thames, consideration should be given to whether a detailed breach assessment is required, unless they are covered by one of the 15 locations modelled or it can be otherwise demonstrated the local conditions, such as topography, condition of flood defences or flow paths would not result in inundation of the site.

Flooding from Rivers

3.3.18 Fluvial flooding occurs when water levels exceed the bank level of a watercourse, causing overtopping into adjacent areas. This can result from prolonged rainfall within the catchment, restrictions or blockages within the channels or high water levels preventing discharge at the outlet. This can also be impacted by wet catchment conditions and high groundwater levels.

3.3.19 Part of Tower Hamlets is within the Lower Lea Valley, which may be impacted by flooding associated with the lower reaches of the River Lee, which runs along the eastern boundary of the Borough. The River Lee system includes the River Lee Navigation Channel, and is also hydraulically connected to the Limehouse Cut, as the other Main Rivers within the catchment. These two watercourses have been assessed as a part of the fluvial flood risk assessment.

3.3.20 The River Lee is additionally tidally influenced along much of its extent within Tower Hamlets; this tidal influence has been considered within the assessment below.

3.3.21 Aside from the River Lee system, there are no other watercourses within the Borough known to present a risk of fluvial flooding. It should be noted that, that limited information is available on the level of flood risk associated with any ordinary watercourses (canals). However, there is no known flood history associated with these sources, and the perceived risk is therefore considered to be low.

3.3.22 The risk of flooding from Rivers and the Sea across the Borough is illustrated in Map 005, which delineates the probability of flooding into the Flood Zones, as defined in Table 1 (Section 2.2.11). This map depicts the main areas at risk of flooding from the River Lee, according to the Flood Zones, as located in the north-eastern corner of the Borough, close to the border with Hackney and Newham. This is due to overtopping of the banks of the River Lee Navigation Canal.

3.3.23 It should be noted that these flood zones are defined based on an undefended scenario, not taking into account the influence of defences. Therefore the actual risk of flooding from these sources is much lower. Under a 1 in 20 year event, water levels within the River Lee are confined within the defences. For this reason, there is no Flood Zone 3b associated with this watercourse within Tower Hamlets.

3.3.24 For the purposes of applying the Sequential Test combined fluvial and tidal flood zones are illustrated in Map 005, Appendix A.

Overtopping

3.3.25 The actual risk of flooding from the River Lee, due to overtopping of defences, has been assessed considering a defended scenario and is illustrated in Map 013A - 013C, Appendix A. It can be seen that areas to the north west of the Borough, within the Legacy Olympic area, are at risk of flooding. In particular, several areas of the Borough are shown as impacted by channel overtopping for all events above and including the 1 in 100 year (1% AEP) event, including:

- A localised area to the west of the confluence of the River Lee and River Lee Navigation Canal;
- A small area to the south of the intersection between the A12 and A11, along the River Lee;
- Small areas along the River Lee adjacent to Pudding Mill Station; A small area at the confluence of the River Lee and the Limehouse Cut; and
- A small area to the north of the Borough, near Hackney Wick, is impacted by flooding from the River Lee Navigation Canal.

The extent of flooding increases, particularly around the north west of the Borough, under increasing climate change scenarios, and all subsequent return period events.

Breaching

3.3.26 No assessment of risk associated with breach of the River Lee defences has been made as part of this study. Development proposals adjacent to River Lee defences should include a FRA considering the risk of defence breach.

Flooding from Surface Water

3.3.27 Pluvial flooding occurs when high intensity rainfall generates runoff which flows over the surface of the ground and ponds in low lying areas, before the runoff enters any watercourse or sewer. It is usually associated with high intensity rainfall events and can be exacerbated when the soil is saturated and natural drainage channels or artificial drainage systems have insufficient capacity to cope with the flow.

3.3.28 This source of flooding can be compounded when combined with impermeable sub-soils, significant areas of development with associated hard standing areas or areas of open grassland. As the majority of the study area is heavily developed, the risk of surface water flooding is increased.

3.3.29 The Tower Hamlets SWMP undertook a comprehensive review of pluvial flood risk, including direct rainfall modelling and mapping across the Borough. As part of this study, the surface water flood risk was mapped and analysed. The following primary flooding mechanisms identified were:

- *Topographical Low Lying Areas* - greater susceptibility to surface water flooding in areas such as underpasses, subways and lowered roads beneath railway lines;
- *Railway Cuttings and Embankments* - stretches of railway track in cuttings and areas along the upstream side of raised embankments are likely to be susceptible to surface water flooding;
- *Topographical Low Points* – areas at topographical low points within the Borough may result in small, discrete areas of deep surface water ponding;
- *Sewer Flood Risk* – the influence of sewer flooding mechanisms (alongside pluvial, groundwater and sewer flooding sources) is likely to result in extensive and deep surface water flooding in certain areas; and
- *Fluvial/Tidal Flood Risk (River Lee)* - the influence of fluvial flooding mechanisms (alongside pluvial and groundwater sources) is likely to result in extensive and deep surface water flooding in certain areas.

3.3.30 The SWMP further identified LFRZs) where flooding may affect houses, businesses or infrastructure. Those areas identified to be at more significant risk were further delineated into CDAs representing one or several LFRZs as well as the contributing catchment area and features that influence the

predicted flood extent. 14 CDAs were identified during the SWMP study, as deemed to be at risk of significant flooding (greater than 0.5 m deep) during the 1% AEP rainfall event.

3.3.31 However, subsequent to the SWMP, further more refined surface water modelling has been undertaken, as part of the Tier 3 Drain London programme. This work has increased the precision of the hydraulic modelling and also, incorporated the local sewer and drainage system to obtain a more accurate understanding of flood risk across the Borough. As a result, the original CDAs have been redefined into four new CDAs.

3.3.32 The surface water flood risk and latest CDAs across the Borough are shown on Map 006, Appendix A.

3.3.33 As illustrated on Map 006, Appendix A, the updated modelling highlights a particularly high level of pluvial flood risk across the Isle of Dogs. Topographically, this is a low lying area positioned at the downstream end of the sewage catchment which drains a large proportion of the Borough towards Abbey Mills pumping station (from where it is pumped towards the Beckton Sewage Treatment Works). Abbey Mills is known to have capacity limitations which impact upon surface water flood risk under higher return period events. The Isle of Dogs is thereby impacted when flood volumes across the wider northern London catchment exceed the capacity of the drainage network, resulting in surcharge. The increased level of surface water flood risk in this area is additionally likely to be exacerbated by the particularly intense rates of redevelopment in this area.

Flooding from Groundwater

3.3.34 Groundwater flooding occurs as a result of water rising up from an underlying aquifer or flowing from abnormal springs. This tends to occur after much longer periods of sustained high rainfall, and the areas at most risk are often low-lying where the water table is likely to be at shallow depth. Groundwater flooding tends to occur sporadically in both location and time, and tends to last longer than fluvial, pluvial or sewer flooding. Groundwater flooding can also interact with other flood sources, exacerbating the risk of pluvial, fluvial or sewer flooding by reducing rainfall infiltration or infiltrating to sewers.

3.3.35 Within London, the primary mechanisms for elevated groundwater are associated with:

- Above average rainfall for a number of months in Chalk outcrop areas;
- Shorter period of above average rainfall in permeable superficial deposits;
- Permeable superficial deposits in hydraulic continuity with high river water levels;
- Interruption of groundwater flow paths; and
- Cessation of groundwater abstraction causing groundwater rebound.

3.3.36 The areas deemed to be at greater susceptibility to flooding from groundwater are illustrated in Map 007, Appendix A.

3.3.37 It can be seen that there are significant areas, predominately within the North of the Borough, which are indicated to have a higher potential for groundwater flooding.

3.3.38 It should be noted that the dataset used to produce these map provides only a high level indication of groundwater flooding susceptibility, based on broad scale assumptions. In particular, where non-aquifers are present at the ground surface, these areas have been denoted as not susceptible to groundwater flooding. This may not be appropriate for consideration of flood risk to basement areas or impedance to flow from below ground structures where aquifers are known at depth. Additionally, within the areas delineated, the local rise of groundwater will additionally be heavily controlled by local geological features and artificial influences (e.g. structures or conduits).

3.3.39 This data should therefore be used in conjunction with a range of other relevant information to inform land-use and planning decisions. Reference should additionally be made to the assessment of

subterranean development contained in Section 4.3. Site specific investigation and assessment is recommended to confirm groundwater levels at development sites.

Flooding from Artificial Sources

3.3.40 Reservoirs, canals, water retention ponds, docks and other artificial structures may have a potential flood risk associated with them. Generally, under normal circumstances, the flood risk posed is low; however, if a breach occurs, extensive flooding could be experienced.

3.3.41 A number of reservoirs, canals and open water bodies have been identified within Tower Hamlets, as described below.

Canals

3.3.42 There are a number of canals present within Tower Hamlets, which are owned and operated by the Canal and Rivers Trust, including Regents / Grand Union Canal, Hertford Union Canal, Limehouse Cut and the River Lee Navigation Canal.

3.3.43 Whilst the Limehouse Cut and Lee Navigation are owned and maintained by the Canal and Rivers Trust; they are also classified as Main Rivers and hydraulically influenced by the River Lee system. For this reason, the flood risk from these sources has been considered as a part of the fluvial flood risk assessment in Section 3.3.18.

Docks and Basins

3.3.44 There are many docks and basins present across Tower Hamlets. These are predominately connected to the River Thames by lock gates and include:

- St Katherine Docks, Wapping;
- Shadwell Basin, Shadwell;
- Limehouse Basin, Limehouse;
- West India Docks, Isle of Dogs;
- Poplar Dock and Blackwall Basin, Isle of Dogs;
- Millwall Docks (outer and inner), Isle of Dogs; and
- East India Docks, Blackwall.

3.3.45 These structures are all maintained by the Canals and Rivers Trust. It is understood that there is a very low risk of flooding associated with these structures, provided active management and regular maintenance is undertaken.

Reservoirs

3.3.46 There are no reservoirs located within Tower Hamlets; however, areas along the eastern boundary of the Borough and in the Poplar area are shown to be within the extent of flooding anticipated by breach of the Willing Girling, King George V and Lockwood Reservoirs, to the North of the Borough.

3.3.47 It should be noted that reservoir flooding is considered extremely unlikely, with no loss of life in the UK from reservoir flooding since 1925. The EA is the enforcement authority for the Reservoirs Act 1975 in England, and is responsible for ensuring regular inspection and maintenance.

3.3.48 Areas at residual risk of flooding from reservoirs (during a breach event) within the Borough are illustrated within Map 008, Appendix A.

Other Artificial Sources

3.3.49 Numerous small local ponds and water features are also present across the Borough; however, very limited information exists with regards to their capacity and connectivity and therefore an assessment of the flood risk posed by them will need to be made at a site specific level.

Flooding from Sewers

3.3.50 Tower Hamlets is served by a largely combined sewer system, managed by Thames Water. Flooding can occur along the route of sewers when the flow entering a sewer exceeds its hydraulic capacity and the system becomes surcharged. Under these conditions water will overflow from the pipe network at manholes and storm overflows, often causing flooding in the vicinity.

3.3.51 London's first sewerage systems were constructed in the Victorian era and, while much improved over the years, they remain under increasing pressure, and are occasionally overwhelmed. Increasing periods of prolonged and heavy rainfall, along with a number of factors including population growth, the loss of green areas and changes in agricultural land practices, are increasing the risk of sewer and surface water flooding, particularly in urban catchments.

3.3.52 Under current Thames Water standards, sewer systems are typically designed and constructed to accommodate a 1 in 30 year rainfall event (3.33% AEP). Therefore, during rainfall events of greater than a 1 in 30 year event, the sewer system may be susceptible to surcharge and flooding. Additionally, drainage systems across London are of varying age and capacity, with many parts of the system thought to be designed to accommodate a 1 in 15 year return period (6.67% AEP) rainfall event or less.

3.3.53 In addition to capacity issues, sewer flooding can be caused or exacerbated by blockage by debris or sediment within drainage infrastructure, connected to the combined sewer system. There are a number of stakeholders who have important drainage responsibilities and therefore, play an essential role in alleviating sewer flooding. As such, riparian owners, the highways authority, Thames Water and other stakeholders all have responsibility for maintaining drainage infrastructure. Thames Water are seeking to work in partnership with all stakeholders to ensure that together, they implement and maintain the most effective, environmentally-responsible and sustainable drainage strategies.

3.3.54 A contributing factor to system surcharge is high water levels in receiving watercourses. Within the Borough there is potential for sewer outfalls to rivers to become submerged during high water levels (either fluvial or tidal). When this happens, water is unable to escape into the river and flows back along the sewer. Once storage capacity within the sewer itself is exceeded, the water will overflow into streets and houses.

3.3.55 As highlighted in Section 3.3.33, the configuration of the sewer network is likely to influence the level of pluvial flood risk, particularly in the southern extent of the Borough around the Isle of Dogs.

3.3.56 Limited information on sewer capacity and associated flood risk is available for the Borough. The information provided by Thames Water (as described in Section 3.2.10 and shown within Map 004, Appendix A), is restricted to description of general areas where there is a history of flooding from sewers. This data is provided as a four-digit postcode area and only covers the previous ten years of records, resulting in the representation of relatively large areas by limited and isolated recorded flood events thus making it difficult to determine precisely where sewer flooding risk is greatest. Thames Water additionally prioritise investment for potential flood alleviation schemes depending on the severity and frequency of flooding so it is important that all flooding is reported so records can be kept up-to-date.

3.4 Flood Defences

Condition and Standard of Protection

3.4.1 There are two main categories of flood defences, formal and informal (de facto). Formal defences are specifically constructed to control floodwater. Informal defences include structures that have not necessarily been constructed for this purpose but do have an impact on retaining flood water, such as railway and road embankments or other linear infrastructure such as boundary walls and buildings.

3.4.2 The primary flood defences within the Borough are the River Thames defences, including the Thames Barrier and secondary tidal flood defences along the Thames frontage. The Thames Barrier, located in Woolwich Reach downstream of the Borough, is the main structure of the TTD system. When closed, the barrier prevents extreme storm surges from flowing up the estuary and flooding central London. Additionally, the Barrier has also been used to control the risks of fluvial flooding to the upper stretches of the Thames, by closing during low tides to increase the storage capacity in the river channel to safely store fluvial floodwaters that are travelling downstream from the upper catchment in extreme events. Overall, the TTD are designed to provide protection up to a 1 in 1000 year flood event (0.1%AEP).

3.4.3 The River Lee is protected by hard defences along the watercourse frontage, and is further influenced by a complex range of other hydraulic structures and assets. Notably this includes the River Lea Flood Relief Channel (RLFRC), which flows parallel to the River Lee Navigation Canal. Several associated sluice gates, radial gates, weirs and other control structures maintaining constant water levels, with water discharged in times of flood. The channel was completed in 1976, with capacity for a 1 in 70 year event (1.43% AEP) and was running almost full during the storms of October 1987, 1993 and 2000.

3.4.4 Other defences within Tower Hamlets include a floodgate at the entrance to Limehouse Basin, a tidal weir and sluice (Prescott Weir) on the Prescott Channel near Three Mills, a tide flap on the River Lee immediately upstream of Three Mills and flood gates at Bow Lock.

3.4.5 The location of flood defences within the Borough is shown on Map 009, Appendix A, along with the area of the Borough benefiting from their protection. These defences, consisting of masonry, concrete or sheet piled walls are categorised as ‘hard defences’. Such defences may fail through the slow deterioration of structural components such as the rusting of sheet piling, erosion of concrete reinforcement and toe protection or the failure of ground anchors. Erosion of the river bed is understood to be occurring within the Borough, which may require defence improvement to avoid damage.

3.4.6 The EA regularly monitors the condition of their flood defences and has a regular maintenance programme for them. During these inspections, defects are noted and maintenance is usually carried out following a priority scale.

Future Policy on Flood Defences

TE2100

3.4.7 The EA has recently completed a comprehensive study referred to as Thames Estuary 2100 (TE2100), to establish the best approach to manage flood risk in the estuary throughout the 21st century, taking into consideration various Climate Change scenarios.

3.4.8 For the geographical area encompassing the Borough, the study indicates that further action is required in order to keep up with climate change and further manage and reduce both the likelihood and consequence of flooding. This advocates an increase in the level of flood protection from the current 1 in 1000 year level (0.1% AEP) to 1 in 10,000 (0.01% AEP); justified by the unique commercial, economic and historic value of London, as well as the potential for loss of life in the unlikely event of a flood.

3.4.9 Under the TE2100 plan, the recommended measures for defences on the River Thames and Lee within Tower Hamlets include:

- An ongoing programme of inspection, maintenance, repair and replacement of defences;
- Raising of all defences by up to 0.5 m by 2065; and
- Raising of all defences by an additional 0.5 m by 2100. This allows for projected increases in sea level to 2135.

3.4.10 As the defence levels are raised, it will also be necessary to raise the level of the floodgates at Limehouse Basin and Bow Locks, and the River structures on the River Lee and Prescott Channel at Three Mills.

3.4.11 The West India and Millwall docks form an extensive potential flood pathway and there are currently no floodgates on the dock entrances. As water levels in the Thames rise, it is likely that new flood gates will be required at the lock entrances to South West India Dock and Blackwall Basin, as current quay levels may not be sufficient to contain the higher water levels. Similarly, the dock gates at St Katherine's Dock will require raising. The drainage outfalls into the River Thames and Lee may also require improvement to facilitate continued floodplain drainage as the sea level rises and storm rainfall increases.

3.4.12 The actual dates of defence raising will depend on the rate of sea level rise and may be revised with ongoing updates of the TE2100 Plan. Similarly, the requirement and configuration of raised defences and upgraded dock gates will be dependent on ongoing consultation and exploration of options.

3.4.13 The TE2100 plan further highlights the requirement for safeguarding land corridors adjacent to the River Thames and its tributaries (including the River Lee) and setting back development where possible, to allow for defence maintenance, repair and wider riverside enhancement. A recommended width of 10 metres is specified.

3.4.14 It should be noted that, in the future, climate change is anticipated to increase the frequency of closure of the Thames Barrier. Operational constraints, and the needs of the river and its users, may place restrictions on this. Consequently other means of reducing the risk of fluvial flooding from the River Thames may have to be sought in future years.

Thames CFMP

3.4.15 The Thames CFMP addresses the non-tidal sections of the Lower Lea catchment, with a policy to "Take further action to reduce flood risk". The general policy approach is to continue to maintain the Lower Lee defences, while taking opportunities to simplify the system, reducing the complexity and expense of future maintenance. The plan also emphasises the importance of floodplain management to reduce residual risk and reliance on defences, while facilitating adaptation to future climate change.

Flood Alleviation Schemes

3.4.16 In addition to fluvial and tidal flood defences, a number of flood alleviation schemes have been implemented and are planned to manage the flood risk from other sources across the Borough, particularly surface water and sewer flooding. These range from localised SuDS schemes, to more strategic regional infrastructure solutions.

3.4.17 Of particular note is the Thames Tideway Tunnel, a significant new combined sewage storage and transfer system that will help protect the River Thames by alleviating the problem of overflows from London's Victorian sewers. Currently, many low level interceptor sewers overflow directly into the River, with a detrimental impact on the aquatic environment and the fish, invertebrates, birds and aquatic mammals it supports. It is estimated that around 10,000 tonnes of sewage related litter enters the tidal River Thames from combined sewer overflows every year. This will be reduced by 90% once the Tideway Tunnel is operational in 2023.

3.4.18 The main Tideway Tunnel will run from Acton in west London to Abbey Mills Pumping Station in east London, controlling the most polluting combined sewer overflows (CSOs) by intercepting, storing and conveying the discharges which currently flow into the river.

3.4.19 In addition to this large scale project, local stakeholders are undertaking a range of sustainable drainage initiatives across the Borough. Thames Water are currently undertaking catchment studies, which include surveying, monitoring and consultation activities, to investigate whether properties can be protected from flooding through both traditional and new methods. Across their service area, Thames Water are also contributing £20m over the next 5 years towards projects delivering SuDS features (such as rain gardens, swales and permeable paving), with the ultimate aim of removing approximately 20 hectares of hard, impermeable surfaces and subsequently reducing the risk of sewer flooding and pollution following heavy rainfall. These initiatives are part of a long term programme to reduce the strain on the drainage network as a result of population growth, urbanisation and climate change.

3.5 Impact of Climate Change

3.5.1 Climate change is anticipated to have a significant impact on temperature, rainfall and seasonal changes within London. The latest predictions are for warmer and drier summers, and wetter winters, with appreciable changes anticipated by the 2020s[19]. Within London the following impacts are anticipated:

- *By the 2020s* - increase in summer mean temperature of 1.5°C, decrease in mean summer rainfall of 6% and increase in mean winter rainfall of 6% (from a 1961–1990 baseline)
- *By the 2050s*- increase in mean summer temperature of 2.7°C, increase in mean winter rainfall of 15% and decrease in mean summer rainfall of 18%
- *By the 2080s* - increase in mean summer temperature of 3.9°C, an increase of 20% in mean winter rainfall and decrease in mean summer rainfall of 22%

3.5.2 The expected impacts of Climate Change on various sources of flooding across the Borough are broadly described in Table 3 below.

Table 3 - *Anticipated Impact of Climate Change on Flood Risk within the Borough*

Source	Anticipated Impact within Tower Hamlets
Groundwater Flooding	Increased frequency and intensity of rainfall events is anticipated, which could lead to further groundwater flooding in the Borough due to increased perched groundwater levels and associated spring flows.
Surface Water and Sewer Flooding	Increased storm intensity, frequency and duration is anticipated to further exacerbate pressure on existing drainage and sewer systems, potentially leading to more frequent localised flooding incidents.
Tidal Flooding	Thermal expansion of the oceans and polar ice melt is anticipated to lead to rises in mean sea level, storm surge height and frequency, and wave heights thus exacerbating the tidal flood risk to the Borough from the Thames.
Fluvial Flooding	Changing rainfall patterns are likely to increase peak river flows, thereby resulting in higher levels of fluvial flood risk from the River Lee across the Borough.

[19] UK Climate Projections (2009) http://ukclimateprojections.metoffice.gov.uk/

3.5.3 The impact of climate change has been taken into account as a part of the hydraulic modelling work undertaken for the Borough. For the Tidal Thames, this is reflected in the flood outlines for the 2065 and 2100 year scenarios, illustrated within the breach mapping shown in Map 012, Appendix A. The maximum water levels utilised in each of these scenarios were formulated to be consistent with the levels used within the TE2100 study, considering the interaction of anticipated flow, tide and the operational philosophy of the Thames Barrier.

3.5.4 Similarly, the impact of climate change has been considered as a part of the hydraulic modelling of the River Lee. To represent the impact of climate change an uplift of 15%, 35% and 70% was applied to the 1 in 100 year (1% AEP) scenario, illustrated in Map 013A - 013C, Appendix A.

Climate Change Allowances

3.5.5 The EA have recently updated national climate change allowances, to be used in the assessment of future flood risk, to support the NPPF in minimising vulnerability and providing resilience to the impacts of climate change. This includes predictions of anticipated change for:

- Peak river flow by river basin district;
- Peak rainfall intensity;
- Sea level rise; and
- Offshore wind speed and extreme wave height.

3.5.6 The range of allowances provided for river flow, rainfall intensity and sea levels are based on statistical percentiles, representing the range of possible climate change scenarios, which give rise to the central (50th percentile), higher central (70th percentile) and upper end (90th percentile) estimates of impacts.

3.5.7 The allowances provided are additionally based on a range of time periods, representing the anticipated impact over the next 100 years. The percentile and time period to be used are dependent on the proposed development location, vulnerability and design life. The range of different climate change scenarios should be considered in the analysis of flood risk.

3.5.8 The EA has provided detailed online guidance[20] on the use of these allowances for site specific FRAs and reference should be made to this source for the most up to date guidance.

3.5.9 Given the tidal and fluvial nature of both the River Thames and River Lee in this part of London, anticipated rises in sea level, river flow, offshore wind and wave height will largely influence the maximum expected water levels and flows over the next century. This will be influenced by a complex interaction of sea levels, fluvial flows and operation of the Thames Barrier, as investigated in detail during the TE2100 project[21].

[20] Climate change allowances for Flood Risk Assessment https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

[21] Thames Estuary 2100 Plan https://www.gov.uk/government/publications/thames-estuary-2100-te2100

4 Development Assessment

4.1 Background

4.1.1 As a large inner city Borough, Tower Hamlets is experiencing rapid rates of development, characterised by high levels of density, with limited open space and significant basement areas. There is additionally an emerging precedent for development encroaching onto the docks. These characteristics are of potential concern from a planning, disruption and public leisure perspective; however, the potential cumulative hydrological impacts of this type and scale of development within the Borough are not currently well understood.

4.1.2 There is additionally a need to understand whether any of the current spatial development plans for the Borough give rise to any strategic flood mitigation requirements or opportunities, and whether current LBTH flood risk policy is adequate to sustainably support the anticipated future growth.

4.1.3 The following sections provide a high level examination of development within the Borough, including considerations of typology and spatial distribution, and analyse how these emerging characteristics interact with existing and expected levels of flood risk.

4.2 High Density Development

4.2.1 Hydrologically, high density development is of concern due to a typical increase in impermeable areas arising from large building footprints and paving over vegetated areas. This is generally accompanied by a loss in public open space, and increasing hardstanding areas, such as footpaths, roads and large parking areas.

4.2.2 Unmitigated, this type of development reduces the overall permeability of the urban landscape by replacing free draining ground with impermeable roofs, roads and paved areas that are drained by artificial pipe or channel systems. Clearance also removes the natural vegetation that intercepts, slows down and returns rainfall to the air through evapotranspiration. During development, the natural surface vegetated soils are removed and the subsoil is compacted. All these processes reduce the amount of water that can infiltrate into the ground, and significantly increase the volume and rate at which water runs off the surface.

4.2.3 The alteration of natural flow patterns (both in terms of the total quantity of runoff and the peak runoff rates) arising from these landscape changes can substantially increase localised and downstream surface water flood risk.

4.2.4 Flows from urban catchments are typically collected by conventional underground drainage systems, designed to maximise the rate of conveyance. As the majority of London is served by a combined sewer system, these increased volumes of surface water runoff interact with increased sewage loadings due to dense residential, commercial or industrial development. The cumulatively impact of increased surface water and foul drainage would reduce the network capacity, leading to further exacerbation of surface water and sewer flood risk.

4.2.5 Aside from potential impacts to flood risk, the wider ecological effects of urban hydrology include channel erosion in downstream areas, reduced base flows in watercourses, reduced aquifer recharge, and damage to in-stream and riparian habitats. The loss of topsoil and vegetation additionally removes a valuable filtering mechanism for runoff and as traditional drainage systems are designed to carry water away quickly without treatment, they can transfer collected urban pollutants to receiving waters downstream to the detriment of local aquatic ecosystems.

4.2.6 Within Tower Hamlets, increasing density of urbanisation is a concern across the Borough, but particularly within the Isle of Dogs. This is an area experiencing significant high density development despite being identified as being at high risk of surface water flood risk and containing several CDAs.

Recommendations

4.2.7 In order to manage the impacts of increasing urbanisation, sustainable drainage is a particularly high priority for the Borough. These systems mimic natural environments, increasing the volume of water that is attenuated, infiltrated and transpired through the natural hydrological processes. By reducing runoff volumes and peak flow rates, these systems can substantially reduce flood risk, while improving water quality and delivering a suite of potential ecological and amenity benefits, to ameliorate the wider impacts of urbanisation on the local environment and community. Greenfield discharge rates should be achieved wherever possible, and captured runoff preferentially recycled, infiltrated and discharged to local waterways. Discharge to the combined sewer system should be avoided wherever possible.

4.2.8 Existing blue and green spaces and corridors should be preserved, and where possible, their exceedance flood management functionality enhanced. Permeability should be maximised across the streetscape wherever possible, and surface management of water prioritised, prior to use of underground storage. Holistic and integrated approaches to managing rainfall, surface water, water supply and sewage should be harnessed wherever possible.

4.3 Subterranean Development

4.3.1 Another emerging development characteristic within the Borough is for extension of new and existing development further below the ground. This includes large residential and commercial basements within new developments, as well as smaller scale residential extensions.

4.3.2 There is concern that, unmitigated, cumulative development of this nature could have an adverse impact on local hydrogeology. Currently, flood risk mitigation approaches to basements include waterproofing and dewatering; however, the wider sustainability impacts of these techniques are questionable.

4.3.3 The following sections provide an overview of the hydrogeological characteristics across Tower Hamlets, summarising potential impacts and considerations with respect to basement areas.

Groundwater Impact

Principal Aquifers

4.3.4 As shown in the geological mapping contained in Map 003, Appendix A, Lambeth Group and Thanet Sands outcrop in the southern part of the Borough, across the Isle of Dogs. There is generally hydraulic continuity between the deep chalk groundwater flow and the overlying Thanet Sands, and variable continuity with the Lambeth Group depending on the clay and silt content of this unit (which varies).

4.3.5 Chalk groundwater levels are typically located 5 -10 m below the surface in the Isle of Dogs area. However, this regime is the result of abstraction in eastern and central London, as well as to the south at Deptford. Under a naturalised condition this area would have a very shallow water table, forming a natural discharge area for the regional chalk groundwater flow through the London Basin. Therefore, it is important to this area of London that the current groundwater abstraction regime in the chalk is maintained, to prevent flooding in the Isle of Dogs.

4.3.6 Groundwater extraction is regulated in this region; therefore, it is recommended that LBTH liaises with the EA, Thames Water and the GLA with respect to abstraction regimes, such that any changes appropriately consider the impact of chalk groundwater rebound in the Isle of Dogs.

4.3.7 Borehole logs show sand and gravels make up the Lambeth Group above the chalk in the Isle of Dogs. The top of the chalk is located at approximately -28 m AOD and, with the chalk water table measured at -5 to -10 m AOD across the Isle of Dogs, chalk groundwater can be expected to be encountered at this depth in sand and gravel horizons in superficial deposits overlying the Lambeth Group. Alluvium overlies these formations in the Isle of Dogs in the order of 5-10 m thick.

4.3.8 Therefore, structures with large footprints such as basements may cause groundwater impedance when positioned in the order of 5 -10 m below ground or deeper where aquifers are encountered beneath alluvium. Groundwater in the Chalk aquifer has sufficient thickness to flow under structures though upward pressures would need to be considered in structure design. Groundwater in thinner units such as Lambeth Group and gravels are at higher risk of impedance. Site investigations would be required to measure the actual depth as the water table falls steeply across the area, from Greenwich to the south, and current published chalk groundwater maps are understood to interpolate between monitoring points.

4.3.9 Chalk groundwater flow in the Isle of Dogs is from the south to the north so there may be a risk that large east-west orientated basements could impede groundwater flow. Therefore, planning applications for new basements in this orientation should be carefully considered. Where such basements are already present, assessment should be made of whether additional proposals will impede surrounding throughflow. This is of importance as impeding groundwater flow can cause the water table to rise on the upgradient (south) side, which would subsequently increase the risk of groundwater flooding to other structures (basements, sewers).

4.3.10 Hydraulic connections between the River Thames, and the docks and aquifers in the Isle of Dogs may provide a preferential flow path for any impeded groundwater, meaning that the water table may not rise and additional flow would be generated to the surface waters. However, this would be dependent on the depth of the surface waters in relation to the groundwater, the elevation of the impeding structure, and the geology local to a development site; in particular, whether the medium is permeable enough to deliver groundwater laterally to a surface water body at a rate sufficient as to not cause the local water table to rise. Lateral groundwater flow in the shallow subsurface may be impeded from discharging into the River Thames or docks depending on bank materials (e.g. sheet piled walls).

4.3.11 In the north east corner of the Borough, the Lambeth Group is also at outcrop and hydraulically connected to chalk groundwater at depth. Chalk groundwater in this area is at approximately -5 to -15 m AOD and is strongly influenced by abstraction. This area is between the central London groundwater depression and depression further east toward Romford. Changes in abstraction regimes affect the levels in between these depressions.

4.3.12 In this north east corner, groundwater is likely to be in excess of 15 m deep with a general surface elevation around 10 m AOD. Additionally, the Lambeth Group contains significant clay horizons, from approximately 5 m AOD to -10 m AOD which is likely to limit groundwater flow from the chalk into the Lambeth Group. If the chalk aquifer were confined in the area then chalk groundwater would not be encountered until the chalk (or sandy units above below the clay layers) was penetrated by a structure at approximately -10 m AOD. Therefore it is likely that any structures of less than 20 m depth would not encounter significant groundwater flows). However, local site investigation would be required to determine whether the Lambeth Group is clayey at a proposed development site, in order to confirm whether continuity with the Chalk is limited. If a hydraulic connection was present then as groundwater may flow east or west depending on the location. As such, deep structures should be aligned east-west where possible to minimise any flow impedance.

Superficial Aquifers

4.3.13 Considering the superficial sand and gravel aquifers, there are no local groundwater monitoring points available to compare groundwater levels, the surface elevation and possible deep structures.

4.3.14 The northern part of the Borough is underlain by Taplow Gravel, while the southern part is underlain by Kempton Park Gravel. These aquifers are large in extent and so are likely to be receiving recharge

from rainfall. They are underlain across most of the Borough by London Clay which, as stiff clay, forms a barrier to vertical flow. Therefore, recharge will form a base and then fill the gravel to a saturated thickness to form a water table.

4.3.15 Borehole logs suggest the Taplow Gravel is generally around 4 m thick, while the Kempton Park Gravel has more variable thickness typically between 2 and 6 m. The extensive outcrop and limited thickness would indicate a shallow water table is likely; however, due to the impacts of urbanisation and extensive hard standing, which limit recharge and generate direct runoff to rivers, recharge is likely to be much less than for a genuine outcrop.

4.3.16 In the northern part of the Borough, where the land elevation rises above the River Thames to approximately 10 m AOD, it is possible the gravel aquifer water table is at least present in the lower half of the aquifer, 2 to 3 m below surface. The southern part of the Borough is situated on the Thames floodplain and will therefore effectively have a water level following the changing levels in the River Thames. As such, with tidal variations, groundwater levels may be 1 to 3 m below surface.

4.3.17 In the northern part of the Borough, basement structures are not likely to cause significant impedance to groundwater flow. This is due to limited recharge which will limit flow rates. There is a large area of aquifer for small flows to flow around structures, and there is a significant unsaturated zone thickness to accommodate a likely modest water table rise caused by limited flow impedance. These groundwater level changes are expected to be at depth beneath alluvium and may not increase flood risk but developers need to understand the effects of water pressures on structures. The long history of development and limited record of local flooding suggest it is a sensible conclusion that the superficial aquifers can accommodate some flow impedance in the northern part of the Borough.

4.3.18 Groundwater flow directions will vary locally, with flow typically toward local streams. LBTH should ensure that developments to approximately 4 m depth do not run parallel to streams without gaps for groundwater through flow.

4.3.19 In the Isle of Dogs area, the gravel aquifer is overlain by alluvium generally between 5-10 m thick. A shallow tidally influenced water table can drain vertically into the Lambeth Group and, being relatively permeable in this area; can also drain to the Chalk aquifer due to the absence of the London Clay. Local site investigations should identify whether the clay content of the gravel aquifer and Lambeth Group is causing shallow groundwater to drain slowly, or is composed of sand and gravel and may be relatively free draining. In the first case a development may impede lateral flow in and out from the tide and where the aquifer has slow vertical draining the water table may rise thus increasing flood risk. In the second case where the material has little silt and clay and is free draining then this is where the tidal inflow is absorbed and the water table is lowered vertically at a rate not less than the inward flow and as such structures are unlikely to cause impedance. Any potential development will require these judgements to be made based on local site investigation findings.

4.3.20 As the Isle of Dogs is surrounded on three sides by the River Thames and is tidal, gravel aquifer groundwater flows may occur in any direction. It would be advisable as a precaution to not allow a series of neighbouring developments to have deep structures, but to keep them well spaced.

Conclusions

4.3.21 In the Isle of Dogs, groundwater levels in the Chalk aquifer are controlled by abstraction while shallow groundwater is controlled by River Thames levels which are tidal. Deep structures may encounter chalk groundwater at depths of 5 to 10 metres below ground level across the Isle of Dogs, which is flowing north and north-west toward the central London depression. Therefore, deep structures should not have large east-west orientated footprints in order to minimise groundwater impedance.

4.3.22 In the northern area, chalk groundwater is deeper and may be encountered in the north east area of the Borough. Excavations are most likely to extend to a depth within the Lambeth Group which is more clayey in this area and is expected to limit groundwater flows and hence have a low groundwater flood risk. The gravel aquifers in the north are of a large spatial extent and not expected to have very

shallow water tables, such that potentially flow impeding structures would have a low risk of flooding from groundwater.

4.3.23 The nature of the gravel deposits and Lambeth Group, as described in this section, are based on available desktop geological mapping and borehole logs. It should be noted that the findings of this assessment are contradictory to the findings of the groundwater susceptibility mapping (Map 007). This is due to the nature of the broad assumptions underlying this mapped dataset, which are not appropriate for considering the impedance and flood risk characteristics of structures at depth. Additionally, this subsequent assessment has analysed aquifers in their broader context across the Borough (as opposed to within discrete modelled cells). This highlights the need to take into account all relevant data sources and local conditions in considering groundwater flood risk. Site investigation is required to confirm the local conditions at any given development site.

Surface Water and Sewer Flood Risk

4.3.24 Aside from the potential impacts of basements on hydrogeological groundwater flow, increased basement development can also have an impact on levels of surface water and sewer flood risk.

4.3.25 Subterranean developments, including extended residential basements or carparks underneath surface gardens and other green spaces, act to reduce the available land surface area through which rainfall can percolate into the ground, exacerbating the hydrologic issues of urbanisation and increased hard surfacing on surface water runoff rates and volumes, as described in Section 4.2. Basement impacts on groundwater levels also interact with levels of surface water flood risk, by restricting infiltration potential and further increasing runoff.

4.3.26 By virtue of their low lying nature, basements are particularly vulnerable to many types of flooding and in particular sewer flooding. This can be from surcharging of larger trunk sewers, but it can also be a result from operational issues, such as blockages. Historically certain developments have sought to pump groundwater ingress into basements into the sewer network, further contributing to levels of sewer flood risk.

Recommendations

4.3.27 It is recommended that LBTH builds upon the findings of this assessment and establishes an evidence-based basement policy, to limit the potential impacts of basement development and promote strengthened mitigation.

4.3.28 The established basement policy should holistically consider the potential hydro-geological impacts of basement development, in addition to issues of construction disruption, land stability and surface water flood risk. In particular, it is recommended that critical consideration is given to limiting the size of residential basement extensions and large commercial car parks beneath areas of open space, in order to avoid further exacerbating the loss of effective permeable area within the Borough.

4.3.29 Limitations on basement location and use as a result of flood risk should be firmly established for the Borough. It is recommended that basement impact assessments are a requirement for all proposed basement developments. By this means, developers of basements would be required to demonstrate that proposals safeguard structural stability, are safe from a flood risk perspective, and will not have any adverse impacts on local hydrogeology.

4.3.30 This is likely to require a structural stability statement and description of appropriate flood mitigation. Drainage connections from basements to sewers should be fitted with a one way valve to prevent the drains flooding the basements if they surcharge. Thames Water also requires a pumped sewage system in basements where there is a record of sewer flooding in the local area and pumping of groundwater into the sewer network should be avoided wherever possible. Basement proposals should also consider the requirements for SuDS and runoff reduction, as described in 6.3.

4.3.31 It should be noted that the groundwater assessment has been based on limited available data and boreholes. All basement assessments should be informed by detailed site investigation and consideration of local and surrounding hydrogeological conditions. In assessing basement proposals, particular attention should be applied to large east-west orientated basements, over 5 metres in depth.

4.3.32 Across the Borough, it is recommended that groundwater levels are monitored and appraised against the impacts of subterranean development.

4.4 Dock Infill

4.4.1 A further concern for LBTH is an emerging precedent for development encroaching on the dock area. This is of concern from a perspective of biodiversity and amenity, and there is additional concern that this may also contribute to adverse impact on flood risk.

4.4.2 Under normal operation of the London Docklands, water is pumped from the River Thames at high tide into the docks so as to maintain a head of water at the West India Dock lock gates (the only entrance into the docks). At spring tides the River Thames can overtop the West India Dock Lock Gates and there is tidal ingress into the pound; however, this situation is mitigated by the Thames Barrier under normal operating circumstances.

4.4.3 At normal water levels, there is approximately 1 m of freeboard available in the dock. As the docks are hydraulically connected to the Tidal River Thames, they can perform a flood storage function under certain circumstances.

4.4.4 Recent modelling studies have been carried out to confirm the impact of the Docks on water levels in the Tidal Thames. This determined that the presence of the docks contributes to an estimated reduction in water levels in the adjacent Thames of 1.1 mm for the baseline flood conditions and 4 to 6 mm when tidal levels are increased by 300 mm. This represents the impact of the flood storage functionality of the docks, compared to a situation in which they are completely disconnected from the river, or infilled.

4.4.5 While this may be a relatively minor individual impact under normal operation, the docks play a role in providing some natural flood storage during a breach scenario. The 1 metre of freeboard, typically present within the docks, would capture and safely store a significant amount of flow. If these areas are infilled for development, this water would be displaced and distributed to surrounding areas thus increasing flood risk.

4.4.6 Considering the local topography (illustrated in Map 002, Appendix A), the Docklands are situated at the lowest point of the Borough. The area is known to have a particularly high level of surface water flood risk, as indicated by the allocation of CDAs. The strategic surface water mapping shown on Map 006, Appendix A, illustrates several areas at high risk of flooding, within the docks themselves. This indicates that water is likely to travel overland towards these areas, and there is likely to be some natural entry of drainage. Thus, removal of these natural storages could have an impact on the level of surface water flood risk.

4.4.7 The docks are also known to be a direct receptor for surface water discharges from surrounding areas, a function which is likely to become increasingly important as regional development progresses. At the downstream of a large sewer catchment, capacity in this area is likely to become increasingly constrained, making effective surface water management in this area a critical consideration for any proposed development. Given known infiltration restrictions across much of this area, there are limited options for discharge of surface water in line with the SuDS hierarchy. Removing surface water from the combined sewer through managed discharge to available waterbodies (such as the docks) will play a crucial role in the sustainability of future development.

4.4.8 In more general terms, the docks provide a valuable function in limiting the density of development within this area, therefore providing some mitigation to the issues associated with high density

development, discussed above. Furthermore, the safeguarding of these areas is in line with local and regional priorities for protecting flood storage areas and enhancing blue corridors within urban areas.

Recommendations

4.4.9 It is recommended that the dock areas within Tower Hamlets are preserved, in recognition of their multi-functionality in managing surface water and contributing to flood storage, whilst providing valuable contribution towards public amenity and biodiversity within the Borough.

4.5 Allocated Development Sites

4.5.1 As a part of the emerging Local Plan, LBTH has identified 21 allocated development sites, as shown on Map 014, Appendix A, and described in Table 4 on the following page.

4.5.2 A brief profile has been created for each of these sites, contained in Appendix F. The site assessments provide an overview of the various sources of flood risk, utilising the strategic datasets collated during this SFRA. Key recommendations for managing flood risk are provided for each site. Where required, the suitability of the proposed development, and requirement for justification in accordance with the NPPF, has been highlighted and the need for the Sequential and Exception Tests clarified.

Table 4 – *Allocated Development sites and Flood Zone Classification*

Number	Site Name	Flood Zone(s)
1	Bishopsgate Goods Yard	1
2	Marian Place Gas Works and the Oval	1
3	London Dock	1 and 2
4	Bow Common Gas Works	1
5	Chrisp Street Town Centre	2
6	Ailsa Street	3a
7	Leven Road Gas Works	3a
8	Billingsgate Market	3a and 2
9	Wood Wharf	3a and 2
10	Westferry Printworks	3a
11	Crossharbour Town Centre	3a
12	Aspen Way	3a and 2
13	Limeharbour	3a
14	Marsh Wall East	3a and 2
15	Marsh Wall West	3a
16	Millharbour	3a
17	North Quay	3a and 2
18	Reuters Ltd	3a
19	Riverside South	3a

Number	Site Name	Flood Zone(s)
20	Whitechapel South	1
21	Millharbour South	3a

4.6 Spatial Development Considerations

4.6.1 Considering development across Tower Hamlets from a broader spatial perspective, the Borough is split into four key regions of growth, as summarised below:

- *Central* - Bethnal Green, Bow West, Limehouse, Mile End, Shadwell, Stepney Green, St Dunstans;
- *City Fringe* - Spitalfields and Banglatown, St Katharine's and Wapping, St Peters, Weavers, Whitechapel;
- *Isle of Dogs & South Poplar* – Blackwall and Cubitt Town, Canary Wharf, Island Gardens, Poplar; and
- *Lower Lea Valley* – Bow East, Bromley North, Bromley South, Lansbury.

4.6.2 Of these areas, the most significant growth is expected to come forward within the Isle of Dogs and South Poplar. This area is almost entirely located within Flood Zone 3a, so flood risk mitigation will be a key ongoing consideration to facilitate the expected level of growth. Similarly, large areas adjacent the riverside in all four regions are assessed as being within the zone of flood risk from this source.

4.6.3 Maintaining and improving the current high levels of protection provided by the Thames Tidal Defence system is critical to development safety in this area. The level of defences along the River Thames and River Lee will eventually need to be raised (by up to 0.5 m by 2065 and an additional 0.5 m by 2100) to cater for increased water levels anticipated as a result of climate change. As such, early provision needs to be made for maintaining, enhancing and replacing existing flood defence structures. The crest levels of connected flood gates and river and dock structures will also need to be raised and improvements made to drainage outfalls along both rivers.

4.6.4 To enable this in a cost effective, sustainable and aesthetically appealing way, opportunities should be pursued for wider riverside improvement through integrated design, considering public access and connectivity, amenity, landscaping and environmental enhancement. Consideration should also be given to realigning and setting back defences to provide additional space for these additional functions. Such opportunities have already been pursued across London, including positive examples implemented on the Isle of Dogs.

4.6.5 The high levels of proposed development within this region may present an opportunity to facilitate flood defence and wider riverside improvement through either direct works or financial contribution towards improvements.

4.6.6 Aside from maintenance of flood defences, robust emergency planning strategies will also be critical to facilitating the safety of ongoing development. All development in flood risk areas should establish safe access and egress routes above 2100 year maximum water level anticipated through a breach of the River Thames defences. Routes should lead to high ground outside the floodplain. For residential developments where this is not feasible, a dedicated 'safe haven' should be provided above the flood level to enable rapid escape should failure of the defences occur. This may be provided in the form of a sheltered communal space within the building, accessed via internal stairs and sufficient in size to safely house all residents.

4.6.7 Consideration may also need to be given to emergency planning for breach events at a more regional level, through engagement with the emergency services and local community.

4.6.8 The high rates of development within the Isle of Dogs are of particular concern with respect to drainage and the risk of exacerbating surface water and sewer flood risk, as discussed in Section 4.2. In this region, uniform implementation of SuDS to achieve greenfield runoff rates is particularly important. Recycling or alternative discharge of runoff to surface waterbodies should be pursued wherever possible. Where large areas of development are proposed, opportunities should be pursued for strategic and integrated approaches to surface water networks, water supply and drainage.

4.7 Review of Existing Flood Risk Policy

4.7.1 Considering the findings of this SFRA and the nature of development within the Borough, the adequacy of existing flood risk policies have been reviewed. The primary policy documents with an implication for flood risk management across the Borough include the Core Strategy (2010)[22] and Development Management Document (2014)[23], which comprise the existing Local Plan. The existing flood risk policies reflect the flood risk management process detailed in Planning Policy Statement 25 (the precursor to the NPPF) and generally promote approaches of flood resilience, emergency planning and implementation of SuDS. A more detailed overview of the flood risk related policies contained within these documents is contained in Section 2.4.

4.7.2 Whilst these policies generally promote positive flood risk management principles, there is a need to review and update these during the new local planning cycle. These revised policies must be reflective of the NPPF, which has superseded the previous planning policy statements. Additionally, it is important that LBTH's flood risk policy is aligned with other regional flood risk policies, as described in Section 2.3.

4.7.3 In particular, the implications of the TE2100 Plan are of integral importance to flood risk management in Tower Hamlets and should be considered in the formulation of local planning policy. Emphasis should be given to the requirement for ongoing maintenance and improvement of flood defences, including eventual raising of crest levels, and the need to safeguard defined areas of land adjacent to river corridors. Opportunities to improve the riverside through integrated design should be promoted for combined amenity, ecological and flood risk benefit.

4.7.4 Additionally, it is important that the revised local flood risk policies reflect and build upon the London Plan, particularly in relation to the implementation of sustainable drainage. This should firmly establish the position of LBTH in relation to the need to reduce post-development runoff rates and maximise the utilisation of alternative surface water discharge pathways. In order to provide clarification for both planners and developers, a defined expectation in terms of runoff reduction should be provided. It is recommended that all developers should achieve greenfield runoff rates, unless robust demonstration can provided that this is not feasible.

4.7.5 In addition to the policies contained within these local planning documents, development is also informed by other local studies and plans, particularly including the Borough's LFRMS and SWMP.

4.7.6 Currently, the LFRMS provides general guidance and information for residents, businesses and developers regarding management of flood risk. The document outlines the responsibilities of LBTH and other organisations in managing flooding across the Borough, additionally providing an overview of the sources of flood risk across the Borough and broadly outlining options for mitigation.

4.7.7 In line with the local planning cycle, the LFRMS may require updating to reflect any revised flood risk policies. This document should provide clear guidance for developers, particularly in relation to the Borough's expectations in terms of sustainable drainage, including post-development runoff rates and the associated evidence base which should be provided. Developers should be strongly encouraged

[22] Tower Hamlets Core Strategy http://www.towerhamlets.gov.uk/Documents/Planning-and-building-control/Strategic-Planning/Local-Plan/Core-Strategy-and-MDD/Core-Strategy-low-resolution.pdf

[23] Tower Hamlets Managing Development Document http://www.towerhamlets.gov.uk/Documents/Planning-and-building-control/Strategic-Planning/Neighbourhood-Planning/Managing-Development-Document-April-2013.pdf

to provide SuDS design solutions which are in line with LBTH's priorities for maximising blue-green infrastructure, and follow the SuDS Hierarchy (as defined in the London Plan).

4.7.8 Flood risk from other sources should also be addressed, including the need for riparian owners to demonstrate safety of flood defences over the lifetime of the development and facilitate ongoing access for improvement and maintenance. Mitigation requirements for managing residual risk associated with the Tidal Thames should also be clarified, including the need for raised FFLs and robust emergency response plans in flood risk areas.

4.7.9 Consideration should be given to establishing a specific basement policy across the Borough, and to imposing a requirement for basement impact assessments at a planning stage.

4.7.10 The LBTH SWMP is another important local document, which is used to inform flood risk management. This document is generally required to be updated every 6 years; however, it is understood that understanding of surface water flood risk, including the allocation of CDAs, has evolved substantially since production of the original SWMP. For this reason, it is recommended that the SWMP is revised in light of this new information, to provide the most updated findings and recommendations for LBTH and the local community.

4.7.11 Further specific recommendations to inform local planning policy, development control and emergency planning are provided in Section 5.2. These key recommendations should be considered and incorporated into the emerging Tower Hamlets Local Plan, to ensure a holistic approach to flood risk management across the Borough.

5 Managing Flood Risk

5.1 Risk Based Approach to Planning

5.1.1 The NPPF approach aims to ensure that flood risk is considered at all stages of the planning process, and to avoid inappropriate development in areas of greatest flood risk; steering development towards areas of lower risk.

5.1.2 Development is only permissible in areas at risk of flooding in exceptional circumstances where it can be demonstrated that there are no reasonably available sites in areas of lower risk, the sustainability benefits outweigh flood risks and, the development will be safe for its lifetime without increasing flood risk elsewhere. Such development is required to include mitigation/management measures to minimise risk to life and property should flooding occur.

5.1.3 Building on these principles, the NPPF and Planning Practice Guidance have established a process for the assessment of flood risk, with each stage building upon the previous assessment with a refinement of the evidence base. Utilising a Source – Pathway – Receptor approach, the source of flooding, the spatial distribution of flood risk and the vulnerability of development types are assessed to inform decision making through each of the key stages of the Flood Risk Management Hierarchy, as shown in Table 5 below.

Table 5 - *Flood Risk Management Hierarchy and the SFRA Process*

Hierarchy

Stage	Approach
Level 1 SFRA	Assessment (broad scale and comprehensive)
Sequential Test Across Planning Area	Avoidance
Level 2 SFRA (if required)	Detailed Assessment (Growth Area or Site Specific)
Sequential Approach at Site	Avoidance
Control and Improvement	Through Design (e.g. SuDS)
Mitigate Remaining Risks	Flood Resilient Design and Construction

Applying the Sequential Test

5.1.4 As described in the NPPF, the aim of the Sequential Test is to steer new development to areas with the lowest probability of flooding. As such, development should not be permitted in areas of flood risk, where there are reasonably available sites appropriate for the proposed development in areas with a lower probability of flooding. The Sequential Test should be carried out on all development sites and can be applied at all levels and scales of the planning process, both between and within Flood Zones.

5.1.5 The approach seeks to prevent the allocation of sites that are inappropriate on flood risk grounds by considering the vulnerability of the type of development proposed and how compatible the intended use is with the level of flood risk at the site. Five vulnerability classifications are defined; these are listed below and further defined in Table 6.

- Essential Infrastructure;
- Highly Vulnerable;
- More Vulnerable;
- Less Vulnerable, and
- Water Compatible.

Table 6 *Flood Risk Vulnerability Classifications (from Table 2 in the Planning Practice Guidance)*

Appropriate Use Classification	Examples of Classification
Essential Infrastructure	• Essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk. • Essential utility infrastructure which has to be located in a flood risk area for operational reasons need to remain operational in times of flood. • Wind turbines.
Highly Vulnerable	• Police stations, ambulance stations and fire stations and command centres and telecommunications installations required to be operational during flooding. • Emergency dispersal points. • Basement dwellings. • Caravans, mobile homes and park homes intended for permanent residential use. • Installations requiring hazardous substances consent.
More Vulnerable	• Hospitals. • Residential institutions such as residential care homes, children's homes, social services homes, prisons and hostels. • Buildings used for dwelling houses, student halls of residence, drinking establishments, nightclubs and hotels. • Non–residential uses for health services, nurseries and educational establishments. • Landfill and sites used for waste management facilities for hazardous waste. • Sites used for holiday or short-let caravans and camping, subject to a specific warning and evacuation plan.
Less Vulnerable	• Police, ambulance and fire stations which are not required to be operational during flooding. • Buildings used for shops, financial, professional and other services, restaurants and cafes, hot food takeaways, offices, general industry, storage and distribution, non–residential institutions not included in "more vulnerable", and assembly and leisure. • Land and buildings used for agriculture and forestry. • Waste treatment (except landfill and hazardous waste facilities). • Minerals working and processing (except for sand and gravel working). • Water treatment works which do not need to remain operational during times of flood. • Sewage treatment works (if adequate measures to control pollution and manage sewage during flooding events are in place).
Water Compatible Development	• Flood control infrastructure. • Water and Sewage transmission infrastructure and pumping stations. • Sand and gravel working. • Docks, marinas and wharves. • Navigation facilities. • Ministry of Defence, defence installations. • Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location. • Water-based recreation (excluding sleeping accommodation). • Lifeguard and coastguard stations. • Amenity open space, nature conservation and biodiversity, outdoor sports and recreation. • Essential ancillary sleeping or residential accommodation for staff required by uses in this category, subject to a specific warning and evacuation plan.

5.1.6 Table 7 illustrates the types of development that are considered as suitable within areas of varying perceived flood risk. This utilises the Flood Zones defined in Table 1 (Section 2.2.11), and delineated for the Borough in Map 005.

Table 7 - *Flood Zones and Development Compatibility (adapted from Table 3 in the Planning Practice Guidance)*

Flood Zone	Description	Annual probability of river or sea flooding	Appropriate uses
Zone 1	Low Probability	1 in 1000 (<0.1% AEP)	· All uses
Zone 2	Medium Probability	1 in 100 – 1 in 1000 (river) (1-0.1% AEP) 1 in 200 – 1 in 1000 (sea) (0.5-0.1% AEP)	· Water Compatible · Less Vulnerable · More Vulnerable · Essential Infrastructure · Highly Vulnerable*
Zone 3a	High Probability	1 in 100 or greater (river) (>1% AEP) 1 in 200 or greater (sea) (>0.5% AEP)	· Water Compatible · Less Vulnerable · More Vulnerable* · Essential Infrastructure*
Zone 3b	The Functional Floodplain	1 in 20 or greater (5% AEP) or land which is designed to flood in an extreme (0.1% AEP) flood.	· Water Compatible · Essential Infrastructure*

Note: *only if Exception Test passed

5.1.7 This SFRA provides the tools to undertake the Sequential Test by presenting information to identify the variation in flood risk across the Borough, allowing an area-wide comparison of future development sites with respect to flood risk considerations. The flow diagram presented as Figure 2 illustrates how the Sequential Test process should be applied to identify the suitability of a site for allocation, in relation to the flood risk classification.

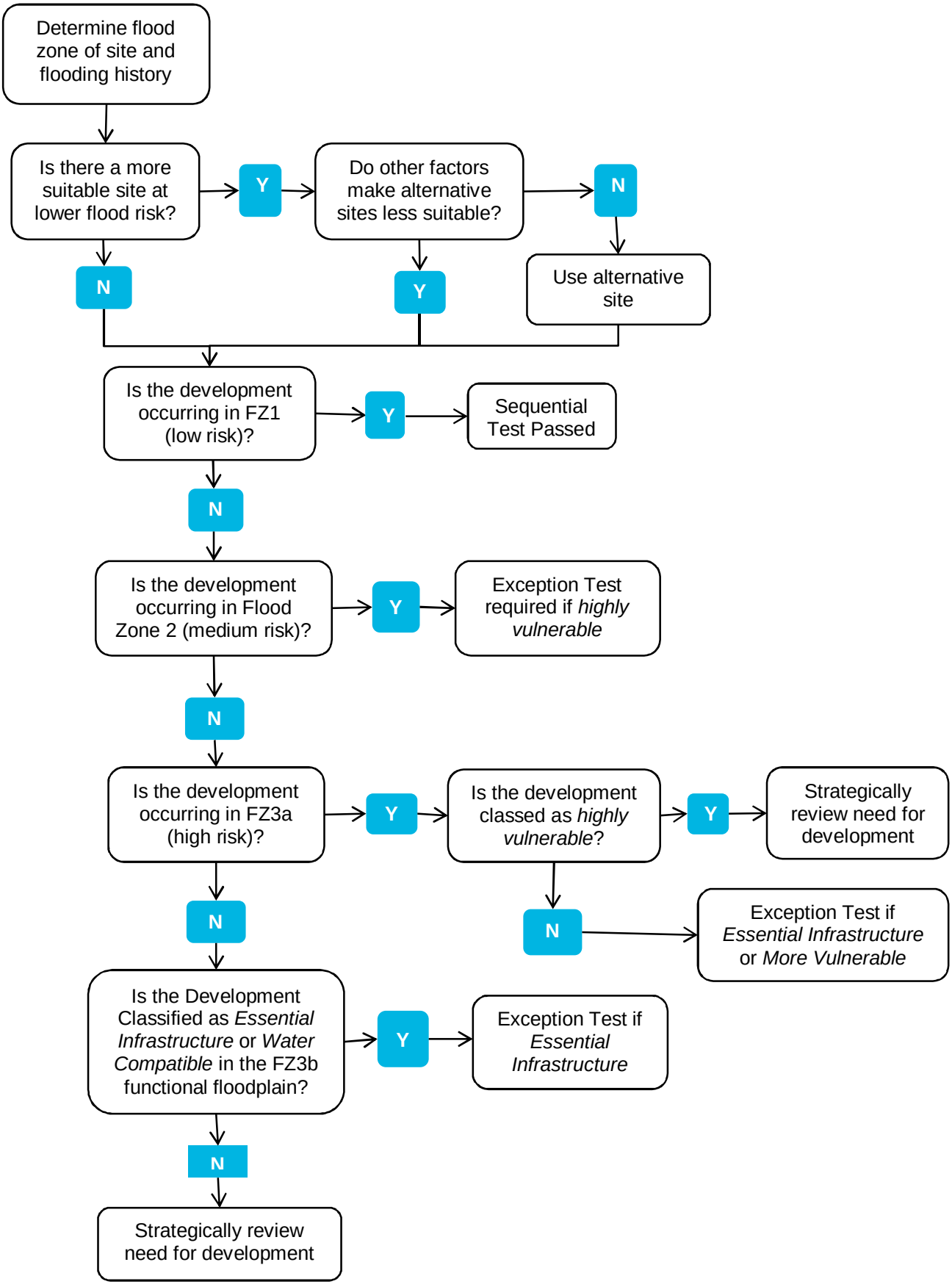

Figure 2: *Sequential Test Process - Schematic*

5.1.8 Tower Hamlets is a large and rapidly developing inner city Borough, with a large proportion of land located in Flood Zones 2 and 3. Therefore, locating all required development in the Borough away from these areas is unlikely to be completely achievable. If, following the application of the Sequential Test, a proposed site allocation does not meet the criteria of acceptability, that site might qualify for the application of an Exception Test. This test considers both the development safety and the benefit of the site to the wider sustainability objectives of the Borough in order to establish whether the development can be deemed acceptable. This test is further described below.

5.1.9 It should be noted that, while the focus of the Sequential Test is on tidal and fluvial flood risk (through use of the NPPF Flood Zones), some areas of the Borough will be at risk of flooding from other sources. Consequently all sources of flooding must be considered in the location of new development. If the development is not deemed water compatible, and the site is found to be impacted by a recurrent flood source (other than fluvial), the site and flood sources should be investigated further irrespective of a requirement for the Exception Test.

Exception Test

5.1.10 The Exception Test is an additional test to be applied by decision-makers following application of the Sequential Test. The Exception Test has two elements as shown below, both of which must be satisfied for development in a flood risk area to be considered acceptable.

5.1.11 The Exception Test provides a method of managing flood risk while still allowing necessary sustainable development to occur. The test is only appropriate for use when there are large areas in Flood Zones 2, 3a and 3b, where the Sequential Test alone cannot deliver acceptable sites, but where some continuing development is necessary for wider sustainable development reasons. The flow chart presented in Figure 2 and Table 7 demonstrates the methodology to determine whether an Exception Test is required for proposed site allocations.

5.1.12 In order to pass the Exception Test, the Planning Practice Guidance identifies the following considerations that need to be demonstrated/fulfilled to the satisfaction of the LPA:

- That the development provides wider sustainability benefits to the community that outweigh flood risk, informed by a SFRA where one has been prepared; and
- A site-specific FRA must demonstrate that the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, reducing flood risk overall.

5.1.13 Satisfying the Exception Test involves consideration of the reasons behind the selection of the site for development, from the sustainability appraisal, as well as consideration in planning and design, such that the site will remain safe and operational in the event of flooding. This may involve demonstrating:

- A sequential approach is taken to development site layout, such that within the site, the most vulnerable development is located in areas of lowest flood risk, unless there are overriding reasons to prefer a different location;
- Buildings are designed to be appropriately flood resilient and resistant, with essential services remaining functional in the event of flooding, and quick recovery following a flood;
- Provision of safe means of access and egress during a flood event;
- Emergency evacuation procedures are developed, to be utilised following receipt of a flood warning; and
- Priority is given to the use of SuDS.

5.1.14 Further detail on undertaking site specific FRAs, including measures to safely mitigate and manage flood risk, are provided in Chapter 6.1.

5.1.15 Both parts of the Exception test must be satisfied in order for the development to be considered acceptable in terms of flood risk. There must be robust evidence in support of every part of the test.

5.1.16 A significant proportion of LBTH is located within Flood Zone 3a of the River Thames; therefore it is likely that the requirements of the Exception Test will need to be satisfied for 'more vulnerable' e.g. residential, development in this area.

5.1.17 In considering this, breach modelling results for the River Thames should be taken into account to determine the variation in flood depth and hazard within Flood Zone 3a. This will confirm whether more appropriate locations maybe available within Flood Zone 3a, with a lower hazard rating.

5.2 Recommendations for Policy and Practice

5.2.1 Adopting a holistic approach to flood risk management should help ensure that flooding is taken into account at all stages of the planning process. To aid this holistic approach, it is recommended that all key recommendations set out in this report are considered and incorporated into the emerging Tower Hamlets Local Plan.

5.2.2 Tower Hamlets is bordered by the River Thames and the River Lee and is therefore highly reliant on flood defences. Ongoing maintenance of these defences is critical, and priority should be given to safeguarding the SoP provided by defences over the lifetime of any development. However, redevelopment rates across the Borough are very high and may additionally offer the opportunity to reduce the current risk and the reliance on flood defences. This includes making the urban environment more resilient and with a layout that offers added options for managing future flood risk and the impacts of climate change. As such, it is recommended that policy options are expanded to include greater emphasis on active floodplain management, in addition to flood defence maintenance. This may include promoting more appropriate use of floodplain areas (Flood Zone 3), making space for water, improved flood preparedness and enhanced emergency planning and response measures.

5.2.3 Specific recommendations for LBTH are detailed in the following sections.

Strategic Planning

5.2.4 When considering strategic spatial planning across the Borough, flood risk should be an early and primary consideration. A sequential approach should be taken to allocating strategic development areas in regions of lowest flood risk, taking into account vulnerability of land use. Consideration should also be given to strategic allocation of open space and preserving and expanding river corridors to create space for flooding to be managed effectively.

5.2.5 In particular, the following specific recommendations are made:

- Ensure the Sequential Test is undertaken for all strategic land allocations and check that the vulnerability classification of the proposed land use is appropriate to the Flood Zone classification;
- Pursue potential opportunities to move existing development from within the floodplain to areas with a lower risk of flooding. This should include consideration of the vulnerability of existing developments and whether there is potential for land swap with lower vulnerability uses.
- Identify opportunities to create space for water through appropriate location, layout and design of development, in order to accommodate climate change and assist in managing future flood risk. This can be achieved by restoring floodplain and flood flow pathways and by identifying, allocating and safeguarding open space for storage. Equally, existing flood storage areas and water spaces (including dock areas) should be identified, conserved and protected against loss through redevelopment.
- Safeguard existing corridors of land along the River Thames, River Lee and tributaries and promote the setting back of development to enable sustainable and cost effective flood risk management, including upgrading of river walls and embankments. As a minimum, an 8 m and 16 m buffer strip should be maintained along fluvial and tidal river corridors, respectively.
- Pursue opportunities to realign or set back defences and improve the riverside frontage to provide amenity space and environmental enhancement. A combination of defence realignment and

floodplain management could reduce the impact of flooding to existing properties and other assets located in the floodable areas on the river side of realigned defences (similar to the approach used around the Tate Modern at Bankside).

- The consultation and initial investigation associated with detailed site specific FRAs should be undertaken at an early stage for major development locations to ensure opportunities to reduce flood risk are identified early and maximised wherever possible.
- Ensure that developments at residual risk of flooding are designed to be flood compatible and/or flood resilient and maximise the use of open spaces within these developments to make space for water during times of flooding. Opportunities should be sought to identify a safe route for any exceedance flow of floodwaters and a suitable storage or discharge location, to avoid any risk to people.
- Strategic development allocations should specifically consider the issues of water supply and drainage infrastructure to service development proposed, taking into account regional constraints. An early and integrated approach should be taken to holistically assessing and planning for the flood risk, water supply and drainage requirements and constraints in these areas. This is likely to be an issue of particular importance in certain Opportunity Areas, including the Isle of Dogs, where limited drainage capacity may create challenges for strategic development.

Development Control

5.2.6 In consulting on and determining development applications, LBTH must ensure that all new developments have considered flood risk management from the planning stage. In general, this means that:

- Development is located in the lowest risk area where possible;
- New development is flood-proofed to a satisfactory level/standard and does not increase flood risk elsewhere; and
- Surface water is managed effectively on site using the SuDS hierarchy and the latest guidance and best practice.

5.2.7 When a proposed development is located within an area perceived to be at risk of flooding, then a suitably detailed FRA should determine the actual level of risk to the development and identify options to mitigate the flood risk to the development, site users and surrounding area. In particular, development located adjacent to flood defences is required to demonstrate that these defences will be safe over the lifetime of the development. The requirements for site specific FRAs and their contents are further detailed in Chapter 6. Planning applications should be considered and assessed in line with the sequential approach detailed in Section 5.1. Specific recommendations and considerations for development planning are provided below:

- If development is to be constructed with less vulnerable uses on the ground level, covenants need to be put in place to prevent future alteration of these areas to ‘more vulnerable’ uses without further consideration of the associated flood risk.
- Single storey residential development should not be considered in high flood risk areas as they offer no opportunity for safe refuge.
- NPPF does not permit basement dwellings to be located within Flood Zone 3a, and as such these should not be permitted in any areas at risk of flooding. This would include the excavation of basements under existing dwellings.
- Residual flood risk should be managed through emergency planning, site design and protection measures. The key residual flood risks within Tower Hamlets are overtopping or breach of the River Thames and River Lee. Developers should assess the risk of defence breach within their site specific flood risk assessments.
- Where development within flood risk areas is necessary due to wider sustainability/regeneration objectives, flood resistance and resilience practices should be followed in the construction and operation of the buildings to minimise the impact of flooding.

- Finished floor levels of all residential accommodation should be raised above the 1 in 100 year (1% AEP) plus Climate Change defended level, with an allowance for freeboard (300 mm). For properties within the tidal flood zone associated with the River Thames, floor levels should be above the anticipated 2100 breach levels. For properties associated with the flood zone of the River Lee, floor levels should be raised above the 1 in 100 year flood level, taking into account the most updated climate change allowances. Potential access and egress routes should also be considered and recommendations made for emergency response by occupants in the event of a breach occurring.
- Flood risk from all sources should be considered when identifying the perceived level of flood risk affecting a site. Robust consideration of surface water flood risk is particularly important in certain regions of the Borough, including the Isle of Dogs.
- Opportunities should be taken to identify sites where developer contributions could be used to fund future flood risk management schemes, improvements to surface water drainage systems or flood defences in adjacent areas. However, it should be noted that developer installed defences should not wholly justify development in locations with inappropriate levels of flood risk.
- Existing flood storage areas and water spaces within development areas should be identified, conserved and protected against loss through redevelopment. This includes dock systems.
- An 8 m and 16 m buffer strip should be maintained along fluvial and tidal river corridors, respectively, to ensure maintenance of the channel can be undertaken. As such, any new development should be avoided in existing buffer areas. A pragmatic approach should be adopted for existing development in these areas and opportunities pursued for small scale set back of development from river walls to enable these structures to be modified, raised and maintained as needed.
- For developments adjacent the River Thames and, River Lee, particular consideration should be given to facilitating the recommendations of the TE2100 plan and Thames CFMP in maintaining, enhancing and replacing flood defences, and safeguarding riverside land. Development adjacent to the dock system should also consider future requirement for wall raising.

Flood Defences

5.2.8 The SFRA has highlighted the importance of flood defences to the Borough. As such, future policy should seek to ensure that the current high level of protection is retained (and improved where possible) by those responsible for maintaining flood defences in the area (i.e. riparian land owners, EA, others). Any development located adjacent to flood defences is required to demonstrate that these defences will be safeguarded and maintained over the lifetime of the development.

5.2.9 In particular, the future sustainability of the Borough (and London as a whole) is dependent to a large degree upon the retention and ongoing maintenance of flood defence infrastructure, including the TTD and River Lee Defences. However, decisions surrounding investment of this nature in future years cannot be predicted with any certainty. Additionally, the exact impact of climate change, and the interaction of the resulting hydrological effects with operational and wider issues is still uncertain. Consequently other means of reducing the risk of fluvial flooding from the River Thames may have to be sought in the future. It is therefore imperative that planning decisions are taken with a clear understanding of the potential risks posed to property and life should things ultimately go wrong. As such, redevelopment must ensure that residual flood risk is reduced in areas benefiting from flood defence measures through prevention and effective mitigation.

5.2.10 As discussed, management of defences within the Borough will include routine inspection, maintenance, repair and replacement, in addition to eventual raising of levels to allow for the impact of climate change. Defences along the Thames and much of the Lee will need to be raised by up to 0.5 m before 2065 and an additional 0.5 m before 2100. However, raising the level of defences on the current footprint may introduce visual barriers and will not achieve any wider sustainability objectives. Therefore, opportunities should be pursued for subsequent improvement of the riverside through

integrated design, considering public access and connectivity, amenity, landscaping and environmental enhancement.

5.2.11 As such, where fluvial defences require replacement, consideration should be given to flood defence adaptation rather than like-for-like replacement, utilising a combination of flood storage, river defences and floodplain attenuation.

5.2.12 Where new development is proposed adjacent to the TTD and River Lee Defences (within 16 metres), consideration should be given to the specific recommendations of the TE2100 plan, in requiring reduction of current and future flood risk through:

- Raising existing flood defences to the required levels in preparation for future climate change impacts or otherwise demonstrate how tidal flood defences can be raised in the future, through submission of plans and cross-sections of the proposed raising;
- Demonstrating the provision of improved access to existing flood defences and safeguarding land for future flood defence raising and landscape, amenity and habitat improvements;
- Maintaining, enhancing or replacing flood defences to provide adequate protection for the lifetime of the development;
- Where opportunities exist, re-aligning or setting back flood defence walls and improving the river frontage to provide amenity space, habitat, access and environmental enhancements; and
- Securing financial contributions towards the anticipated costs of FRMI required to protect the proposed development over its lifetime.

5.2.13 Consideration should also be given to the associated future requirements for raising or upgrading of dock walls or gates and improvement of drainage outfalls as water levels rise.

5.2.14 In more general consideration of FRMI, local policy should continue to maintain and expand assets that are effective in managing current and future flood risk and promote wider sustainability.

Sustainable Drainage Systems

5.2.15 SuDS must be included in new developments as a way to manage surface water flood risk, improve water quality and increase amenity and biodiversity. This is of particular significance in the Isle of Dogs, where higher levels of pluvial flood risk are anticipated to interact with intense development.

5.2.16 Runoff rates from new development must be restricted to greenfield runoff rates wherever possible. Robust justification must be provided for any sites where this is not achievable and an alternative discharge rate agreed with LBTH.

5.2.17 Limiting the volume and rate of discharge, particularly for surface water entering the foul and combined surface water networks, is of critical importance within the Borough to help ensure the sewage network has the capacity to cater for population growth and the effects of climate change.

5.2.18 In line with the Sustainable Drainage Hierarchy, set out in Policy 5.13 of the London Plan (and repeated in Section 6.3), surface water should be prevented and controlled at source wherever possible through rainwater harvesting and infiltration techniques. Managed discharge of surface water to adjacent surface water bodies should also be considered. However, controls would need to be implemented to avoid any adverse harm to biodiversity and ecological habitat within receiving waters. Sustainable drainage should be delivered in accordance with the LBTH SuDS Guidance, the London Plan, the emerging Sustainable Design and Construction SPG, the emerging London Sustainable Drainage Action Plan and CIRIA guidance C753.

5.2.19 Presently, there is a tendency for required attenuation volumes to be accommodated below ground. However, preference should be given to the installation of blue-green surface infrastructure wherever possible, as opposed to hardscape or underground solutions, due to the wider benefits for biodiversity, amenity and microclimate.

5.2.20 The underlying geology within Tower Hamlets is likely to impose constraints on the implementation of infiltration SuDS in many areas across the Borough. This is likely to necessitate the installation of lined systems to provide attenuation and reduction of runoff rates, requiring reuse of runoff or discharge to local surface water bodies or drainage systems. Site specific assessment of geological conditions should be undertaken as a part of the drainage strategy for new developments.

5.2.21 Greater detail and recommendations for SuDS within the Borough are contained in Section 6.3.

Emergency Planning

5.2.22 It is strongly recommended that emergency planning strategies are put in place in areas deemed at actual and/or residual risk of flooding to ensure adequate preparation and response during flood events. Where a new development or change of land use is proposed, flood evacuation plans should be developed through liaison with the emergency planners and the emergency services.

5.2.23 Additionally, following production of this SFRA, it is recommended that emergency planning strategies should be reviewed to determine the suitability of refuge centres and evacuation routes based on the updated flood risk mapping produced.

5.2.24 Emergency Planning can be broadly split into three phases, all of which should be considered in managing flood risk across the Borough:

- *Before a flood* – raising flood awareness, ensuring no inappropriate use of the floodplain/flow paths, preparing suitable flood emergency plans and communicating them to the wider community;
- *During a flood* – Flood alerts and communication, rescuing occupants, providing safe refuge and alternative accommodation;
- *After the flood* – providing support to help people recover and return to their homes and businesses.

5.2.25 Consideration of emergency planning is even more critical when it relates to vulnerable sites and essential infrastructure, as further described below.

Vulnerable Sites

5.2.26 Emergency service authorities responsible for hospitals, ambulance, fire and police stations as well as prisons should ensure that emergency plans, in particular for facilities in flood risk areas, are in place and regularly reviewed so that they can cope in the event of a major flood. These plans should put in place cover arrangements through other suitable facilities, if deemed needed.

5.2.27 The NPPF classifies police stations, ambulance stations, fire stations and command centres as Highly Vulnerable buildings. It is essential that all establishments related to these services are located in the lowest flood risk zones to ensure that in the event of an emergency those services vital to the rescue operation are not impacted by flood water. Furthermore, development control policies should seek to locate more vulnerable uses such as schools and care homes in areas at the lowest risk of flooding to minimise the impact of a flood on their vulnerable users.

5.2.28 Allied to this, nominated rest and reception centres should also be identified within the study area and compared with the outputs of this SFRA to ensure that these centres are not at risk of flooding, so that evacuees will be safe during a flood event. Developments that would be suitable for such uses would include leisure centres, churches, schools and community centres.

5.2.29 On occasions where development of vulnerable sites within flood risk areas is unavoidable, necessary measures should be implemented to ensure the site is as safe as possible.

Critical Infrastructure

5.2.30 In the event of a flood incident, it is essential that the evacuation and rescue routes to and from any proposed development remain safe. Floodplain management and emergency response activities must

have a focus on key infrastructure such as the London Underground network and any properties that are below sea level. Essential infrastructure located in Flood Zone 3a or 3b must be operational during a flood event to assist in the emergency evacuation process.

5.2.31 Relevant transport authorities and operators should examine and regularly review their infrastructure including their networks, stations, and depots, for potential flooding locations and to identify the need for any flood risk reduction measures. For large stations and depots, solutions should be sought to store or disperse rainwater from heavy storms in a sustainable manner.

Basements

5.2.32 Basement dwellings are classified as highly vulnerable development and should not be permitted within Flood Zone 3. All basement access threshold levels should be raised above the 1 in 100 year flood level with climate change, and all basements must include provision of internal staircases to upper floors. Flood resilient construction techniques should be employed and consideration given to all forms of flood risk.

5.2.33 It is recommended that basement impact assessments are stipulated as a requirement for all proposed basement developments, in order to demonstrate that the proposals are safe from a flood risk perspective, and will not have any adverse impacts on local hydrogeology.

Water Environment

5.2.34 It is recommended that LBTH take a holistic approach to flood risk management across the Borough within the wider context of the water cycle and local environment. Within Tower Hamlets, the majority of waterbodies are designated as heavily modified (as defined by the Water Framework Directive), with an absence of natural river processes leading to lost habitat diversity and poor water quality.

5.2.35 Additionally, it is anticipated that growing population numbers and changing climate patterns will place increased pressure on already stressed water resources across Greater London. New development can assist in alleviating this water scarcity by incorporating water efficiency measures such as grey water recycling, rainwater harvesting and water use minimisation technologies. This will also have a substantial benefit on the sewer system which will receive less wastewater from properties, potentially freeing up capacity during flood events.

5.2.36 Consideration should be given to maximising the benefits of surface water management infrastructure, enhance the urban environment for the benefit of communities and biodiversity. Through high quality design and installation, such infrastructure can contribute to multi-functional benefit in the following areas:

- Provision of habitat and biodiversity - when adequately planned, the delivery of diverse, high quality green spaces can provide valuable habitat to a range of flora and fauna.
- Recreation and community - provision of space for recreation and contribution to community health, wellbeing and social cohesion. Water features can create a sense of place.
- Microclimate adaptation - Reducing the impact of the urban heat island effect by providing shading to protect against radiations, reducing local temperatures through evapotranspiration and reducing heat absorbed and then released by surfaces.
- Public realm - street greening and the delivery of effectively landscaped open spaces can substantially improve the amenity value of neighbourhoods.

Consultation and Coordination

5.2.37 For future flood risk management within the Borough to be successful, it is essential that relevant partners and stakeholders, who have responsibility for flood risk management assets, work collaboratively to reduce flood risk.

5.2.38 In particular, LBTH should continue to work with the EA and others to ensure ongoing maintenance and improvement of the River Thames Defences. This will include ensuring that the recommendations of the TE2100 Plan are implemented in new and existing developments, to keep communities safe from flooding in a changing climate and improving the local environment.

5.2.39 Ongoing coordination with the Canal and Rivers Trust will additionally be required to manage the flood risk associated with canals and docks across the Borough, and the hydraulic interaction of these systems with the River Lee and the River Thames.

5.2.40 Similarly, opportunities should be sought to reduce the risk of flooding from surface water and sewer surcharge through consultation with Thames Water, to determine key areas for maintenance and locations that would benefit from flood alleviation schemes.

5.2.41 It is further recommended that LBTH continues to collaborate with stakeholders to maintain and expand upon the existing understanding of flood risk across the Borough and, in particular, to confirm the impact of revised climate change allowances on understanding of fluvial flood risk associated with the River Lee.

6 Guidance for Developers

6.1 Site Specific Flood Risk Assessment

6.1.1 The aim of a site specific FRA is to assess the flood risk to and from a proposed development, and demonstrate that it will not be at risk of flooding during the design event during the lifetime of the development. This includes assessment of mitigation measures required to safely manage flood risk and demonstration that the proposed development will not increase flood risk elsewhere. All sources of flood risk will need to be considered.

6.1.2 This section presents the recommendations for site specific FRAs prepared for submission with planning applications to LBTH, following the approach recommended by:

- The EA, particularly its Flood risk standing advice [24];
- NPPF and Planning Practice Guidance[25];
- CIRIA C753 The SuDS Manual[26];
- CIRIA report 624, Development and Flood Risk: Guidance for the construction industry; and
- LBTH's Guidance for Developers.

6.1.3 FRA reports are usually undertaken by the developer and submitted as part of the planning application process. However, there are instances where a LPA might wish to commission a detailed, site-specific FRA to further understand the level of risk associated with a strategic site, and to inform decision making. An example of this would be where new flood defences or improved SoP to existing defences is considered for a site, and the resultant flood reduction benefits, loss of floodplain storage and downstream implications need to be understood.

6.1.4 A site specific FRA is required in the following circumstances:

- Proposals of 1 hectare or greater in Flood Zone 1;
- Proposals for new development (including minor development and change of use) in Flood Zones 2 and 3;
- Proposals for new development (including minor development and change of use) in any CDA (as designated by the EA or the Borough); and
- Where proposed development or a change of use to a more vulnerable class may be subject to other sources of flooding.

6.1.5 A FRA should demonstrate that the proposed development is safe from flooding from all sources, including the provision of safe access and egress, and that the development does not increase flood risk elsewhere. The FRA should consider the latest climate change guidance and allowances.

6.1.6 Proposals for the sustainable management of surface water should also be presented through a suitable drainage strategy incorporating SuDS techniques and demonstrating betterment in terms of runoff rates, amenity and biodiversity, as further described in Section 6.3.

6.1.7 If a detailed FRA is required, it must be undertaken by a suitably qualified professional. Assessments should be on a site by site basis making use of local knowledge. However, an initial assessment of flood risk can be made by consulting the mapping section of this SFRA.

[24] Environment Agency Flood Risk Standing Advice https://www.gov.uk/guidance/flood-risk-assessment-standing-advice
[25] National Planning Policy Framework https://www.gov.uk/government/publications/national-planning-policy-framework--2
[26] The SuDS Manual http://www.ciria.org/Resources/Free_publications/SuDS_manual_C753.aspx

6.1.8 FRAs should also be appropriate to the scale, nature and location of the development. Table 8 presents the different levels of site-specific FRA (as defined in CIRIA publication C624) and identifies typical sources of information that can be used.

Table 8 - *Levels of Site Specific FRA (CIRIA C624)*

Level	Requirements	Typical Sources of Information
Level 1 Screening Study	The Level 1 FRA should identify whether there are any flooding or surface water management issues related to a development site that may warrant further consideration. This should be based on readily available existing information.	Typical sources of information include: • LBTH SFRA, SWMP and PFRA; • Flood Map for Planning (Rivers and Sea); • Local flood risk policy documentation (such as Flood Risk Management Plan, CFMP and LFRMS); • EA Standing Advice; and • NPPF Tables 1, 2 and 3.
Level 2 Scoping study	The Level 2 FRA should be undertaken if the Level 1 FRA indicates that the site may lie within an area that is at risk of flooding, or the site may increase flood risk due to increased run-off. This study should confirm the sources of flooding which may affect the site. The study should include: • An appraisal of the availability and adequacy of existing information; • A qualitative appraisal of the flood risk posed to the site, and potential impact of the development on flood risk elsewhere; and • An appraisal of the scope of possible measures to reduce flood risk to acceptable levels. The scoping study may identify that sufficient quantitative information is already available to complete a FRA appropriate to the scale and nature of the development.	Typical sources of information include those listed above, plus: • Local policy statements or guidance, LFRMS; • CFMP; • Data request from the EA to obtain result of existing hydraulic modelling studies relevant to the site and outputs such as maximum flood level, depth and velocity; • Consultation with EA/LBTH/sewerage undertakers and other flood risk consultees to gain information and to identify in broad terms, what issues related to flood risk need to be considered including other sources of flooding; • Historic maps; • Interviews with local people and community groups; • Walkover survey to assess potential sources of flooding, likely routes for floodwaters, the key features on the site including flood defences, their condition; and • Site survey to determine general ground levels across the site, levels of any formal or informal flood defences.
Level 3 Detailed study	To be undertaken if a Level 2 FRA concludes that further quantitative analysis is required to assess flood risk issues related to the development site. The study should include: • Quantitative appraisal of the potential flood risk to the development; • Quantitative appraisal of the potential impact of the development site on flood risk elsewhere; and • Quantitative demonstration of the effectiveness of any proposed mitigations measures.	Typical sources of information include those listed above, plus: • Detailed topographical survey; • Detailed hydrographic survey; • Site-specific hydrological and hydraulic modelling studies which should include the effects of the proposed development; • Monitoring to assist with model calibration/verification; and • Continued consultation with the LPA, EA and other flood risk consultees.

Flood Risk Assessments for Flood Zone 1

6.1.9 Site specific FRAs are required in Flood Zone 1, if a proposed development is:

- 1 hectare or greater in size;
- Within a CDA (as designated by either the EA or LPA); or
- Where proposed development or a change of use to a more vulnerable class may be subject to other sources of flooding.

6.1.10 The following recommendations are made for site specific FRAs in Flood Zone 1.

- The developer should check whether the site has been identified as at risk from other (non-river related) flood sources by referring to the relevant maps within this SFRA. If so, a more detailed assessment of this risk over the lifetime of the development must be made;
- Assess the flood risk from all sources, including an assessment of the effects of climate change over the lifetime of the development;
- A drainage impact assessment must be carried out by a suitable professional to identify the impact of the proposed development on surface water drainage and recommend the approach to controlling runoff to the required discharge rates, through the use of SuDS. Where possible, runoff should be reduced to Greenfield Rates, in accordance with the recommendations of the London Plan. If the development is adjacent to a river, it must be set back an appropriate distance from the watercourse and development must enhance the river form and habitat. If culverted, the development should not build over the culvert and the developer should seek opportunities to de-culvert the watercourse as part of the development; and
- The FRA must show that flood risk will be reduced overall.

6.1.11 The Planning Practice Guidance (Table 3) confirms that all types of development are deemed suitable in Flood Zone 1.

6.1.12 If the site is on a ‘dry island’, surrounded by Flood Zone 2 or 3, the developer must also show that safe access and egress will be possible during a flood event.

Flood Risk Assessments for Flood Zones 2 and 3

6.1.13 A FRA must be undertaken for any proposed developments in flood zones 2 and 3. It is strongly recommended that the Sequential Test, and, depending on the vulnerability of the development (refer to Table 6), the first part of the Exception Test, be satisfied before the FRA is commenced.

6.1.14 If the development is within Flood Zone 2 or 3, the flood risk will be greater, and therefore the following recommendations and comments are made in addition to those that apply to sites in Flood Zone 1.

- Demonstrate, through the application of the Sequential Test, that there are no other suitable alternative sites in Flood Zone 1 for development;
- Show that flood risk will be reduced, and that suitable methods of mitigation will protect the development against the following (whichever are applicable):
  - 1% AEP fluvial event plus climate change over the lifetime of the development;
  - 0.5% AEP tidal event plus climate change over the lifetime of the development;
- Show that safe access can be provided to an appropriate level for the type of development;
- Show that flow routes are preserved and floodplain storage capacity is not reduced;
- The residents and occupiers of commercial buildings should be made aware their home / business is located in an area of flood risk, and should be encouraged to sign up to the EA Floodline Warnings Direct service (if available in this location);
- For development proposals adjacent to the River Thames or River Lee, the risk of overtopping or breaching of defences should be considered, including breach assessment where necessary; and

- Any development which includes or is immediately adjacent to a flood defence must additionally demonstrate that the flood defence will be fit for the lifetime of the development. This may require a survey of defences, proposals for required remedial works and / or complete replacement of defences.

6.1.15 If in Flood Zone 3, the FRA must also confirm whether the development is located in Flood Zone 3a or 3b. It should be noted that only planning applications for essential infrastructure or water compatible development will be considered in Flood Zone 3b. Within Flood Zone 3b it must additionally be demonstrated that the development will:

- Remain operational and safe for users in times of flood;
- Result in no net loss of floodplain storage;
- Not impede water flows; and
- Not exacerbate flood risk elsewhere.

6.2 Reducing Residual Flood Risk

6.2.1 The minimum acceptable SoP against flooding for new property within flood risk areas is 1% AEP for fluvial flooding and a breach during a 0.5% AEP tidal event, with allowance for climate change over the lifetime of the development. The measures chosen will depend on the nature of the flood risk. Some of the more common measures are broadly outlined in this section.

Reducing Flood Risk through Site Layout and Design

6.2.2 Flood risk should be considered at an early stage in determining the layout and design of a development, providing an opportunity to reduce flood risk within the site. The NPPF and Planning Practice Guidance state that a sequential, risk-based approach should be applied in order to locate more vulnerable land uses (such as residential use) to higher ground, while more flood-compatible development (e.g. parking, recreational space) can be located in areas at the highest risk of flooding within the site.

6.2.3 Low-lying waterside areas, or areas along known surface water flow routes, can be used for recreation, amenity and environmental purposes, allowing the preservation of flow routes and flood storage, and at the same time providing valuable social and environmental benefits contributing to other sustainability objectives. Landscaping should ensure safe access to higher ground from these areas, while avoiding the creation of isolated islands as water levels rise.

Modification of Ground Levels

6.2.4 Modifying ground levels to raise land above the required flood levels may be a potential means of reducing flood risk at certain sites, particularly where the risk is entirely from tidal flooding and the land does not provide conveyance for flood waters. However, in most areas of fluvial flood risk, conveyance or flood storage would be reduced by raising land above the floodplain, thereby adversely impacting on flood risk downstream. As such, compensatory flood storage must be provided to account for any land raising in the floodplain. Where the site is entirely within the floodplain it is not possible to provide compensatory storage at the maximum flood level so this will not be a viable mitigation option.

6.2.5 For proposed sites shown to be at risk of flooding from the 1 in 100 year plus Climate Change event, localised topography raising must be balanced with suitable floodplain compensation storage at another location (to be agreed with the EA). Such locations need to be sited in areas that currently do not flood (i.e. not part of the floodplain) and ideally within the redline application boundary.

6.2.6 Hydraulic modelling is likely to be required to demonstrate that the floodplain compensation design is technically robust, that there is no increase in flood risk off-site and that flood flow paths are not

altered in such a way as to cause increase of flooding elsewhere. Consideration should also be given to surface water ponding, which may be increased due to changes in local topography.

Raised Defences

6.2.7 Construction of raised floodwalls or embankments can divert floodwaters away from new development or reduce the rate of flood inundation following a residual event. However, this should not be regarded as a preferred option for new development, as a residual risk of flooding will remain. Additionally, it is essential to ensure that diversion of flood waters does not increase flood risk to people or properties in other areas. Compensatory storage must be provided where raised defences remove storage from the floodplain. Temporary or demountable defences are not acceptable flood protection for new development unless flood risk is residual only.

Upstream Flood Storage

6.2.8 Flood storage areas can be an effective way of attenuating floodwater for management of flood risk in surrounding areas. The basic function of these techniques is increased flood storage, through installation of features including pools, ponds, ditches and river restoration schemes. These features can provide habitat for local wildlife, contributing to local ecology and biodiversity, while additionally providing open space for recreational and amenity benefit. It is important that ongoing maintenance of flood storage areas is considered at an early stage to avoid future exacerbation of flood risk to surrounding areas as a result of poor upkeep.

Developer Contributions to Flood Defences and Risk Management Infrastructure

6.2.9 Riparian developments are required to renew or otherwise adequately maintain flood defences to the required SoP, over the lifetime of the development, accounting for the effects of climate change. In some cases, it may be necessary for the developer to make a contribution to the improvement of flood defences, or flood alleviation schemes for the benefit of both the development and the local community. Developers should also assess other existing assets (e.g. bridges, culverts, embankments) and renew them to last (as a minimum) the lifetime of the development.

6.2.10 Proposed developments which are adjacent to main rivers must demonstrate that sufficient access is provided to existing defences to enable ongoing maintenance and, where appropriate, improvement has been considered. Where possible, development should be set back from the edge of main rivers and watercourses to enable future sustainable and cost effective flood risk management, including upgrade of river walls and embankments.

Building Design and Finished Floor Levels

6.2.11 Where developing in flood risk areas is unavoidable, the most common method of mitigating flood risk to occupants is to ensure that habitable floor levels are raised above the estimated design flood level, with an allowance for freeboard. This significantly minimises the risk of damage to the building interior, furnishings and electrical installations during flood events. Floor levels should ideally be raised by the following recommended amounts, as a minimum:

- In areas at fluvial flood risk:
  - 300 mm above the 1% AEP event plus climate change water level;
- In areas at risk of a breach of the tidal defences:
  - 300 mm above the maximum water level caused by a defence breach during a 0.5% AEP plus climate change event.

6.2.12 This additional height that the floor level is raised is referred to as the ‘freeboard’.

6.2.13 Making the ground floor use of a building water compatible (for example a garage), may also provide an effective means of raising living space above likely flood levels.

6.2.14 Constructing a building on stilts is not considered an acceptable means of flood mitigation for new development. However, this may be considered in special circumstances if replacing an existing solid building, as it can improve flow routes. In these cases, safe access and egress must be provided and covenants established to ensure the ground floor use is not changed at a later stage.

Flood Resistance and Resilience

6.2.15 There may be certain circumstances under which flood risk to a development is unavoidable, for example:

- Proposed water compatible uses;
- Alterations to existing buildings;
- Development behind flood defences, where residual risk remains; or
- Where building floor levels have been raised but there is still a remaining risk under the 0.1% AEP event.

6.2.16 In such cases (and for existing development in the floodplain), additional measures may be implemented to reduce damage during a flood and increase the speed of recovery. These measures should not be relied on as the only mitigation method.

6.2.17 Flood resistance measures aim to prevent floodwater from entering a property and causing damage. These measures may be temporary, such as demountable flood barriers and door flood guards for individual properties. If installed correctly and in advance of a flood event, these measures can provide effective protection. On a smaller scale, temporary snap-on covers for airbricks and vents can also be fitted to prevent entry of flood water. However complications can arise regarding the time for transportation and installation of defences and therefore a reasonable duration between flood warning and onset of flooding is generally required. This may be mitigated by the use of automatic barriers that do not require manual assembly.

6.2.18 The use of temporary resistance measures is considered appropriate for existing properties, however is not recommended for new development. This is because most temporary measures require intervention to function effectively, along with continued maintenance, which cannot be guaranteed. Permanent flood resistance measures, such as the use of low permeability materials to prevent water ingress are therefore recommended for new development.

6.2.19 Flood resilience measures aim to reduce the consequences of flooding events and ensure that buildings can be swiftly returned to normal use. This means that design provision is made for conveyance of flood waters through the building, avoiding the risk of structural damage and allowing rapid re-occupancy.

6.2.20 This includes interior design to reduce damage caused by flooding and may include:

- Designing structural capability to handle levels of water pressure associated with anticipated depths of flooding.
- Use of appropriate construction materials for surfaces, walls and floors which retain structural integrity during flooding and have good drying and cleaning properties. This may include vinyl and ceramic tiles, pressure treated timber, glass block, or metal. Alternatively sacrificial materials can be used for internal and external finishes (such as gypsum plasterboard which may be removed and replaced following flooding).
- Consideration given for appropriate water entry points into properties including doors, windows and air bricks.
- Placement of electrical circuitry and appliances above predicted levels of flooding with power cables carried down from the ceiling (not up from the floor level).

- Appropriate design of plumbing fittings, including toilets, with non-return valves to minimise the risk of contamination of floodwaters.

6.2.21 Flood resilience measures are most appropriate for less vulnerable uses where temporary disruption is acceptable and suitable flood warning is received.

6.2.22 The measures implemented should be specific to the nature of flood risk and the type of development proposed and, as such, will be informed and determined by the FRA. Further detailed guidance on flood resilient construction techniques is provided within readily available publications from CIRIA (2010)[27] and DCLG (2007)[28].

Basements

6.2.23 Basement dwellings are classified as highly vulnerable development and should not be permitted within Flood Zone 3. Basement access threshold levels should be raised above the 1 in 100 year flood level with climate change, and all basements must include provision of internal staircases to upper floors. Flood resilient construction techniques should be employed and consideration given to all forms of flood risk.

6.2.24 Basement impact assessments should be undertaken for all proposed basement developments, in order to demonstrate that the proposals will safeguard structural stability, are safe from a flood risk perspective, and will not have any adverse impacts on local hydrogeology.

6.2.25 Drainage connections from basements to sewers should be fitted with a one way valve to prevent the drains flooding the basements if they surcharge. Thames Water also requires a pumped sewage system in basements where there is local record of sewer flooding. Pumping of groundwater into the sewer network should be avoided.

6.2.26 Basement proposals should also consider the requirements for SuDS and runoff reduction, as described in 6.3.

6.3 Sustainable Drainage Systems

6.3.1 Implementing SuDS aims to recreate more natural drainage systems within the urban environment. These features celebrate the presence of water, enriching the urban environment, while providing valuable function for flood alleviation and biodiversity enhancement. Within developments, SuDS measures look to maximise permeable surfaces in an effort to increase the amount of water that is attenuated, treated and processed within the natural hydrological cycle.

6.3.2 Incorporating SuDS features will assist in absorbing runoff generated within development sites, reducing flooding, improving water quality, providing irrigation for vegetation and improve amenity. Such features can also contribute to a range of wider benefits, including provision of habitat for biodiversity, recreational opportunities, improved air quality and amelioration of the urban heat effect.

6.3.3 All new developments within the Borough must incorporate SuDS to provide attenuation and management of rainfall runoff unless there is a valid reason to justify that they are not suitable. SuDS features are also suitable for retrofit on many sites, with a number of well-regarded SuDS retrofit schemes installed across Tower Hamlets. Sustainable drainage should be delivered in accordance with the SuDS Hierarchy, below:

- Store rainwater for later use;
- Use infiltration techniques, such as porous surfaces in non-clay areas;
- Attenuate rainwater in ponds or open water features for gradual release;

[27] Flood resilience and resistance for critical infrastructure (2010) http://www.ciria.org/Resources/Free_publications/Flood_resilience.aspx
[28] Improving the Flood Performance of New Buildings - Flood Resilient Construction (2007) https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/7730/flood_performance.pdf

- Attenuate rainwater by storing in tanks or sealed water features for gradual release;
- Discharge rainwater direct to a watercourse;
- Discharge rainwater to a surface water sewer/drain; and
- Discharge rainwater to the combined sewer.

6.3.4 Within Tower Hamlets, sewer capacity is understood to be constrained in certain areas (as discussed in Section 3.3.50 and 3.3.33), and minimising the volume and rate of discharge entering the foul and combined drainage networks is of critical importance to help ensure ongoing capacity to cater for population growth and the effects of climate change. Where infiltration is not achievable, managed discharge of surface water to adjacent surface water bodies, such as rivers, canals or docks, should also be considered. However, controls would need to be implemented to avoid any adverse harm to biodiversity and ecological habitat within receiving waters.

6.3.5 Runoff rates from new development should be restricted to greenfield runoff rates wherever possible. This is particularly important within CDAs. Where this is not achievable, robust justification will be required, and an alternative reduction in runoff agreed through consultation with LBTH.

6.3.6 SuDS schemes should be in accordance with the LBTH SuDS Guidance, the London Plan and associated Sustainable Design and Construction SPG and the London Sustainable Drainage Action Plan.

6.3.7 Appendix B provides a brief summary of the main SuDS techniques that could be suitable for implementation within LBTH. Detailed guidance on the selection, design, construction and maintenance of SuDS is provided in the LBTH SuDS Guidance and the CIRIA SuDS Manual[29]. However, it should additionally be noted that the field of sustainable drainage is rapidly developing; therefore reference should be made to the latest guidance and best practice in developing site drainage strategies.

6.3.8 The selected SuDS scheme will be dependent on various factors including (but not limited to) topography, geology (soil permeability), and available area. This should be based on a comprehensive understanding of the catchment hydrological processes (i.e. nature and capacity of the existing drainage system). The design, construction and maintenance regime of such a scheme must be carefully defined, including the need and responsibility for ongoing inspection and maintenance to avoid future exacerbation of flood risk as a result of poor upkeep.

6.3.9 Many SuDS measures are designed to promote infiltration of runoff into the ground beneath, promoting recharge of the water table and reducing runoff. However, implementation of infiltration SuDS within Tower Hamlets may be constrained by geological conditions, including contaminated land. Site specific assessment of geological conditions should be undertaken to confirm that infiltration SuDS are suitable. Where sites lie within or close to source protection zones further restrictions may apply, and guidance should be sought from the EA.

6.3.10 Map 011 contains information on the likely suitability of infiltration SuDS across the Borough. This map delineates four subsurface categories across the Borough, in which infiltration is likely to be of varying suitability, based upon a range of hydrogeological indicators. Further detail on the four categories is included in Table 9 below.

[29] The SuDS Manual http://www.ciria.org/Resources/Free_publications/SuDS_manual_C753.aspx

Table 9 - *SuDS Infiltration Suitability category descriptors*

Category	Description
Highly suitable	The subsurface is likely to be suitable for free-draining infiltration SuDS
Probably suitable	The subsurface is probably suitable for infiltration SuDS although the design may be influenced by the ground conditions.
Potentially suitable for bespoke designs	The subsurface is potentially suitable for infiltration SuDS although the design will be influenced by the ground conditions
Unlikely to be suitable	There is a very significant potential for one or more geo-hazards associated with infiltration.

6.3.11 If subsurface conditions are not suitable to facilitate infiltration in a certain area, selected SuDS features will need to be focused on surface water storage and attenuation, and appropriately lined so as to transport water to an area where it can be safely disposed.

6.4 Managing Flood Risk from Other Sources

Surface Water and Sewer Flooding

6.4.1 New development should seek to improve on-site drainage infrastructure to reduce flood risk. The site FRA and drainage strategy should demonstrate that the development will not increase flood risk elsewhere, and that LBTH's drainage requirements regarding runoff rates and SuDS are met. SuDS are a highly effective way of managing surface water flood risk, as described in Section 5.3 and Appendix B, and should be incorporated on all development sites

6.4.2 When redeveloping existing buildings, the installation of some flood-proofing and resilience measures can be used to protect against both surface water and sewer flooding. Non-return valves prevent water entering the property from drains and sewers. These valves can be installed within gravity sewers or drains, within the property's private sewer, upstream of the public sewer system. These need to be carefully installed and must be regularly maintained.

Groundwater

6.4.3 Groundwater flooding has a unique flooding mechanism, as it may emerge from below ground level and for this reason many conventional flood defence and mitigation methods are not suitable. Flood risk may be reduced through building design, by ensuring that floor levels are raised sufficiently above the water table. Site design would also need to preserve any flow routes followed by the groundwater overland and make sure flood risk is not increased downstream. Proposed basement areas are likely to be particularly susceptible to groundwater flooding in certain areas. This may be mitigated through waterproof construction; however, consideration should be given to the potential impact on subterranean flow or water tables. When redeveloping existing buildings, it may be acceptable to install pumps in basements as a resilience measure. However, for new development this is unlikely to be considered an acceptable solution.

6.4.4 Site specific ground investigation is also likely to be required in locations where below ground development is proposed or there is known groundwater flood risk.

Artificial Sources

6.4.5 The flooding mechanism associated with flood risk from artificial sources is primarily related to breach or failure of structures (reservoir, lake, canal, flood storage areas, etc.). Due to the nature of this

mechanism, it is difficult to foresee the location or extent of these problems and therefore it is important that the site specific FRA takes into consideration the integrity and history any relevant artificial structures and makes recommendations/provisions aimed at reducing the level of risk from these sources where applicable.

6.5 Making Development Safe

Safe Access and Egress

6.5.1 Emergency access and egress is required for developments during times of flooding to enable the evacuation of occupants and facilitate the emergency response. An emergency access and egress route is a path that is 'safe' for use by occupiers without the intervention of emergency services or others. A route can only be completely 'safe' in flood risk terms if it is dry at all times.

6.5.2 The FD2320/21 Defra/EA Flood Risks to People Report provides requirements for maximum flood depth and velocity to quantify whether an evacuation route should be deemed safe, where the requirements for safe access and egress from new developments are as follows in order of preference:

- Safe, dry route for people and vehicles;
- Safe, dry route for people;
- If a dry route for people is not possible, a route for people where the flood hazard (in terms of depth and velocity) is low and should not cause risk to people; and
- If a dry route for vehicles is not possible, a route for vehicles where the flood hazard (in terms of depth and velocity) is low to permit access for emergency vehicles.

6.5.3 Provision of safe access and egress may involve raising access routes to a suitable level above flood levels. As with land raising, it is imperative that any assessment takes into consideration the volume of floodwater potentially displaced.

Flood Warning and Evacuation

6.5.4 Emergency and evacuation plans should be in place for all properties at residual risk of flooding. Those developments which house vulnerable people (i.e. care homes and schools) will require more detailed plans.

6.5.5 Advice should be sought from the LBTH Emergency Planning Team when producing an emergency evacuation plan for developments as part of an FRA. Those preparing detailed emergency evacuation plans for vulnerable developments should undertake consultation not only with LBTH's Emergency Planning team but also the emergency services, so they know what is expected of them in the event of an emergency.

6.5.6 The EA operates a flood warning service in certain areas at risk of both fluvial and tidal flooding. The Flood warning system helps residents in these areas to prepare for flooding to minimise its potential consequences.

6.5.7 All homes and businesses within Flood Zone 2 and 3 are eligible for the EA's Floodline Warnings Direct service, and should be encouraged to sign up to it. It is recommended that the developers make new owners of the property aware of this so they can sign up to FWD.

6.5.8 Areas of the Borough which are subject to flood warnings and alerts are illustrated in Map 010.

6.6 Making Space for Water

Opportunities for River Restoration and Enhancement

6.6.1 All new development close to watercourses should consider the opportunity to improve and enhance the water environment. Developments should look at particular opportunities for river restoration and enhancement. Restoration can take place on various scales, from small enhancement measures to full river restoration. Options include backwater creation, de-silting, in-channel habitat enhancement, removal of in-stream structures (e.g. weirs), and restoration of banks among others.

6.6.2 These measures have the potential of reducing the costs of maintaining hard engineering structures, reducing flood risk, improving water quality and increasing biodiversity. Social benefits are also gained by increasing green space and access to the river.

6.6.3 In particular, there should be a presumption against further culverting of watercourses and constructing over culverts. All new developments with culverts running through their site should seek opportunities to de-culvert rivers, for flood risk management and conservation benefit.

6.6.4 These measures are supported by the European Water Framework Directive (WFD) a comprehensive river basin management planning system which aims to protect and improve the ecological health of waterbodies across Europe. In the UK, the EA is the authority charged with implementation of the Directive, and must meet certain targets aimed at restoring water bodies towards good condition. In line with the objectives of the directive, opportunities for waterbody improvement must be considered across all development proposals incorporating watercourses.

Buffer Strips

6.6.5 Developers must aim to set back development from the edge of adjacent waterways, in order to provide a buffer strip to ‘make space for water’ and allowing additional capacity to accommodate the effects of climate change. This is also necessary in areas where flood defences or other engineered structures are present in order to provide a corridor for maintenance and improvement works. As a minimum, development should be set back:

- 5 meters from Ordinary Watercourses;
- 8 meters from fluvial Main Rivers; and
- 16 meters in tidal areas.

6.6.6 Map 01 in Appendix A identifies the Main Rivers and Ordinary Watercourses present within Tower Hamlets.

6.6.7 An Environmental Permit will be required from the EA for all works within 8 metres of main rivers and 16 metres of the Tidal Thames.

Designing for Exceedance

6.6.8 The capacity of existing drainage systems is limited, and can be overwhelmed by rainfall events of intensity above the design capacity, possibly leading to surcharge and flooding. In order to manage and minimise the impacts of such events, developers should seek opportunities to identify a safe route for any exceedance flow and suitable storage or discharge location, so that this does not put people or property at risk.

6.6.9 As exceedance is expected to occur infrequently, such measures should ideally provide other benefits. An example of this is blue-green urban corridors, which provide ecological, recreational and functional benefits under the small rainfall events, whilst offering an effective and safe means of managing extreme events when these do occur.

7 Summary

7.1 Overview

7.1.1 The NPPF and accompanying Guidance emphasise the responsibility of LPAs to ensure that flood risk is understood and managed effectively and sustainably throughout all stages of the planning process. This SFRA aims to facilitate this process by identifying the spatial variation in flood risk across the Borough, allowing an area-wide comparison of future development sites with respect to flood risk considerations.

7.1.2 The Borough is bounded to the South by the River Thames and to the East by the River Lee. Whilst the tidal Thames poses a potential risk of flooding to the Borough, the TTD provide a substantial SoP, up to the 1 in 1000 year event (1% AEP). This protection is effective provided the Thames Barrier is operated to protect against storm surges from the North Sea and that there is sufficient storage behind the barrier to accommodate the River Thames when it is shut during extreme fluvial events at high tides. The River Lee is also defended; however, small areas to the north-east of the Borough are at actual risk of fluvial flooding from this source, for events above a 1 in 50 year return period (2% AEP).

7.1.3 A potential risk of flooding from other (non-river related) sources exists throughout the Borough, including sewer surcharge, and surface water flooding as a result of heavy rainfall and limited capacity of drainage infrastructure. This is particularly known to be an issue within certain CDAs, in particular, the Isle of Dogs. Geological indicators also suggest that certain areas throughout the Borough may be susceptible to elevated groundwater levels, which may additionally interact with and exacerbate these sources of flood risk. It is expected that changing climate patterns will have a substantial impact on the level of flood risk from all sources within the Borough. The mapping contained in Appendix A illustrates the spatial distribution of flood risk from all sources across the Borough.

7.1.4 As a large inner city Borough, Tower Hamlets is experiencing rapid rates of high density development, including both large-scale commercial development and smaller-scale residential development. This development is spatially disparate across the Borough, with dominant density characteristics of large building footprints with limited open space and significant basement areas. There is additionally an emerging precedent for new development encroaching on existing water spaces across the Borough. Without adequate mitigation, development of this spatial distribution and typology has the potential to impact upon the hydrology and hydrogeology across LBTH.

7.1.5 In particular, increased density of urbanisation and encroachment of development onto existing water spaces, particularly within the Isle of Dogs, may lead to exacerbation of surface water flood risk if not adequately mitigated. Uncontrolled construction of basements may also impede ground water flows within the principle and superficial aquifers underlying the Borough, interacting with the various sources of flood risk.

7.1.6 This SFRA identifies the floodplain areas associated with the River Thames, River Lee and presents Flood Zone Maps that delineate the flood zones outlined in the NPPF. These maps provide the necessary information to facilitate the NPPF risk-based approach to planning. This process determines the compatibility of various types of development within each flood zone, subject to the application of the Sequential Test and the Exception Test when required.

7.2 Key Recommendations and Next Steps

7.2.1 Adopting a holistic approach to flood risk management should help ensure that flooding is taken into account at all stages of the planning process. To aid this holistic approach, it is recommended that all key recommendations set out in this report are considered and incorporated into the emerging Tower Hamlets Local Plan. These recommendations are fully detailed in Chapter 5.2.

7.2.2 Flood risk should be an early and primary consideration in strategic planning for development across the Borough. A sequential approach should be taken to allocating strategic development areas in regions of lowest flood risk, taking into account vulnerability of land use. Consideration should also be given to strategic allocation of open space and preserving and expanding river corridors to create space for flooding to be managed effectively. In consulting on and determining development applications, LBTH must ensure that all new developments have considered flood risk management from the planning stage, including site specific flood risk assessment, where required.

7.2.3 Given the position of the Borough adjacent to the River Thames and River Lee, it is highly reliant on flood defences. Ongoing maintenance of these defences is critical, and priority should be given to safeguarding the SoP provided by defences over the lifetime of any development. Additionally, consideration should be given to the specific recommendations of the TE2100 plan in requiring reduction of current and future flood risk through raising, maintaining and enhancing flood defences. Existing corridors of land along the river frontage should be safeguarded and opportunities taken to set back development to enable sustainable and cost effective flood risk management, including upgrading of river walls and embankments and landscape, amenity and habitat improvements

7.2.4 Despite the high SoP provided by to the Borough, there is a residual risk through breaching or overtopping of defences. This should be managed through flood resistant and resilient design and protection measures. Flood awareness and robust emergency planning and response will additionally be critical to sustainable ongoing flood risk management.

7.2.5 Given the rate and nature of development anticipated across the Borough, robust surface water management, including the use of SuDS, will be critical to ensuring sustainability. It is recommended that runoff rates from new development be restricted to greenfield runoff rates, wherever possible, and managed in line with the SuDS hierarchy. Existing water spaces, including dock areas, should be safeguarded, and their flood management functionality enhanced where possible. Further consideration should additionally be given to hydrogeological conditions across the Borough and managing the impacts of subterranean development through site-specific impact assessments.

7.3 Maintenance of this FRA

7.3.1 In order for this SFRA to serve as a practical planning tool now and in the future, it is imperative that the SFRA is adopted as a ‘living document’ and is reviewed periodically in light of emerging policy directives and an improving understanding of flood risk within the Borough.

7.3.2 Appendix D lists a series of recommendations ensuring that the SFRA is kept up-to-date and maintained. This will allow the SFRA to follow emerging best practice and developments in policy, modelling and climate change predictions.

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