

London Borough of Tower Hamlets
Level 2 Strategic Flood Risk Assessment

Volume 1 – Guidance



CAPITA SYMONDS

FINAL January 2012

Quality Management

DOCUMENT INFORMATION

Title:	London Borough of Tower Hamlets Level 2 Strategic Flood Risk Assessment
Owner:	Marissa Hernandez
Version:	V2.0
Status:	Working Draft
Project Number:	CS051300
File Name:	G:\environment\ZWET\CS051300_TowerHamlets_L2_SFRA\Reports\Draft Report\Draft_LBTH_Level_2_Vol1_SFRA_003.doc

REVISION HISTORY

Summary of Changes	Completed By	Date of Issue	Version
First Draft	SI	19/09/2011	1.0
Amendments following feedback from LBTH and EA	SI / MA	18/01/2012	2.0

AUTHOR

Name	Organisation and Role
Stephanie Ip	Senior Consultant, Capita Symonds
Louise Tattersall	Consultant, Capita Symonds
Elisabeth Rewcastle	Consultant, Capita Symonds

APPROVALS

Name	Title	Signature	Date
Michael Arthur	Principal Consultant, Capita Symonds		
Paul Hlinovsky	Senior Consultant, Capita Symonds		

DISTRIBUTION

Name	Organisation and Role
Marissa Hernandez	LB of Tower Hamlets
Manmohan Dayal	LB of Tower Hamlets
Pete Thomas	Environment Agency
Ian Blackburn	Environment Agency

RELATED DOCUMENTS

Doc Ref	Document Title	Author	Date of Issue	Version
N/A	London Borough of Tower Hamlets Strategic Flood Risk Assessment – Level 1	Capita Symonds	Aug 2008	1.0
N/A	London Borough of Tower Hamlets Surface Water Management Plan	Capita Symonds	Aug 2011	1.0

Executive Summary

Capita Symonds has been commissioned to prepare a Level 2 Strategic Flood Risk Assessment (SFRA) on behalf of the London Borough (LB) of Tower Hamlets. This assessment builds upon the findings of the Level 1 SFRA completed in August 2008. The purpose of the SFRA is to support the borough's Local Development Framework (LDF). This has been done in response to the guidance in „Planning Policy Statement 25 – Development and Flood Risk’ that states that a sequential risk based approach should be applied to decision making at all levels of the planning process. The principle stages being the Regional Level (London Plan), the Local Level (this assessment) and the site level (planning applications).

The fundamental concepts that underpin the SFRA are outlined in PPS 25. The guidance provided in this document requires local authorities and those responsible for development decisions to demonstrate that they have applied a risk based, sequential approach in preparing development plans and consideration of flooding through the application of a Sequential Test, and Exception Test (where applicable). Failure to demonstrate that such a test has been undertaken at this level potentially leaves planning decisions and land allocations open to challenge during the planning process.

The underlying objective of the risk based sequential allocation of land is to reduce the exposure of new development to flooding and reduce the reliance on long-term maintenance of built flood defences. Within areas at risk from flooding, it is expected that development proposals will contribute to a reduction in the magnitude of the flood risk.

SFRAs are essential to enable a strategic and proactive approach to be applied to flood risk management. The assessment allows us to understand current flood risk on a wide-spatial scale and how this is likely to change in the future.

The principle objective of the Level 2 SFRA is to facilitate application of the Sequential and Exception Tests. More detailed information is required where there is deemed to be development pressure in areas that are at medium or high probability of flooding and there are no other suitable alternative areas for development after applying the Sequential Test. This more detailed study considers the detailed nature of the flood hazard, taking account of the presence of flood risk management measures such as flood defences. This will allow a sequential approach to site allocation to be adopted within a flood zone (paragraphs 17 and D4 of PPS25). It will also allow the policies and practices required to ensure that development in such areas satisfies the requirements of the Exception Test, and informs the relevant Local Development Documents of the Local Development Framework.

This SFRA describes the outcome of a „Level 2’ assessment, in accordance with paragraph E6 of PPS 25 and Section 3.59 of the PPS 25 Practice Guide. It contains a general assessment of risk from all sources over the whole study area and also detailed analysis for locations where flood risk is a significant issue (i.e. key development sites). The specific aims of the assessment are to:

- Inform policies and plans to ensure future developments, where appropriate, have been subjected rigorously to the applications of the Sequential and Exception Tests, satisfying PPS 25.
- Identify strategies to limit flood risks and adapt to climate change.
- Ensure the safety of new development.

The SFRA has been divided into two volumes:

- Volume 1 – Guidance
- Volume 2 – Flood Risk Management at Key Development Sites

This report is Volume 1 of the assessment and the structure is shown below. The supporting appendices and mapping are contained within Volume 2 which should be read in conjunction with this report.

The SFRA is a live document that is intended to be updated as new information and guidance becomes available. The outcomes and conclusions of the SFRA may not be valid in the event of future changes to legislation, policy, revised government guidance on flood risk, the data or the baseline flooding situations. It should be noted that at the time of writing this document, central government is undertaking a substantial review of PPS 25 and it is likely that it will be replaced by the 'National Planning Policy Framework' (NPPF). A draft NPPF is currently available and it does not propose significant change to the established PPS 25 processes for the Sequential and Exception Tests.

Decisions also require the inclusive assessment of wider planning issues and the user should be aware that changes to decision making principles affecting other planning issues can potentially affect the outcome of the risk based Sequential Test. It is the responsibility of the user to ensure they are using the best available information.

Volume 1: Main body of Level 2 SFRA Report

Chapter 1 Introduction

Chapter 2 How to Use This Document

Chapter 3 Flood Risk in Tower Hamlets

Chapter 4 Policy Guidance and Recommendations

Chapter 5 References

Volume 2: Flood Risk Management at Key Development Sites

Chapter 1 Introduction

Chapter 2 Flood Risk Assessment at 31 Key Development Sites

Appendices

Mapping

Glossary

Term	Definition
Actual risk	The risk that has been estimated based on a qualitative assessment of the performance capability of the existing flood defences
AEP	Annual exceedance of probability. The annual chance of experiencing a flood with the corresponding flood magnitude, i.e. a 1% AEP flood is a flood with a flow magnitude that has a 1% chance of occurring in each and every year
AAP	Area Action Plan: Development Plan Documents (DPD) that provide specific planning policy and guidance for particular areas where significant regeneration or conservation needs to be managed.
Breach or failure hazard	Hazards attributed to flooding caused by a breach or failure of flood defences or other infrastructure which is acting as a flood defence.
CDA	Critical Drainage Area: A discrete geographic area (usually a hydrological catchment) where multiple and interlinked sources of flood risk (surface water, groundwater, sewer, main river and/or tidal) cause flooding in one or more Local Flood Risk Zones during severe weather thereby affecting people, property or local infrastructure.
CFMP	Catchment Flood Management Plan: A high-level planning strategy through which the Environment Agency works with their key decision makers within a river catchment to identify and agree policies to secure the long-term sustainable management of flood risk.
CLG	Communities and Local Government. Government Department responsible for issuing Planning Policy Statement 25: Development and Flood Risk
Climate Change	Long term variations in global temperature and weather patterns caused by natural and human actions.
Consequence	Impact that the flood event would cause if it occurred
Defra	Government Department for Environment, Food and Rural Affairs
DG5 Register	A water-company held register of properties which have experienced sewer flooding due to hydraulic overload, or properties which are 'at risk' of sewer flooding more frequently than once in 20 years.
DPD	Development Plan Document
EA	Environment Agency: Government Agency reporting to Defra charged with protecting the Environment and managing flood risk in England.
Exception Test	The Exception Test should be applied following the application of the Sequential Test. It must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk, is on developable land, the development is safe and will not increase flood risk elsewhere.
Flood defence	Natural or man-made infrastructure used to prevent flooding
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 risk	Flood risk is a combination of two components: the chance (or probability) of a particular flood event and the impact (or consequence) that the event would cause if it occurred (EA 2003).
FRA	Flood Risk Assessment
Flood risk management	Flood risk management can reduce the probability of occurrence through the management of land, river systems and flood defences, and reduce the impact through influencing development in flood risk areas, flood warning and emergency response (EA 2003).

Term	Definition
Flood Zones	This refers to the Flood Zones in accordance with Table D1 of PPS25. For the purpose of the SFRA, the definition of Flood Zones varies slightly from PPS25 in that it shows the extent of flooding ignoring the presence of flooding defences, "except where the 'actual risk' extent is greater"
Floods and Water Management Act	An Act of Parliament which forms part of the UK Government's response to Sir Michael Pitt's Report on the Summer 2007 floods, the aim of which is to clarify the legislative framework for managing surface water flood risk in England. The Act was passed in 2010 and is currently being enacted.
Fluvial	Relating to a watercourse (rivers or streams)
FRR	Flood Risk Regulations: Transposition of the EU Floods Directive into UK law. The EU Floods Directive is a piece of European Community (EC) legislation to specifically address flood risk by prescribing a common framework for its measurement and management.
Groundwater	Groundwater is the term used to describe the water stored underground in areas of permeable rocks, known as aquifers. Consistently high levels of groundwater can lead to groundwater flooding.
LLFA	Lead Local Flood Authority: Local Authority responsible for taking the lead on local flood risk management. The duties of LLFAs are set out in the Floods and Water Management Act.
LB	London Borough e.g. LB Tower Hamlets, London Borough of Tower Hamlets
LiDAR	Light Detection and Ranging, a technique to measure ground and building levels remotely from the air, LiDAR data is used to develop DTMs and DEMs (see definitions above).
LDD	Local Development Documents: Documents describing a Local Planning Authority's strategy for development and use of land within their area of authority.
LDF	Local Development Framework: The spatial planning strategy introduced in England and Wales by the Planning and Compulsory Purchase Act 2004 and given detail in Planning Policy Statements 12. These documents typically set out a framework for future development and redevelopment within a local planning authority.
LPA	Local Planning Authority
LFRSP	London Flood Response Strategic Plan
Main River	Main rivers are a statutory type of watercourse in England and Wales and are usually larger streams and rivers, but may also include some smaller watercourses. A main river is defined as a watercourse marked as such on a main river map, and can include any structure or appliance for controlling or regulating the flow of water in, into or out of a main river. The Environment Agency's powers to carry out flood defence works apply to main rivers only.
Ordinary Watercourse	All watercourses that are not designated Main River, and which are the responsibility of Local Authorities or, where they exist, IDBs are termed Ordinary Watercourses.
PFRA	Preliminary Flood Risk Assessment:
PPS25	Planning Policy Statement Note 25: Development and Flood Risk (December 2006).
Probability of Consequence	The probability of a flood event being met or exceeded in any one year. For example, a probability of 1 in 100 corresponds to a 1 per cent or 100:1 chance of an event occurring in any one year.
Residual risk	Flood risks resulting from an event more severe than for which particular flood defences have been designed to provide protection.
RFRA	Regional Flood Risk Appraisal
RPB	Regional Planning Body
RSS	Regional Spatial Strategy

Term	Definition
Sequential risk-based assessment	Priority in allocating or permitting sites for development, in descending order to the Flood Zones set out in Table 1 of PPG25, including the sub divisions in Zone 3. Those responsible for land development plans or deciding applications for development would be expected to demonstrate that there are no reasonable options available in a lower- risk category (PPG25 paragraph 30).
Sequential Test	Test to determine if there are other reasonable available sites in areas with a lower probability of flooding that would be appropriate to the type of development or land use proposed.
Sewer flooding	Rainwater (including snow and other precipitation) which is on the surface of the ground (whether or not it is moving), and has not entered a watercourse, drainage system or public sewer.
SFRA	Strategic Flood Risk Assessment
SUDs	Sustainable Urban Drainage Systems
Surface water	Any body of water that is not groundwater (for example rivers, estuaries, ponds etc) as well as temporary waters resulting from flooding, run-off etc.
SWMP	Surface Water Management Plan
TWUL	Thames Water Utilities Ltd
Windfall Sites	Sites which become available for development unexpectedly and are therefore not included as allocated land in a planning authority's development plan

Contents

Quality Management.....	ii
Executive Summary.....	iii
Glossary.....	v
Contents.....	viii
1.0 Introduction.....	1
1.1 Linkages with Other Plans.....	2
1.2 Study Area.....	2
2.0 How to Use this Document.....	5
2.1 Introduction.....	5
2.2 Guidance for Developers.....	5
2.3 Guidance for LB of Tower Hamlets.....	8
3.0 Flood Risk in Tower Hamlets.....	12
3.1 Introduction.....	12
3.2 Fluvial Flood Risk.....	12
3.3 Tidal Flood Risk.....	15
3.4 Surface Water Flood Risk.....	18
3.5 Sewer Flood Risk.....	19
3.6 Groundwater Flood Risk.....	20
3.7 Other Sources of Flooding.....	21
4.0 Policy Guidance and Recommendations.....	23
4.1 Introduction.....	23
4.2 Policy Guidance.....	23
5.0 References.....	27

Tables

Table 3-1 Definition of Fluvial Flood Zones (Table D1, PPS 25).....	13
Table 3-2 Definition of Tidal Flood Zones (Table D1, PPS 25).....	16
Table 3-3 Breach Scenarios.....	17
Table 3-4: Number of Thames Water sewer flood records within the London Borough of Tower Hamlets	19

1.0 Introduction

The information in this Level 2 Strategic Flood Risk Assessment (SFRA) is used to inform the London Borough (LB) of Tower Hamlets Sustainability Appraisal, land allocations, and policies regarding catchment wide flooding issues. In August 2008, the London Borough of Tower Hamlets Strategic Flood Risk Assessment (Level 1) was published to support their Local Development Framework (LDF). The SFRA provides information required to apply the Sequential Approach, Sequential Test and Exception Test on the Local Development Document (LDD) scale as defined by PPS25. This has been done in response to the guidance in „Planning Policy Statement 25 – *Development and Flood Risk*’ that states that a sequential risk based approach should be applied to decision making at all levels of the planning process.

In July 2011, Capita Symonds was commissioned by the LB of Tower Hamlets to undertake a Level 2 SFRA. The purpose of this assessment is to provide more detailed information regarding the nature of flood risk at the 31 suggested sites outlined in The LB of Tower Hamlets LDF document. The assessment will assist in facilitating the application of the Exception Test at these sites.

The underlying objective of the SFRA is to provide a platform for the consistent consideration of flood risk, accommodation of current practice and best available data for the duration of the plan. Inevitably this will require that consideration is given to the lifetime of development included within the plan (taken to be 100 years for residential development by the Environment Agency) so climate change effects described in PPS 25 and other relevant guidance should be incorporated.

This document is Volume 1 – Guidance of the Level 2 SFRA. This is the user guide element of the SFRA document and should be read in conjunction with Volumes 2 – Flood Risk Management at Key Development Sites. This Volume provides a summary of the background and methodology adopted for assessing strategic flood risk, and presents new datasets that have emerged since the Level 1 SFRA was published in August 2008.

Volume 2 presents the assessment of flood risk carried out for the 31 key development sites highlighted in the LB of Tower Hamlets LDF. It describes the potential sources of flooding and provides guidance for planners and developers.

This document (Volume 1) has been broken into chapters, with the following structure designed to support the LB of Tower Hamlets in a range of activities:

- **Chapter 1: Introduction** – this chapter;
- **Chapter 2: How to use this Document** - Explains how the SFRA should be used to support Tower Hamlets in their strategic land use planning, including an explanation of the application of the Sequential Test, and Exception Test;
- **Chapter 3: Flood Risk in Tower Hamlets** - a brief summary of the findings of Volume 2;
- **Chapter 4: Policy Guidance and Recommendations** – outlines guidance for policy development on the basis of Environment Agency recommendations and the strategic assessment of flood risk across the borough;
- **Chapter 5: References**

1.1 LINKAGES WITH OTHER PLANS

The Level 1 and Level 2 LB of Tower Hamlets SFRA provide an important tool to guide planning policies and land use decisions. The SFRA also link to the following documents:

Preliminary Flood Risk Assessment (PFRA)

These are required as part of the Flood Risk Regulations which implement the requirements of the European Floods Directive. A PFRA was produced for the LB of Tower Hamlets as part of the Drain London study and draws upon new data and information regarding surface water flooding. The assessment gives an overview of all local sources of flood risk. Boroughs must review these PFRAs every 6 years.

Surface Water Management Plans (SWMP)

A SWMP was produced for the LB of Tower Hamlets as part of the Drain London study. They provide detailed information on the potential for surface water flooding, based on probabilistic 2-dimensional modelling. This information improves greatly on data which has previously been provided at a national scale by the Environment Agency. In addition each SWMP contains an Action Plan that has been developed in conjunction with both the borough and relevant other Risk Management Authorities. This data and actions and associated policy interventions will feed directly into the operational level of the borough across many departments, in particular into spatial and emergency planning policies and designations and into the management of local authority controlled land.

The SWMP has identified 14 Critical Drainage Areas (CDAs) with the LB of Tower Hamlets. These are defined with the SWMP as *“a discrete geographic area (usually a hydrological catchment) where multiple and interlinked sources of flood risk (surface water, groundwater, sewer and/or river) often cause flooding in a Flood Risk Area during severe weather thereby affecting people, property or local infrastructure.”* Where a key development site falls within these CDAs, this has been identified and discussed within the individual site assessments carried out in Volume 2 of this SFRA.

Local Flood Risk Management Strategies

The Flood and Water Management Act 2010 (FWMA) requires each LLFA to produce a Local Flood Risk Management Strategy by December 2012. The SWMP, PFRA and SFRA for the LB of Tower Hamlets and their associated risk maps will provide the necessary evidence base to support the development of LFRMS.

1.2 STUDY AREA

The LB of Tower Hamlets is situated to the east of the City of London and covers an area of approximately 20km². The Isle of Dogs and the important financial centre of Canary Wharf lie within the southeast of the borough, whilst the Tower of London and the Crown Jewels are located in the west.

The LB of Tower Hamlets is bound by the River Lee along its eastern boundary and the River Thames along its southern boundary. The River Lee is part of the Bow Back River System and has connections to a number of canals including the Limehouse Cut, Hertford Union Canal and the River Lea Navigation Canal. The LB of Tower Hamlets is also home to the West India Docks, a series of three docks located on the Isle of Dogs.

There are significant targets for new jobs and new homes in Tower Hamlets. Over 43,000 new homes are to be constructed within the borough by 2025 in line with the Greater London Authority's London Plan (February 2008). This growth is to be supported by infrastructure including public transport, schools, health facilities and open space.

The LDF for the LB of Tower Hamlets identifies growth areas in:

- Lower Lee Valley;
- Millennium Quarter and Crossharbour;
- Wapping;
- Fish Island;
- Bethnal Green North;
- Bishopsgate Goodsynd;
- Wood Wharf; and
- Ocean Estate.

New framework plans including one Development Plan Document (DPD) and an Area Action Plan (AAP) of Fish Island have recently undergone public consultation. These documents outline the vision set out in the Tower Hamlets Core Strategy on how to manage the future growth and development within the borough. The comments collated from the consultation are to be analysed by Tower Hamlets before being fed back into the documents.

A draft Bromley-by-Bow Masterplan Supplementary Planning Document (SPD) is currently undergoing public consultation at the time of writing this report. The document outlines the future of Bromley-by-Bow, including the provision of a new town centre, housing, job opportunities, and improved transport links. The outcomes of the consultation will be used to inform the final SPD with the anticipation that the document will be adopted in Spring 2012.

The LB of Tower Hamlets completed consultation of the Marsh Wall East Masterplan in May 2011. The area has been identified as a growth area for new homes and jobs due to its close proximity to Canary Wharf. The Masterplan will become a SPD in February 2012 and will inform the Tower Hamlets Core Strategy 2025.

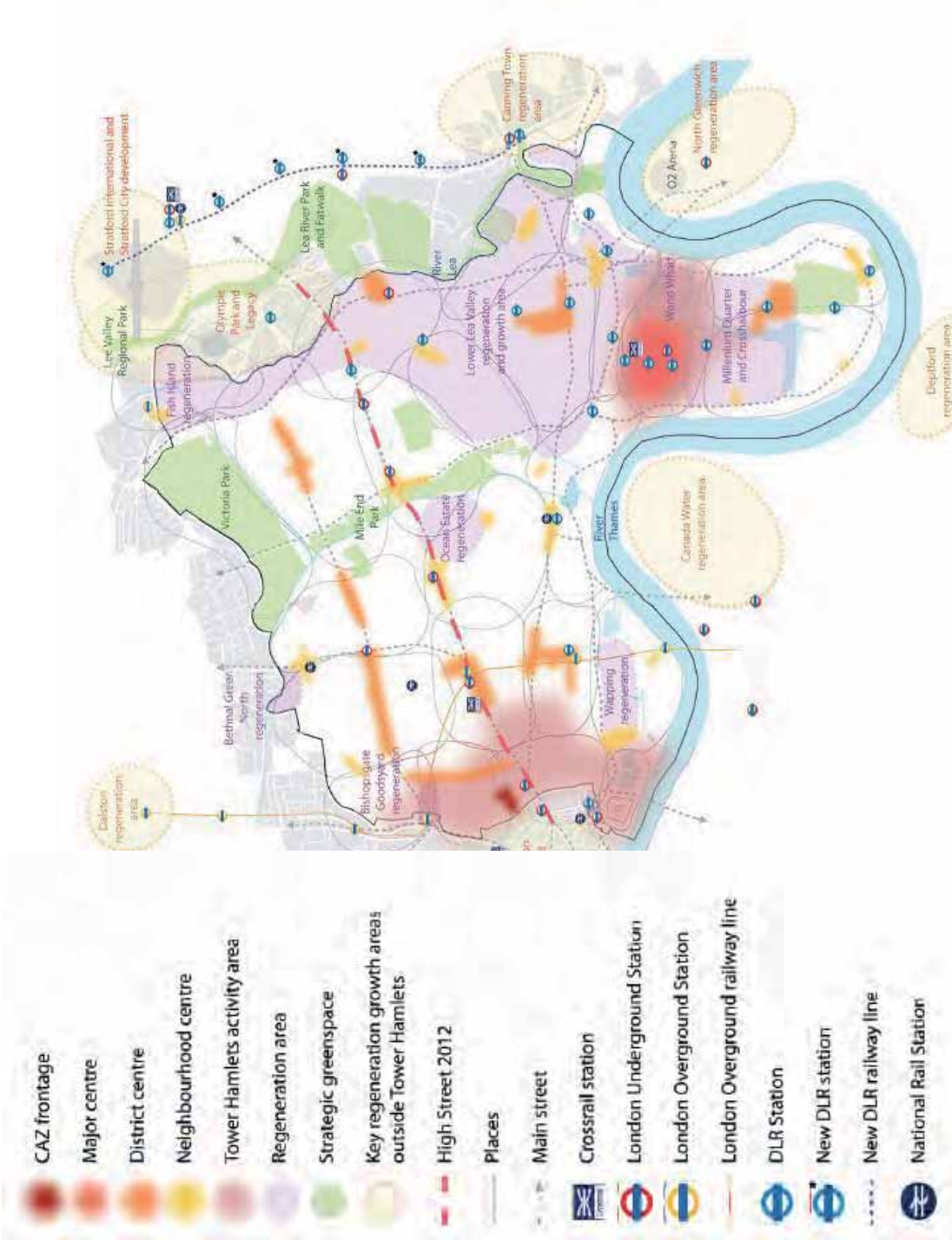


Figure 1-1 Growth Areas in the London Borough of Tower Hamlets (Source Tower Hamlets LDF)

2.0 How to Use this Document

2.1 INTRODUCTION

SFRAs set the context within which any planning application should be considered, by establishing:

- the category of Flood Zone within which the proposed site sits;
- the flood risk constraints in accordance with guidance in PPS25;
- planning constraints within designated development areas and windfall planning applications;
- the basis of the policies of the LB of Tower Hamlets regarding proposed development in each Flood Zone; and
- the level of detail required for site-specific FRAs.

The SFRA should be used to provide high-level flood risk information for decisions on land use planning. This can be done on an “as required” basis, matching the needs of phased submission of applications.

2.2 GUIDANCE FOR DEVELOPERS

A developer is not required to apply the Sequential Test if a proposed development is located on a site which has been allocated for that type of development in a LDD that has been sequentially tested and supported by a SFRA. However, the developer should still apply the sequential approach to any flood risk within the site itself and demonstrate compliance with PPS 25 when determining the location of appropriate land uses. The aim of the sequential approach is to minimise the flood risk by considering the probability of flooding in conjunction with the vulnerability of receptors.

Where developers promote development outside of the allocated areas identified in the LDDs and within flood risk areas defined by the SFRA they are responsible for demonstrating compliance with PPS25 notably obtaining confirmation from the LB of Tower Hamlets that the proposed application site satisfies the outcome of the Sequential Test. The PPS 25 Practice Guide reinforces the fact that in this situation it is the responsibility of the developer to collate the evidence required for the LPA’s planning officer to carry out the Sequential Test. Chapter 4 of the Practice Guide lists the information that may be required in this case. This is likely to include evidence:

- on the flood risk on the site;
- on the availability of ‘reasonably available’ sites in areas of lower flood risk;
- on the vulnerability classification of the development;
- of the wider sustainability benefits of the site (if the Exception Test will need to be applied);
- that the development is safe. This might require the developer to collect and submit information to the LB of Tower Hamlets as evidence to be used in performing the Sequential Test and if appropriate the Exception Test.

In areas where flood risk has been identified as an issue, developers should liaise with the LB of Tower Hamlets to agree on who should be consulted. Pre-application discussions between the LB of Tower Hamlets, the Environment Agency and other relevant stakeholders should be used to scope out the availability of other sites which may meet the requirements of the application and what evidence will be

required to show that other sites have been considered. The scope of any site specific FRA should also be agreed with the LB of Tower Hamlets, and will be informed by the outputs from the Level 1 and Level 2 SFRA and consultation with the Environment Agency.

Flood Risk Assessments (FRAs)

It is the responsibility of developers to carefully consider the flood risks at a site as early as possible. Developers should be referred to the SFRA at the start of any pre-application consultation with the LB of Tower Hamlets. Planning applications for development proposals of 1 hectare or greater in Flood Zone 1 and all proposals for new development located in Flood Zones 2 and 3 require a FRA.

PPS 25 dictates that FRAs should be carried out to the appropriate degree at all levels of the planning process, to assess the risks of all forms of flooding to and from development taking climate change into account and to inform the application of the sequential approach. The SFRA provides information already available which should be considered in the production of site-specific FRAs.

Although this SFRA has been undertaken for the LB of Tower Hamlets, it does not negate the need for site specific FRAs to be undertaken at the planning application stage. Instead, this SFRA provides advice on the scope of the additional information likely to be required within the FRA.

A FRA will be required to demonstrate that flood risk to the development can be managed now and in the future, that the development will not increase the risk of flooding elsewhere and that the proposals are compliant with the SFRA. The requirement for site-specific FRAs is detailed in PPS25 and further information is provided in Chapter 3 of the PPS 25 Practice Guide. The principles and key requirements of a FRA are provided in PPS25 Appendix E. The scope of a FRA should include the following key points directed by the policy guidance and recommendations included in Chapter 8:

- **A description of the development and the planning context**
 - What is the development proposed and where will it be located?
 - What are the proposed developments Vulnerability Classifications (see Table D.2 of PPS25)?
 - Is the proposed site consistent with Local Planning Policy, and has the Sequential Test or Exception Test been applied in the selection of the proposed site for the development type proposed?
- **Definition of flood hazard**
 - What sources of flooding could affect the proposed development site?
 - For each source, describe the pathway and receptor of the flooding. Refer to historic records where available.
 - Is the site located within a Critical Drainage Area of Flood Risk Zone as identified in the LB of Tower Hamlets SWMP? (refer to Section 4.2)
 - What are the existing surface water drainage arrangements for the proposed development site?
- **Probability of flooding**
 - Which flood zone is the proposed development site within?

- What does the LB of Tower Hamlets SFRA show of relevance to the proposed development site?
- What is the extent of flooding, including depth and velocities, on the proposed development site?
- What are the existing rates and volumes of run-off generated by the proposed development?
- **Impacts of climate change on flood risk**
 - How is the flood risk at the proposed development site likely to be affected by climate change?
- **Detailed description of development proposals**
 - Details of the development layout, referring to relevant drawings.
 - Where appropriate, demonstrate how land uses most sensitive to flood damage have been placed in areas within the site that are at least risk of flooding.
- **Flood risk management measures including the application of Sustainable Urban Drainage Systems (SUDS)**
 - How will the site be protected from flooding, including the potential impacts of climate change, over the development's lifetime?
 - How will the developer maintain flood defences (for sites adjacent to watercourses)? The riparian owner is required to survey, renew and maintain the flood defences.
 - How will the surface water management strategy relate to guidance in the LB of Tower Hamlets Surface Water Management Plan (SWMP)?
- **Impacts of the development off site**
 - How will the proposed development ensure it does not increase flood risk elsewhere, both in terms of flood protection measures on site and run-off from the completed development?
- **Assessment of residual risk**
 - What forms of flood risk management are proposed for the site, for example, flood warning and evacuation?
 - What flood related risks will remain after implementing flood risk management measures?
 - A breach analysis may be required for developments close to a watercourse, canal or dock/basin. The parameters of the breach analysis should be agreed with the Environment Agency or British Waterways where relevant.
 - How, and by whom, will these risks be managed over the lifetime of the development?

Consultation with the Environment Agency

Due to the large number and variety of planning applications received by the LB of Tower Hamlets, and the need to consult with the Environment Agency on many of these applications, it is becoming increasingly difficult to identify when, and how, the LB of Tower Hamlets should consult with the Agency on receipt of a

planning application. To ease this process, the Agency has developed a consultation matrix, which identifies when the Agency should be consulted, and what level of information needs to accompany the FRA if one is required. The LB of Tower Hamlets SFRA can support this process by identifying the location of the development site within a particular Flood Zone and the likely vulnerability of the site.

The Environment Agency consultation matrix is part of the Environment Agency's Flood Risk Standing Advice (FRSA), which is provided to LPAs for more straightforward planning applications. The FRSA also allows LPAs to identify those higher risk development situations where consultation with the Agency is essential. This information is available on the Agency website at www.environment-agency.gov.uk/planning.

Consultation with Thames Water

The LB of Tower Hamlets is extensively serviced by surface water, foul and combined sewers. Unless new development is to be located directly adjacent to a watercourse (including the River Thames), it is likely that development runoff will discharge to the local sewer network.

Developers should consult with Thames Water as early as possible in the formulation of development proposals in order to determine the capacity of the local drainage network as well as potential connection points. New legislation may remove the automatic right to connect to sewer. Developers should also seek opportunities to reduce the existing discharge from the site (in accordance with London Plan policy and PPS 25).

Consultation with British Waterways

The canals and docks within the LB of Tower Hamlets are owned and managed by British Waterways. British Waterways must be consulted in relation to any development next to the canals or the docks.

2.3 GUIDANCE FOR LB OF TOWER HAMLETS

Flood Risk Assessments (FRAs)

The information within the SFRA should also be used to inform the development of planning constraints within development areas designated in the LDDs, AAPs and where relevant, in the case of windfall planning applications.

The overview figures in Volume 3 of the Level 1 SFRA should be used at the start of the development control process. This will enable the Development Control team at the LB of Tower Hamlets to quickly identify the likely level of information on flood risk and flood risk management required from a developer. The figures are as follows:

- Figure ST1: Environment Agency Flood Zones
- Figure ST2: Sequential Test – Essential Infrastructure
- Figure ST3: Sequential Test – Highly Vulnerable Land Uses
- Figure ST4: Sequential Test – More Vulnerable Land Uses
- Figure ST5: Sequential Test – Less Vulnerable Land Uses
- Figure ST6: Sequential Test – Water Compatible Land Uses

Note: The SFRA is a live document, and should be regularly updated, however it is recommended that Development Control verify the currency of Figure ST1 for particular sites by checking the Flood Zone Map available on the Environment Agency website at:

www.environment-agency.gov.uk/homeandleisure/default.aspx

The Development Control team should then refer to the more detailed maps in Volume 3 as appropriate. For

example, in those areas of fluvial flood risk – Figures 4.1 to 4.7: Actual and Residual Risk should be referred to. Figures 5.1 to 5.6 should be used in areas at risk of tidal flooding. In addition to the Level 1 SFRA information, the site should also be reviewed in the context of local flood risk sources - surface water, sewers or groundwater. The Development Control team should refer to the figures presented in Volume 2 of the Level 2 SFRA where details on local flood risk sources summarised from the LB of Tower Hamlets SWMP can be found.

Volume 2 of this Level 2 SFRA provides a strategic assessment at each of the key development sites identified at flood risk. It also includes guidance on the type and scale of flood risk management required to demonstrate compliance with PPS 25. This information should be used as a guide by Development Control to identify the level of detail required in a FRA. Chapter 5 includes development control policy guidance and recommendations.

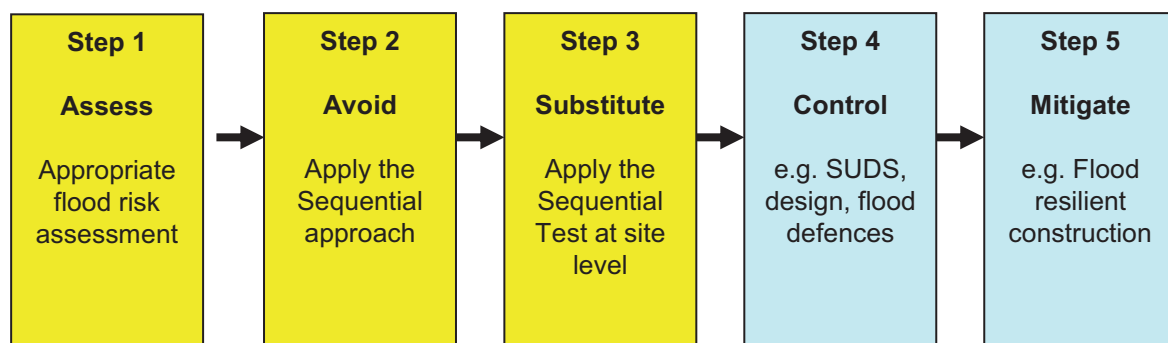
Assessing FRAs

Once a planning application, together with an appropriate FRA, is submitted by the developer, it should be assessed to ensure that the applicant has considered flood risk from all sources and demonstrated how flood risk will be managed taking climate change into account. It is the developer's responsibility to provide sufficient detail to demonstrate compliance with PPS 25. It is therefore particularly important that pre-application discussions are conducted with the LB of Tower Hamlets, the Environment Agency, and Thames Water (as a minimum), to avoid lengthy consultation following submission, or potential planning objections.

PPS25 requires a precautionary approach to be undertaken when making land use planning decisions regarding flood risk. This is partly due to the considerable uncertainty surrounding flooding mechanisms and how flooding may respond to climate change. It is also due to the potentially devastating consequences of flooding to the people and property affected. FRAs should be reviewed to determine how the following key principles have been used to manage flood risk for new development in Tower Hamlets.

Flood risk is a combination of the probability of flooding and the consequences of flooding. Hence 'managing flood risk' involves managing either, the probability of flooding or the consequences of flooding, or both. Modern flood risk management involves identifying how the source, the pathway, and the receptors can be managed to reduce flood risk. PPS 25 requires flooding from tidal, fluvial, land, surface water & sewerage and from groundwater to be considered.

A subset of the source - pathway - receptor model is the spatial planning framework for regulating development in flood plains (PPS 25) – the 'Flood Risk Management Hierarchy':



In Tower Hamlets, Development Control officers should ensure that this hierarchal approach has been adopted through:

- **Assess:** An appropriate FRA accompanies the planning application that demonstrates development will be 'safe' in accordance with PPS 25, including safe access and egress for the lifetime of the

development;

- Avoid: At the site scale, an appropriate Sequential Test (and Exception Test where necessary) accompanies the planning application;
- Substitute: the sequential approach has been applied within the development site, locating the most vulnerable elements in the lowest probability flooding areas;
- Control: The PPS 25 Practice Guide identifies the following broad measures to 'control' flood risk.
 - Raising floor levels – managing both 'actual' and 'residual' flood risk, 'safe refuge' above flood levels. This is particularly relevant for areas in Tower Hamlets identified at risk of flooding in the event of a breach in tidal defences;
 - Modification of ground levels – can be used to reduce the depth of flooding during 'extreme' flood events, however will need to be considered early in the design process as it can affect the overall layout and design, plus impact neighbouring sites. Raising ground levels in areas at 'actual' risk of fluvial flooding from the River Lee will generally not be suitable, unless it can be demonstrated that compensatory flood storage can be provided;
 - Construction of new floodwalls or embankments – Tower Hamlets benefits from extensive defences that provide protection from tidal flooding. Construction of new tidal defences to enable development will generally not be necessary, however opportunities to improve the standard of protection or condition of defences should be considered as part of development proposals. New defences to reduce the risk of fluvial flooding should be avoided, unless it can be demonstrated there are no other options available;
 - Upstream flood storage – The River Lee in Tower Hamlets is tidally influenced. Upstream storage to manage flood risk is likely to only be appropriate in the borough if undertaken on a 'strategic' basis, and may require works in neighbouring boroughs, rather than on a site basis;
 - Sustainable Drainage Systems (refer below); and
 - Developer contributions – developers can contribute to the 'strategic' upgrade or redesign of flood defence infrastructure.
- Mitigate: in accordance with the Sequential Approach, flood resilience and resistance measures in new buildings should only be used as a means to manage relatively 'low' hazard or 'residual' flooding risk. Where development is exceptionally necessary (i.e. the Exception Test), using flood resilience and resistance measures is not a justification for new development.

Building Regulations do not currently allow for flood resilience and resistance measures, however future proposed revisions may include additional guidance. Until this time, where developers are proposing the use of resilience and resistance measures to manage flood risk the following guidance should be consulted:

- Improving the Flood Performance of New Buildings: Flood Resilient Construction, CLG, June 2007
- Flood Resistance and Resilience Solutions: an R&D scoping study, Defra, May 2007
- Flood Resilient Homes: What homeowners can do to reduce flood damage, ABI

The hierarchal approach to managing flood risk should take account of climate change in design, and include

an appropriate freeboard to allow for uncertainty. Developers should consult with insurers to discuss the suitability of flood risk management measures and how this affects the overall insurability. Where appropriate the Environment Agency should be consulted on flood risk assessment and in the discharge of planning conditions related to flood risk management measures.

Where a planning application includes works to a watercourse that fall within the Water Resources Act 1991 or Land Drainage Act 1991, additional approval from the Environment Agency is required in the form of Flood Defence Consent or Land Drainage Consent (refer to the Thames Region Land Drainage Byelaws available from the Environment Agency). This mechanism can also be used in conjunction with planning conditions to ensure the appropriate level of detail is provided and approved when constructing flood defence infrastructure.

Sustainable Urban Drainage Systems (SUDS)

As recognised within PPS25 and the accompanying guidance, SUDS are a useful tool in the management of flood risk and water quality. As a result, the use of SUDS in individual planning applications should be promoted by Tower Hamlets.

The advantages and disadvantages of different SUDS techniques should be considered for each proposed development site. The Development Control team should consider the particular setting – including consideration of the site area, the proposed development type, its environmental soundness, and its location in or out of the flood plain – and especially the ground conditions.

Based on the geology and soils there are few areas within Tower Hamlets with permeable soils that would be suitable to implement infiltration SUDS. The soils that cover all of Tower Hamlets have inherently high groundwater tables. This is not helped by the underlying solid geology that is predominantly impermeable London clay. Geology close to the main watercourses of the River Thames and Lee along with pockets of sands and gravels are moderately permeable, which could allow infiltration, although development/redevelopment should, where possible, be located outside the floodplain. In other areas of the catchment where the geology is less permeable, swales and balancing ponds may be suitable where space is available but the potential for infiltration based drainage solutions may be limited. Green roofs are a valuable technique in the urban environment to reduce existing site runoff and the LB of Tower Hamlets should consider actively promoting their use. Similarly, use of permeable paving with suitable bedding should be considered for paving of private parking or gardens.

The extensive historical industrial land use in Tower Hamlets has resulted in a legacy of contaminated land. Where site investigation identifies unacceptable levels of contaminants in underlying soils, this is likely to limit any increase in infiltration on development sites due to the potential to negatively impact groundwater quality and consequential effects to surface watercourses. Additional consultation with the Environment Agency is recommended in this instance.

Reference should be made to the LB of Tower Hamlets SWMP (August 2011) which outlines the preferred surface water management strategy for the borough and includes an 'Infiltration SUDS Suitability Map'.

3.0 Flood Risk in Tower Hamlets

3.1 INTRODUCTION

Flooding is heavily dependent on the interaction of rainfall, catchment characteristics and the sea. PPS25 identifies six sources of flooding to be investigated in an SFRA:

- Flooding from rivers
- Flooding from the sea (tidal and coastal)
- Flooding from groundwater
- Flooding from surface water
- Flooding from sewers
- Flooding from artificial sources (docks, canals, reservoirs, lakes).

The London Borough of Tower Hamlets contains localised areas that are prone to flooding from a range of processes including: fluvial, tidal, surface water, sewer, groundwater, and flooding from artificial sources. Each source of flooding has been analysed in detail in Volume 2 of the Level 1 SFRA. A summary of the findings is discussed in the following chapter of this report. The discussion of any new datasets that have been produced since the release of the Level 1 SFRA in August 2008, is also included in this chapter.

3.2 FLUVIAL FLOOD RISK

3.2.1 SOURCES

Flooding from rivers occurs when water levels rise higher than bank levels, causing floodwater to spill across adjacent land (floodplain). The main reasons for water levels rising in rivers are:

- Intense or prolonged rainfall causing runoff rates and flow to increase in rivers, exceeding the capacity of the channel. This can be exacerbated by wet antecedent (the preceding time period) conditions and where there are significant contributions of groundwater;
- Constrictions in the river channel causing flood water to backup;
- Blockage of structures or the river channel causing flood water to backup; and
- High water levels and/or locked flood gates preventing discharge at the outlet of the river.

The consequence of river flooding depends on how hazardous the flood waters are and what the receptor of flooding is. Flood hazard can vary greatly throughout catchments and even across floodplain areas. The hazard posed by floodwater is proportional to the depth of exposure, the velocity of flow and the speed of onset of flooding. Hazardous river flows can pose a significant risk to exposed people, property and infrastructure. Whilst low hazard flows are less of a risk to life (shallow, tranquil water), they can disrupt communities, require significant post-flood cleanup and can cause costly and possibly structural damage to property.

The eastern parts of the LB of Tower Hamlets are within the Lower Lee Valley and may be affected by flooding on the lower reaches of the River Lee. The River Lee forms the eastern boundary of Tower Hamlets (and the western boundary of the LB of Newham).

3.2.2 HISTORIC RECORDS

The March 1947 floods affected nearly all of the main rivers in the south of England and caused the greatest flood event on the River Lee since records began 100 years earlier. Figure 4.1 in Volume 3 of the Level 1 SFRA shows the extent of flooding for this event. East India Docks Basin, parts of South Bromley, and Canning Town are shown to be inundated. The flood extent also covered the present route of the Docklands Light Railway through this area. There were also smaller areas of flooding north of the present route of the A13 affecting what is now the Blackwall Trading Estate. In this event, flooding from the Lower Lee was also significant in the neighbouring London Boroughs of Hackney, Newham and Waltham Forest.

The 1947 floods were caused by snowmelt followed by rainfall and were unique in their volume and persistence. Rainfall on 12 March 1947 triggered the thaw that led to rapid snowmelt and an extremely high runoff rate that caused a rise in water levels in the tributaries of the River Lee and then in the Lee itself.

Following the 1947 floods, flood defence structures were put in place in the Lower Lea designed to prevent a repeat of the consequences. The main flood events to occur in the area since 1947 were witnessed in 1968, 1978, 1983 and 2000. On these occasions, the worst flooding was restricted to the upper catchment and did not seriously affect Tower Hamlets or the Lower Lee Valley.

3.2.3 FLOOD ZONES

This assessment considers Flood Zones 1, 2 and 3 (see Table 3-1). The Level 1 SFRA states that there is no Functional Floodplain (Flood Zone 3b) within Tower Hamlets. The PPS 25 definition of Functional Floodplain is *“land where water has to flow or be stored in times of flood”* and is generally land which would flood with an annual probability of 5%.

Figure 4.3 in Volume 3 of the Level 1 SFRA shows that a small area around Dace Road on Fish Island is predicted to flood for the 5% AEP fluvial event. The ‘Planning Policy Statement 25: Development and Flood Risk Practice Guidance’ (CLG December 2009) further clarifies the definition within PPS 25 by stating areas *‘which are prevented from (flooding) by existing infrastructure or solid buildings, will not normally be defined as functional floodplain’*. As the area around Dace Road is found to consist of brick buildings it has been decided that there are no areas within Tower Hamlets which meet this definition. This decision was been made in consultation with the Environment Agency.

Table 3-1 Definition of Fluvial Flood Zones (Table D1, PPS 25)

Flood Zone	Probability of Flooding	Definition
Flood Zone 1	Low probability	Land assessed as having a less than 1 in 1000 annual probability of river flooding in any year (<0.1%)
Flood Zone 2	Medium probability	Land assessed as having between a 1 in 100 and a 1 in 1000 annual probability of river flooding in any year (1% to 0.1%)
Flood Zone 3	High probability	Land assessed as having a 1 in 100 or greater annual probability of river flooding in any year (>1%)

There are two main areas at risk of fluvial flooding in Tower Hamlets, as indicated by the EA Flood Zones. There are small areas of Flood Zone 2 and 3 in the north-eastern corner of the borough, closet to the borough’s borders with the LBs of Hackney and Newham. Flooding in these locations is from the River Lee Navigation Canal.

There is a larger area of the borough within Flood Zone 3 in the low area around the confluence of the River Lee and the River Thames which has a high probability of fluvial flooding, when the existing defences are ignored. The flooding in this region is caused by the River Lee overtopping the banks downstream of Limehouse cut. This area of flooding covers parts of the South Bromley and Blackwall area including the A12 and the approach road to the Blackwall Tunnel which are major transport routes in East London. The area of South Bromley including Clove Crescent and Tower Hamlets council offices is in Flood Zone 2 and is at risk of flooding in an extreme fluvial event on the River Lee.

The majority of fluvial flooding from the River Lee and associated watercourses is to the east of Tower Hamlets, in the neighbouring LB of Newham. Flooding in this area is caused by an overland flow path originating from north of Stratford.

For the purposes of applying the Sequential Test, combined fluvial and tidal flood zones for the borough will be used and have been mapped as Figure B.1 in Volume 2 of the Level 2 SFRA.

3.2.4 LOWER LEE VALLEY (LLV) MODELLING

Actual risk

The actual risk of flooding is typically assessed for a defended scenario for flood events with a 5% and 1% AEP. This provides a more real estimate of likely flooding than that provided by the Flood Zones. The actual risk of fluvial flooding in Tower Hamlets was assessed using outputs from the LLV Regeneration Model which has been run for the 5% and 1% AEP flood events (combined with a 5% AEP tidal surge as the downstream boundary). The flood risk has been assessed with all existing defences, including the Thames Barrier, included in the modelling. Flood hazard maps were produced (Figures 4.3 to 4.5, Volume 3 of Level 1 SFRA) and can be used to provide further detail on the actual risk of flooding and the degree of hazard within the Flood Zones. After undertaking the Sequential Test, this information on the actual risk of flooding can be used to inform the application of the Exception Test, where necessary.

In the 5% AEP flood event there is a small area of flooding at Old Ford Locks caused by overtopping on the right bank of the Lee Navigation Canal just upstream of the lock. Predicted flood depths in this area (near Dace Road) are up to 0.20m. The predicted depths and velocities of flooding are not significant and so the flood hazard at this location is considered to be low. Elsewhere in the borough, this flood event is confined within the defences.

In the 1% AEP flood event, the extent of flooding in the Old Ford Locks area is greater than in the 5% AEP event. Predicted flood depths here are greater than 0.25m and in low spots are greater than 1m. The increase in predicted flood depths here means that the risk to people is increased and considered to be significant in this case. In this event, there is also out of bank flooding further upstream on the borough boundary with Hackney. Here flooding is caused by overtopping on a low spot in the defences on the right bank of the Lee Navigation Canal in the Rothbury Road / Post Lane area. Predicted flood depths here are between 0.25 and 1.25m. The flood hazard in this area is generally low, but in places where the depths are greater there is a moderate to significant risk to people. This overtopping mechanism also causes inundation to the north in the LB of Hackney, in Hackney Wick. Outside of these two areas, this flood event remains contained within bank in Tower Hamlets.

An allowance for an increase of flows on the Lower Lea of 20 % as a result of climate change has been considered for both defended and undefended scenarios. There are no new areas of inundation that are not seen in the 1% AEP flood event in this case.

Residual risk

The residual risk of flooding caused by the overtopping of defences in an extreme flood event in the Lower

Lee has been considered. An additional modelling scenario was assessed using a defended scenario (the same as for the assessment of actual risk) for the 0.1% AEP flood event (combined with a 5% AEP tidal surge as the downstream boundary). The flood hazard map for this scenario is shown in Figure 4.7 of Volume 3 of the Level 1 SFRA. The results can be used to provide the further information required if applying the Exception Test.

In an extreme event such as this, there are areas of overtopping near Old Ford Locks and at the boundary between the boroughs of Tower Hamlets and Hackney but there are no new areas of inundation not seen in the consideration of the 1% AEP flood event. In this extreme event, predicted flood depths in the Old Ford Locks area are greater than 1m and up to 1.35m in places, which creates a significant risk to people.

At the boundary between Tower Hamlets and Hackney the predicted flood extent in this extreme event causes some small areas of inundation on the A102(M) which is the main route through the borough to the Blackwall Tunnel. Although limited in extent, the inundation on this road is predicted to be to depths of up to 0.5m. The depths of flooding predicted in this extreme case mean that the hazard rating, and the risk to people, is significant. In the case of an extreme flood event such as this, the closure of this road may have significant impacts on traffic movements in the borough.

Model Updates

At the time of writing this report, the results from the LLV Regeneration Model remain the most up-to-date for the borough. The Environment Agency is currently in the process of updating the LLV hydraulic model. The completed model is expected to be a fully linked 1D-2D model extending from Hertford to the River Thames. The expected completion date of the modelling work is 2012. Guidance on maintaining and updating the SFRA with new information is provided in Chapter 6, Volume 1 of the Level 1 SFRA.

3.3 TIDAL FLOOD RISK

3.3.1 SOURCES

There is a risk of tidal flooding in Tower Hamlets caused by a storm surge in the North Sea and the associated impacts in the River Thames. Surge conditions develop in the North Sea during times of low pressure and due to the funnelling effect caused by the shape of the coastline, surges can build to significant heights as they move south towards mainland Europe. If these surges coincide with a high tide, the risk of tidal flooding to the east coast of England is high. Surge conditions at the mouth of the Thames Estuary are amplified upstream in central London creating a risk of tidal flooding in the city if defences are overtopped or breached.

The Thames Tidal Defences protect London from flooding during an extreme tidal event. In combination with the Thames Barrier, the defences are high enough that they should not be overtopped in an extreme event, such as the 0.1% AEP surge event.

3.3.2 HISTORIC RECORDS

Figure 5.9 (Volume 3 Level 1 SFRA) shows the extent of flooding in Tower Hamlets observed during this flood event. It is recorded that during this event the flood tide in central London was 1.8m above predicted level and flooding affected an extensive part of London and caused fourteen deaths and made four thousand homeless.

The 1953 flood event affected parts of Tower Hamlets around the confluence of the River Lee and the River Thames. The storm surge hit the east coast of the UK and breached flood defences, knocked out tide gauges between The Wash and South End and devastated Canvey Island in the Thames Estuary. By the

time the storm surge reached central London the winds were abating but the surge still caused serious flooding in the Docklands area. This area was mostly industrial at the time and there were no recorded fatalities.

3.3.3 FLOOD ZONES

The assessment of Tidal Flood Zones in Tower Hamlets, carried out as part of the Level 1 SFRA has considered an undefended scenario where the Thames tidal defences have been removed and the Thames Barrier is assumed to be non-operational during a storm surge event. This assessment considered three Flood Zones as described in PPS 25 and summarised in Table 3-2 below.

Table 3-2 Definition of Tidal Flood Zones (Table D1, PPS 25)

Flood Zone	Probability of Flooding	Definition
Flood Zone 1	Low probability	Land assessed as having a less than 1 in 1000 annual probability of tidal flooding in any year (<0.1%)
Flood Zone 2	Medium probability	Land assessed as having between a 1 in 200 and a 1 in 1000 annual probability of tidal flooding in any year (0.5% to 0.1%)
Flood Zone 3	High probability	Land assessed as having a 1 in 200 or greater annual probability of tidal flooding in any year (>0.5%)

There are three main areas at risk of tidal flooding in Tower Hamlets, as indicated by the EA Flood Zones. These are the Isle of Dogs extending into Poplar, Wapping, and Blackwall. All areas are shown to be located within Flood Zone 3. Parts of Poplar are shown to be within Flood Zone 2.

For the purposes of applying the Sequential Test, combined fluvial and tidal flood zones for the borough will be used and have been mapped as Figure B.1 in Volume 2 of the Level 2 SFRA.

3.3.4 THAMES TIDAL MODEL

The Environment Agency has provided predicted tidal surge levels in the River Thames from their 2D joint probability model of the tidal Thames. The levels take into account the probability of tidal surge events in the North Sea and the operation of the Thames Barrier, and have been provided for a range of return period events, for present day (2005) as well as future years (2055 and 2107). The predictions of future tidal peaks take into account DEFRA's climate change allowances as set out in PPS25.

The predicted tidal surge levels provided for the Level 1 SFRA, were calculated using the Environment Agency iSIS joint probability model. A comparison of these levels with those provided for this Level 2 assessment shows that the revised predicted levels are lower, particularly for the present day scenario where levels are lower by up to 0.2m.

The Lower Lee Valley Regeneration Model used in the assessment of fluvial flooding was also been used to assess the risk of tidal flooding in Tower Hamlets in breach scenarios.

Actual risk

The actual risk of tidal flooding in Tower Hamlets is much reduced by the presence of the Thames tidal defences, including the Thames Barrier. The Level 1 SFRA reports that there is at least 0.14m of freeboard on the existing defences for a 0.5% AEP tidal surge level (refer to Chapter 5 Volume 2 of the Level 1 SFRA). As the predicted tidal surge levels are now lower, this freeboard has increased to a minimum of 0.3m.

Residual risk

There is a residual risk of tidal flooding in LBTH from an extreme surge event. The Level 1 SFRA reports that there is approximately 0.05m of freeboard on the existing defences for a 0.1% AEP tidal surge level (refer to Chapter 5 Volume 2 of the Level 1 SFRA). As the predicted tidal surge levels are now lower, this freeboard has increased to a minimum of 0.27m.

The residual risk of flooding caused by a breach in existing defences during a tidal surge event was also assessed as part of the Level 1 SFRA. The probability of such an event occurring is low but the consequences of a breach are potentially high. There are areas in Tower Hamlets where the predicted hazard rating in a breach event is classed as extreme and a danger to all.

Seven breach locations were originally assessed and were developed in consultation with the Environment Agency. The locations were identified in consideration of the following:

- The most likely point of breaching, i.e. overtopping will occur at the lowest point of a tidal defence wall before a breach occurs at the highest point along the same wall.
- The proximity of low-lying land to tidal defence and accessible flow paths.

Table 3-3 provides details of the seven breaches assessed as part of the Level 1 SFRA. All breaches were assessed based on a 0.5% AEP tidal surge event:

Table 3-3 Breach Scenarios

Breach Scenario		Grid Reference	Breach details	Breach sill level
1	Bromley	538651 181749	45m wide From LLV Regeneration model	3.2m AOD
2	Blackwall	538492 180368	45m wide From LLV Regeneration model	2.7m AOD
3	South Quay	538379 179737	20m wide Isle of Dogs breach model	3.6m AOD
3A	South Quay	538248 179917	Isle of Dogs breach model This breach scenario will be an assessment of the hazard if the South Quay dock gates were to fail during a tidal surge event	
4	Lockes Wharf	537780 178233	20m wide Isle of Dogs breach model	4m AOD
5	Milwall	537010 179364	20m wide Isle of Dogs breach model	2.8m AOD
6	Limehouse	536526 180707	20m wide Isle of Dogs breach model	4m AOD
7	Wapping	534424 180080	20m wide Wapping breach model	3.25m AOD

Details of the breach assessments, including model parameters and results are discussed in Chapter 5 Volume 2 of the Level 1 SFRA. Mapped result of the breach analyses are presented in Figures 5.2 to 5.8 of Volume 3, Level 1 SFRA. Further breach analysis as part of the FRA process may be required for specific sites as they are brought forward for development.

Model Updates

The predicted tidal surge levels provided for this Level 2 SFRA represent the most up-to-date for the borough and an improvement on the data provided for the Level 1 SFRA. An update to the breach modelling is recommended to ascertain potential changes to the predicted flood extent and depths of water in at risk areas. Guidance on maintaining and updating the SFRA with new information is provided in Chapter 6 Volume 1 of the Level 1 SFRA.

3.4 SURFACE WATER FLOOD RISK

3.4.1 SOURCES

Surface water flooding is the term used to describe flooding which occurs when intense, often short duration rainfall is unable to soak into the ground or to enter drainage systems and therefore runs over the land surface causing flooding. It is most likely to occur when soils are saturated so that they cannot infiltrate any additional water or in urban areas where buildings tarmac and concrete prevent water soaking into the ground. The excess water can pond (collect) in low points and result in the development of flow pathways often along roads but also through built up areas and open spaces. This type of flooding is usually short lived and associated with heavy downpours of rain.

3.4.2 HISTORIC RECORDS

One incident of surface water flooding in the LB of Tower Hamlets is reported in the Level 1 SFRA. Significant flooding occurred in 1999 due to prolonged rainfall. This resulted in an area around White Post Lane and in the Hackney Borough area (including surrounding roads), residential property (Hackney's) and commercial properties (in Hackney and Tower Hamlets) being flooded to a depth of around 0.75 metres.

No further records of surface water flooding were provided by the LB of Tower Hamlets or the Environment Agency. This is not to say that no other incidents have occurred or that there is no future flood risk to the Borough from surface water.

3.4.3 HYDRAULIC MODELLING

Surface water modelling of Tower Hamlets was undertaken in March 2011 as part of the Drain London project to inform the borough's Preliminary Flood Risk Assessment (PFRA) and Surface Water Management Plan (SWMP). The results of this modelling represent the 'locally agreed surface water information' for the borough and supersedes the national data sets ('Areas Susceptible to Surface Water Flooding' and Flood Map for Surface Water') produced by the Environment Agency.

Several 2-dimensional direct rainfall models were created using the TUFLOW software to determine the causes and consequences of surface water flooding within the LB of Tower Hamlets. The results of the models provide an indication of key flowpaths, velocities and areas where water is likely to pond. The models were run for the 3.33%, 1.33%, 1%, 1% with inclusion of climate change, and the 0.5% AEP rainfall events. The predicted maximum water depth and hazard for each of the return periods are mapped and presented in the SWMP.

The key assumptions include the use of a continuous loss (6.5mm/hr) to represent the presence of the underground drainage network. The model does not take into account any capacity issues associated with the drainage network such as surcharging of manholes leading to backing up of surface water or blocked outfalls. A detailed discussion on the hydraulic modelling methodology is presented in Appendix C of the SWMP.

The LB of Tower Hamlets SWMP assessed the susceptibility of surface water flooding in the borough based on a 1% AEP rainfall event and identified 'Critical Drainage Areas' (CDAs) across the borough. A CDA is

defined as ‘a discrete geographic area (usually a hydrological catchment) where multiple and interlinked sources of flood risk (surface water, groundwater, sewer and/or river) often cause flooding in one or more Local Flood Risk Zones during severe weather thereby affecting people, property or local infrastructure’.

Local Flood Risk Zones are defined as ‘discrete areas of flooding that do not exceed the national criteria for a ‘Flood Risk Area’ but still affect houses, businesses or infrastructure. LFRZ is defined as the actual spatial extent of predicted flooding in a single location. Related LFRZs can be grouped together as a Critical Drainage Area’.

To ensure consistency with the SWMP, the assessment of surface water carried out for key development sites (Volume 2) has been carried out based on the 1% AEP rainfall event.

3.5 SEWER FLOOD RISK

3.5.1 SOURCES

Flooding from foul and combined sewers occurs when rainfall exceeds the capacity of networks or when there is an infrastructure failure. In the LB of Tower Hamlets the sewer network is a largely combined foul and surface water system managed by Thames Water.

The risk of flooding from sewers is increasing due to the increasing urbanisation of areas and rising rainfall intensities. Several recent flood events across the country have been attributed to the failure of the drainage network to contain runoff during severe storm events. The combined surface water and foul water drainage system in London dates from Victorian times and cannot cope with runoff from the ever-growing city and increasing rainfall intensities.

3.5.2 HISTORIC RECORDS

The data provided by Thames Water for use in this Level 2 SFRA shows postcodes where properties are known to have experienced sewer flooding prior to June 2010. The data provides a broad overview of flood incidents in the Borough as it is not property specific, instead providing information in postcode sectors (a four digit postcode). As some of these sectors extend into other London Boroughs, it is not possible to determine the exact number of properties that have experienced a sewer flooding incident. Figure B.6 in Volume 2 of this report.

The majority of the incidents of sewer flooding are clustered in the north of the borough around Bow and Victoria Park – post codes E3 2, E3 5, E9 5 and E9 7. The post code areas of E9 5 and E9 7 extend into the LB of Hackney and it cannot therefore be said with certainty within which borough the incidents have occurred. However, considering Victoria Park covers majority of the post code areas within the LB of Tower Hamlets, it is likely that the majority of the incidents have occurred within the LB of Hackney.

The relatively high number of incidents reported in post code areas E3 2 and E3 5 may be the result of a shallow gradient drainage network, as it is observed that the topography in Bow is relatively uniform.

Table 3-4: Number of Thames Water sewer flood records within the London Borough of Tower Hamlets

Post Code Sector	2 in 10 external	2 in 10 internal	1 in 10 external	1 in 10 internal	1 in 20 external	1 in 20 internal	Severe	Total Properties
E1 1H	0	0	0	0	0	1	0	1
E1 1N	0	0	0	0	0	1	0	1
E1 2L	0	0	0	0	0	1	0	1
E1 3J	0	0	0	0	0	1	0	1

Post Code Sector	2 in 10 external	2 in 10 internal	1 in 10 external	1 in 10 internal	1 in 20 external	1 in 20 internal	Severe	Total Properties
E1 4A	0	0	0	0	0	2	0	2
E1 4L	0	0	0	0	0	1	0	1
E1 4U	0	0	0	0	0	2	0	2
E1 6B	0	0	0	0	0	1	0	1
E1 6Q	0	0	0	0	0	1	0	1
E1 6R	0	0	0	0	0	2	0	2
E1 7N	0	0	0	0	0	1	0	1
E1 7T	0	0	0	0	0	1	0	1
E1 8B	0	0	0	0	0	2	0	2
E1 8D	0	0	0	0	0	2	0	2
E14 0	0	0	0	0	0	3	0	3
E14 3	0	0	0	0	1	2	0	3
E14 6	0	0	0	0	1	0	0	1
E14 7	0	0	0	1	0	1	0	2
E14 8	0	0	0	0	0	2	0	2
E14 9	0	0	0	0	0	0	1	1
E2 0	0	0	1	0	0	0	0	1
E2 6	0	0	0	0	1	3	0	4
E2 7	0	0	0	1	0	3	0	4
E2 9	0	0	0	0	0	1	0	1
E3 2	0	0	0	5	0	4	0	9
E3 5	0	0	0	0	0	13	0	13
E9 5	0	0	0	0	0	52	0	52
Total	0	0	1	7	3	102	1	114

3.5.3 DRAINAGE NETWORK MODELLING

Consultation with Thames Water determined that the sewer system across London could be assumed to have an approximate capacity of 6.5mm/hr. This was represented in the surface water modelling by removing 6.5mm/hr from the rainfall totals for the duration of the model.

The sewer system was not modelled for the SWMP explicitly hence interaction between the sewer system and surface water modelling was not investigated. This was beyond the scope of the borough wide Drain London study but in specific areas where the sewer network has been identified to be of particular relevance to flood risk more detailed integrated modelling may be required at a later date. Areas where surface water sewers can have a significant influence on flood risk are generally adjacent to watercourses or rivers (where downstream water levels can directly influence sewer capacity).

3.6 GROUNDWATER FLOOD RISK

3.6.1 SOURCES

Groundwater flooding is caused by the emergence of water originating from sub-surface permeable strata. In short groundwater flooding is water which emerges from the ground from either a specific point (such as a spring) or over a wide diffuse location. A groundwater flood event results from a rise in groundwater level sufficient for the water table to intersect the ground surface and inundate low lying land. Groundwater floods tend to be long in duration developing over weeks or months and prevailing for days or weeks.

3.6.2 HISTORIC RECORDS

Limited records of flood incidents attributed to groundwater flooding in the LB of Tower Hamlets were available for this study. In fact, only one record was found, provided by the Environment Agency occurring on Eric Street, Mile End on the 21st December 2004. Standing water was observed to occur.

3.6.3 IPEG MAPPING

As part of the Drain London project, a dataset referred to as the Increased Potential Elevated Groundwater (iPEG) maps was commissioned in March 2011 and was used to inform the LB of Tower Hamlets PFRA and SWMP. The iPEG mapping assists in identifying areas which have an increased potential to experience groundwater flooding. The map shows those areas within the borough where there is an increased potential for groundwater to rise sufficiently to interact with the ground surface or be within 2 m of the ground surface. The assessment was carried out at a Greater London scale.

The four data sources listed below have been utilised to produce the 'Increased Potential for Elevated Groundwater' (iPEG) map:

- British Geological Survey (BGS) Groundwater Flood Susceptibility Map;
- Jacobs Groundwater Emergence Maps (GEMs);
- Jeremy Benn Associates (JBA) Groundwater Flood Map; and
- Environment Agency Thames Estuary 2100 (TE2100) groundwater hazard maps.

More information on the production of the iPEG map is discussed in Appendix C of the LB of Tower Hamlets SWMP. The iPEG mapping is presented in Figure B.4 in Volume 2 of this Level 2 SFRA together with historic records of flooding which have been identified as related to groundwater. The mapping shows an increased potential for ground water to rise most noticeably in the north-west corner of the borough in Bethnal Green and extending into parts of Stepney Green and Poplar.

3.7 OTHER SOURCES OF FLOODING

3.7.1 CANALS

There are a number of canals, docks and basins within Tower Hamlets that are potential sources of flooding in the borough. These include the four canals owned and operated by British Waterways: Regents/Grand Union Canal, Hertford Union Canal, Limehouse Cut, and the River Lee Navigation Canal. Of the four canals, the River Lee Navigation Canal is the most vulnerable in terms of overtopping during times of high flows in the Lower Lee catchment. Some overtopping of the embankments was observed in 2000.

3.7.2 DOCKS AND BASINS

Due to its previous industrial nature, there are many docks and basins in Tower Hamlets. These are mostly connected to the River Thames by lock gates and the areas around the docks have recently undergone regeneration to create housing and commercial properties. Many of the docks are no longer used for industrial purposes, but mostly for recreational purposes. West India Docks are the exception, and still host medium sized military vessels that are visiting London. Within the study area there are the following docks and basins:

- St Katharine Docks, Wapping;

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

The locks, docks and basins in Tower Hamlets are also the responsibility of British Waterways. British Waterways has a specific team dedicated to the management and maintenance of the locks, docks and basins in the London Docklands. British Waterways must be consulted in relation to any development next to or within the docks in the London Docklands.

The risk of flooding from these artificial sources was discussed with British Waterways. The Level 1 SFRA concludes that due to the active management and regular maintenance of the structures, there is a very low risk of flooding from them. The potential hazard caused by lock gate failure during a tidal surge event on the River Thames has been considered as a breach scenario in the assessment of residual tidal risk. As it is very unlikely that both sets of dock gates would fail at the same time and because the dock walls and surrounding ground levels are relatively high, the risk of flooding is considered to be extremely low.

3.7.3 RESERVOIRS

In 2009, the Environment Agency commissioned inundation mapping of all 2092 reservoirs listed under the Reservoirs Act 1975. The inundation maps show the effects of a dam breach on the downstream catchment and were produced to assist Local Authorities in their responsibilities in coordinating emergency plans. The Environment Agency has provided the flood extents of the inundation maps for the purposes of this study however, were not able to supply information as to the depth or hazard of flooding, nor the expected rate of onset.

There are five reservoirs in the Lee Valley within North London in the LBs of Enfield and Waltham Forest. Although the closest reservoir is located over 6km away from the Tower Hamlets borough boundary, the inundation mapping shows that the flood extents of the Willing Girling, King George V and Lockwood reservoirs encroach into the borough. Three key areas of the borough are shown to be affected – Fish Island, South Bromley and Poplar. These flood extents can be viewed in Figure B.5 in Volume 2 of this Level 2 SFRA and also on the Environment Agency website:

<http://www.environment-agency.gov.uk/business/sectors/125359.aspx>.

4.0 Policy Guidance and Recommendations

4.1 INTRODUCTION

This chapter of the SFRA provides recommendations with regards to the development of flood risk policy by the LB of Tower Hamlets. It includes consideration of flood risk management techniques, as well as providing guidance on sustainable drainage requirements. These recommendations are based on the findings of this SFRA, and importantly existing policy and guidance.

The list of recommendations is not exhaustive and it is therefore recommended that Tower Hamlets refer to both key flood risk management documents and spatial planning documents to inform the development of their policies.

The main risks of flooding identified in the Tower Hamlets SFRA are fluvial flooding from the Lower Lee catchment, breaches in the Thames Tidal Defences during tidal surge events, breaches in reservoirs and surface water flooding from impermeable surfaces. When the existing defences are considered, the actual risk of flooding from the River Lee is significantly reduced. Only the Fish Island site in the northeast of the borough is shown to be at risk, with the majority of the flooding predicted to flow into the neighbouring borough of Newham.

The probability of a breach in the Thames Tidal Defences is low but cannot be easily quantified. The risk of a breach occurring cannot be eliminated but the consequences of such an event, if it were to occur, can be reduced through land use planning, development control and emergency planning.

The probability of flooding from surface water can be reduced on new developments by reducing the flows and volumes of runoff from the site. Runoff should be controlled as close to the source as possible through the use of SUDS. The layout of sites should be developed so that areas at greatest risk of surface water flooding are avoided. The LB of Tower Hamlets SWMP defines Critical Drainage Areas and provides guidance on optimising the use of SUDS in new development and on locally specific cost-beneficial solutions to managing surface water flood risk. The solutions proposed should be incorporated into land use planning and development control policies in the LDF Core Strategy and other LDDs.

The LB of Tower Hamlets must consider how to respond to two quite different types of risk outlined above. There is the risk of surface water flooding where the probability (chance) of occurrence is quite high and the consequences of the event are often quite low or very localised. At the opposite extreme is a breach scenario. The probability of such an event occurring is much lower than surface water flooding, yet the consequences of such an event occurring are potentially huge. The response to these events will be quite different and must be targeted. The probability of surface water flooding can be reduced through managed surface water runoff from new developments. It would be much harder to reduce the probability of a breach event occurring and therefore this risk should be managed through measures that reduce the consequences of such an event if it were to occur.

4.2 POLICY GUIDANCE

Based on the findings of both the Level 1 and Level 2 SFRA a number of key recommendations for further consideration by the LB of Tower Hamlets have been identified. These recommendations provide advice in two separate areas: potential Core Strategy; and, potential Development Control policies.

We would recommend that LB of Tower Hamlets consider developing specific policies relating to the following flood risk issues whilst preparing their Local Development Documents (LDDs) including DPDs. Guidance for specific sites assessed in this SFRA has been included within Volume 2.

Forward Planning

- Seek opportunities to apply the PPS 25 principle of 'avoiding flood risk' by allocating development outside of Flood Zone 2 and 3 and areas in Flood Zone 1 identified at high risk of surface water flooding, where possible;
- Avoid locating 'more vulnerable' development in areas identified at 'actual risk' of fluvial flooding;
- Adopt a Sequential Approach to the location of development across the borough allocating the most vulnerable development in the lowest risk flood zones;
- Encourage the local community in flood risk areas to take up opportunities to improve resilience and resistance of existing homes and buildings.

Development Control

- Encourage the adoption of the Sequential Approach for all new developments where possible, allocating the most vulnerable development in the lowest risk flood zones;
- Large investment in flood defence infrastructure will be required in Tower Hamlets in the future. Although TE2100 identifies that most defence improvements will be required beyond 2030, where appropriate, Tower Hamlets should seek to improve flood defences as development occurs, including assessment of:
 - defence condition;
 - CFMP and TE2100 policies; and
 - developer contributions policy (see below).
- Discourage the location of basement dwellings within areas of 'actual risk' of fluvial flooding.
- Consider obligations for developers on sites bordering the River Thames and River Lee to maintain and improve flood defences for the lifetime of the development, either directly or through contributions for strategic management (refer recommendation 24). This should be informed by the EA System Asset Management Plans, and agreed with the Environment Agency.
- Seek to adopt the Environment Agency requirements for 8m buffer strips on main rivers, and 16m buffer strips from tidal defences for developments alongside the River Thames and River Lee wherever possible.

Flood Risk Management

- Seek measures to reduce flood risk (both the probability and consequences) as part of new development. This could include considering measures such as:
 - Making lengths of flood defence 'unbreachable';
 - Introducing secondary defences close to the existing defence line, through a strategic or specific site approach;
 - Ground raising; or
 - Using lower vulnerability land uses around the perimeter of a development to act as a secondary flood defence to higher vulnerability development within the centre.
- Following the application of the Sequential Test, where proposed development is necessary in areas at 'actual risk' of fluvial flooding (1 in 1% AEP plus climate change) from the River Lee it must be 'safe' in accordance with PPS 25 and the Practice Guide including measures such as:

- Setting all 'more vulnerable' finished floor levels a minimum of 300mm above modelled flood levels;
 - Ensure dry access is available for 'more vulnerable' development, preferably including dry vehicular access that enables voluntary and free movement out of the floodplain. If it can be demonstrated that this is not feasible then 'safe access' in accordance with FD2320 is appropriate.
 - Appropriate flood warning and emergency planning is available to enable 'less vulnerable' site users to safely evacuate the site and floodplain prior to the onset of flooding;
 - Development demonstrates there is no increase in flood risk as a result of development, in particular no loss of flood storage;
 - 'Essential infrastructure' remains operational during flood conditions, including access where necessary.
- Following the application of the Sequential Test, where proposed development is necessary in areas at 'residual risk' of tidal or fluvial flooding, from a breach in a reservoir upstream or from a breach in the tidal or fluvial defences in an extreme flood event, it must be 'safe' in accordance with PPS 25 and the Practice Guide including measures such as:
 - Setting all 'more vulnerable' finished floor levels a minimum of 300mm above modelled flood levels;
 - Safe refuge is available for all site users above modelled flood levels;
 - Where appropriate, emergency plans are in place to enable site users to safely evacuate the site and floodplain prior to the onset of flooding. The plan should include measures to ensure site users are aware of both the risk of flooding and actions to take;
 - 'Essential infrastructure' remains operational during flood conditions, including access where necessary.
 - Demonstrate emergency services can safely access the site, and site users, where necessary.
 - In considering major planning applications in areas where rising groundwater is an existing or potential problem, Tower Hamlets should expect reasonable steps to be taken to abstract and use that groundwater. The water may be used for cooling or watering purposes or may be suitable for use within the development or by a water supply company.
 - The functional floodplain should be safeguarded from development, including removing or reducing obstructions, and provide environmental enhancement.
 - Develop site specific flood emergency plans with an overall aim to reduce the risk to life of people within the area. The plan should include at a minimum the source and mechanisms of flooding, local flood actions, and the location of vulnerable people. The flood plan must be discussed with relevant agencies including Tower Hamlets, the Environment Agency, and Thames Water. Refer to 'Flooding – Minimising the Risk: Flood Plan Guidance for Communities and Groups' (Environment Agency).

Surface Water

- Developments within Critical Drainage Areas (CDAs) should seek to incorporate the recommended surface water management measures identified in the LB of Tower Hamlets SWMP. It should be noted that the extents of CDAs are defined by the Tower Hamlets SWMP (refer Section 1.1). The

SWMP is a living document and extents of CDAs may change in line with climate change, significant modifications to the drainage system or localised alterations to topography.

- Developments located in CDAs and greater than 0.5 hectares in area are required to reduce runoff to that of a predevelopment Greenfield runoff rate (calculated in accordance with IoH124). It is recommended that a SuDS treatment train is utilised to assist in this reduction.
- All developments across the borough (excluding minor house extensions less than 250m²) which relate to a net increase in impermeable area are to include at least one 'at source' SuDS measure (e.g. waterbutt, rainwater harvesting tank, bioretention planter box etc). This is to assist in reducing the peak volume of runoff discharging from the site;
- Proposed 'brownfield' redevelopments greater than 0.1 hectare are required to reduce post development runoff rates for events up to and including the 1 in 100 year return period event with an allowance for climate change (in line with PPS25 and UKCIP guidance) to 50% of the existing site conditions. If this results in a discharge rate lower than the Greenfield conditions it is recommended that the Greenfield rate (calculated in accordance with IoH124) is used.
- All developments should consider the London Plan and should thoroughly demonstrate an aim to achieve greenfield rates through consideration of all SUDS techniques. Where this is not possible all development should meet the Mayor's essential standard of 50% and justify this.
- All SuDS guidance regard drainage as being fundamental to site design so must be considered early in the design process to ensure sufficient space is provided. Applications should thoroughly demonstrate a consideration of SuDS. The surface water management train should be followed, and justified.
- Greenfield or undeveloped sites must comply with the requirements of PPS25 Annex F paragraph F6.
- It should be noted that consultation with the Environment Agency with regard to surface water drainage is not required if the proposed development site is within Flood Zone 1 and is less than 1 Ha in area.

5.0 References

Communities and Local Government (2006) 'Planning Policy Statement 25' (PPS25)

Communities and Local Government (2000) „Planning Policy Statement 25: Development and Flood Risk Practice Guidance’

Environment Agency „Flooding – Minimising the Risk: Flood Plan Guidance for Communities and Groups’

Environment Agency (2000) 'Lessons Learnt - Autumn 2000 floods' November 2000

Environment Agency (2003) 'Strategy for Flood Risk Management 2003 - 2008'

Environment Agency/Defra (2005) 'Flood Risk Assessment Guidance For New Development' Phase 2 Framework and Guidance for Assessing and Managing Flood Risk for New Developments - Full Documentation and Tools, R&D Technical Report TR2320/TR2, October 2005

Defra (October 2006) „FCDPAG3 Economic Appraisal Supplementary Note to Operating Authorities – Climate Change Impacts.’

CIRIA 624 (2004) „Development and Flood Risk – Guidance for the Construction Industry’

Greater London Authority (GLA) (2007) Draft Regional Flood Risk Appraisal

Government office for London (2007) London Flood Response Strategic Plan

LB Tower Hamlets (2008) „London Borough of Tower Hamlets: Level 1 Strategic Flood Risk Assessment’

LB Tower Hamlets (2011) „Preliminary Flood Risk Assessment for London Borough of Tower Hamlets’

LB Tower Hamlets (2011) „Surface Water Management Plan for London Borough of Tower Hamlets’

Capita Symonds Ltd
Level Seven
52 Grosvenor Gardens
Belgravia
London SW1W 0AU

Tel +44 (0)20 7808 4520
Fax+44 (0)20 7901 9901

www.capitasymonds.com