SURFACE WATER MANAGEMENT PLAN

Project no. 4021383

Prepared for:

London Borough of Havering

Date: April 2025

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Details of document preparation and issue:

Version no.	Prepared	Checked	Reviewed	Approved	Issue date	Issue status
1	Katie Allsopp	Patri Cuervo	Ruth Burnham	Hannah Burgess	16/07/2024	Draft for comment
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1. Introduction

1.1 What is a Surface Water Management Plan?

Surface Water Management Plans (SWMPs) are non-statutory plans produced to understand surface water flood risk and how it will be managed. They provide important evidence base documents for the development of local flood risk management strategies[1].

This SWMP covers the entirety of the London Borough of Havering and includes an action plan to manage local sources of flood risk and provide an understanding of flood risk. It can be used to inform planning, identify opportunities, and outline roles and responsibilities.

In 2023, Binnies were commissioned to assist Council Officers at the London Borough of Havering (LBH) in their review of the Local Flood Risk Management Strategy (LFRMS), SWMP and their implementation of the Lead Local Flood Authority (LLFA) duties. The previous SWMP[2] was published in 2013.

1.2 Developing the Surface Water Management Plan

This SWMP has been developed using the government's SWMP technical guidance developed for local authorities[3]. The guidance divides the process into four sections covering undertaking the assessment and producing and implementing an action plan to address the study findings. The SWMPs phases are:

- Preparation (section 2 of this document)
- Risk Assessment (section 3)
- Options (section 4)
- Implementation and Review (section 5)

[2] Drain London/Jacobs UK Limited, *London Borough of Havering Surface Water Management Plan*, July 2011

[3] Defra, *Surface Water Management Plan Technical Guidance*, 2011, www.gov.uk/government/publications/surface-water-management-plan-technical-guidance

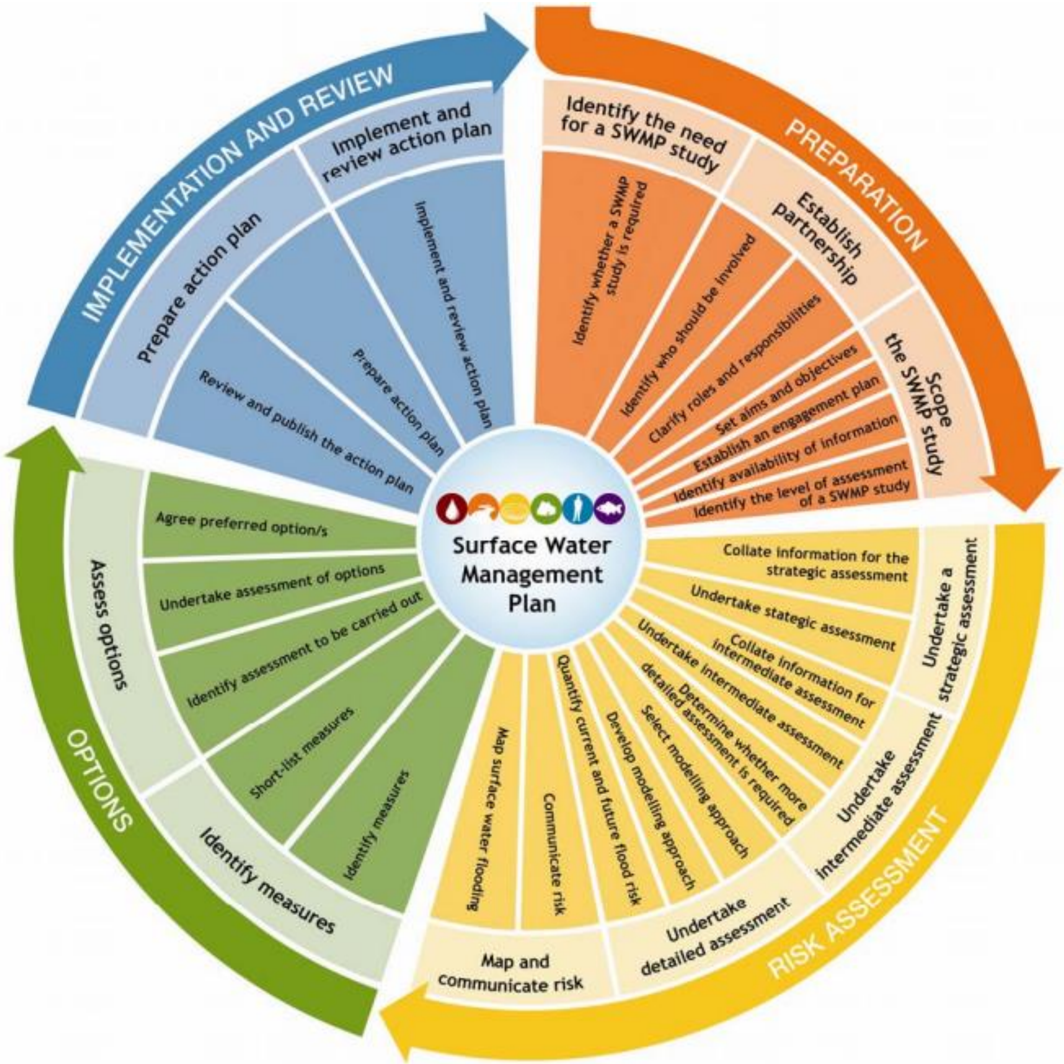

Figure 1.2-1: SWMP Development Framework taken from Defra Surface Water Management Plan Technical Guidance, 2011

The review of the SWMP fed into the review of the Local Flood Risk Management Strategy (LFRMS). The diagram below sets out how these activities were interlinked throughout the review of both documents.

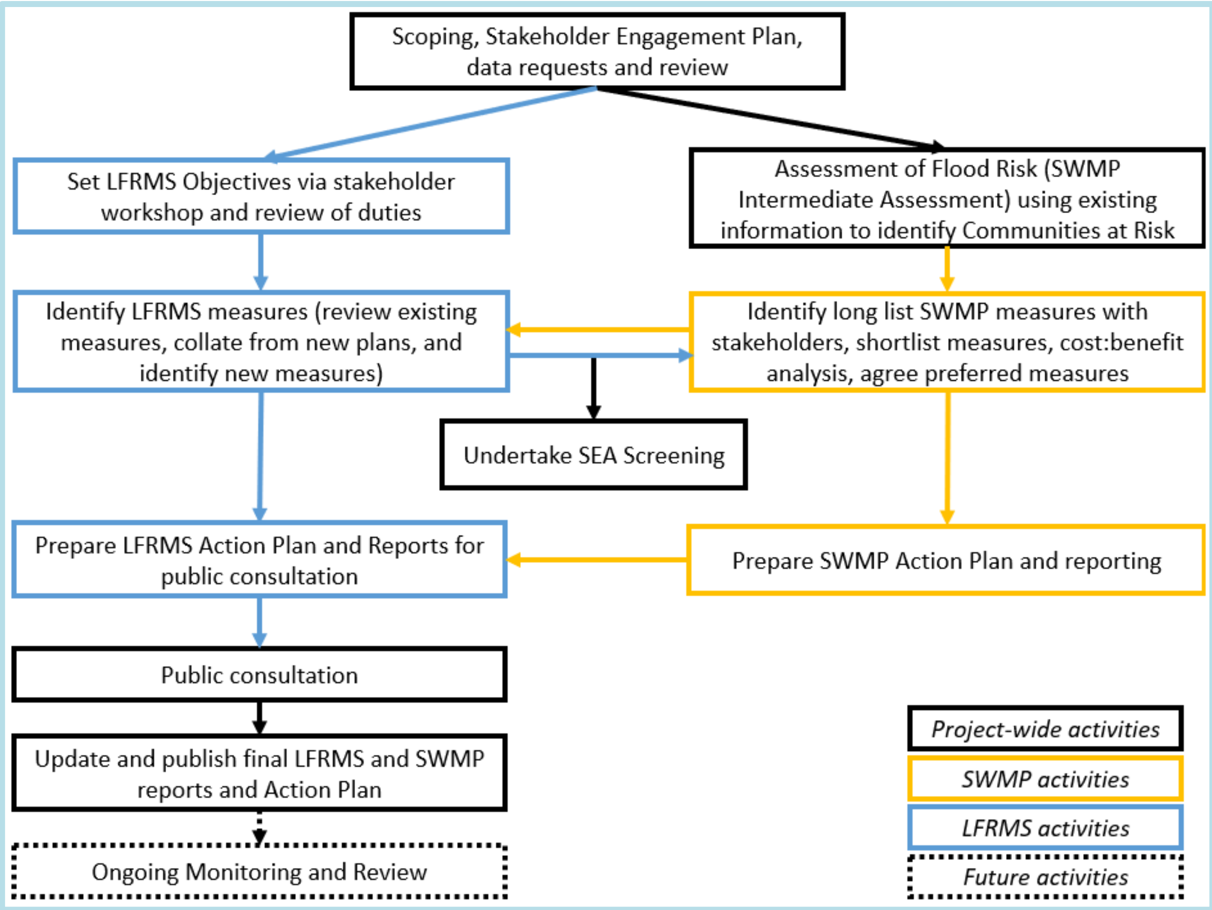

Figure 1.2-2: Steps for the LFRMS review

1.3 Structure of the SWMP

The SWMP is structured as follows:

- Introduction: explains what a SWMP is, its structure and what has changed since the last SWMP was produced. It also includes information on the London Borough and the sources of flood risk.
- Preparation: explains the importance of partnership working, how the aims and objectives were set. It also covers the data used in the methodology and its review.
- The Risk Assessment section explains the methodology for the intermediate risk assessment, its limitations and assumptions and the results obtained.
- The Options Development section explains how the measures in the long list were assessed and prioritised through multicriteria and cost benefit analysis to produce the Action Plan.
- The implementation and review section provides information about what is included in the Action Plan for both the SWMP and the LFRMS, and how the SWMP will be implemented, reviewed, and monitored.

1.4 Changes since last Surface Water Management Plan

The previous SWMP was published in 2013 as a part of the Drain London Project. Since 2013 there have been flooding events and investigations as well as updates to guidance, strategies, and policy context:

- Defra's Non-Statutory Technical Standards for Sustainable Drainage Systems (SuDS)[4].
- National Flood and Coastal Erosion Risk Management (FCERM) Strategy[5] and Roadmap[6]
- National Planning Policy Framework[7] and Planning Practice Guidance[8]
- Defra Climate Change Adaptation Plan[9]
- Thames River Basin Flood Risk Management Plan 2021 to 2027[10]
- Thames Catchment Flood Management Plan[11]
- Thames Estuary 2100 (TE2100) Plan[12] and the 2023 update[13].
- London Strategic Flood Response Framework[14]
- Thames Water Drainage and Wastewater Management Plan[15]
- London Plan 2021[16]
- London Regional Flood Risk Appraisal[17]
- Havering Local Plan 2016-2023[18].
- Havering Strategic Flood Risk Assessment[19]
- Havering Multi Agency Flood Plan 2017[20]
- Havering Emergency Planning Handbook[21]

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[4] Department for Environment, Food and Rural Affairs, *Non-statutory technical standards for sustainable drainage systems*, March 2015, https://assets.publishing.service.gov.uk/media/5a815646ed915d74e6231b43/sustainable-drainage-technical-standards.pdf

[5] Environment Agency, *National Flood and Coastal Erosion Risk Management Strategy for England: Executive Summary*, June 2022, https://www.gov.uk/government/publications/national-flood-and-coastal-erosion-risk-management-strategy-for-england--2/national-flood-and-coastal-erosion-risk-management-strategy-for-england-executive-summary

[6] Environment Agency, *Flood and Coastal Erosion Risk Management Strategy Roadmap to 2026,* https://assets.publishing.service.gov.uk/media/629de862e90e07039c27b440/FCERM-Strategy-Roadmap-to-2026-FINAL.pdf

[7] Department for Levelling Up, Housing and Communities, National Planning Policy Framework, https://www.gov.uk/guidance/national-planning-policy-framework

[8] Department for Levelling Up, Housing and Communities*, Flood Risk and Coastal Change*, 6th March 2014, https://www.gov.uk/guidance/flood-risk-and-coastal-change

[9] Defra, *Climate Change Adaptation: Policy Information*, 11th August 2022, https://www.gov.uk/government/publications/climate-change-adaptation-policy-information/climate-change-adaptation-policy-information

[10] Environment Agency, *Thames River Basin District Flood Management Plan 2021 to 2027*, December 2022, https://assets.publishing.service.gov.uk/media/6380a45d8fa8f56ea9d462d8/Thames-FRMP-2021-2027.pdf

[11] Environment Agency, *Thames Catchment Flood Management Plan*, December 2009, https://www.gov.uk/government/publications/thames-catchment-flood-management-plan

[12] Environment Agency, Thames Estuary 2100 (TE2100), https://www.gov.uk/government/collections/thames-estuary-2100-te2100

[13] Defra, *Major updates to Thames Estuary 2100 from 2012 to 2023*, April 2023, https://www.gov.uk/guidance/major-updates-to-thames-estuary-2100-from-2012-to-2023

[14] London Resilience, London Strategic Flood Response Framework, 2020 https://www.london.gov.uk/sites/default/files/london_strategic_flood_response_framework_2020_v3.2.pdf

[15] DEFRA, Drainage & Wastewater Management Plans: Guiding Principles for the Water Industry https://www.gov.uk/government/publications/drainage-and-wastewater-management-plans-guiding-principles-for-the-water-industry

[16] Greater London Authority, The London Plan 2021, March 2021, https://www.london.gov.uk/sites/default/files/the_london_plan_2021.pdf

[17] Greater London Authority, *London Regional Flood Risk Appraisal,* August 2014, https://www.london.gov.uk/sites/default/files/gla_migrate_files_destination/Regional%20Flood%20Risk%20Assessment%20-%20First%20Review%20-%20August%202014.pdf

[18] London Borough of Havering, *Havering Local Plan 2016-2031 Adopted November 2021*, https://www.havering.gov.uk/downloads/file/5300/havering_local_plan_2016_-_2031.pdf

[19] London Borough of Havering, Strategic Flood Risk Assessment, 2017 https://www.havering.gov.uk/downloads/download/153/strategic_flood_risk_assessment_2017

[20] Havering London Borough, *Multi-Agency Flood Plan for London Borough of Havering*, August 2017, https://www.havering.gov.uk/downloads/file/5785/multi-agency_flood_plan_-_august_2017.pdf

[21] London Borough of Havering, *Emergency Planning Handbook*, https://www.havering.gov.uk/downloads/file/5738/emergency_planning_handbook

- Havering LFRMS 2015
- Havering Climate Emergency Action Plan 2024-2027[22]
- Havering's Surface Water Management Plan 2013 and the reviewed SWMP
- Section 19 of the Flood and Water Management Act 2010 (FWMA 2010) Flood Investigation Reports[23 24 25].

Section 9 of the FWMA 2010[26] requires the LLFA to develop, maintain, apply, and monitor a LFRMS. The previous LFRMS was published in 2015. The SWMP provides an important evidence base for the review of the LFRMS. Existing problems are highlighted in the SWMP and can be used to inform planning decisions. Both documents complement other plans and polices on flood risk in the Borough.

1.5 Study Area

In this SWMP the study area is the administrative boundary for the London Borough of Havering (LBH).

Location and Characteristics

The LBH is located in Northeast London, England on the north bank of the river Thames. The Borough is bordered by the London Borough of Redbridge, London Borough of Barking and Dagenham and Essex County. It is the third largest Borough in London covering 112.3 km^2 [27], with a population of 262,100[28].

The London Borough is characterised by its suburban location. Around 60% of the Borough is open green space mainly located in the east. There are strict Green Belt restrictions to prohibit the extension of developments. In contrast to this, the principal town of Romford, which is in the west of the Borough, is densely populated. The southern part of Borough is adjacent to the River Thames and in the London Riverside section of the Thames Gateway redevelopment areas, so will be an area of increasing development and population pressures.

The rivers Rom, Ravensbourne and Ingrebourne flow north to south in the Borough and are all tributaries of the river Thames. The River Rom forms the boundary between the LBH and London Borough of Barking and Dagenham.

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[22] London Borough of Havering, Havering Climate Emergency Action Plan 2024-2027, 2024 https://www.havering.gov.uk/downloads/file/6573/climate_change_action_plan_2024_to_2027

[2] Jacobs U.K Limited, Havering Flooding, *June 2016 Flood Investigation Report*, 20th January 2017, www.havering.gov.uk/download/downloads/id/675/havering_2016_flood_investigation_report.pdf

[24] Jacobs U.K Limited, *Flood Investigation Section 19 Report*, 01st November 2021, www.havering.gov.uk/download/downloads/id/5246/havering_2021_flood_investigation_report.pdf

[25] Jacobs Ltd, *London Borough of Havering Section 19 Flood investigation Report*, 11th October 2023, www.havering.gov.uk/download/downloads/id/6454/havering_2022_flood_investigation_report.pdf

[26] Flood and Water Management Act 2010, *Section 9*, 2010, www.legislation.gov.uk/ukpga/2010/29/section/9

[27] Areas. London, *Havering Area Guide,* 23RD April 2023, https://areas.london/havering-area-guide/#:~:text=Havering%20is%20112.3%20km2%2C%20making%20it%20the%203th,31%20as%20the%20most%20populous%20per%20km2%20Borough.%3E.

[28] Office for National Statistics, *Census 2021*, 19th January 2023, https://www.ons.gov.uk/visualisations/censusareachanges/E09000016/

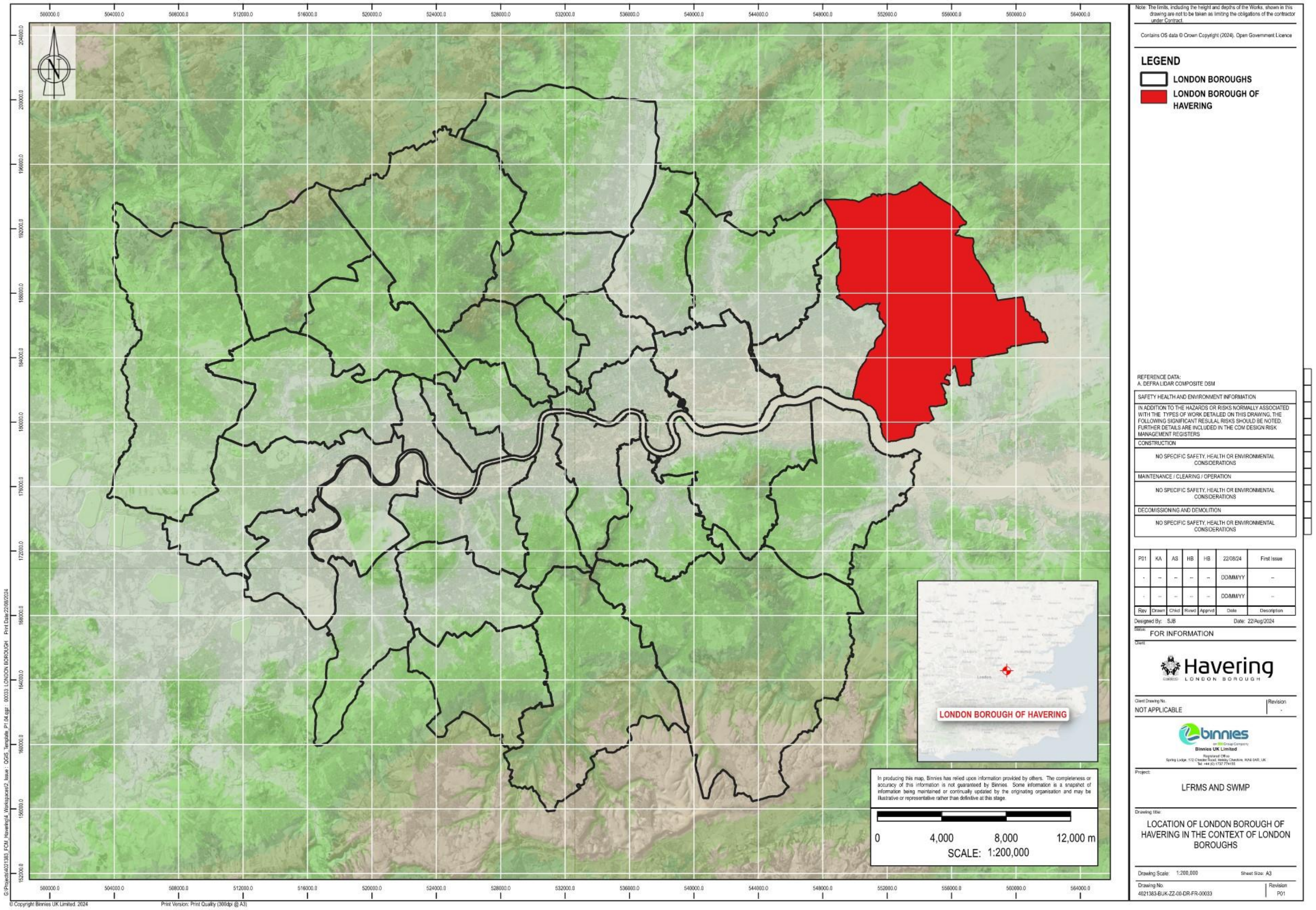

Figure 1.5-1: Location of the London Borough of Havering in the context of London Boroughs (not to scale, see A3 scaled maps in Appendix G)

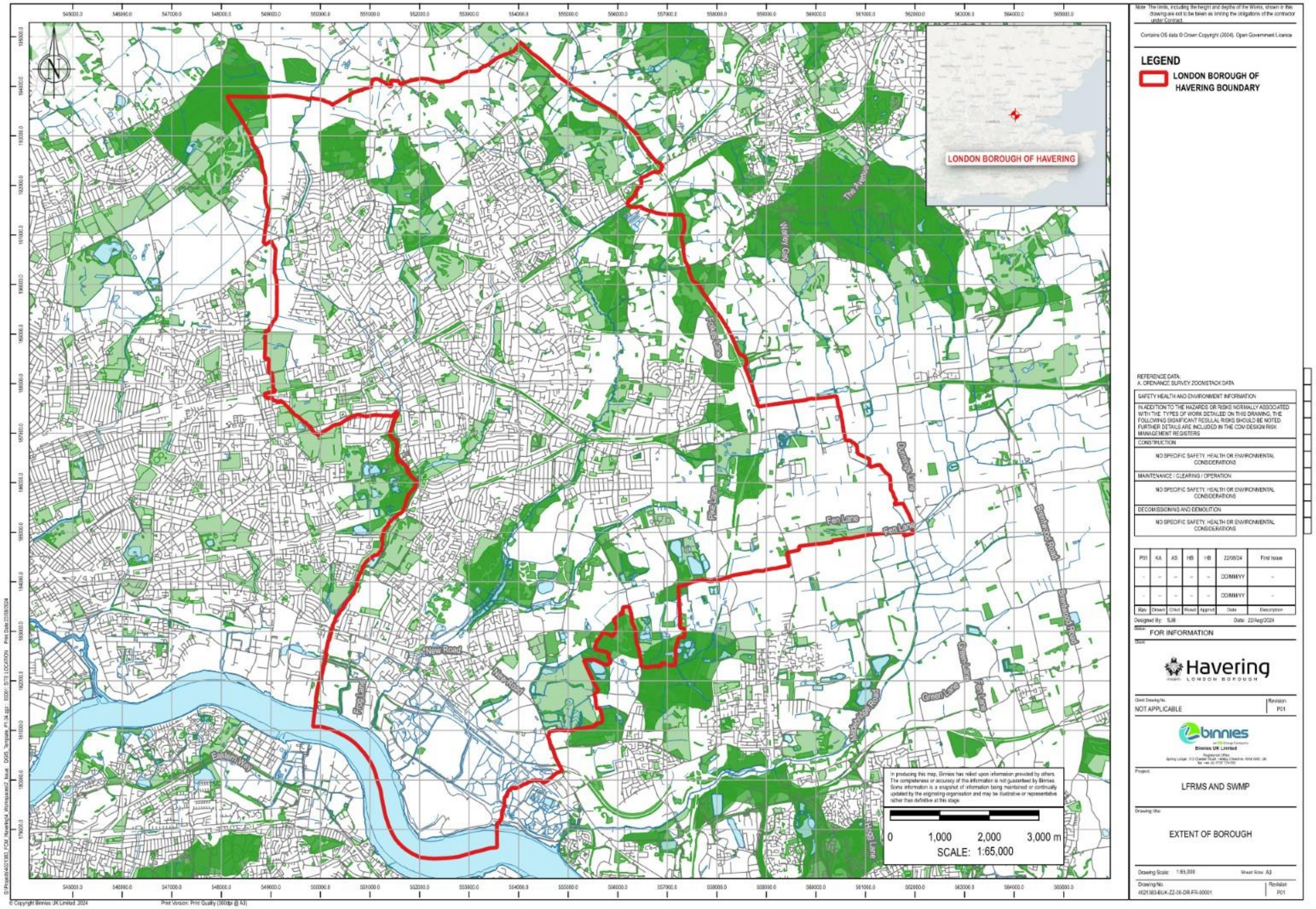

Figure 1.5-2: Extent of Borough (not to scale, see A3 scaled maps in Appendix G)

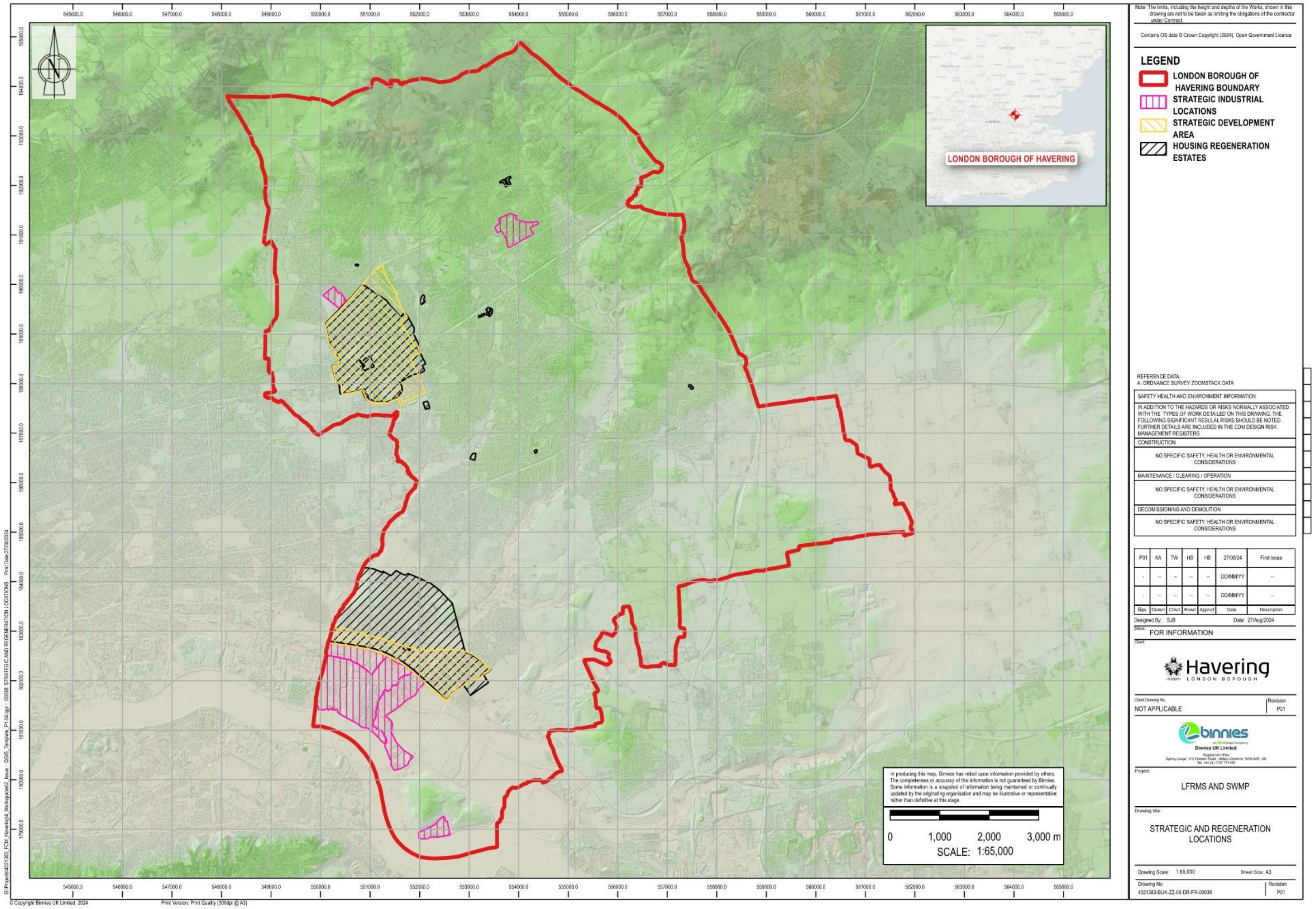

Figure 1.5-3: Strategic Development and Regeneration Areas (not to scale, see A3 scaled maps in Appendix G)

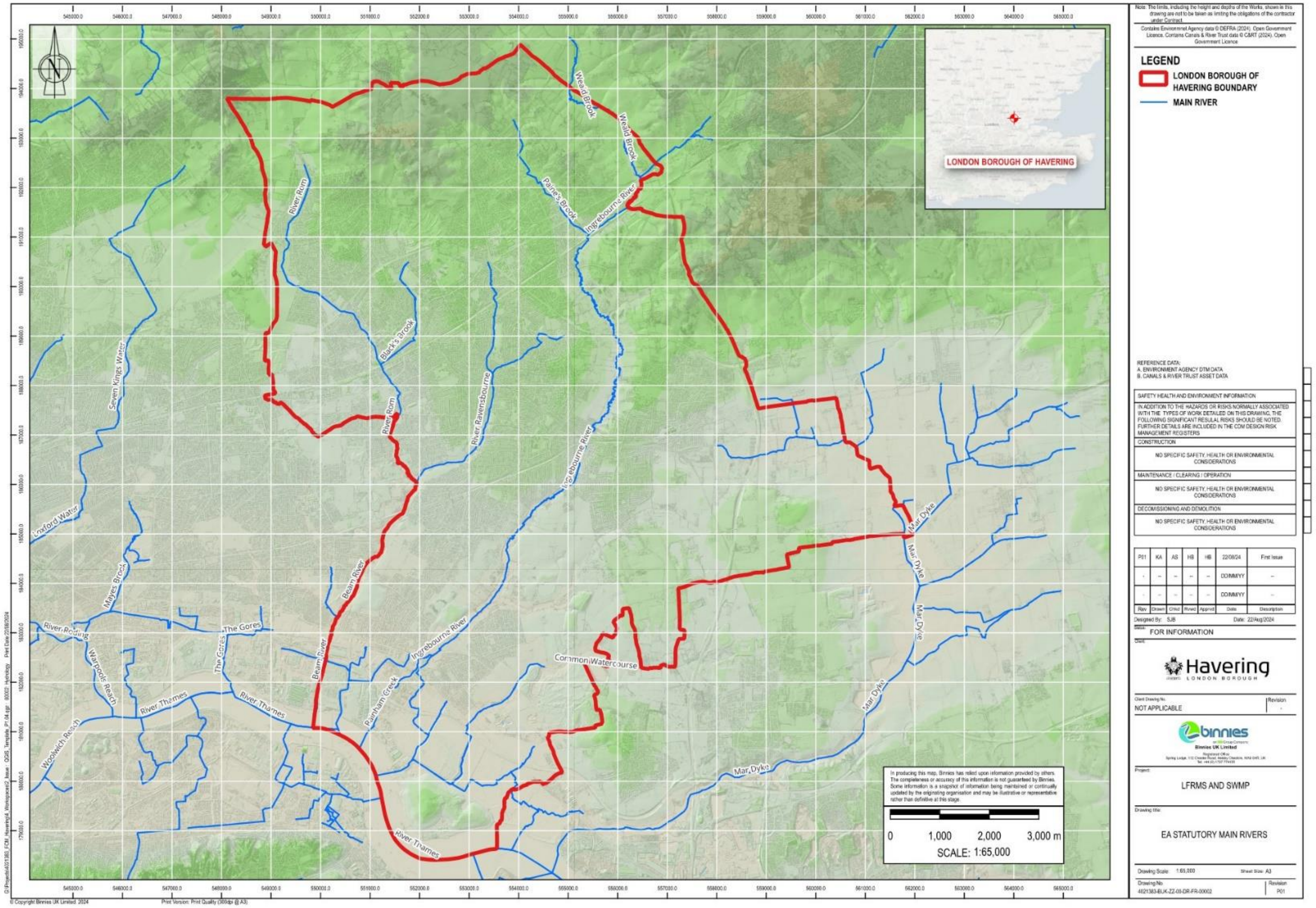

Figure 1.5-4: EA Statutory Main River (not to scale, see A3 scaled maps in Appendix G)

Future Development Plan

The Havering Local Plan 2016-2031[29] covers two strategic Development Areas: Romford Strategic Development Area and Rainham and Beam Park Strategic Development Area.

Romford Strategic Development Area is in Havering's largest town and is one of outer London's major growth and regeneration areas. Over the next 15 years LBH will work with its partners to facilitate housing and economic growth, alongside new and enhanced supporting infrastructure.

The Rainham and Beam Park Strategic Development Area will provide the opportunity for major growth and regeneration. This will be achieved by establishing an exciting new residential neighbourhood linked to the construction of a new railway station in the Essex Thameside line at Beam Park. The development is located within the London Riverside Opportunity Area identified in the London Plan to provide new homes and jobs. In addition, Rainham and Beam Park is one of the Greater London Authority (GLA) Housing Zones which is providing investment to help secure and accelerate the delivery of new homes.

1.6 Flooding Interactions/Flooding Sources

Surface water flooding is the main risk source in London[30]. However, in LBH the main flooding risk source is tidal. Havering has experienced flooding from fluvial, tidal surface water, sewer, and groundwater sources. These sources interact in certain scenarios causing complex flooding. Flooding events recorded by LBH in their 'Flood Incident Register 2007-2023' show that surface water flooding is the most observed source of flooding in Havering, followed by sewer and fluvial sources. The least common source is groundwater flooding and there are no records of tidal flooding since 2007.

[29] London Borough of Havering, *Havering Local Plan 2016-2031 Adopted November 2021,* https://www.havering.gov.uk/downloads/file/5300/havering_local_plan_2016_-_2031.pdf

[30] London Councils, *Managing Flood Risk in London*, https://www.landofthefanns.org/

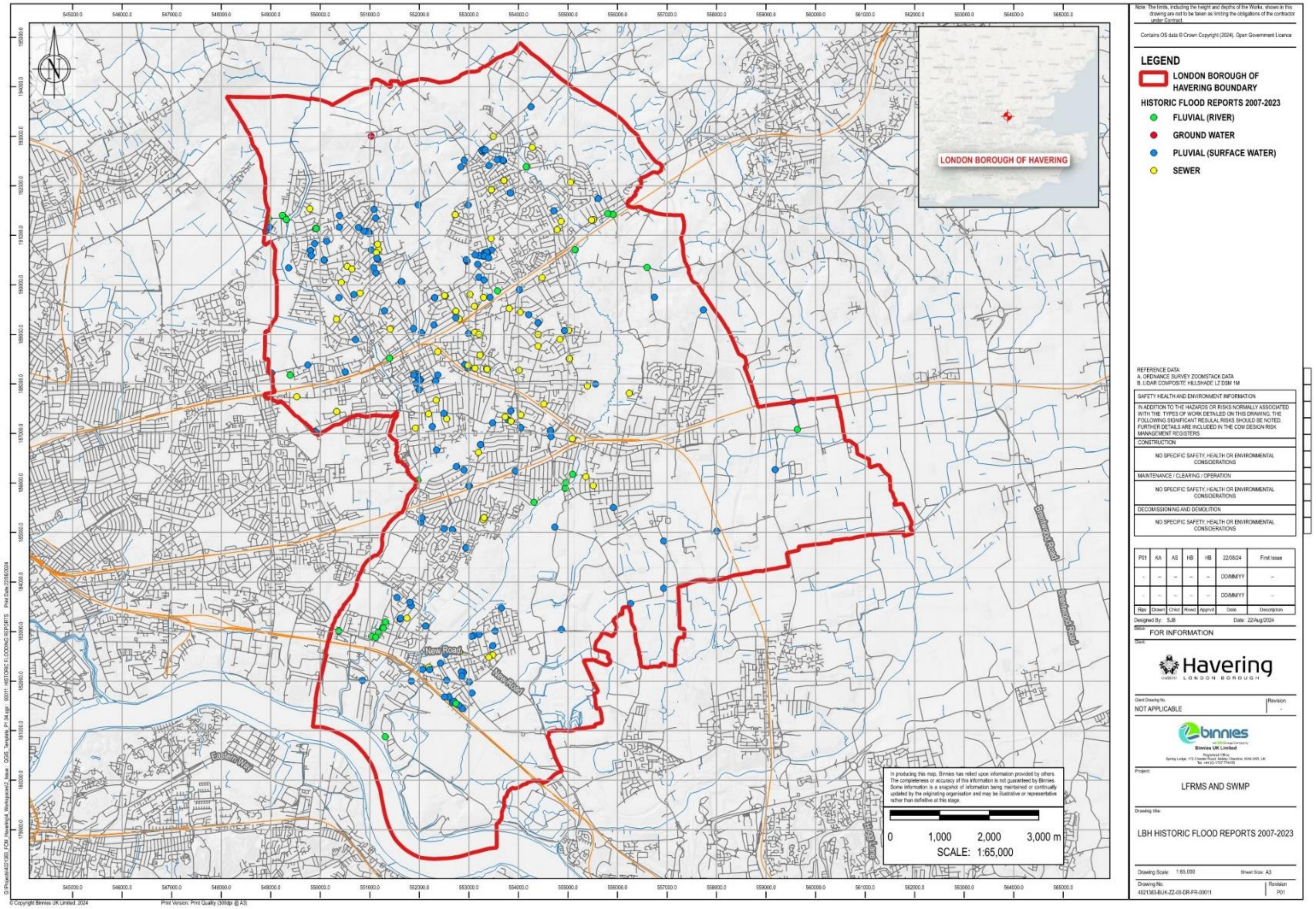

Figure 1.6-1: LBH Historic Flood Reports 2007-2023 (not to scale, see A3 scaled maps in Appendix G)

2. Phase 1: Preparation

Phase 1 of the SWMP focuses on understanding and need, scoping and requirements for the review of the SWMP. This involves working with relevant stakeholders to agree the scope, aims and objectives, and to understand the information available and current knowledge of surface water flooding. This will support the decision of the level of assessment required for the review of the SWMP.

2.1 Partnership Working

Stakeholder Engagement

Several stakeholders were engaged and updated from the start and throughout the process to access information and ensure that the objectives and actions produced are appropriate and realistic.

A stakeholder engagement plan was created to identify the stakeholders that would be affected by the outcomes of the plan, enabling them to be engaged through the process of producing the SMWP. The Stakeholder Engagement Plan covers the individual stakeholder details, what their interest is in the project, what they would want from the project, what is expected from them and methods of communication for each.

The stakeholders involved in the preparation of the Surface Water Management Plan are:

- Thames Water,
- Anglian Water,
- Environment Agency,
- LBH Lead Local Flood Authority,
- LBH Planning,
- LBH Emergency Planning,
- LBH Highways,
- LBH Parks and Environment,
- LBH Lead Members,
- Greater London Authority (GLA).

Other stakeholders will be involved during the consultation on the SWMP and the LFRMS. This will include neighbouring LLFAs, businesses and householders, statutory consultees in the SEA process, etc.

Partnership roles and responsibilities

Stakeholders and Risk Management Authorities (RMA) have various roles and responsibilities to help coordinate flood risk management. Their aim is to collaborate and share knowledge to ensure effective drainage and flood prevention. Please note that the tables below show all flood risk stakeholders and their roles and responsibilities. This does not mean that all of them but not all of them are required to participate in the review of LBH SWMPs.

Table 2.1.1: Risk Management Authorities and Responsibilities

RMA	Powers and Responsibilities
LLFA	LLFAs are responsible for: • Preparing flood risk documents: Preliminary Flood Risk Assessments. • Publishing and updating the LFRMS. • Managing local flood risk. • Maintaining an asset register. • Investigating and publishing reports on local flood incidents. • Communicating and partnership working with other RMAs. • Acting as a statutory consultee for surface water in the planning process. This duty may change if the Government enacts Schedule 3 of the FWMA 2010 as it includes the role of the Sustainable Drainage System (SuDS) Approval Body (SAB). The SAB will then become the body to approve all major construction work which has drainage implications and ensure that any adopted SuDS schemes are properly maintained. Currently, the LLFAs are approving drainage strategies for major development in England. LLFA have powers to: • Regulate ordinary watercourses to ensure the flow. • Designate flood risk management structures. • Do works to manage flood risk. • Request information from other RMAs and stakeholders. • Make byelaws • Support emergency planning response but they are not first respondents.
Emergency Planning	'Category 1' responders to emergencies are local authorities, the Environment Agency and emergency services. They are responsible for: • Undertaking risk assessments. • Manage business continuity. • Carry out emergency planning. • Warn and advise the public during times of emergency.
Highways Authorities	The authorities (National Highways and LBH Highways Department) provide and manage highway drainage and roadside ditches, ensuring that road projects do not increase flood risk on highways.
Thames Water (TW)	Both water companies are responsible for managing the risks of flooding from piped, foul, or combined sewer systems, as well as managing the risk of flooding to water supply and sewerage facilities.
Anglian Water	
Environment Agency (EA)	The EA is the principal flood risk management authority in England. Responsible for a strategic overview of the management of all sources of flooding and coastal erosion. Their responsibilities include: • Developing and applying the national flood and coastal erosion risk management strategy.

RMA	Powers and Responsibilities
	• Supporting Regional Flood and Coastal Committees (RFCCs) in the allocation of national government funding to projects to manage flood and coastal erosion risks from all sources. • Managing flood risk from main rivers and coastal sources. • Strategic overview of surface water flooding.
Neighbouring LLFAs	They can provide information of flooding issues that could affect the LBH and collaborate in joint flood risk projects.
Transport for London (TfL)	Transport for London oversees a vast network of roads, tunnels, bridges, and public transport infrastructure across London. It collaborates with local authorities, water companies, and other stakeholders to ensure effective drainage and flood prevention. Promotes the use of drainage systems to prevent flooding on roads and other transport routes.

Table 2.1.2: Other Important Flood Risk Stakeholders' Powers and Responsibilities

Other Flood Risk Stakeholders	Powers and Responsibilities
Historic England	They provide guidance to those who manage historic buildings threatened by flooding which covers both preventative measures and post flooding actions. They are also statutory consultees for the Strategic Environmental Assessment process.
Planning Authority	Support flood risk management by: • Taking flooding into account when developing local plans. • Working with the SAB/LLFAs to ensure planning applications address surface water flooding properly and incorporate SuDS. • Consider flood risk assessments submitted in support of applications. • Develop flood risk and water evidence base and guidance such as Strategic Flood Risk Assessments, Sequential Tests, Integrated Water Management Strategies, Strategic Environmental Assessments, Supplementary Planning Documents. • Produce Waste Plans and Local Plans which contain local planning policies to address flood risk and implement SuDS.
Businesses and Households	They are responsible for understanding their risk of flooding, its consequences, to have adequate flood risk insurance and to be prepared in case of flooding.
Greater London Authority (GLA)	They do not have a duty to manage flood risk, but they can investigate London flooding (2021[31]) and support LLFAs by providing information and funding for projects and studies.

[31] Greater London Authority, *Surface Water Flooding in London: Roundtable Progress Report*, 2022, https://www.london.gov.uk/sites/default/files/flooding_progress_report_final_1.pdf

2.2 Setting Aims and Objectives

As the review of the LFRMS and the SWMP was undertaken at the same time, two stakeholder workshops were held to explain how the review would take place and to discuss LBH priorities. The information from the workshops was used to set the joint aims and objectives of the LFRMS and the SWMP, grouped into the seven categories shown on the table below.

Table 2.2.1: Aims and Objectives

Category	SWMP and LFRMS Aims	Objectives
Flood Risk	Increasing understanding and knowledge of flood risk in the Borough.	Over the plan period (2030), we will have increased awareness of flood risk in the Borough with internal and external stakeholders and members of the public.
	Encourage working collaboratively internally and externally.	
	Manage and reduce flood risk.	Over the plan period (2030), we will work together with internal and external stakeholders to manage flooding from all sources in the Borough.
LLFA Duties	Understanding of what LLFA duties are and how they are implemented.	Over the plan period (2030), we will increase understanding internally and externally of the Lead Local Flood Authority role.
Environment	Prioritise NFM projects across the Borough.	Over the plan period (2030), we will deliver a prioritised programme of works to alleviate flooding, including natural flood management measures.
Highways	Address flood risk to reduce flooding on highways.	Over the plan period (2030), we will embed actions to reduce flood risk into our approach to manage the highways network.
Asset Management	Understanding what assets, the LLFA owns, manages and maintains.	Over the plan period (2030), we will work with internal and external stakeholders to take a consistent and prioritised approach to managing drainage and flood risk assets in the Borough, with an emphasis to maintenance of existing drainage infrastructure, including watercourses.
Planning	Ensure more sustainable planning decisions.	Over the plan period (2030), we will integrate policies and guidance to reduce flood risk through new development into our approach as a Local Planning Authority.
	Improved preparedness and resilience to flooding	Over the plan period (2030), we will work with Local Resilience Forum partners, businesses and residents, to improve our preparedness, resilience, and response to flood events.
Economic	Economically sustainable response to flood risk.	Over the plan period (2030), we will take a risk-based approach to managing flood risk across the Borough

2.3 Data Collection

Data was requested from the following stakeholders:

- London Borough of Havering
- Thames Water (TW)
- Anglian Water
- Environment Agency (EA)
- GLA

A breakdown of the data requested is shown in Appendix A

2.4 Data Review

All data received was recorded on a data register. A data gap analysis was completed to identify gaps within the data received, based on information required for the SWMP and LFRMS. The datasets used are summarised below:

Ordnance Survey (OS) MasterMap data were used to extract building extent information.

National Receptor Database (NRD) was used to extract all residential and commercial properties.

EA Risk of Flooding from surface water extents maps were used to extract the properties at risk of flooding. The Risk of Flooding from Surface Water information assesses rainfall flooding scenarios with the following chance of occurring in any given year:

- 3.3 % (1 in 30)
- 1% (1 in 100)
- 0.1% (1 in 1000)

EA Risk of flooding from Wet and Dry Day Reservoir maps were used to extract and identify the number of properties at risk of flooding from reservoirs. 'Dry-day' scenario predicts flooding when rivers are at normal level levels and 'wet day' scenario predicts flooding if a river is experiencing an extreme natural flood.

EA Risk of flooding from Groundwater maps were used to extract and identify the number of properties which are in areas susceptible to groundwater flooding for four different categories (based on proportion of each 1km grid square that is susceptible to groundwater flood emergence):

- Less than 25%
- 25-50%
- 50-75%
- More than 75%

EA Risk of flooding from Rivers and Sea maps were used to extract and identify the number of properties at risk of flooding from rivers and sea for four likelihood categories:

- High - chance of flooding of greater than 1 in 30 year (3.3%).
- Medium - chance of flooding of between 1 in 30 year (3.3%) and 1 in 100 year (1%).
- Low - chance of flooding of between 1 in 100 year (1%) and 1 in 1000 year (0.1%).
- Very low - chance of flooding of less than 1 in 1000 year (0.1%).

LBH Flood Incident records contain data for all flooding incidents reported to the council between 2007-2023. This data was used to verify the Communities at Risk analysis output (see Appendix B) by comparing to actual events that have occurred in the Borough.

LBH Asset Register records provided information to support the analysis.

3. Phase 2: Risk Assessment

Phase 2 of the SWMP uses the outputs from the preparation phase to identify the level of risk assessment needed. Section 3.1 explains the different levels that can be undertaken depending on the agreed level of detailed needed. The findings from the risk assessment should be shared with all stakeholders involved and the public.

3.1 Risk Assessment levels

SWMPs can include different risk assessment levels depending on the level of detail and the geographic scale. The table below includes the various levels of assessment for a SWMP.

Table 3.1.1: Levels of Assessment in a SWMP study (Surface Water Management Plan) [32]

Level of Assessment	Outputs
Strategic Assessment	• A broad understanding of locations which are more vulnerable to surface water flooding. • Prioritised list for further assessment. • Provide outline maps for spatial and emergency planning.
Intermediate Assessment	• Identify flood hotspots which might require further analysis through detailed assessment. • Identification of immediate mitigation measures which can be implemented. • Outputs should be used to inform spatial and emergency planning.
Detailed Assessment	• Detailed assessment of the causes and consequences of flooding, which can be used to understand the flooding, and to test mitigation measures

An intermediate assessment was agreed by the stakeholders as it reflected the local needs better and provided the most cost-effective assessment. The aim of the intermediate risk assessment is to increase the understanding of surface water flood risk in the Borough and identify surface water flooding hotspots. An intermediate assessment is appropriate for a Borough scale assessment. This will identify 'local' hotspots that are likely to be at a higher risk of surface water flooding and will be sufficient to identify mitigation measures.

3.2 Intermediate Assessment methodology

The previous 2011 SWMP was a London-wide analysis, with a borough-level output for each borough, including Havering. This analysis identified properties, businesses and infrastructure at risk from surface water flooding (using a direct rainfall model) and defined Critical Drainage Areas (CDAs) within each borough. The CDAs are intended to define areas of significant flood risk. However, the resulting CDAs for Havering cover nearly the whole of the borough and

[32] Defra *Surface water management plan technical guidance, 2011* https://www.gov.uk/government/publications/surface-water-management-plan-technical-guidance

therefore the feedback from the Council is that they do not provide a useful output for determining where to prioritise resources or where further action is required.

Therefore, the flood risk analysis undertaken for this updated SWMP was developed to provide more localised results. The analysis identifies groups of properties more vulnerable to surface water flooding, sometimes referred to as hotspots.

GIS analysis was used to identify the ground level commercial and residential properties shown to be at risk of flooding in the 1 in 30-, 100-, and 1000-year surface water flood scenarios. Groups of 20 or more of these properties within close proximity were then identified as 'Communities at Risk'. The Communities at Risk have been classified into 20-50, 50-100 and over 100 properties at risk within the group, to allow identification of those at highest risk.

The detailed methodology for the analysis including its assumptions and limitations can be found in Appendix B.

The summary results of the analysis have been presented throughout this report based on the previously designated Critical Drainage Areas, as they form a reasonable breakdown of the Borough by surface water catchment.

3.3 Risk Overview of Different Sources of Flooding

To enable a reasonable comparison of the impact of the different sources of flooding across Havering, Table 3.3.1: below sets out the total numbers of properties at risk of flooding from each source of the main sources of flooding, under a range of scenarios.

Table 3.3.1: Number of Properties at Risk of Flooding

Source of Flooding	Likelihood	Number of Properties at Risk
Surface Water	1 in 30	2,896
	1 in 100	7,515
	1 in 1000	24,409
Rivers and Sea	High - Greater than 1 in 30 (3.3%)	333
	Medium - 1 in 30 (3.3%) to 1 in 100 (1%)	651
	Low - 1 in 100 (1%) to 1 in 1000 (0.1%)	565
	Very low - Less than 1 in 1000 (0.1%)	3,009
Groundwater	<25% (lowest)	23,361
	25-50%	23,134
	50-75%	19,827
	>75% (highest)	23,157
Reservoir	Dry	784
	Wet	764

3.4 Results of Communities at Risk Analysis

Table 3.4.1 below sets out the results of the Communities at Risk analysis for surface water flood risk for the whole Borough. 2% of all properties within the Borough are at risk during a 1 in 30-

year surface water flooding scenario. The risk increases to 8% in a 100-year surface water flooding scenario and 25% in a 1 in 1000-year surface water scenario.

Table 3.4.1: Summary of Communities at Risk and number of properties at risk

	1 in 30-year event	1 in 100-year event	1 in 1000-year event
Communities at Risk within the Borough	7	52	231
Total properties at risk within the Communities at Risk	643	3056	16278
Total properties at risk across the Borough	2,896	7,515	24,409

Maps in figures 3.4-1 to 3.4-3 show the locations of these Communities at Risk for each scenario.

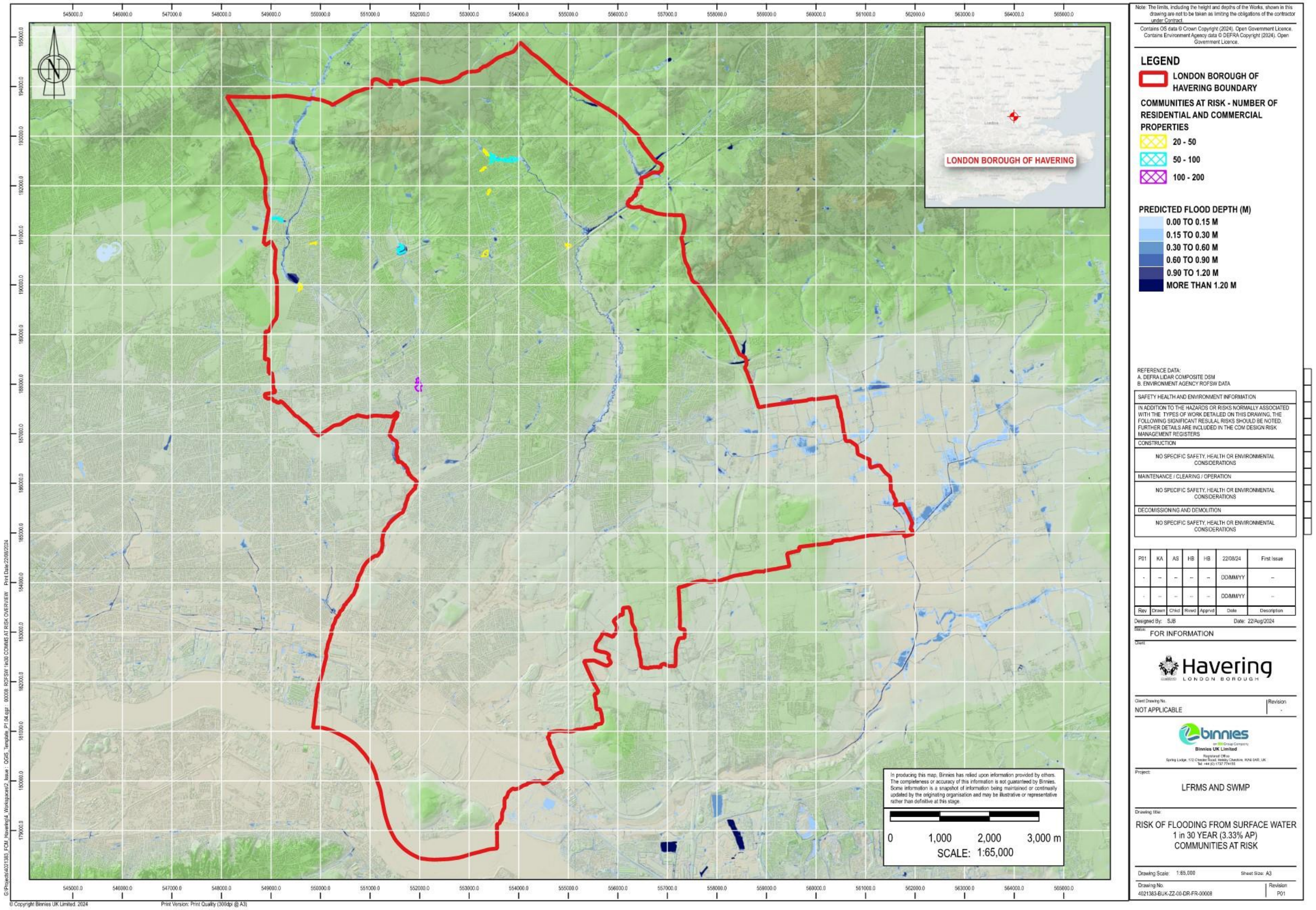

Figure 3.4-1: Risk of Flooding from Surface Water 1 in 30 YEAR (3.33% AP) Communities at Risk (not to scale, see A3 scaled maps in Appendix G)

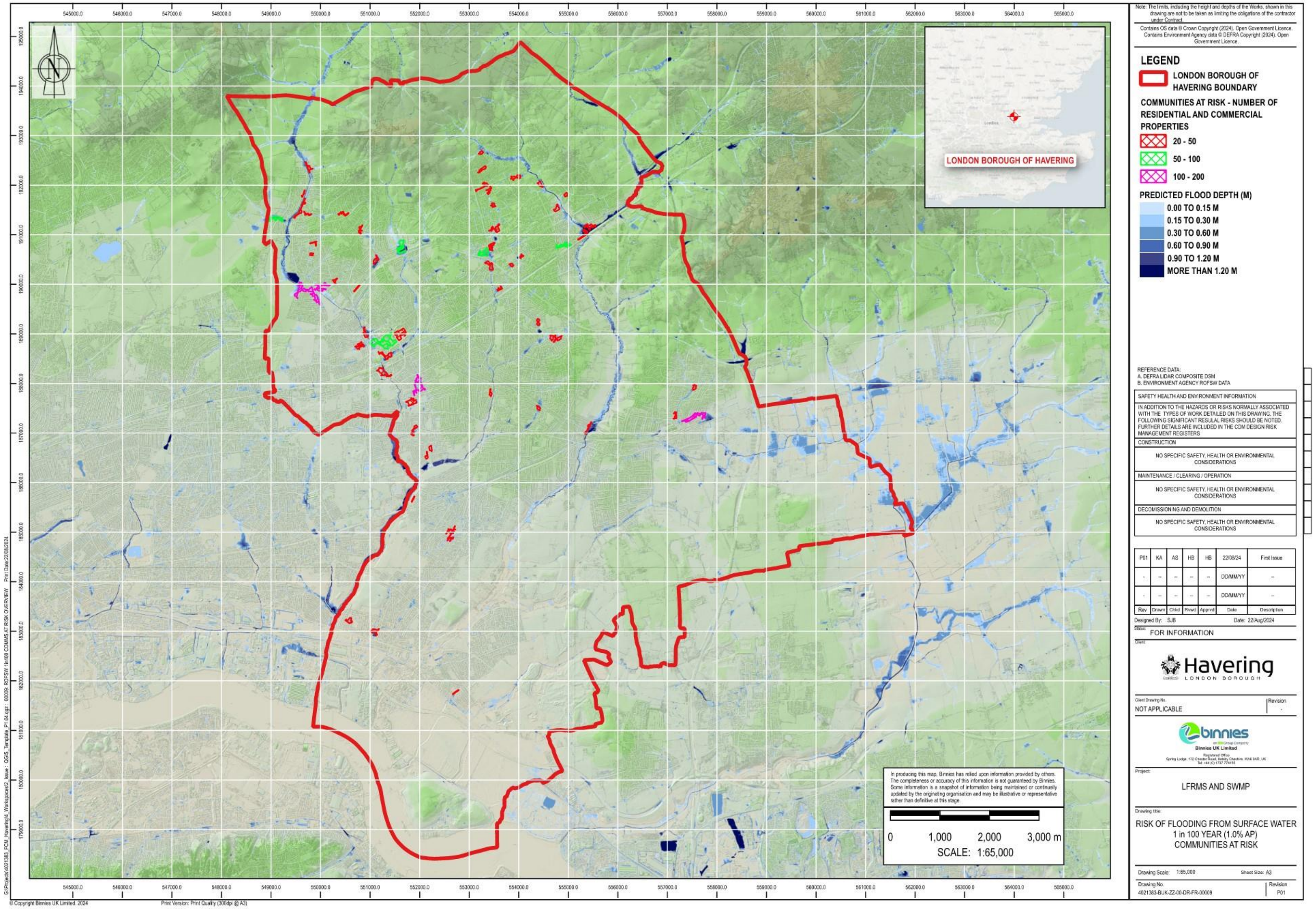

Figure 3.4-2: Risk of Flooding from Surface Water 1 in 100 YEAR (1.0% AP) Communities at Risk (not to scale, see A3 scaled maps in Appendix G)

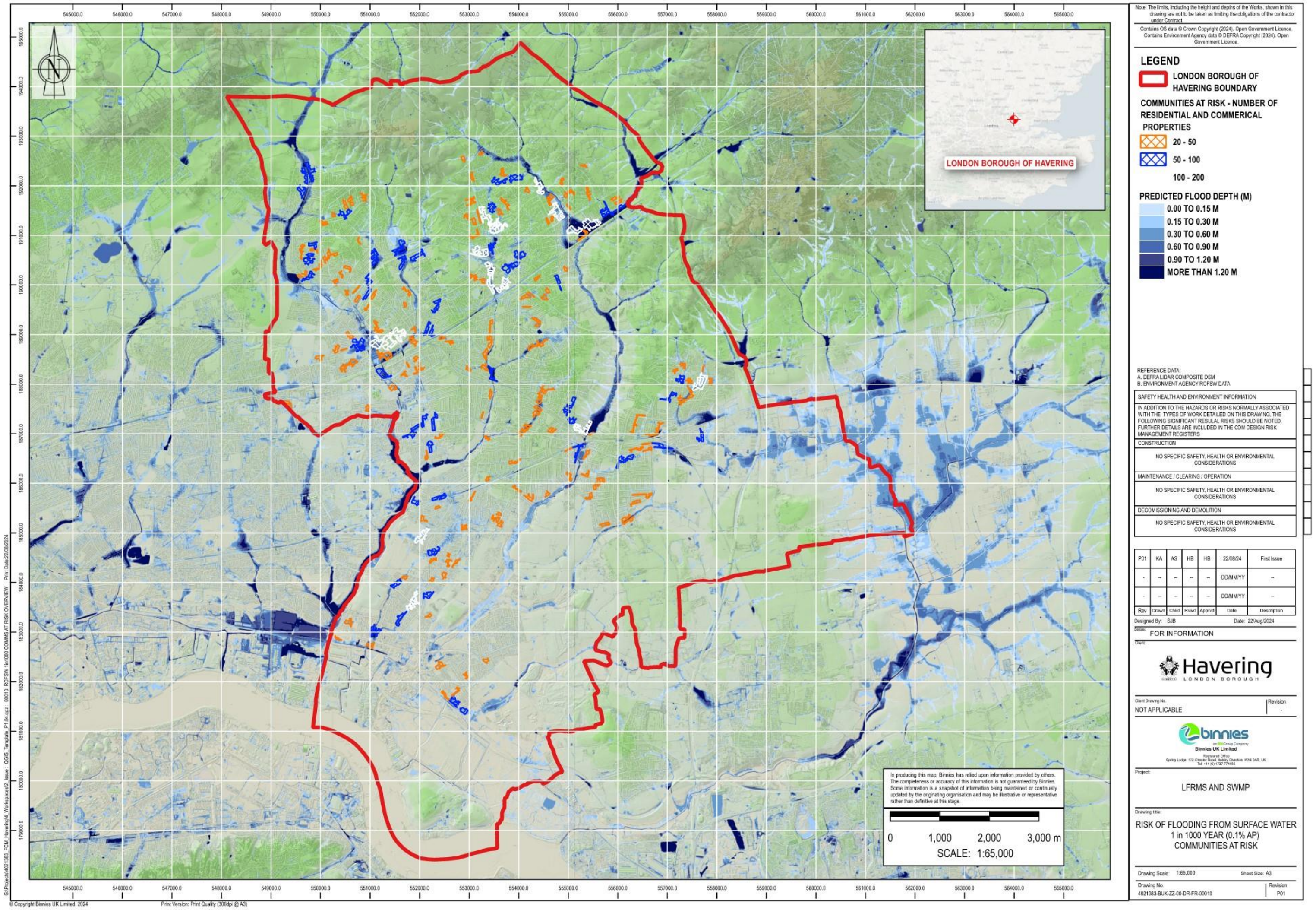

Figure 3.4-3: Risk of Flooding from Surface Water 1 in 1000 YEAR (0.1% AP) (not to scale, see A3 scaled maps in Appendix G)

3.5 Prioritisation of Critical Drainage Areas

The previous SWMP identified twenty-three CDAs. The 'Communities at Risk' analysis shows that eight CDAs have Communities at Risk for the 1 in 30-year surface water flooding scenario and fifteen CDAs contain Communities at Risk for the 1 in 100-year surface water flooding scenario, and therefore these CDAs could be considered as more vulnerable. The CDAs which contain 'Communities at Risk' in 1 in 30- and 100-year surface water flooding scenarios have remained as CDAs and the CDAs which do not have 'Communities at Risk' have been renamed as 'Drainage Areas'. The tables below show the Drainage Areas and the updated CDAs. For consistency with the previous SWMP, the name and reference number of the areas has remained the same.

Table 3.5.1: Drainage Areas

Drainage Areas
012 – Parsoles Park
013 – West Romford
019 – Heath Park
022 – Dagenham
024 – Hornchurch
030 – Hacton
032 – Corbets Tey
035 – Upminster

Table 3.5.2: Prioritised Critical Drainage Areas

Priority	Critical Drainage Areas	Number of Properties at Risk
1 (Highest)	014 – River Rom and Beam River	1,964
2	036 – Ingrebourne	1,058
3	025 – Gallows Corner	748
4	023 – Elm Park	574
5	018 – Cranham	446
6	026 – Harold Hill North	400
7	005 – Ardleigh Green East	298
8	038 – Heath Park North	268
9	034 – Thames	257
10	040 – Harold Hill South	250
11	037 – River Ravensbourne	220
12	016 – Rise Park West	201
13	017 – Rise Park	150
14	039 – Heath Park South	122
15 (Lowest)	015 – Havering Park	113

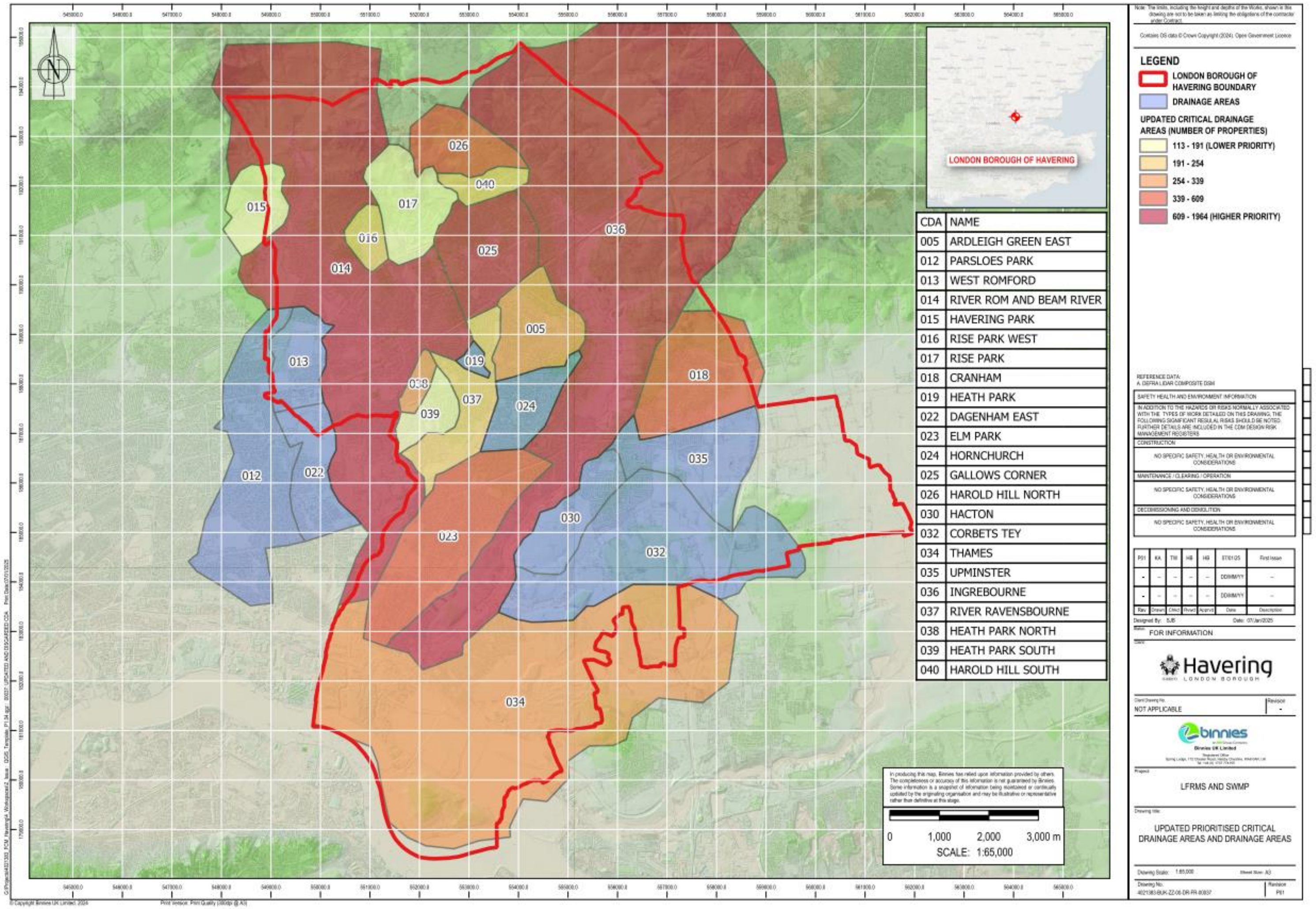

Figure 3.5-0-1: Updated Prioritised Critical Drainage Areas and Drainage Areas (not to scale, see A3 scaled maps in Appendix G)

3.6 Summary of Risk per CDA

Appendix C sets out full details of the flood risk analysis for each CDA, showing the number of infrastructure and homes at risk of flooding, an explanation of flood risk in the CDA, the outputs of the Communities at Risk analysis and the supporting maps.

The table below gives an overview of the risk of surface water flooding for the CDAs. It shows the communities, properties, and critical infrastructure (including public/community facilities, education, health and care facilities, major roads, and emergency services) at risk in each CDA and the total. Further information about the CDAs is given in Appendix C.

Table 3.6.1: Summary of Risk per CDA

CDA	1 in X-year Scenario Event	Communities at Risk	Properties at Risk	Critical Infrastructure at Risk
005 - Ardleigh Green East	**30**	0	98	1
	100	2	298	6
	1000	9	980	11
014 – River Rom and Beam River	**30**	2	756	28
	100	14	1,964	43
	1000	63	5,919	75
015 – Havering Park	**30**	1	72	1
	100	1	113	1
	1000	1	198	2
016 – Rise Park West	**30**	0	76	1
	100	2	201	1
	1000	3	592	2
017 – Rise Park	**30**	1	98	2
	100	1	150	2
	1000	3	292	3
018 – Cranham	**30**	0	136	3
	100	2	446	6
	1000	17	1,357	9
023 – Elm Park	**30**	0	119	10
	100	2	574	20
	1000	26	3,035	33
025 – Gallows Corner	**30**	1	287	5
	100	6	748	8
	1000	18	2,213	16
026 – Harold Hill North	**30**	4	271	3
	100	3	400	3
	1000	4	682	4

CDA	1 in X-year Scenario Event	Communities at Risk	Properties at Risk	Critical Infrastructure at Risk
034 – Thames	**30**	0	55	11
	100	2	257	21
	1000	9	983	30
036 – Ingrebourne	**30**	1	387	18
	100	6	1,058	32
	1000	37	3,659	48
037 – River Ravensbourne	**30**	0	79	2
	100	3	220	2
	1000	10	919	7
038 – Heath Park North	**30**	1	129	2
	100	2	268	2
	1000	2	621	3
039 – Heath Park South	**30**	0	53	2
	100	1	122	4
	1000	5	470	5
040 – Harold Hill South	**30**	0	110	1
	100	4	250	5
	1000	6	573	7
Total	**30**	13	2,726	90
	100	51	7,069	156
	1000	213	22,493	255

3.7 Climate Change

The Intergovernmental Panel on Climate Change (United Nations body for assessing the science related to climate change) explains in its latest report[33] that continued greenhouse gas emissions will lead to average increases in global temperatures reaching 1.5°C soon. This will increase moisture in the atmosphere leading to heavier and more frequent storms. Heavier storms will overwhelm existing drainage systems and lead to surface water flooding more often. This was clearly seen in the London 2021 flooding.

In 2022, the National Infrastructure Commission reported[34] that about 325,000 properties are in areas at the highest risk of surface water flooding in England. Without action, up to 295,000

[33] Intergovernmental Panel on Climate Change, *AR6 Synthesis Report Climate Change 2023* https://www.ipcc.ch/report/ar6/syr/

[34] National Infrastructure Commission, *Reducing the risk of surface water flooding*, 2022 https://nic.org.uk/app/uploads/NIC-Reducing-the-Risk-of-Surface-Water-Flooding-Final-28-Nov-2022.pdf

more properties could be put at risk. They also acknowledged that surface water flood risk is the risk we know the least about, being highly localised and hard to predict.

Climate change will also have a significant impact on tidal flood risk as rising sea levels will reduce the level of protection that existing tidal defences offer. The Thames Estuary 2100 plan 10-year review[35] reports how sea level rise has been accelerating over the last few decades. This will translate into more frequent Thames Barrier closures.

The TE2100 Plan[36] acknowledges that flood risk from the River Ingrebourne is relatively low. However, the marshland drainage system will need enhancing as sea levels rise and storm rainfall increases. The tidal sluices will also need upgrading on the River Beam, Havering New Sewer, River Ingrebourne and Rainham Main Sewer as the sea level rises and fluvial flows increase.

The GLA Regional Flood Risk Appraisal (2018)[37] highlights the importance of analysing future impacts of climate change for local rivers such as the River Rom and Black Brook.

The Havering Climate Change Action plan 2024-2027[38] includes adaptation to flooding as a key element for future service planning.

There is a lack of existing model data to accurately assess the impact of climate change on surface water flood risk within the Borough. The analysis carried out for the SWMP used the relative difference between the EA Risk of Flooding from Surface Water extent maps for the 1 in 100-year and in in 1000-year storm events. This can be used to demonstrate which parts of the Borough may be most sensitive to changes in surface water flood risk, which could be driven by climate change. Increased urban development, deteriorating assets and wider land use change may also serve to increase flood risk.

Using the 1 in 1000-year as a proxy for climate change on the 1 in 100-year storm event shows that boroughwide, over 24,000 properties could be at risk of surface water flooding due to climate change (Table 3.4.1) compared with 7,500 in the present-day scenario, nearly a three-fold increase. Table 3.6.1 shows the CDAs most vulnerable to increases in flood risk which may be driven in part or full by climate change. The five CDAs with the highest vulnerability are:

- 014 – River Rom and Beam River
- 036 – Ingrebourne
- 023 – Elm Park
- 025 – Gallows Corner
- 018 – Cranham

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[35] Defra, *Thames Estuary 2100: 10-year monitoring review (2021)* https://www.gov.uk/government/publications/thames-estuary-2100-te2100-monitoring-reviews/thames-estuary-2100-10-year-monitoring-review-2021#executive-summary

[36] Defra, *Thames Estuary 2100: Rainham Marshes Policy Unit*, 2023 https://www.gov.uk/guidance/rainham-marshes-policy-unit-thames-estuary-2100#managing-flood-risk-in-this-area

[37] Greater London Authority, *Regional Flood Risk Appraisal*, 2018 https://www.london.gov.uk/sites/default/files/regional_flood_risk_appraisal_sept_2018.pdf

[38] London Borough of Havering, *Havering Climate Change Action Plan 2024-2027* https://democracy.havering.gov.uk/documents/s73391/7.1%20Revised%20HCCAP%202024-27%20to%20be%20published%20DRAFT.pdf

4. Phase 3: Options Development

The aim of Phase 3 is to identify a range of boroughwide and CDA specific measures (actions) to manage flood risk. Different measures identified through stakeholder engagement go through a short-listing process to remove those unfeasible. The shortlisted measures are then developed and tested in terms of their effectiveness, costs, and benefits. This process will identify the most suitable measures to be implemented.

4.1 Methodology

A long list of measures was collated and agreed with stakeholders. This included a range of measures including measures from the previous SWMP and measures discussed at the stakeholder workshops. To shortlist and prioritise the measures, a multicriteria analysis was undertaken, followed by a cost benefit analysis for the CDA-specific measures to show which are most beneficial. As the boroughwide measures will not have a measurable impact on flood risk reduction but will support and benefit the implementation of CDA specific measures, they did not undergo cost-benefit analysis.

Figure 4.1-1: Options Development Process

4.2 Measures

Two types of measures were developed: boroughwide measures, which would have an impact across the whole Borough, and CDA specific measures, which would address local issues specific at CDA level. These measures have been proposed based on information available from a range of sources:

- Previous SWMP[39]: measures that have been considered as still needed and likely to have a positive impact at both Borough and CDA level.
- Flood Investigation recommendations[2] [3] [4]: measures from flood investigation reports carried out in accordance with Section 19 of the Flood and Water Management Act. Only those measures considered feasible or viable have been retained.
- Flood Risk Management Plans 2021 to 2027 (FRMP2)[40]: all FRMP2 measures specific for LBH have been included as agreed with the EA in 2022.
- LLFA duties: measures that support the fulfilment of the LLFA duties in the LBH which reflected the agreed priorities.
- Review of the LFRMS: measures defined to meet the objectives of the revised LFRMS.

[39] Jacobs Engineering U.K. Limited, *Havering Surface Water Management Plan*, 2011.
[40] Environment Agency, Flood Risk Management Plans 2021 to 2027: national overview (part a), 12th December 2022, https://www.gov.uk/government/publications/flood-risk-management-plans-2021-to-2027-national-overview-part-a/national-overview-part-a

- SWMP guidance and best practice at CDA level from previous projects.
- Workshops with stakeholders: the long list of measures has been discussed with key internal and external stakeholders. This led to a final long list agreed measures to take forward for analysis.

Boroughwide measures

Table 4.2.1 below shows the long list of boroughwide measures, which have been organised into themes of flood risk knowledge and awareness, emergency planning, land use planning, partnership working, measures on the ground, asset management and skills required. The boroughwide measures were not subject to multi-criteria analysis and therefore this forms the short list of boroughwide measures.

Table 4.2.1: Boroughwide measures organised by theme

Theme	Boroughwide Measures
Flood Risk Knowledge and Awareness	• Improve understanding of flood risk in the Borough and raising public awareness • Improve information on surface water flood events. • Commission Section 19 reports promptly after flooding event. • Produce a holistic Thames Estuary 2100 Riverside Strategy in the London Borough of Havering. • Link actions from this SMWP plan directly to the Local Flood Risk Management Strategy for the Borough such that a programme of work is visible. • Update the Borough's Strategic Flood Risk Assessment • Maintain a register of critical flood risk sites across the Borough, plus make it available to internal and external stakeholders. • Ensure more sustainable planning decisions by providing developers with copies/links of the Local Flood Risk Management Strategy and Action Plan. • Identify a list of priorities that can be managed with the budget available for flood risk. • Review corporate plans and strategies to identify where mutual goals and aims can be met through discharging LLFA responsibilities and actions.
Emergency Planning	• Develop emergency response plans across the Borough. • Ensure business continuity planning. • Raising flood insurance awareness for residents and businesses. • Encourage community flood action groups and resilient community plans. • Empower volunteers to undertake Flood Warden duties in the London Borough of Havering. • Raising flood insurance awareness for residents and businesses. • Encourage community flood action groups and resilient community plans.

Theme	Boroughwide Measures
	• Improve preparedness by arranging for term service contractor to maintain a stock of plant and materials for emergency flooding responses.
Land Use Planning	• Develop a land-use planning policy to address flood risk locally. • Review existing Planning Policy to ensure that Local Flood Risk Management is suitably linked to new development - in line with SuDS approval status, increased knowledge of flood risk and future Local Flood Risk Management Strategy. • Engage developers at pre-approval stage in the Borough.
Partnership Working	• Encourage working in partnership with other RMAs, Water Companies, residents, and businesses. • Undertake stakeholder mapping as a part of the Communication Plan development. • Ensure key messages in the Community Engagement (CE) Plan that encourage attitude and behaviour change with the public are delivered. • Develop a collaborative resourcing approach across Drain London group 5, (neighbouring LLFAs) enabling the relationships developed in the group to be the springboard to efficient resource management on local flood risk issues. • Have quarterly flood risk meetings to encourage collaboration with internal and external parties. • Work with the Roding, Beam, and Ingrebourne Catchment Partnership to implement flood risk measures on the ground and engage with the local community more effectively, supporting both their Catchment Plan and the Council's Local Flood Risk Management Strategy and Action Plan. • Produce a concise table documenting LLFA duties and their implementation, plus make it available to internal and external stakeholders. • Agree with other stakeholders the precise maintenance responsibility for every drainage asset within the Borough.
Measures on the Ground	• Take forward on the ground measures in the Action Plan towards option appraisal and design. • Installation of additional rain gauges. • Investigate scope to supply airbrick covers to properties at risk. • Investigate opportunities for SuDS retrofitting at council buildings and on highways. • Review of need for the implementation of new watercourse assets. • Develop a prioritised 5-year programme of NFM projects across the Borough. • Address flood risk to reduce flooding on highways by adding drainage considerations to a checklist for scheme designs.
Asset Management	• Increased asset monitoring and clearance.

Theme	Boroughwide Measures
	• Develop systematic maintenance regime of watercourse and its assets within the area. • Maintain the asset register and continue developing it, setting out the assets owned, maintained and managed by the LLFA and others. • Develop an assets management system in line with the requirements under the FWMA 2010 and regulations. • Work with the Infrastructure Delivery Group to improve processes for asset data collection and utilise asset condition data in the Borough. • Improve SAB awareness and resource implications. • Carry out an assessment of potential desilting and ditch clearing works. • Invest in main rivers and watercourses by seeking biodiversity and natural flood management opportunities and employ a risk-based maintenance approach in the Borough. • Manage and reduce flood risk by having a risk-based maintenance regime that prioritises critical flooding locations.
Skills Required	• Devise a professional development plan to upskill officers involved with flood risk management. • Ensure required skills and technical capability to deliver SMWP actions and the LLFA duties and powers in line with the resources available.

4.3 Critical Drainage Area measures

Long List

The long list of CDA specific measures identified to reduce surface water flooding is shown in the table below.

Table 4.3.1: Long list CDA specific measures

Scale/Type	Measure
CDA Specific - Non-Structural (Management and maintenance)	• Property-level protection and resilience. • Asset Management and maintenance. • Relocation of properties or infrastructure away from flood risk areas. • Watercourse management and maintenance.
CDA Specific - Structural	• Infiltration (and evaporation) for managing 'everyday rainfall'. • Conveyance for managing 'unusual rainfall'. • Storage for managing 'extreme rainfall'. • Restoring urban watercourse. • Urban watercourse engineering. • Run-off reduction strategy. • Reducing surface water in the sewer.

Scale/Type	Measure
	• Land management. • Underground storage. • Underground conveyance. • Modification of culverted watercourses.

Shortlisting using Multi Criteria Analysis

To determine which of the long list of CDA specific measures would be prioritised for consideration in more detail, a Multi Criteria Analysis was completed. Within each CDA, each measure was analysed based on 11 questions within the following five topics: technical, economic, social, environmental and objectives (or agreed LLFA priorities). Each measure was then given a total score.

Figure 4.3-1:Multi-Criteria Analysis scoring guidelines summary

Score	Technical	Economic	Social	Environmental	Objectives
+2	More effective/practical	Less expensive	Increases community benefits	Improves the environment	Meets all objectives
+1					
0					
-1					
-2	Less effective/practical	More expensive	Decreases community benefits	Damages the environment	Meets no objectives

For consistency across CDAs, all measures which scored 0 or above in the Multi-Criteria Analysis were shortlisted. This meant that some CDAs have more short-listed measures than others. The number of measures in each CDA range from three to twelve.

Measure Prioritisation

The CDA specific measures were prioritised using the scores given in the multi criteria analysis. The higher the score, the higher priority as the measure will provide the most benefit. This was discussed with the stakeholders to use knowledge on the ground to validate the outputs. Prioritisation is included in the action plan with the categories shown in the table below.

Table 4.3.2: Measure Prioritisation

<table>
<tr><th>MCA Score</th><th>Priority Ranking</th></tr>
<tr><td>0</td><td>Very Low</td></tr>
<tr><td>1</td><td rowspan="2">Low</td></tr>
<tr><td>2</td></tr>
<tr><td>3</td><td rowspan="2">Medium</td></tr>
<tr><td>4</td></tr>
<tr><td>5</td><td rowspan="2">High</td></tr>
<tr><td>6</td></tr>
<tr><td>7</td><td>Very High</td></tr>
</table>

The outputs from the measure prioritisation shows the degree of urgency to implement CDA measures. However, the implementation on the ground of these measures depends on resources available (officer time, skills & knowledge, budget and funding availability, partnership working, etc). This could vary over time and depends, not only on the LLFA resources, but on the overall Council resources as they discharge many duties and must be agile responding to changing budgets and priorities.

Cost Benefit Analysis - affordability assessment

The assessment of viability of measures, in line with FCERM Appraisal guidance (EA 2020 update)[41] requires a proportionate approach to the stage of the project. For the SWMP, the evaluation of potential viability of each measure was carried out using the best available data at the time of the assessment: flood depth data available in Havering from the EA Risk of Flooding from surface water extents maps, and counts of properties at risk.

The following options have been considered:

- **Do nothing**: No maintenance or interventions of any kind, resulting in a gradual deterioration of the sewer network and flood risk management assets. This scenario assumes that there will be an increase of flood risk due to the lack of maintenance or interventions.
- **Do minimum**: Maintenance of the current sewer network and flood risk management assets with patch repairs. Assumed to represent the current situation based on existing reported levels of properties at risk.
- **Do something**: This option considers that within each CDA, all the shortlisted measures are carried out in order to alleviate flooding within the CDA.

Both 'Do something' and 'Do minimum' scenarios were compared with the 'Do nothing' scenario to understand the benefits and affordability of each scenario. As there is no modelled data for each 'Do something' option, an assessment was made to the expected level of protection for each option. Details of the full methodology of this assessment are included in Appendix D.

4.4 Shortlisted Measures by CDA

The following section shows the benefits of the shortlisted measures per CDA rounded to the nearest £k.

CDA 005 – Ardleigh Green East

Table 4.4.1: Ardleigh Green East potential measures

005 – Ardleigh Green East	Estimated Standard of Protection (SoP)	Estimated Number of Properties Protected	Estimated Benefit Per Property (£)
Infiltration (and evaporation) for managing 'everyday rain'	5	46	299,000
Storage for managing 'extreme rainfall'	10	298	94,000

[41] Environment Agency, *FCERM Appraisal Guidance*, September 2021, https://www.gov.uk/guidance/fcerm-appraisal-guidance

CDA 014 – River Rom and Beam River

Table 4.4.2: River Rom and Beam River potential measures

CDA 014 – River Rom and Beam River	Estimated Standard of Protection (SoP)	Estimated Number of Properties Protected	Estimated Benefit Per Property (£)
Infiltration (and evaporation) for managing 'everyday rain'	5	358	285,000
Conveyance for managing 'usual rainfall'	10	512	238,000
Storage for managing 'extreme rainfall'	100	1964	101,000
Run-off reduction strategy	30	756	215,000
Specific planning policy	10	512	238,000

CDA 015 – Havering Park

Table 4.4.3: Havering Park potential measures

CDA 015 – Havering Park	Estimated Standard of Protection (SoP)	Estimated Number of Properties Protected	Estimated Benefit Per Property (£)
Relocation of properties or infrastructure away from flood risk areas	30	72	203,000
Infiltration (and evaporation) for managing 'everyday rain'	5	34	260,000
Conveyance for managing 'usual rainfall'	10	49	223,000
Storage for managing 'extreme rainfall'	100	113	150,000
Run-off reduction strategy	30	72	203,000
Land Management	10	49	223,000

CDA 016 – Rise Park West

Table 4.4.4: Rise Park West potential measures

CDA 016 – Rise Park West	Estimated Standard of Protection (SoP)	Estimated Number of Properties Protected	Estimated Benefit Per Property (£)
Self-help – Property-level protection and resilience	10	51	187,000
Infiltration (and evaporation) for managing 'everyday rain'	5	36	291,000
Conveyance for managing 'usual rainfall'	10	51	249,000
Storage for managing 'extreme rainfall'	100	201	104,000
Run-off reduction strategy	30	76	225,000

CDA 017 – Rise Park

Table 4.4.5: Rise Park potential measures

CDA 017 – Rise Park	Estimated Standard of Protection (SoP)	Estimated Number of Properties Protected	Estimated Benefit Per Property (£)
Asset management and maintenance	5	46	161,000
Watercourse management and maintenance	5	46	161,000
Infiltration (and evaporation) for managing 'everyday rain'	5	46	267,000
Conveyance for managing 'usual rainfall'	10	66	229,000
Storage for managing 'extreme rainfall'	100	150	154,000
Restoring urban watercourse	30	98	204,000
Run-off reduction strategy	30	98	204,000
Reducing surface water in the sewer	30	98	204,000
Land management	10	66	229,000
Specific planning policy	10	66	229,000
Work with Land of the Fanns[42] to carry out flood modelling and scope potential natural flood management options in Bedfords Park local nature reserve	10	66	229,000
Work together to carry out flood modelling to scope options for flood alleviation projects and natural flood management options in the Rise Park Critical Drainage Area	10	66	229,000

CDA 018 – Cranham

Table 4.4.6: Cranham potential measures

CDA 018 – Cranham	Estimated Standard of Protection (SoP)	Estimated Number of Properties Protected	Estimated Benefit Per Property (£)
Infiltration (and evaporation) for managing 'everyday rain'	5	64	301,000
Conveyance for managing 'usual rainfall'	10	92	251,000
Storage for managing 'extreme rainfall'	100	446	88,000
Run-off reduction strategy	30	136	230,000
Reducing surface water in the sewer	30	136	230,000

[42] Land of the Fanns, *Project Overview*, https://www.landofthefanns.org/

CDA 018 – Cranham	Estimated Standard of Protection (SoP)	Estimated Number of Properties Protected	Estimated Benefit Per Property (£)
Land management	10	92	251,000
Specific planning policy	10	92	251,000

CDA 023 – Elm Park

Table 4.4.7: Elm Park potential measures

CDA 023 – Elm Park	Estimated Standard of Protection (SoP)	Estimated Number of Properties Protected	Estimated Benefit Per Property (£)
Infiltration (and evaporation) for managing 'everyday rain'	5	56	340,000
Conveyance for managing 'usual rainfall'	10	81	277,000
Storage for managing 'extreme rainfall'	100	574	72,000
Specific planning policy	10	81	277,000

CDA 025 – Gallows Corner

Table 4.4.8: Gallows Corner potential measures

CDA 025 – Gallows Corner	Estimated Standard of Protection (SoP)	Estimated Number of Properties Protected	Estimated Benefit Per Property (£)
Infiltration (and evaporation) for managing 'everyday rain'	5	136	287,000
Conveyance for managing 'usual rainfall'	10	81	241,000
Storage for managing 'extreme rainfall'	100	574	102,000
Specific planning policy	10	81	241,000

CDA 026 – Harold Hill North

Table 4.4.9: Harold Hill North potential measures

CDA 026 – Harold Hill North	Estimated Standard of Protection (SoP)	Estimated Number of Properties Protected	Estimated Benefit Per Property (£)
Relocation of properties or infrastructure away from flood risk areas	30	271	197,000
Infiltration (and evaporation) for managing 'everyday rain'	5	128	262,000
Conveyance for managing 'usual rainfall'	10	183	223,000
Storage for managing 'extreme rainfall'	100	400	154,000

CDA 026 – Harold Hill North	Estimated Standard of Protection (SoP)	Estimated Number of Properties Protected	Estimated Benefit Per Property (£)
Carry out flood modelling of main river and adjacent educational facility in the Harold Hill Critical Drainage Area	10	183	233,000

CDA 034 – Thames

Table 4.4.10: Thames potential measures

CDA 034 – Thames	Estimated Standard of Protection (SoP)	Estimated Number of Properties Protected	Estimated Benefit Per Property (£)
Asset management and maintenance	5	26	202,000
Watercourse management and maintenance	5	26	202,000
Infiltration (and evaporation) for managing 'everyday rain'	5	26	332,000
Conveyance for managing 'usual rainfall'	10	37	279,000
Storage for managing 'extreme rainfall'	100	257	74,000
Restoring urban watercourse	30	55	262,000
Urban watercourse engineering	100	257	74,000
Run-off reduction strategy	30	55	262,000
Specific planning policy	10	37	279,000

CDA 036 – Ingrebourne

Table 4.4.11: Ingrebourne potential measures

CDA 036 – Ingrebourne	Estimated Standard of Protection (SoP)	Estimated Number of Properties Protected	Estimated Benefit Per Property (£)
Infiltration (and evaporation) for managing 'everyday rain'	5	183	290,000
Conveyance for managing 'usual rainfall'	10	262	242,000
Storage for managing 'extreme rainfall'	100	1058	99,000
Run-off reduction strategy	30	387	219,000
Specific planning policy	10	262	242,000

CDA 037 – River Ravensbourne

Table 4.4.12: River Ravensbourne potential measures

CDA 037 - River Ravensbourne	Estimated Standard of Protection (SoP)	Estimated Number of Properties Protected	Estimated Benefit Per Property (£)
Watercourse management and maintenance	5	37	178,000
Infiltration (and evaporation) for managing ‘everyday rain’	5	37	291,000
Conveyance for managing ‘usual rainfall’	10	53	247,000
Storage for managing ‘extreme rainfall’	100	220	100,000
Restoring urban watercourse	30	79	225,000
Run-off reduction strategy	30	79	225,000
Specific planning policy	10	53	247,000

CDA 038 – Heath Park North

Table 4.4.13: Heath Park North potential measures

CDA 038 – Heath Park North	Estimated Standard of Protection (SoP)	Estimated Number of Properties Protected	Estimated Benefit Per Property (£)
Infiltration (and evaporation) for managing ‘everyday rain’	5	61	273,000
Storage for managing ‘extreme rainfall’	100	268	120,000
Specific planning policy	10	87	324,000

CDA 039 – Heath Park South

Table 4.4.14: Heath Park South potential measures

CDA 039 – Heath Park South	Estimated Standard of Protection (SoP)	Estimated Number of Properties Protected	Estimated Benefit Per Property (£)
Infiltration (and evaporation) for managing ‘everyday rain’	5	25	294,000
Conveyance for managing ‘usual rainfall’	10	36	250,000
Storage for managing ‘extreme rainfall’	100	122	120,000
Run-off reduction strategy	30	53	229,000
Land management	10	36	250,000
Specific planning policy	10	36	250,000

CDA 040 – Harold Hill South

Table 4.4.15: Harold Hill South potential measures

CDA 040 – Harold Hill South	Estimated Standard of Protection (SoP)	Estimated Number of Properties Protected	Estimated Benefit Per Property (£)
Self-help – Property-level protection and resilience	10	74	176,000
Infiltration (and evaporation) for managing 'everyday rain'	5	52	278,000
Conveyance for managing 'usual rainfall'	10	74	318,000
Storage for managing 'extreme rainfall'	100	250	113,000
Run-off reduction strategy	30	110	214,000
Specific planning policy	10	74	237,000

5. Phase 4: Implementation, Monitoring and Review

5.1 Developing a detailed Action Plan

This report explains how the flood risk analysis led to an increase in understanding of flood risk in the Borough, which was used to develop target measures. These measures were assessed to understand their benefits and prioritise them.

The measures from the LFRMS and from the SWMP have been combined into a detailed Action Plan for the SWMP and the LFRMS. (Appendix F) and can be found in LBH's website[43].

The Action Plan is split into two sections showing boroughwide and CDA specific measures. The information included in the plan covers the following categories:

- **Measures and description:** shows the name of the measure and provides details of what the measure is**.**
- **General location:** states what CDA it is in or if it is boroughwide.
- **Priority ranking:** shows the ranking of CDA specific measures which ranges from very low to very high.
- **Cost/funding:** details what funding could be available to implement the measure and the average cost of the measures.
- **Estimated benefit:** provides the 'per property' and 'total' benefit of implementing the measure, taken from the cost benefit analysis.
- **Duration:** explains the time needed to implement the measure (short, medium or long-term and an idea of the implementation time). The implementation time will vary depending on resources, internal and external funding and priorities. Ongoing measures are those that are already being implemented.
- **Responsibility:** states the lead LBH team and primary support for implementing the measure.
- **Stakeholders:** shows who will/could be involved and support the measure implementation.
- **LFRMS:** states which LFRMS aims/objectives the measures apply to. Applies to boroughwide measures only.
- **Review/monitoring:** shows the Key Performance Indicators (KPIs) against which the measure should be monitored.
- **Origin:** sets out whether the measure is new or has been identified from a previous study, strategy or plan.

5.2 Action Plan Funding

There are several potential funding sources for delivery of the Action Plan, which are explained below.

[43] https://www.havering.gov.uk/environmental-issues/hazards-pollution-flooding/8

Internal Funding

LLFA Grant from Local Government Financial Settlement provides most of the LLFAs funding to carry out their duties under the Flooding and Management Act 2010.

Estates Improvement Budgets which could support projects to reduce flood risk in the estates.

Council budget which could support enhance partnership working, upskilling and implementation of other flood risk related projects. This includes Service Area Revenue Budgets which are the financial plans and estimates made by local authorities for their revenue expenditure.

External Funding - RMAs

The Thames Regional Flood and Coastal Committee (TFRCC), Flood Defence Grant in Aid (FDGiA) and Local Levy Funding is funding from central government for managing flood risk in England for the development of feasibility studies and implementation of capital flood risk projects.

Thames Water has previously made funding available for projects which manage flood water and prevent it entering the sewer network.

The **Greater London Authority (GLA)** has previously provided funding for projects which provide green infrastructure and climate change adaptations across London.

Other Sources of Funding

The Department for Education (DfE) has previously provided for projects which will reduce the impacts of flooding for schools.

Local Wildlife and River Trusts occasionally have funds which can be used to support delivery of SuDS in communities.

Central Government occasionally make funding available to improve quality of housing, commercial and local areas.

Business Improvement Districts (BIDs) have programmes focuses on improving the local environment in their area, may have implemented SuDS and are open to exploring opportunities to improve the areas they operate in.

Funds from developer contributions and the planning system.

The table below shows more details of the potential funding streams.

Table 5.2.1: Funding Streams Summary

Source	Funding stream	Project development	Capital delivery	Maintenance	Funding criteria
London Borough of Havering	Internal funding	Yes	Yes	Yes	Local government service budgets are set annually. Projects will need to deliver multiple benefits to bring in funding from other departments. This includes LLFA Grant from Local Government Financial Settlement which provides most of the LLFAs funding, Estates Improvement Budgets and Council Budgets.
Defra (administered by the Environment Agency - EA)	External Funding, Flood Defence Grant in Aid (FDGiA)	Yes	Yes	No	The amount of funding available depends on the 'Outcome Measures' a capital scheme will deliver, such as residential properties protected, reduction of other damages from flooding and environmental enhancements. 'Partnership Funding' from other sources is needed to fill any gaps needed in the funding required to deliver a scheme. Occasionally other funding becomes available, targeted towards reducing flooding to Frequently Flooded Communities or Schools.
Thames Regional Flood and Coastal Committee (administered by the EA)	External Funding, Local Levy	Yes	Yes	No	This funding is administered by the RFCC to meet local priorities, which may change from time to time. The TRFCC follows local levy principles relating to climate change, net zero carbon impact, multiple-benefits, biodiversity net gain, partnership working, communicating and building capability standards, catchment-based approaches, cost-effectiveness, efficiency, learning lessons and sharing information from similar schemes. Funding for Sustainable Drainage Systems and Natural Based Solutions projects is high up on the TRFCC's agenda.
Thames Water	Partnership funding, SuDS specific funding	Yes	Yes	Only for maintaining sewerage elements	Thames Water provide Partnership Funding towards schemes where there are also elements that reduce the risk from sewer flooding. Their priorities for allocating funding are set out in their Drainage and Wastewater Management Plan. Appendices on SuDS and London Flooding 2021 contain information on projects funded by Thames Water.
Greater London Authority (GLA)	Partnership funding, specific local	Yes	Yes	In some cases	The GLA has previously provided funding for projects which provide green infrastructure and climate change adaptation across London. previously provided funding for projects which provide green infrastructure and climate change adaptations across London. Some examples include:

Source	Funding stream	Project development	Capital delivery	Maintenance	Funding criteria
	schemes without FDGiA				• Greener City Fund: Community Green Space Grants • Green and Resilient Spaces Fund
Developers via the Planning System	Partnership funding	Yes	Yes	No	Section 106 monies collected from larger developments may be able to be used. Larger flood alleviation projects may be eligible for Community Infrastructure Levy. Local authorities must spend the levy on infrastructure needed to support the development of their area.
Other funding streams	Partnership funding, specific local schemes without FDGiA	Yes	Yes	Maybe	The list of potential funding streams is extensive and will depend on the direct benefits a scheme provides to reducing flood risk to certain infrastructure/ businesses/ utilities and/ or the delivery of multiple benefits. For example, this might include: - Developers - Businesses - Utility companies - Organisations, such as Business Improvement Districts, Wildlife and Rivers Trusts - Charities - Natural England - Historic England - National Lottery Community Fund - Department for Education - Levelling Up Fund - Ofwat Innovation Fund

The process of bidding for external funding may require specific expertise in obtaining grant funding. The value of the funding available can vary significantly and the outcome(s) of any funding bid(s) may remain uncertain for some time after a bid is made. This can make pooling together funding from different stakeholders and sources complex and resource intensive.

The LBH will work together with other organisations to bid for available funding on a prioritised basis to deliver the measures in the Action Plan. The Council's LLFA team will work with partners to maximise the funding available and to bid for further funding as new projects and funding opportunities emerge. The information in the Action Plan will support future bids for funding, particularly for Flood Defence Grant in Aid and Local Levy.

Measures have been ranked in order of priority to give an idea of which measures are likely to be implemented first. However, it is important to note that measure implementation is subject to the borough's resources and funding, and these could change at a short notice due to different factors such as national government funding changes, internal changes, responses to emergencies, etc. The implementation of the measures will be monitored regularly.

5.3 Ongoing Monitoring

Monitoring the Action Plan is key as part of the overall implementation of the LFRMS. The LLFA will carry out regular monitoring of the LFRMS.

5.4 Review Timeframe

There is no statutory duty for reviewing a SMWP, but it is a useful document to understand flood risk and how it changes over time. It is advised that the SWMP is reviewed when key flood risk knowledge is updated or if a major flooding event shows that a review is needed. As per with the implementation of the action plan, the review of the SWMP will be subject to the Borough's funding and resources.

6. Glossary

AEP - Annual Exceedance Probability

CDA – Critical Drainage Area

CE – Community Engagement

Defra – Department for Environment, Flood and Rural Affairs

DWMP – Thames Water Drainage and Wastewater Management Plan 2025-2050

EA – Environment Agency

FRMP2 - Flood Risk Management Plans 2021 to 2027

FWMA 2010 – Flood and Water Management Act 2010

GIS – Geographic Information System

GLA – The Greater London Authority

IMD – Index of Multiple Deprivation

KPI – Key Performance Indicators

LBH – London Borough of Havering

LFRMS – Local Flood Risk Management Strategy

LLFA – Lead Local Flood Authority

MCH – Multi-Coloured Handbook

NRD – National Receptor Database

OS – Ordnance Survey

RFCC – Regional Flood and Coastal Committee

RMA - Risk Management Authority

SAB – SuDS Approval Body

SoP – Standard of Protection

SuDS – Sustainable Drainage Systems

SWMP – Surface Water Management Plan

TfL – Transport for London

TRFCC – The Thames Regional Flood and Coastal Committee

TW – Thames Water

APPENDICES

Appendix A: Data Request Table

A.1 Data Request Table

Table A.1.1: Data request table

Information Requested	Requested From				
	London Borough of Havering	Environment Agency	Thames Water	Anglian Water	Greater London Authority
Strategies, plans, studies, and investigations	/	/	/	/	
Spatial Geographic Information System (GIS) data	/		/	/	/
Historic flooding records	/	/	/	/	
Asset information	/	/			
Highways, drainage, and maintenance	/	/			
Monitoring	/				
Climate change	/	/			

Appendix B: Intermediate Assessment – Communities at Risk Analysis

B.1 Communities at Risk Analysis

To undertake this analysis, the EA risk of flooding from surface water extent maps for different storm events (1 in 30-, 100-, and 1000-year events) maps were used. The 1000-year flood event was used as a proxy for a climate change.

Ground level commercial and residential properties at risk of flooding in the 1 in 30-, 100-, and 1000-year surface water flood events were identified. The analysis then identified groups of 20 or more properties at risk of surface water flooding within a 35 metre distance. These were termed 'Communities at Risk'.

As the outputs are a result of spatial distance and location of properties at risk, the number of Communities at Risk in different CDAs varies. In some cases, it may appear that the Communities at Risk decrease as the return periods increase. This is because two Communities at Risk that in a lower return period are in close proximity are joined under a higher return period scenario, as the flood risk increases, to create a larger Community at Risk. This can be seen in CDA 026 – Harold Hill North under the 1 in 100-year event scenario.

It should be noted that there may be many properties at risk of flooding which are not located within a Community at Risk. They are no less important than those within Communities at Risk. However, priority is given to clusters of properties at risk as this is an indication of a significant issue, and measures are more likely to be deliverable to address the cause(s) of flooding where there are multiple properties at risk.

The locations of Communities at Risk have been verified through comparison with records of historic flooding, although it should be noted that an area may be at high risk of flooding but not experienced flooding if it has not been subject to the appropriate conditions to cause flooding.

B.2 Limitations and Assumptions

Methodology Assumptions

While undertaking the 'Communities at Risk' analysis, it was assumed that only ground level residential and commercial properties were included.

Data Limitations

The EA Risk of Flooding from Surface Water maps were produced by The Environment Agency. These maps were developed with the aim of producing the best national surface water flood map[44] but they have limitations including:

- It assumes single drainage rate for all urban areas unless LLFAs were able to provide local data[21].

[44] Environment Agency, *What is the Risk of Flooding from Surface Water map?*, April 2019, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/842485/What-is-the-Risk-of-Flooding-from-Surface-Water-Map.pdf

- It assumes a free outfall, so does not consider tide locking or high river levels[21].
- Many LLFAs have not been able to validate the nationally produced modelling[12].

EA Risk of flooding from Wet and Dry Reservoir maps were used to extract and identify the number of properties at risk in both scenarios. The outputs were modelled by computer software. A laser recorded height of the ground, and this was added to computer software to produce a model[45]. The assumptions made during the modelling included:

- A void occurs through the full height of the dam and stops at the base of the dam.
- The base of the dam is the bed of the watercourse.
- Openings and culverts in embankments of smaller than 2 metres are blocked to represent floating debris.
- Wave walls were not considered.
- A reservoir on a different tributary would not fail at the same time.
- That cascade reservoirs not regulated by the EA have an average depth of 1 metre.
- Flood defences are included in the model.
- Where there is a boundary with the coast, that water will leave the model based on the slope of the land and is not restricted by the sea.

EA Risk of flooding from Groundwater maps were used to extract and identify the number of properties which are susceptible to flooding for four different percentages. This data was not supplied with supporting documents.

EA Risk of flooding from Rivers and Sea maps were used to extract and identify the number of properties in each likelihood of flooding from rivers and sea[46]. This data only considers flooding from watercourses where the contributing catchment is greater than $0.5km^2$.

The main limitation of all the datasets is that they do not take individual property threshold heights into account so the assessment at property level is indicative only.

Data Quality

It was assumed that all information published by the EA has undergone quality checks to ensure consistent high-quality data.

[45] Environment Agency, *Reservoir Flood Maps Guidance for users of the Defra Data Services Platform*, August 2021, https://environment.data.gov.uk/api/file/download?fileDataSetId=17af618d-1be0-44b6-bf91-199460a534ac&fileName=Reservoir_Flood_Maps_Data_Guide.pdf

[46] Environment Agency, *Risk of Flooding from Rivers and Sea Product Description*, February 2024, https://environment.data.gov.uk/api/file/download?fileDataSetId=d1651d70-29a8-406a-8e66-cdf15a11ef23&fileName=RoFRS_Product_Description_v2_3.pdf

Appendix C: CDA Flooding Summary and Maps

C.1 CDA 005 – Ardleigh Green East

Table C.1.1: Flooding in the Ardleigh Green East CDA

<table>
<tr><th>CDA</th><th colspan="4">005 – Ardleigh Green East</th></tr>
<tr><td rowspan="15">Potential Receptors (Critical Infrastructure and Homes)</td><td colspan="2">Infrastructure</td><td colspan="2">Number</td></tr>
<tr><td colspan="2">Public/Community Facility</td><td colspan="2">4</td></tr>
<tr><td colspan="2">College</td><td colspan="2">20</td></tr>
<tr><td colspan="2">GP Surgery</td><td colspan="2">1</td></tr>
<tr><td colspan="2">Care/Nursing Home</td><td colspan="2">2</td></tr>
<tr><td colspan="2">Health Centres</td><td colspan="2">2</td></tr>
<tr><td colspan="2">Higher/Further Education</td><td colspan="2">1</td></tr>
<tr><td colspan="2">Major Roads</td><td colspan="2">1</td></tr>
<tr><td colspan="2">Schools</td><td colspan="2">6</td></tr>
<tr><td colspan="2">Strategic Sites Allocated</td><td colspan="2">0</td></tr>
<tr><td colspan="2">Fire Stations</td><td colspan="2">0</td></tr>
<tr><td colspan="2">Railway Station</td><td colspan="2">0</td></tr>
<tr><td colspan="2">Police Stations</td><td colspan="2">0</td></tr>
<tr><td colspan="2">Hospitals</td><td colspan="2">0</td></tr>
<tr><td colspan="2">Properties</td><td colspan="2">3,768</td></tr>
<tr><td rowspan="3">Modelled Flooding</td><td>Surface Water</td><td colspan="3">The risk of surface water flooding mainly follows the watercourse which flows in a south easterly direction from Wingletye Lane through the CDA and into the river Ravensbourne. Other roads affected in all surface water flooding scenarios (1 in 30-, 1 in 100- and 1 in 1000-year events) are Birch Crescent, Platford Green, Wakefield Close, Nelmes Close, Wiltshire Avenue and Oxford Avenue.</td></tr>
<tr><td>Groundwater</td><td colspan="3">The risk of flooding from groundwater varies across the CDA following a north/south pattern. The very north of the CDA has a less than 25% risk, the very east's risk is between 25 and 50%, central area's risk is between 50% and 75% and the south is at 75% and higher risk.</td></tr>
<tr><td>River and Sea</td><td colspan="3">A culverted watercourse flows southwest across the CDA from Wingletye Lane and into the river Ravensbourne. There is mainly medium flood risk which, at its widest extent, covers 10 metres.</td></tr>
<tr><td rowspan="2">Communities at Risk</td><td>Scenario</td><td>1 in 30-year event (3.3% chance)</td><td>1 in 100-year event (1% chance)</td><td>1 in 1000-year event (0.1% chance)</td></tr>
<tr><td>Number of Communities</td><td>0</td><td>2</td><td>9</td></tr>
</table>

<table>
<tr><th>CDA</th><th colspan="4">005 – Ardleigh Green East</th></tr>
<tr><td rowspan="3"></td><td>Properties at Risk</td><td>98</td><td>298</td><td>980</td></tr>
<tr><td>Critical Infrastructure at Risk</td><td>1</td><td>6</td><td>11</td></tr>
<tr><td>Description</td><td colspan="3">There are no Communities at Risk in the 1 in 30-year flooding scenario. For the 1 in 100-year flooding scenario there are two Communities at Risk. The first community at risk has 22 properties across Peacocks Close and Birch Crescent. The second has 41 properties mainly across Nelmes Close and Great Nelmes Chase. In both Communities at Risk, for the 1 in 30-year event flooding scenario, depth ranges from 15 to 60cm. This could mean that the road network is unsafe to use. In the 1 in 1000-year flooding scenario there are 9 Communities at Risk across the CDA.</td></tr>
<tr><td>Validation</td><td colspan="4">There have been 12 reported flooding incidents in this CDA since 2007. In 2007, Wingletye Lane and Birch Crescent experienced surface water flooding internally, externally and in the highways. Birch Crescent also experienced the same type of flooding in 3 properties in 2009. In 2012, Birch Crescent, Tyle Green, Pembroke Close, Great Nelmes Chase, Nelmes Crescent, Burntwood Avenue, Rosslyn Avenue and Squirrel Health Lane experienced sewer flooding which flooded the highway. The most recent report was external surface water flooding to one property in Ardleigh Close in 2022. There were three surface water historic flooding reports in 2007, 2009 and 2012 in Birch Crescent. This supports the Communities at Risk analysis outputs on Birch Crescent where 22 properties are at risk in a 1 in 100-year event flooding scenario. Fluvial flooding impacting surface water sewers in the CDA was reported by stakeholders.</td></tr>
</table>

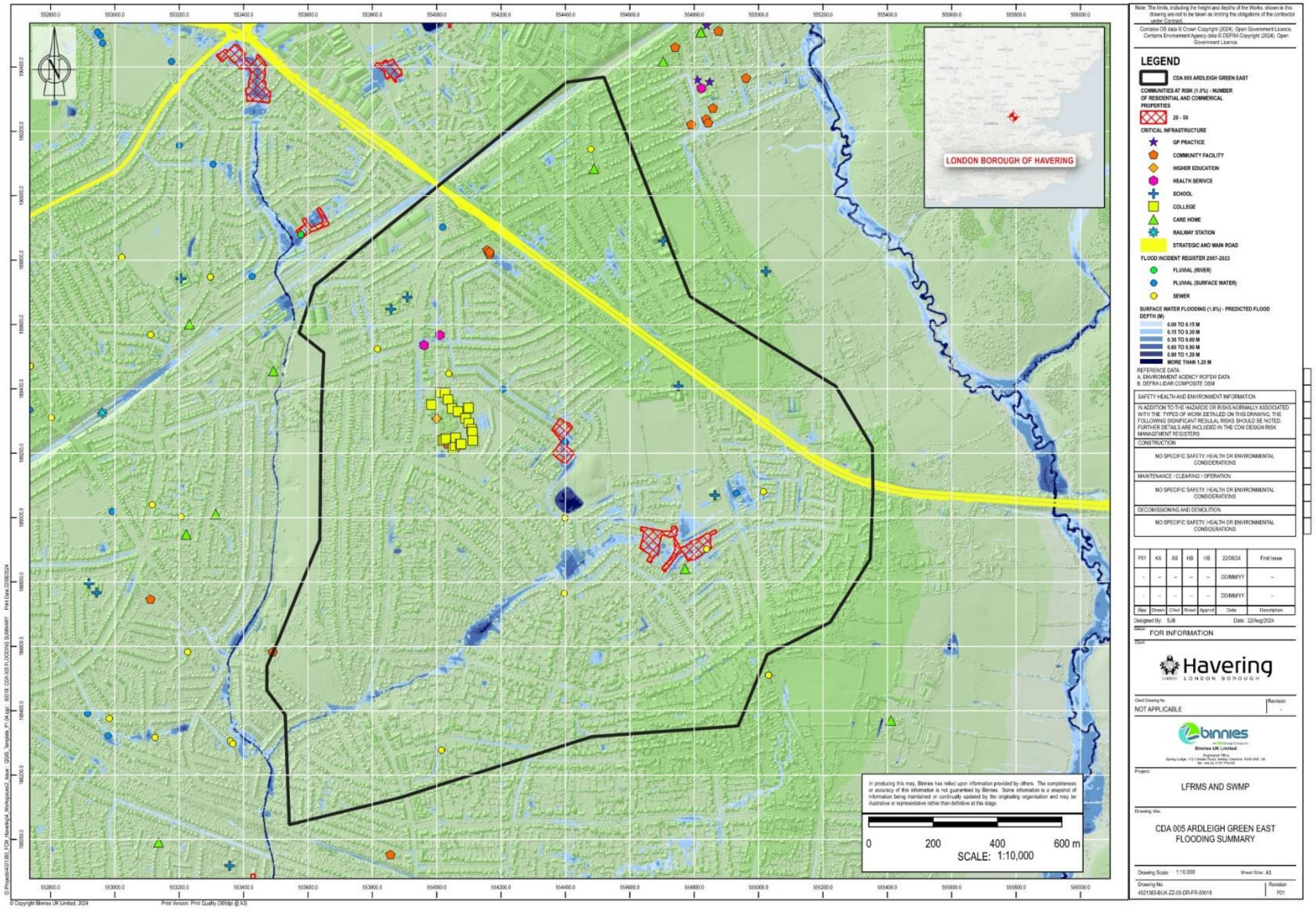

Figure C.1-1: CDA 005 Ardleigh Green East Flooding Summary (not to scale, see A3 scaled maps in Appendix G)

C.2 CDA 014 – River Rom and Beam River

Table C.2.1: Flooding in the River Rom and Beam River CDA

<table>
<tr><th>CDA</th><th colspan="4">014 – River Rom and Beam River</th></tr>
<tr><td rowspan="15">Potential Receptors (Critical Infrastructure and Homes)</td><td colspan="2">Infrastructure</td><td colspan="2">Number</td></tr>
<tr><td colspan="2">Public/Community Facility</td><td colspan="2">40</td></tr>
<tr><td colspan="2">College</td><td colspan="2">0</td></tr>
<tr><td colspan="2">GP Surgery</td><td colspan="2">6</td></tr>
<tr><td colspan="2">Care/Nursing Home</td><td colspan="2">26</td></tr>
<tr><td colspan="2">Health Centres</td><td colspan="2">10</td></tr>
<tr><td colspan="2">Higher/Further Education</td><td colspan="2">1</td></tr>
<tr><td colspan="2">Major Roads</td><td colspan="2">16</td></tr>
<tr><td colspan="2">Schools</td><td colspan="2">17</td></tr>
<tr><td colspan="2">Strategic Sites Allocated</td><td colspan="2">9</td></tr>
<tr><td colspan="2">Fire Stations</td><td colspan="2">0</td></tr>
<tr><td colspan="2">Railway Stations</td><td colspan="2">1</td></tr>
<tr><td colspan="2">Police Stations</td><td colspan="2">1</td></tr>
<tr><td colspan="2">Hospitals</td><td colspan="2">22</td></tr>
<tr><td colspan="2">Properties</td><td colspan="2">20,365</td></tr>
<tr><td rowspan="3">Modelled Flooding</td><td>Surface Water</td><td colspan="3">The EA risk of flooding from surface water maps show that the risk of surface water flooding mainly follows the river Rom and Black's Brook flowing in a southerly direction towards Romford centre. Surface water flooding scenarios affect several strategic and main roads in Romford. These roads are the A12, A125, A1251, A118 and London Road.</td></tr>
<tr><td>Groundwater</td><td colspan="3">The risk of flooding from groundwater follows a north/south pattern. The south of the CDA is mostly at 75% and higher risk of groundwater flooding and the north of the CDA varies from less than 25% to 75%.</td></tr>
<tr><td>River and Sea</td><td colspan="3">There are three watercourses in the CDA: the River Rom, Beam River, and Black's Brook. The river Rom's likelihood of flooding from rivers and sea is highest upstream and lower downstream with very low risk in Romford. Black's Brook has low to high risk but most of the flooding extent is in greenspace. There is generally low risk inside Romford Ring Road (A125). Beam River follows the LBH eastern boundary south. There is high risk along the entirety of the river in this CDA.</td></tr>
<tr><td rowspan="2">Communities at Risk</td><td>Scenario</td><td>1 in 30-year event (3.3% chance)</td><td>1 in 100-year event (1% chance)</td><td>1 in 1000-year event (0.1% chance)</td></tr>
<tr><td>Number of Communities</td><td>2</td><td>14</td><td>63</td></tr>
</table>

CDA	014 – River Rom and Beam River			
	Properties at Risk	756	1964	5919
	Critical Infrastructure at Risk	28	43	75
	Description	There are two Communities at Risk in every surface water flooding scenario. The first community at risk has 30 properties on Cross Road and the river Rom flow through it. The flood depth is up to 0.6 metres. The other community at risk has 22 properties along Hulse Avenue. Most of the flood depth is up to 0.30 metres with a few small locations where the depth increases to 0.60 metres. There are 14 Communities at Risk in the 1 in 100- year flooding scenario. They are mainly located in three locations which in and around Romford town centre, east and west of Mawney Road near the river Rom and between Collier Row Road and Havering Country Park.		
Validation	There have been 53 reports of flooding in the CDA since 2007. The most frequently flooded roads are Balgores Lane and Collier Row Lane. Flooding has been reported five times on Balgores Lane. 12 properties were flooded on the 25th June 2021 from surface water and sewer flooding. In 2007, three commercial properties and the highway were flooded by surface water on two separate occasions. Flooding was reported seven times on Collier Row Lane. In 2012, it was flooded by surface water once and sewer water flooding three times. In 2007, it was impacted by surface water flooding twice. The most recent report of flooding was in 2016 caused by river flooding which affected 10 residential properties internally and externally as well as the highway. Out of the 53 reports of flooding, 54% of the reports were caused by surface water flooding showing that it is the most common cause of flooding in the CDA. There is a report of surface water flooding in 2021 on Hulse Avenue when two residential properties were flooded, which supports the community at risk defined in the same location.			

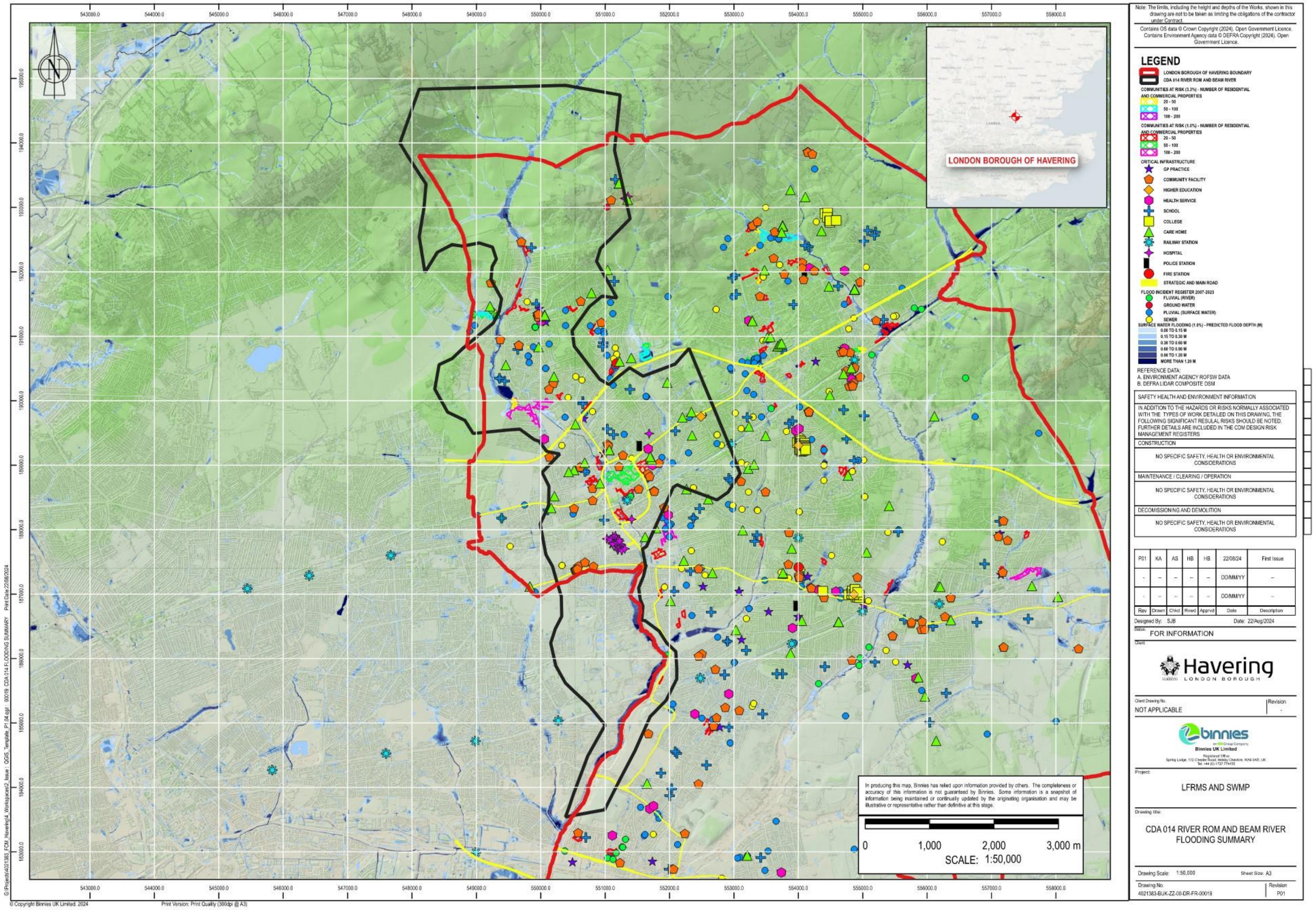

Figure C.2-1: CDA 014 River Rom and Beam River Flooding Summary (not to scale, see A3 scaled maps in Appendix G)

C.3 CDA 015 – Havering Park

Table C.3.1: Flooding in the Havering Park CDA

CDA	**015 – Havering Park**			
Potential Receptors (Critical Infrastructure and Homes)	**Infrastructure**		**Number**	
	Public/Community Facility		1	
	College		0	
	GP Surgery		0	
	Care/Nursing Home		1	
	Health Centres		0	
	Higher/Further Education		0	
	Major Roads		0	
	Schools		0	
	Strategic Sites Allocated		0	
	Fire Stations		0	
	Railway Stations		0	
	Police Stations		0	
	Hospitals		0	
	Properties		376	
Modelled Flooding	**Surface Water**	The EA risk of flooding from surface water maps show that the risk of surface water flooding is mainly located in the south of the CDA which is in the LBH boundary. The risk also extents north along green space and Lodge Lane. The roads impacted by surface water in all scenarios are Walton Road, Frinton Road, Lodge Lane, Penn Gardens and Turpin Avenue.		
	Groundwater	The risk of flooding from groundwater is between 25% and 50% in the east of the CDA and there is narrow section of the CDA on the LBH boundary with less has 25% risk.		
	River and Sea	There is no risk of flooding from rivers and sea.		
Communities at Risk	**Scenario**	**1 in 30-year event** (3.3% chance)	**1 in 100-year event** (1% chance)	**1 in 1000-year event** (0.1% chance)
	Number of Communities	1	1	1
	Properties at Risk	72	113	198
	Critical Infrastructure at Risk	1	1	2
	Description	There is one community at risk in the CDA, it is located across Frinton Road and Lodge Lane. In a 1 in 30-year		

CDA	015 – Havering Park	
		surface water flooding scenario there are 51 properties at risk in the community. In a 1 in 100-year surface water flooding event it increases to 93 properties at risk in the community. In the 1 in 1000-year surface water flooding scenario the number of properties in the community at risk increases to 261. On Frinton Road in a 1 in 30-year surface water flooding scenario, flood depth on the highway could reach 1.20 metres.
Validation	The most frequent type of reported flooding is from river flooding, reported on Frinton Road, Lodge Lane and Penn Gardens in 2006. Surface water flooding was reported on Hog Hill Road and Walton Road were the highway and residential properties were flooded externally. Sewer flooding was also reported on Turpin Avenue highway in 2012. The properties on Frinton Road and Penn Gardens are set lower than the road which would make them more susceptible to surface water flooding and supports the Communities at Risk location.	

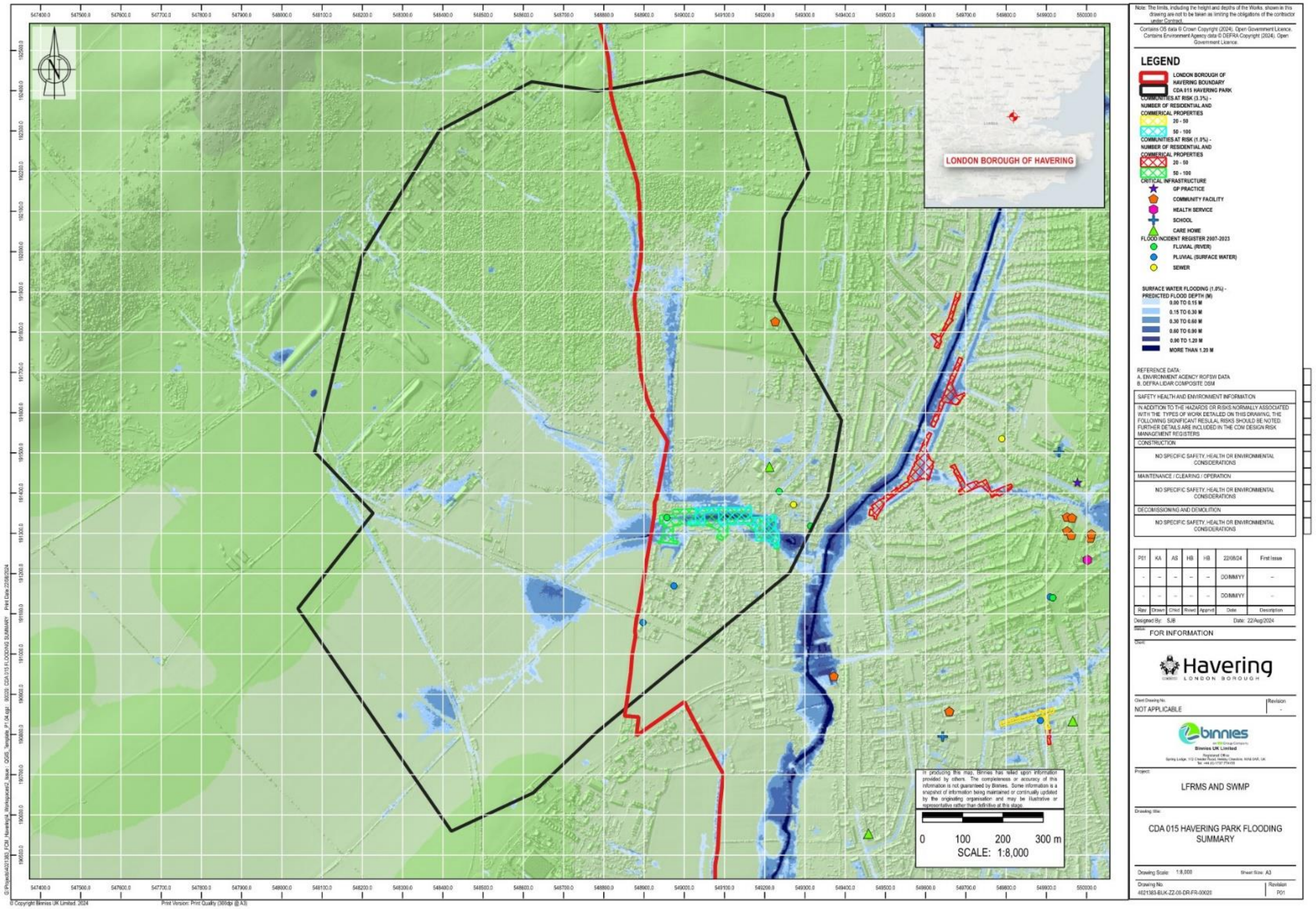

Figure C.3-1: CDA 015 Havering Park Flooding Summary (not to scale, see A3 scaled maps in Appendix G)

C.4 CDA 016 – Rise Park West

Table C.4.1: Flooding in the Rise Park West CDA

CDA	016 Risk Park West			
Potential Receptors (Critical Infrastructure and Homes)	**Infrastructure**		**Number**	
	Public/Community Facility		1	
	College		0	
	GP Surgery		0	
	Care/Nursing Home		1	
	Health Centres		0	
	Higher/Further Education		0	
	Major Roads		0	
	Schools		2	
	Strategic Sites Allocated		0	
	Fire Stations		1	
	Railway Stations		0	
	Police Stations		0	
	Hospitals		0	
	Properties		1,829	
Modelled Flooding	**Surface Water**	The EA risk of flooding from surface water maps show that the risk of surface water flooding is mainly focused along the centre of the CDA from north to south. The largest area at risk of surface water flooding, where it could affect properties and strategic roads, is in the south of the CDA along Linton Court and Pettits Boulevard. The roads affected in all surface water flooding scenarios are The Drive, Faircross Avenue, Gobions Avenue, Chelmsford Avenue, Havering Road, Gary Way, Tweed Way, Moray Way, Ayr Way, Pettits Lane North and the A12.		
	Groundwater	The south of the CDA has 25% to 50% risk of flooding from groundwater and the north of the CDA had less than 25% risk of flooding from groundwater.		
	River and Sea	There is no risk of flooding from rivers and sea.		
Communities at Risk	**Scenario**	**1 in 30-year event** (3.3% chance)	**1 in 100-year event** (1% chance)	**1 in 1000-year event** (0.1% chance)
	Number of Communities	0	2	3
	Properties at Risk	76	201	592

CDA	016 Risk Park West			
	Critical Infrastructure at Risk	1	1	2
	Description	There are two Communities at Risk for the 1 in 100-year surface water flooding event. The first community at risk, located across Havering Road, has 24 properties at risk. This increases to 274 in a 1 in 1000-year scenario. The second community at risk is located on Heather Drive, surrounded by Linton Court, Heather Gardens and Pettits Lane North. It has 30 properties at risk, which increases to 86 in a 1 in 1000-year scenario.		
Validation	There have been 16 reports of flooding in the CDA since 2007. The most frequently flooded roads are Moray Way and Pettits Lane North. Flooding has been reported on Moray Way five times on four different occasions in 2007, 2009 and 2020. Surface water flooding was the cause of every event. Pettits Lane North experienced sewer flooding in 2012 and surface water flooding in 2007, 2020 and 2021. Other roads flooded were Bower Close, Clyde Way, Glenton Way, Rise Park Parade and Wallace Way. Pettits Lane has a community at risk and has had flooding reported. Surface water flooding was reported on three occasions on Pettits Lane North in 2007, 2020 and 2021. In these occasions, residential properties flooded internally and externally. The highway also flooded.			

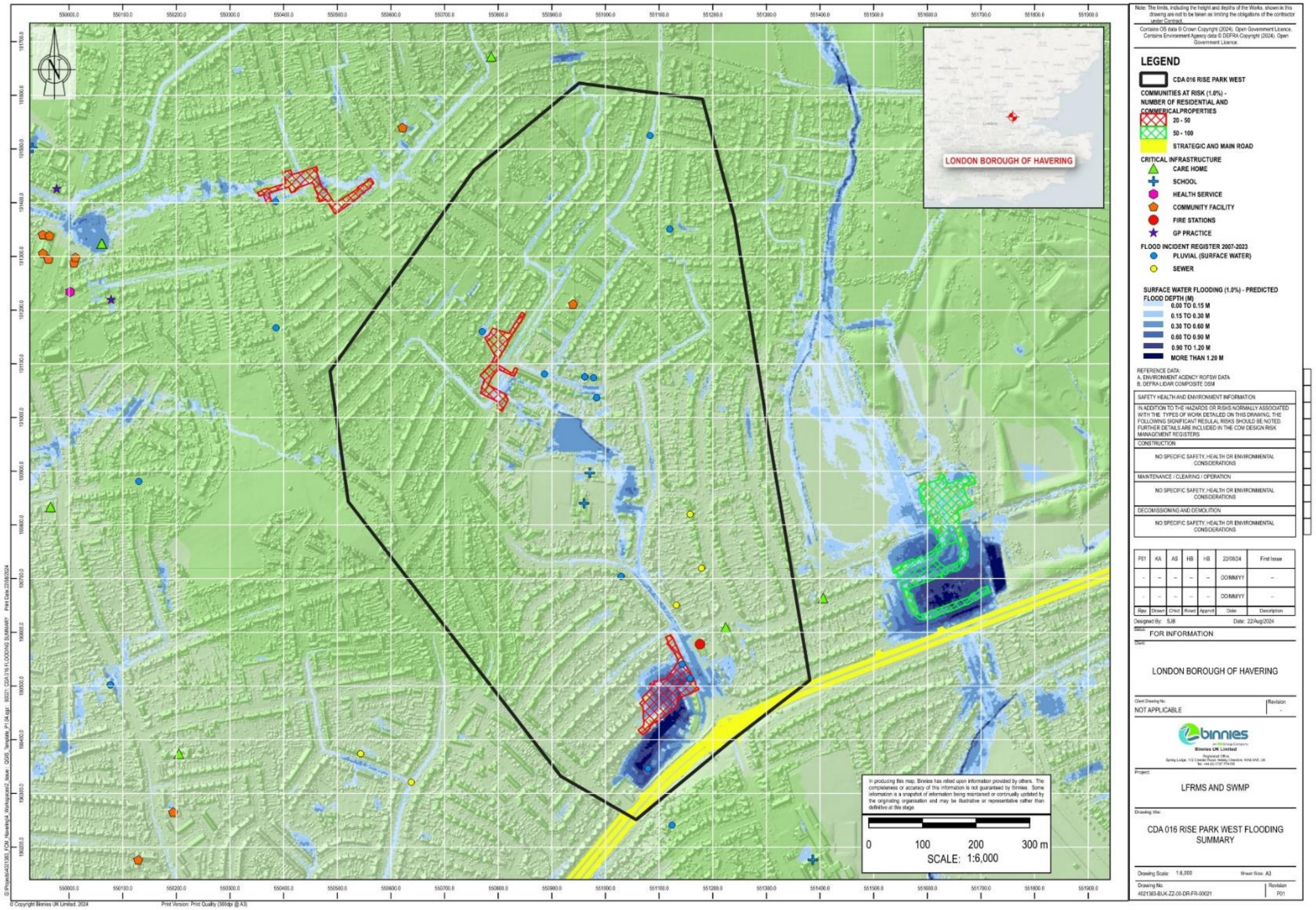

Figure C.4-1: CDA 016 Rise Park West Flooding Summary (not to scale, see A3 scaled maps in Appendix G)

C.5 CDA 017 – Rise Park

Table C.5.1: Flooding in the Rise Park CDA

<table>
<tr><th>CDA</th><th colspan="4">017 – Rise Park</th></tr>
<tr><td rowspan="15">Potential Receptors (Critical Infrastructure and Homes)</td><td colspan="2">Infrastructure</td><td colspan="2">Number</td></tr>
<tr><td colspan="2">Public/Community Facility</td><td colspan="2">0</td></tr>
<tr><td colspan="2">College</td><td colspan="2">0</td></tr>
<tr><td colspan="2">GP Surgery</td><td colspan="2">0</td></tr>
<tr><td colspan="2">Care/Nursing Home</td><td colspan="2">2</td></tr>
<tr><td colspan="2">Health Centres</td><td colspan="2">0</td></tr>
<tr><td colspan="2">Higher/Further Education</td><td colspan="2">0</td></tr>
<tr><td colspan="2">Major Roads</td><td colspan="2">0</td></tr>
<tr><td colspan="2">Schools</td><td colspan="2">1</td></tr>
<tr><td colspan="2">Strategic Sites Allocated</td><td colspan="2">0</td></tr>
<tr><td colspan="2">Fire Stations</td><td colspan="2">0</td></tr>
<tr><td colspan="2">Railway Stations</td><td colspan="2">0</td></tr>
<tr><td colspan="2">Police Stations</td><td colspan="2">0</td></tr>
<tr><td colspan="2">Hospitals</td><td colspan="2">0</td></tr>
<tr><td colspan="2">Properties</td><td colspan="2">736</td></tr>
<tr><td rowspan="3">Modelled Flooding</td><td>Surface Water</td><td colspan="3">The EA risk of flooding from surface water maps show that the risk of surface water flooding mainly around the two watercourses in the CDA and on green space. The main extent of surface water flooding on highways and residential properties is in the south of the CDA along and around the A12. This affects other roads in all scenarios including Rise Park Boulevard, Beauly Way, Tay Way and Park Boulevard.</td></tr>
<tr><td>Groundwater</td><td colspan="3">The majority of the CDA has less than 25% risk of flooding form groundwater except from the south. In the southeast the risk of flooding from groundwater is more than 75% and in the southwest the risk is between 50% and 75%.</td></tr>
<tr><td>River and Sea</td><td colspan="3">Risk of flooding from rivers and sea follows the path of the watercourse in the east of the CDA, flowing south. Medium flood risk starts at Lower Beford Road, and the risk increases to high, and the extent widens before the A12. After the A12, the risk reduces to low and the extent decreases.</td></tr>
<tr><td rowspan="2">Communities at Risk</td><td>Scenario</td><td>1 in 30-year event (3.3% chance)</td><td>1 in 100-year event (1% chance)</td><td>1 in 1000-year event (0.1% chance)</td></tr>
<tr><td>Number of Communities</td><td>1</td><td>1</td><td>3</td></tr>
</table>

CDA	017 – Rise Park			
	Properties at Risk	98	150	292
	Critical Infrastructure at Risk	2	2	3
	Description	Communities at Risk are all located on the south of the CDA. One community at risk is present in all scenarios on Beauly Way. In the 1 in 30-year surface water scenario, 58 properties are at risk. This increases to 73 properties in a 1 in 100-year scenario and 96 properties in a 1 in 1000-year scenario. The other Communities at Risk in a 1 in 1000-year scenario are located on Brook Road and Netherpark Drive.		
Validation	There is one report of flooding in the CDA since 2007, This is located on Lower Bedfords Road. This reported flooding event was in 2012 where one residential property was flooded internally.			

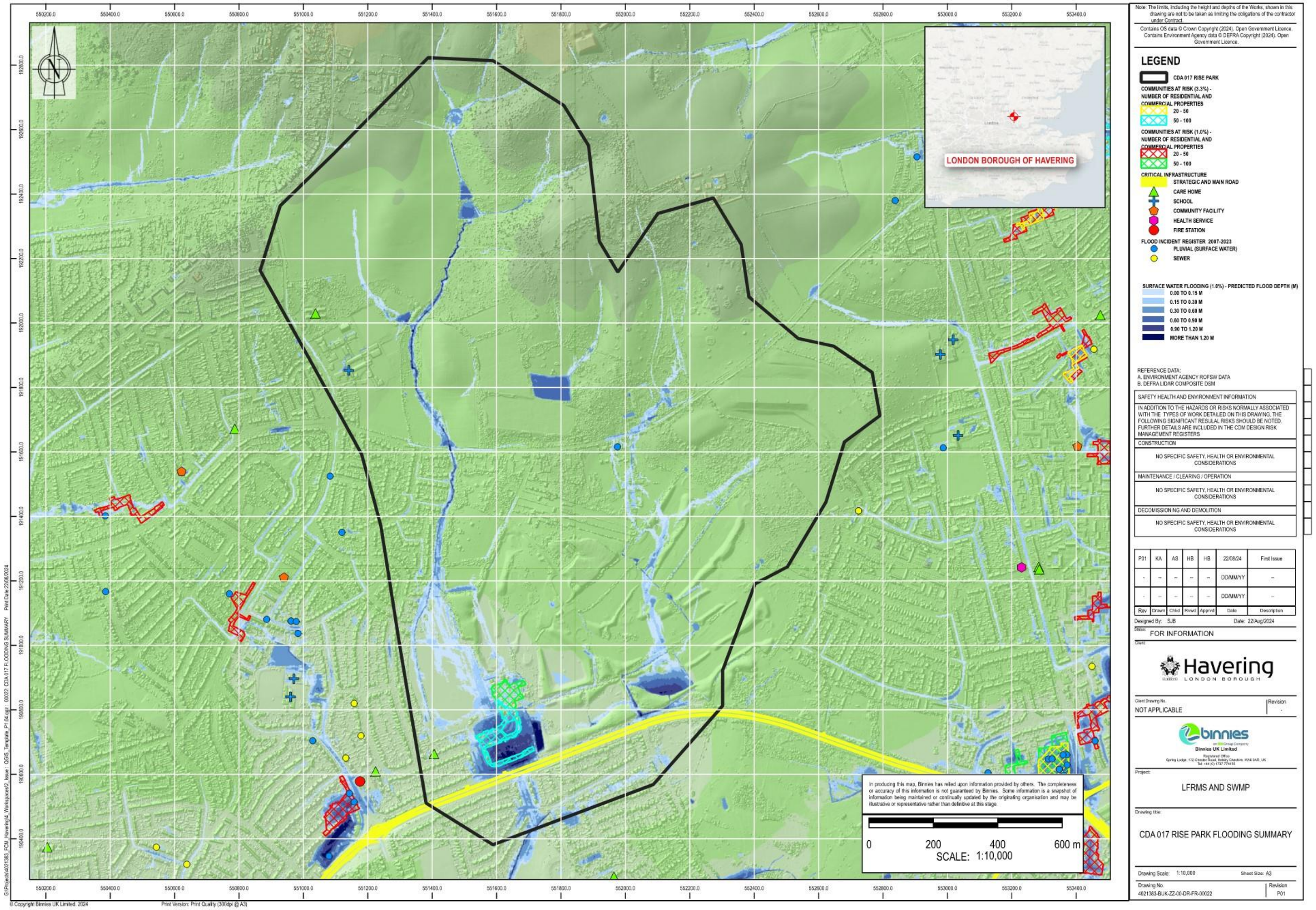

Figure C.5-1: CDA 017 Rise Park Flooding Summary (not to scale, see A3 scaled maps in Appendix G)

C.6 CDA 018 – Cranham

Table C.6.1: Flooding in the Cranham CDA

<table>
<tr><th>CDA</th><th colspan="4">018 – Cranham</th></tr>
<tr><td rowspan="15">Potential Receptors (Critical Infrastructure and Homes)</td><td colspan="2">Infrastructure</td><td colspan="2">Number</td></tr>
<tr><td colspan="2">Public/Community Facility</td><td colspan="2">4</td></tr>
<tr><td colspan="2">College</td><td colspan="2">0</td></tr>
<tr><td colspan="2">GP Surgery</td><td colspan="2">2</td></tr>
<tr><td colspan="2">Care/Nursing Home</td><td colspan="2">0</td></tr>
<tr><td colspan="2">Health Centres</td><td colspan="2">1</td></tr>
<tr><td colspan="2">Higher/Further Education</td><td colspan="2">0</td></tr>
<tr><td colspan="2">Major Roads</td><td colspan="2">1</td></tr>
<tr><td colspan="2">Schools</td><td colspan="2">2</td></tr>
<tr><td colspan="2">Strategic Sites Allocated</td><td colspan="2">1</td></tr>
<tr><td colspan="2">Fire Stations</td><td colspan="2">0</td></tr>
<tr><td colspan="2">Railway Stations</td><td colspan="2">0</td></tr>
<tr><td colspan="2">Police Stations</td><td colspan="2">0</td></tr>
<tr><td colspan="2">Hospitals</td><td colspan="2">0</td></tr>
<tr><td colspan="2">Properties</td><td colspan="2">3,746</td></tr>
<tr><td rowspan="3">Modelled Flooding</td><td>Surface Water</td><td colspan="3">The EA risk of flooding from surface water maps show that surface water flooding is confined mostly to the highway throughout the CDA. Surface water flooding could affect the A127 along a 1.5km stretch. The most significant area of surface water flooding is in the Borough's eastern boundary where the A127 passes under the M25, with the depth being more than 1.2 metres. Other roads affected in a 1 in 30-year surface water flooding scenario, with a depth of up to 0.6 metres, are Front Lane, Moor Lane, Roseberry Gardens, Waycross Road, Isis Drive and Humber Drive.
There seems to be a culvert under Fenchurch Street and Shoeburyness Line, near to Plover Gardens, which does not have sufficient capacity under flooding scenarios. This can cause increased surface water flooding to Heron Way, Nightingale Avenue and Moor Lane.</td></tr>
<tr><td>Groundwater</td><td colspan="3">The risk of flooding from groundwater varies across the CDA. The west and north of the CDA has less than 25% risk, the south has more than 75% risk and the centre and the east vary between 25-75% risk.</td></tr>
<tr><td>River and Sea</td><td colspan="3">There is no risk of flooding from river and sea.</td></tr>
<tr><td>Communities at Risk</td><td>Scenario</td><td>1 in 30-year event (3.3% chance)</td><td>1 in 100-year event (1% chance)</td><td>1 in 1000-year event (0.1% chance)</td></tr>
</table>

CDA	018 – Cranham			
	Number of Communities	0	2	17
	Properties at Risk	136	446	1357
	Critical Infrastructure at Risk	3	6	9
	Description	There are two Communities at Risk in a 1 in 100-year surface water flooding scenario. The first community at risk is located on Roseberry Gardens. In a 1 in 100-year scenario there are 25 properties at risk of flooding in this community, with maximum depth in the highway of 0.6 metres. The second community at risk is located along Moor Lane, Nightingale Avenue and Heron Way. This community at risk had 105 properties at risk and the flood depth in the highways is generally 0.6 metres with a few exceptions of increased depth to 0.9 metres. This community at risk could be affected by the culvert's lack of capacity.		
Validation	There are no reported flooding events in this CDA since 2007. The stakeholders explained that Fenchurch Street and Shoeburyness trainline were built before the properties and surface water flooding has been seen there.			

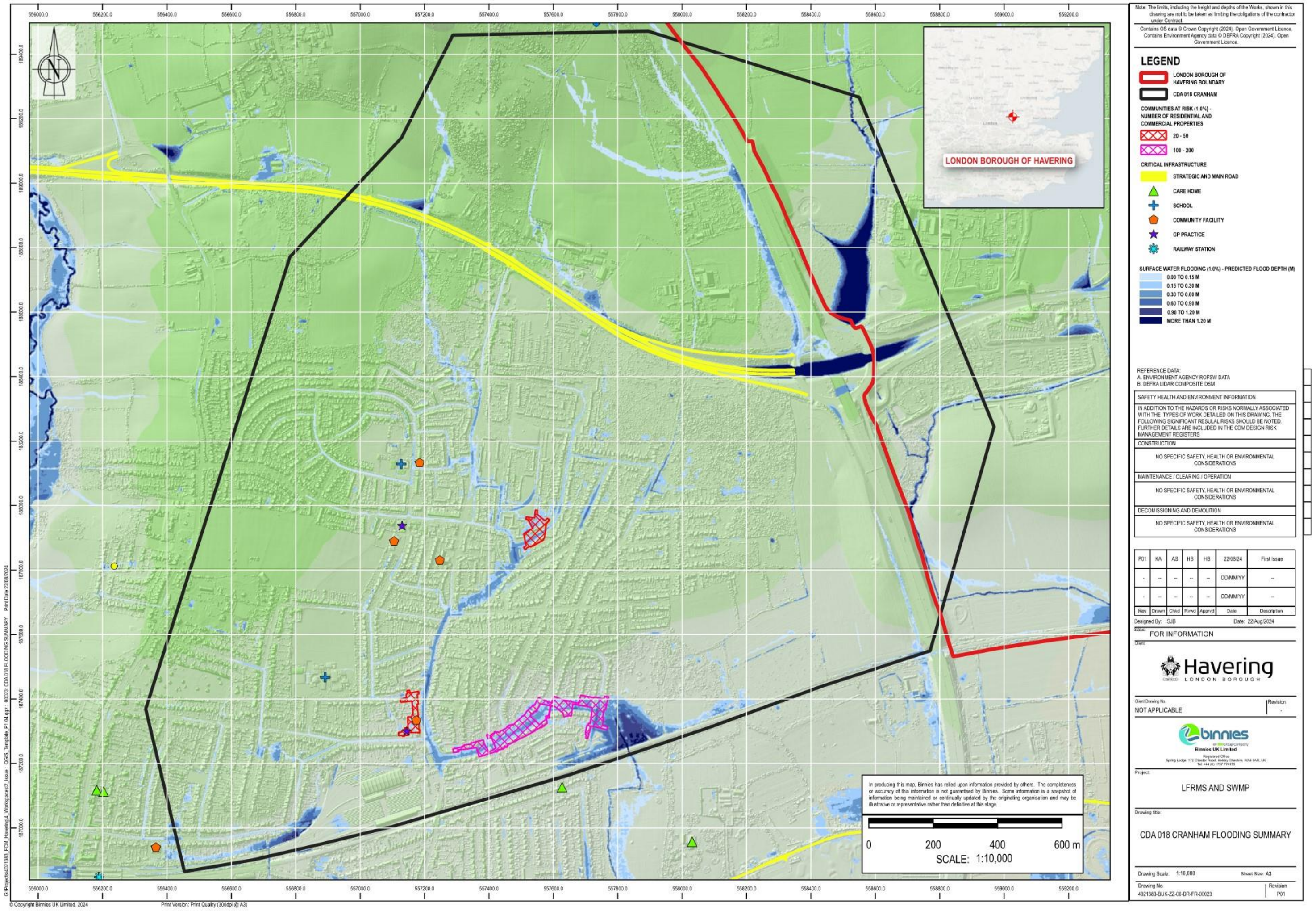

Figure C.6-1: CDA 018 Cranham Flooding Summary (not to scale, see A3 scaled maps in Appendix G)

C.7 CDA 023 – Elm Park

Table C.7.1: Flooding in the Elm Park CDA

<table>
<tr><th>CDA</th><th colspan="4">023 – Elm Park</th></tr>
<tr><td rowspan="15">Potential Receptors (Critical Infrastructure and Homes)</td><td colspan="2">Infrastructure</td><td colspan="2">Number</td></tr>
<tr><td colspan="2">Public/Community Facility</td><td colspan="2">10</td></tr>
<tr><td colspan="2">College</td><td colspan="2">0</td></tr>
<tr><td colspan="2">GP Surgery</td><td colspan="2">2</td></tr>
<tr><td colspan="2">Care/Nursing Home</td><td colspan="2">4</td></tr>
<tr><td colspan="2">Health Centres</td><td colspan="2">9</td></tr>
<tr><td colspan="2">Higher/Further Education</td><td colspan="2">0</td></tr>
<tr><td colspan="2">Major Roads</td><td colspan="2">2</td></tr>
<tr><td colspan="2">Schools</td><td colspan="2">13</td></tr>
<tr><td colspan="2">Strategic Sites Allocated</td><td colspan="2">3</td></tr>
<tr><td colspan="2">Fire Stations</td><td colspan="2">0</td></tr>
<tr><td colspan="2">Railway Stations</td><td colspan="2">2</td></tr>
<tr><td colspan="2">Police Stations</td><td colspan="2">0</td></tr>
<tr><td colspan="2">Hospitals</td><td colspan="2">0</td></tr>
<tr><td colspan="2">Properties</td><td colspan="2">12,776</td></tr>
<tr><td rowspan="3">Modelled Flooding</td><td>Surface Water</td><td colspan="3">The EA risk of flooding from surface water maps in a 1 in 30-year scenario show that surface water flooding in mainly located on the highway. In the 1 in 100-year scenario the extent increases to affect more roads and residential properties both internally and externally.</td></tr>
<tr><td>Groundwater</td><td colspan="3">This risk of flooding from groundwater is highest in the south of the CDA, where it varies from 50% to more than 75%. The risk in the north of the CDA varies from less than 25% to 75%.</td></tr>
<tr><td>River and Sea</td><td colspan="3">There is a very low risk of flooding from rivers and sea in the south of the CDA which affects Spencer Road, Manser Road, Betterton Road, Phillip Road, Edmund Road, and Fredrick Road.</td></tr>
<tr><td rowspan="4">Communities at Risk</td><td>Scenario</td><td>1 in 30-year event (3.3% chance)</td><td>1 in 100-year event (1% chance)</td><td>1 in 1000-year event (0.1% chance)</td></tr>
<tr><td>Number of Communities</td><td>0</td><td>2</td><td>26</td></tr>
<tr><td>Properties at Risk</td><td>119</td><td>574</td><td>3035</td></tr>
<tr><td>Critical Infrastructure at Risk</td><td>10</td><td>20</td><td>33</td></tr>
</table>

<table>
<tr><th>CDA</th><th colspan="2">023 – Elm Park</th></tr>
<tr><td></td><td>Description</td><td>There are two Communities at Risk in the CDA. The first one is in the south of the CDA across Betterton Road, Seaburn Close and Manser Road. It has 37 properties at risk. The flood depth in this location is up to 1.2 metres. The second CDA is located across Bader Way, Malan Square, Wood Lane and Kilmartin Way. Flood depth in this location ranges from 0.15 to 0.6 metres.</td></tr>
<tr><td>Validation</td><td colspan="2">There have been 28 reports of flooding since 2007. The most frequently flooded roads are Calmore Close and Spinney Close. Flooding in Calmore Close has been reported on four occasions. Three of the reports were in 2012 for sewer flooding on the highways. River flooding in Spinney Close has been reported four times in 2020, 2016 and twice in 2012. There have been river flooding reports in both Betterton Road and Manser Road between 2016 and 2020, in the same location as one of the Communities at Risk. For the second community at risk there was a report of surface water flooding in 2013 on Kilmartin Way, which affected the highway.</td></tr>
</table>

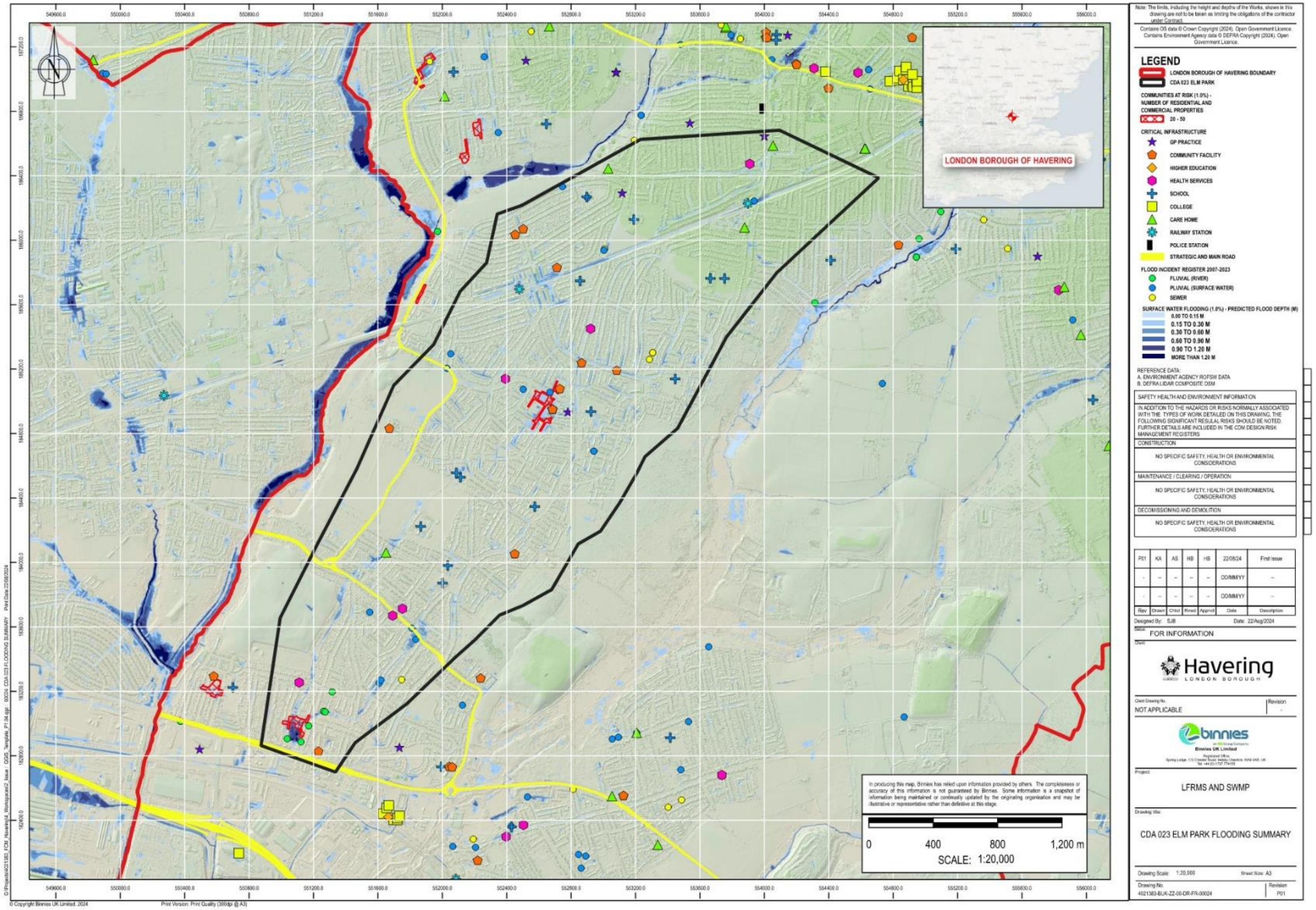

Figure C.7-1: CDA 023 Elm Park Flooding Summary (not to scale, see A3 scaled maps in Appendix G)

C.8 CDA 025 – Gallows Corner

Table C.8.1: Flooding in the Gallows Corner CDA

<table>
<tr><th>CDA</th><th colspan="4">025 – Gallows Corner</th></tr>
<tr><td rowspan="16">Potential Receptors (Critical Infrastructure and Homes)</td><td colspan="2">Infrastructure</td><td colspan="2">Number</td></tr>
<tr><td colspan="2">Public/Community Facility</td><td colspan="2">1</td></tr>
<tr><td colspan="2">College</td><td colspan="2">0</td></tr>
<tr><td colspan="2">GP Surgery</td><td colspan="2">1</td></tr>
<tr><td colspan="2">Care/Nursing Home</td><td colspan="2">8</td></tr>
<tr><td colspan="2">Health Centres</td><td colspan="2">3</td></tr>
<tr><td colspan="2">Higher/Further Education</td><td colspan="2">0</td></tr>
<tr><td colspan="2">Major Roads</td><td colspan="2">4</td></tr>
<tr><td colspan="2">Schools</td><td colspan="2">3</td></tr>
<tr><td colspan="2">Strategic Sites Allocated</td><td colspan="2">2</td></tr>
<tr><td colspan="2">Fire Stations</td><td colspan="2">0</td></tr>
<tr><td colspan="2">Railway Stations</td><td colspan="2">1</td></tr>
<tr><td colspan="2">Police Stations</td><td colspan="2">0</td></tr>
<tr><td colspan="2">Hospitals</td><td colspan="2">0</td></tr>
<tr><td colspan="2">Properties</td><td colspan="2">6,417</td></tr>
<tr style="display:none"></tr>
<tr><td rowspan="3">Modelled Flooding</td><td>Surface Water</td><td colspan="3">The EA risk of flooding from surface water maps show that many highways are affected by surface water flooding. Four strategic roads are shown to be affected by surface water flooding: Main Road, Colchester Road, the A12 and the A127. The largest extent is Colchester Road, Straight Road, and Shenstone Gardens where the maximum flood depth is 0.9 metres, in a 1 in 30-year surface water flooding scenario.</td></tr>
<tr><td>Groundwater</td><td colspan="3">Most of the risk of flooding from groundwater in this CDA is less than 25%. There are pockets in the south and southwest with a risk between 50% and higher than 75%</td></tr>
<tr><td>River and Sea</td><td colspan="3">The risk of flooding from rivers and sea is located around the river Ravensbourne which starts at the junction of Main Road and A127. It then flows south under the railway line. The risk between Main Road and Ferguson Avenue is medium and high risk, and after Ferguson Avenue the risk is very low.</td></tr>
<tr><td rowspan="2">Communities at Risk</td><td>Scenario</td><td>1 in 30-year event (3.3% chance)</td><td>1 in 100-year event (1% chance)</td><td>1 in 1000-year event (0.1% chance)</td></tr>
<tr><td>Number of Communities</td><td>1</td><td>6</td><td>18</td></tr>
</table>

CDA	025 – Gallows Corner			
	Properties at Risk	287	748	2213
	Critical Infrastructure at Risk	5	8	16
	Description	There is one community at risk in the 1 in 30-year surface water flooding scenario, located across Shenstone Gardens. This community at risk has 33 properties at risk and a maximum flood depth of 0.9 metres. In a 1 in 100-year surface water flooding scenario the properties at risk increase to 61 properties. In the 1 in 1000-year surface water flooding scenario the risk increases to 138 properties. The six Communities at Risk in the 1 in 100-year surface wate flooding scenario are located on Gillian Crescent, Shenstone Gardens, Neave Crescent, Juniper Way, Clematis Close and Tulip Close.		
Validation	There have been 33 reports of flooding since 2007, 76% of the reports are about surface water flooding. The three most frequently flooded roads (by surface water) are within the community at risk. These roads are Marlowe Gardens, Ramsay Gardens and Shenstone Gardens. On the 26th June 2021, four properties in Marlowe Gardens, eleven properties in Ramsay Gardens and four properties in Shenstone Gardens were flooded. All these properties were located close in proximity and were all flooded internally and externally. The surface water flooding issue in Gallows Corner is well known by the stakeholders as they reported that all ground level properties had been flooded and that there are underground drainage issues in the area.			

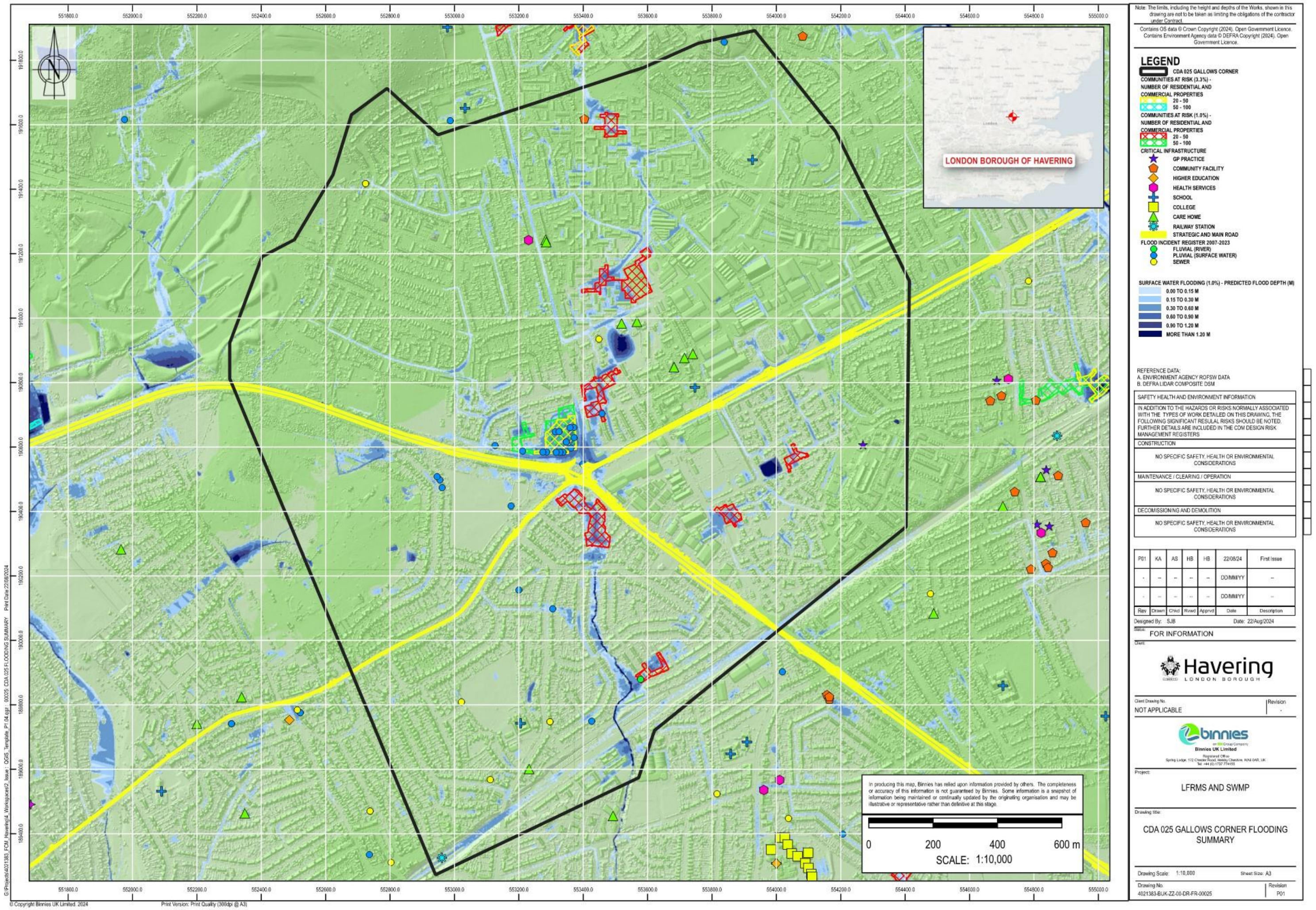

Figure C.8-1: CDA 025 Gallows Corner Flooding Summary (not to scale, see A3 scaled maps in Appendix G)

C.9 CDA 026 – Harold Hill North

Table C.9.1: Flooding in the Harold Hill North CDA

CDA	026 – Harold Hill North			
Potential Receptors (Critical Infrastructure and Homes)	**Infrastructure**	**Number**		
	Public/Community Facility	3		
	College	0		
	GP Surgery	0		
	Care/Nursing Home	2		
	Health Centres	0		
	Higher/Further Education	0		
	Major Roads	0		
	Schools	2		
	Strategic Sites Allocated	0		
	Fire Stations	0		
	Railway Stations	0		
	Police Stations	0		
	Hospitals	0		
	Properties	1,700		
Modelled Flooding	**Surface Water**	The EA risk of flooding from surface water maps show that many highways and residential properties could be affected by surface water. The roads and properties impacted in all flooding scenarios are Noak Hill Road, Hitchin Close, Taunton Road, Seven Oaks Close, North Hill Road, Dorking Road and Drapers' Brookside Primary School. In a 1 in 30- year surface water flood event the maximum depth at Drapers' Brookside Primary School is 0.9 metres.		
	Groundwater	The risk of flooding from groundwater is less than 25%.		
	River and Sea	There is risk of flooding from rivers and sea in the eastern boundary of the CDA. There is a high and medium risk from Carter's Brook which would impact the entirety of Drapers' Brookside Primary School and a section of Dorking Road.		
Communities at Risk	**Scenario**	**1 in 30-year event** (3.3% chance)	**1 in 100-year event** (1% chance)	**1 in 1000-year event** (0.1% chance)
	Number of Communities	4	3	4
	Properties at Risk	271	400	682

CDA	**026 – Harold Hill North**			
	Critical Infrastructure at Risk	3	3	4
	Description	The number of Communities at Risk is lower in the 1 in 100-year scenario because two of the Communities at Risk in the 1 in 30-year scenario join to form a large community at risk in the 1 in 100- year scenario. There are four Communities at Risk in the 1 in 30-year surface water flooding scenario. Three of the Communities at Risk are located along Taunton Road and North Hill Road. These have 32, 78 and 79 properties at risk respectively. The average flood depth in the communities at is 0.3-0.6 metres. The other community at risk in this location is located across Edenhall Road.		
Validation	There have been 16 reported flooding events in the CDA since 2007, with 87% of those being due to surface water flooding. The most frequently reported flooding highways are Hitchin Close and Taunton Road. All of the reports of flooding on Taunton Road were on the 25th June 2021, where 15 residential properties were flooded internally and externally. Two of the three reports on Hitchin Close show two residential properties flooded internally and externally. The other report was in 2016 when six residential properties were flooded internally. These two roads are located within the Communities at Risk. The other road within the Communities at Risk which has suffered from surface water flooding is North Hill Drive. North Hill Drive was flooded in 2021 and 2022 when two residential properties were also flooded internally and externally. Drapers' Brookside Primary School was flooded in 2016, due to river flooding when the Carter's Brook exceeded its capacity. It was reported that flood depths averaged 1 metre which caused damage to the school. In this location there is also two convergent culverts which could be causing various flooding issues.			

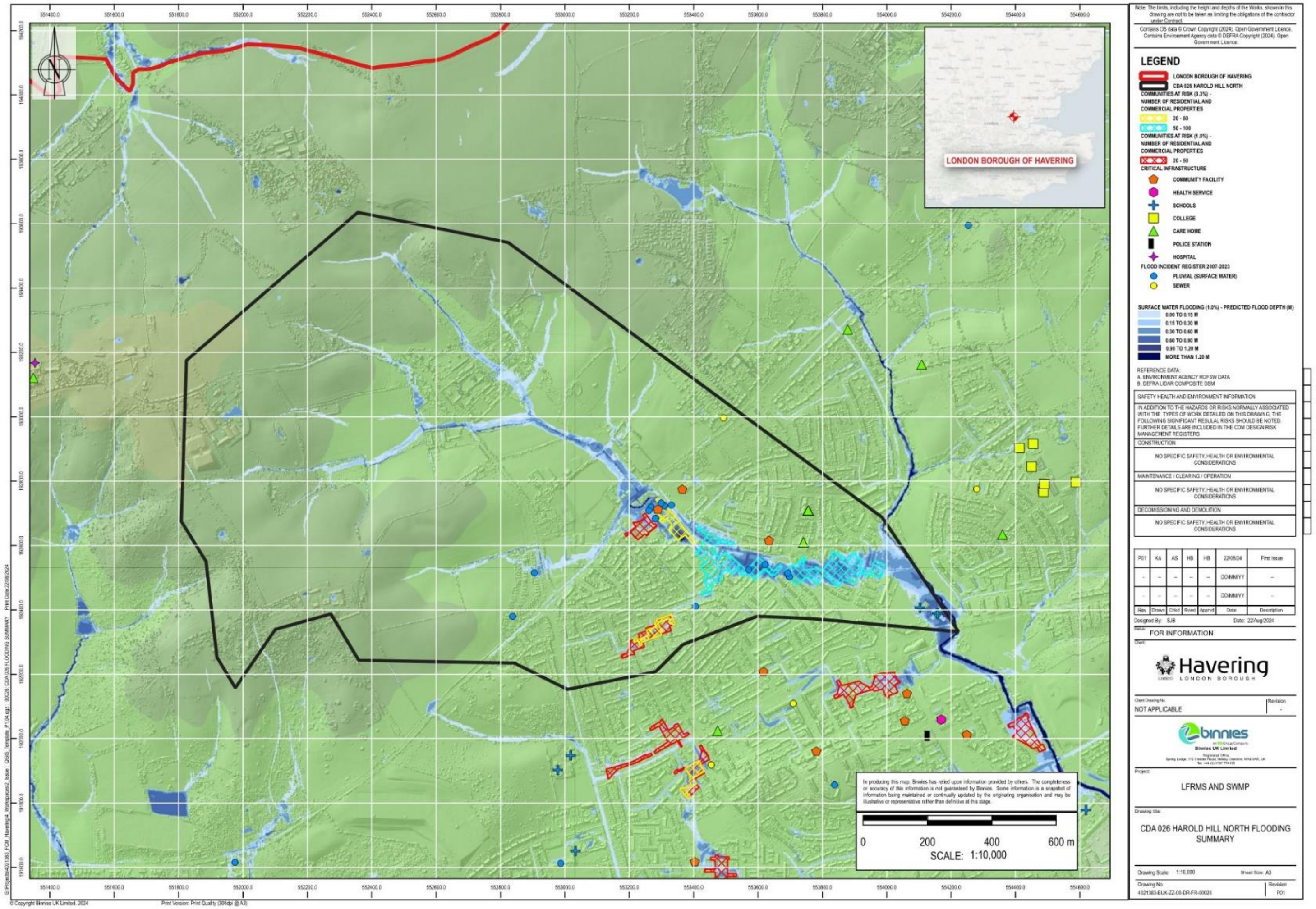

Figure C.9-1: CDA 026 Harold Hill North (not to scale, see A3 scaled maps in Appendix G)

C.10 CDA 034 – Thames

Table C.10.1: Flooding in the Thames CDA

CDA	034 – Thames	
Potential Receptors (Critical Infrastructure and Homes)	**Infrastructure**	**Number**
	Public/Community Facility	3
	College	8
	GP Surgery	2
	Care/Nursing Home	4
	Health Centres	4
	Higher/Further Education	1
	Major Roads	6
	Schools	5
	Strategic Sites Allocated	6
	Fire Stations	1
	Railway Stations	1
	Police Stations	0
	Hospitals	0
	Properties	5,553
Modelled Flooding	**Surface Water**	The EA risk of flooding from surface water maps shows that in a 1 in 30-year flooding scenario there are small areas of shallow localised flooding across the CDA. There are a few locations where this could cause damage such as Brookway and South Hall Drive. The mapping shows that the highways and residential properties could be flooded internally and externally with a depth of up to 0.6 metres. Newton Primary School would be impacted by depths of up to 0.6metres. The severity of surface water flooding increase in these locations in 1 in 100 and 1 in 1000-year event scenarios.
	Groundwater	The risk of flooding from ground water increases from south to north in the CDA. In the south of the CDA, near the river Thames, the risk is less than 25%. It increases to 50-75% in more residential areas near New Road. In Cely Woods, to the north of the CDA, the risk is higher than 75%.
	River and Sea	The risk of flooding from rivers and sea impacts the majority of the CDA south of New Road. The risk varies from very low risk to high risk. Low risk flooding extents north of New Road extents to highways such as South Street and Walden Avenue in South Hornchurch and follows a common watercourse into the northeast of the CDA which has a more rural character.

CDA	034 – Thames			
Communities at Risk	**Scenario**	**1 in 30-year event** (3.3% chance)	**1 in 100-year event** (1% chance)	**1 in 1000-year event** (0.1% chance)
	Number of Communities	0	2	9
	Properties at Risk	55	257	983
	Critical Infrastructure at Risk	11	21	30
	Description	There are two Communities at Risks in the 1 in 100-year surface water flooding scenario. One is located across South Street, Apple Tree Lane, and Walden Avenue. The average flood depth in this community at risk is 0.15-0.6 metres, with 34 properties at risk. The second community at risk is located on Brookway where there are 21 properties at risk with a maximum flood depth of 0.9 metres.		
Validation	There have been 31 reports of flooding the CDA since 2007, 80% caused by surface water flooding. Surface water flooding has been reported once in the Brookway community at risk. A common watercourse flows south from Brookway towards the Thames through a culvert under the railway line. In August 2020 the culvert got blocked causing 20 residential properties and the highways to be flooded by fluvial and surface water. Other roads flooded on more than one occasion are Brights Avenue, Farm Road, Lamson Road, New Road, River Close and Warrick Road.			

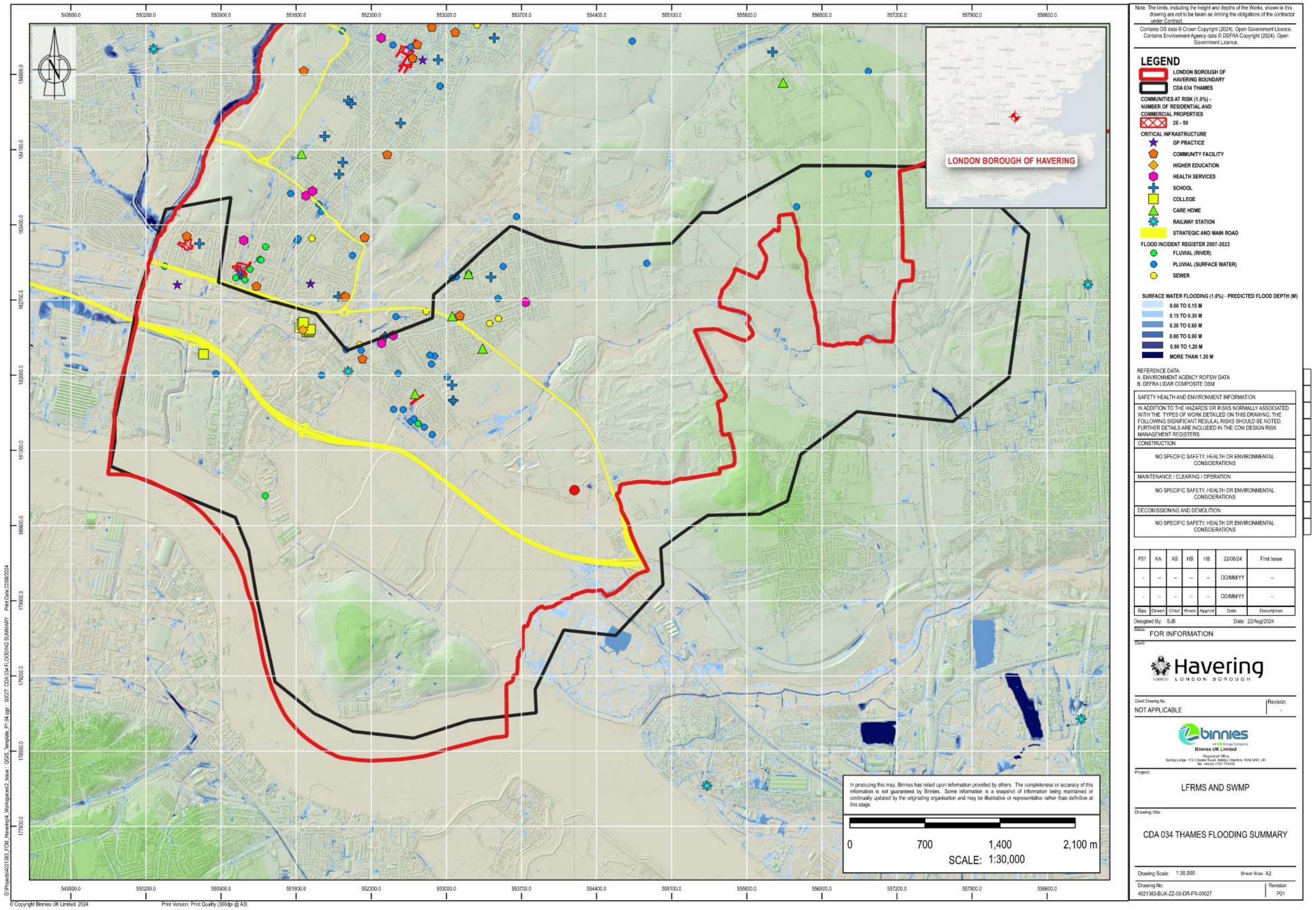

Figure C.10-1: CDA 034 Thames Flooding Summary (not to scale, see A3 scaled maps in Appendix G)

C.11 CDA 036 – Ingrebourne

Table C.11.1: Flooding in the Ingrebourne CDA

CDA	036 – Ingrebourne			
Potential Receptors (Critical Infrastructure and Homes)	**Infrastructure**		**Number**	
	Public/Community Facility		23	
	College		21	
	GP Surgery		7	
	Care/Nursing Home		11	
	Health Centres		6	
	Higher/Further Education		1	
	Major Roads		8	
	Schools		12	
	Strategic Sites Allocated		3	
	Fire Stations		0	
	Railway Stations		2	
	Police Stations		1	
	Hospitals		0	
	Properties		13,836	
Modelled Flooding	**Surface Water**	The EA risk of flooding from surface water maps show that surface water flooding is mainly around the river Ingrebourne. In a 1 in 30-year flooding scenario there are various roads across the CDA impacted by shallow localised flooding. Certain areas are shown to experience increased flooding depth such as Queens Park Road, Elgin Avenue, Reford Road, and Frimley Avenue. All strategic and main roads in this CDA are affected by surface water in all flooding scenarios.		
	Groundwater	The risk of flooding from groundwater follows a north to south pattern. The north of the CDA has less an 25% risk. The middle the CDA from Shepherds Hill to Hornchurch Country Park varies from less than 25% to 75% risk. The south of the CDA has 50% to more than 75% risk.		
	River and Sea	The risk of flooding from rivers and sea impacts the south of the CDA and the River Ingrebourne which flows the length of the CDA. The risk in the south of the CDA is very low and extents to New Road and New Zealand Way. The risk of flooding from the river Ingrebourne is medium to high.		
Communities at Risk	**Scenario**	**1 in 30-year event** (3.3% chance)	**1 in 100-year event** (1% chance)	**1 in 1000-year event** (0.1% chance)

CDA	036 – Ingrebourne			
	Number of Communities	1	6	37
	Properties at Risk	387	1058	3659
	Critical Infrastructure at Risk	18	32	48
	Description	For the 1 in 30-year surface water flooding scenario there is one community at risk. This community at risk is located across Queens Park Road and Avenue Road, where there are 36 properties at risk. For the 1 in 100-year scenario, the number of properties at risk increases to 64. The other Communities at Risk in the 1 in 100-year surface water flooding scenario are on St.Neots Road, Oxford Road, Amersham Close, Harlesden Road, The Old Brickworks and Frimley Avenue.		
Validation	There have been 34 flooding reports since 2007, 35.5% of them refer to surface water flooding,38.5% to sewer flooding and 26% River flooding. The two most frequently flooded highways are David Drive and Hacton Lane. David Drive experienced sewer water flooding on two occasions in 2012 when Thames Water assets were blocked, resulting on the highways and three residential properties impacted. Hacton Lane experienced river flooding from the river Ingrebourne on three occasions, twice 2012 and once in 2016. Surface water flooding has been reported in the community at risk on Harlesden Road. The incident occurred in 2022 when the highway and one residential property were flooded.			

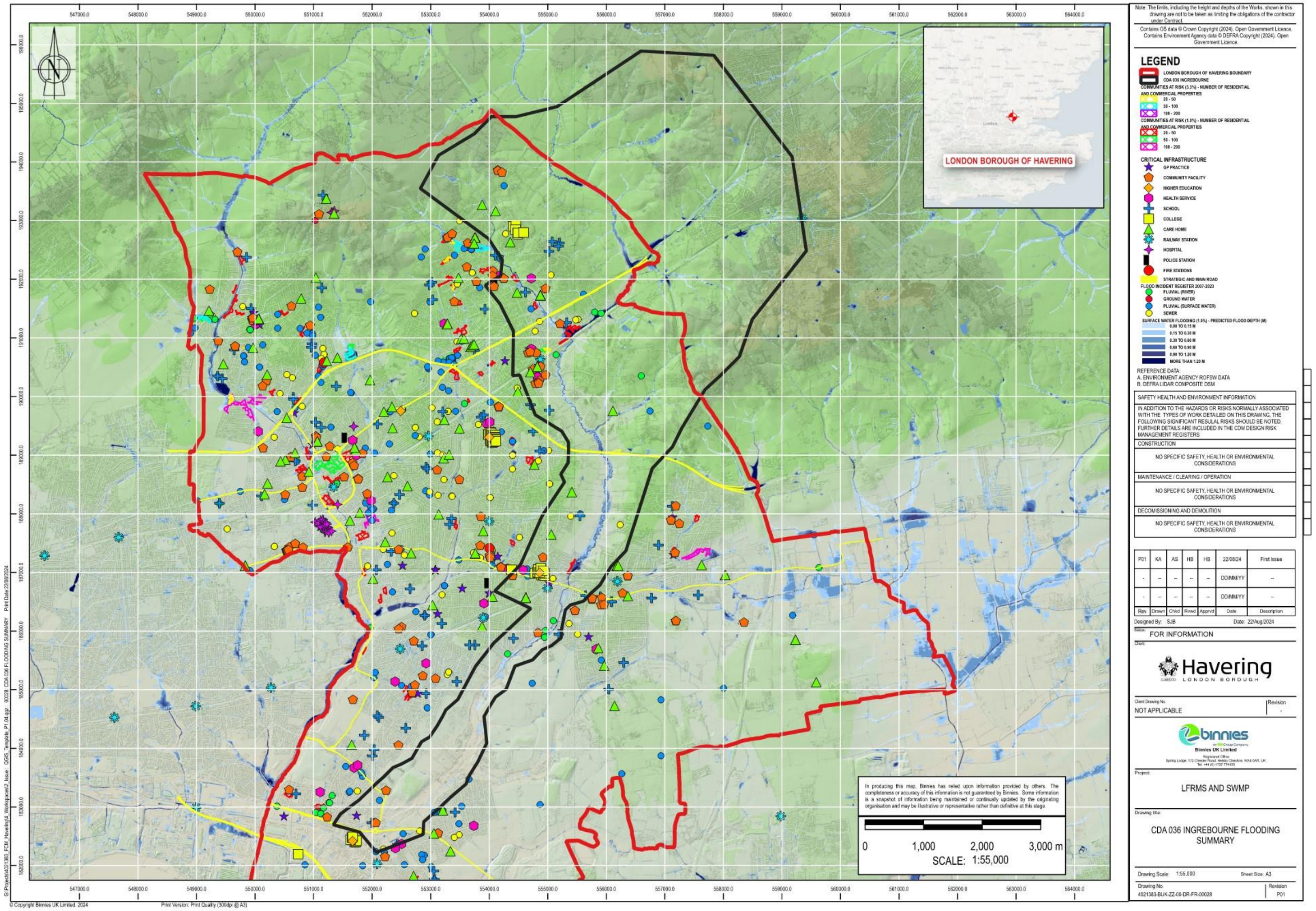

Figure C.11-1: CDA 036 Ingrebourne Flooding Summary (not to scale, see A3 scaled maps in Appendix G)

C.12 CDA 037 – River Ravensbourne

Table C.12.1:Flooding in the River Ravensbourne CDA

<table>
<tr><th>CDA</th><th colspan="4">037 – River Ravensbourne</th></tr>
<tr><td rowspan="15">Potential Receptors (Critical Infrastructure and Homes)</td><td colspan="2">Infrastructure</td><td colspan="2">Number</td></tr>
<tr><td colspan="2">Public/Community Facility</td><td colspan="2">1</td></tr>
<tr><td colspan="2">College</td><td colspan="2">0</td></tr>
<tr><td colspan="2">GP Surgery</td><td colspan="2">1</td></tr>
<tr><td colspan="2">Care/Nursing Home</td><td colspan="2">6</td></tr>
<tr><td colspan="2">Health Centres</td><td colspan="2">0</td></tr>
<tr><td colspan="2">Higher/Further Education</td><td colspan="2">0</td></tr>
<tr><td colspan="2">Major Roads</td><td colspan="2">2</td></tr>
<tr><td colspan="2">Schools</td><td colspan="2">4</td></tr>
<tr><td colspan="2">Strategic Sites Allocated</td><td colspan="2">5</td></tr>
<tr><td colspan="2">Fire Stations</td><td colspan="2">0</td></tr>
<tr><td colspan="2">Railway Stations</td><td colspan="2">0</td></tr>
<tr><td colspan="2">Police Stations</td><td colspan="2">0</td></tr>
<tr><td colspan="2">Hospitals</td><td colspan="2">0</td></tr>
<tr><td colspan="2">Properties</td><td colspan="2">4,134</td></tr>
<tr><td rowspan="3">Modelled Flooding</td><td>Surface Water</td><td colspan="3">The risk of flooding from surface water is mainly located around the river Ravensbourne and extends out to roads surrounding it. In the 1 in 30-year event scenario various highways could experience shallow localised flooding. Highways impacted in all scenarios are Hornchurch Road, Northumberland Avenue, Slewins Lane and Saunton Road.</td></tr>
<tr><td>Groundwater</td><td colspan="3">This risk of flooding from groundwater varies across the CDA. In the north and south of the CDA the risk ranges from 25% to more than 75%. The risk in the centre of the CDA is from 50% to less than 25%.</td></tr>
<tr><td>River and Sea</td><td colspan="3">The risk of flooding from rivers and sea in this CDA comes from the river Ravensbourne which flows north to south. The risk follows a north to south pattern with increased risk downstream. The risk affects properties and highways in proximity of the river Ravensbourne as the extent is small.</td></tr>
<tr><td rowspan="3">Communities at Risk</td><td>Scenario</td><td>1 in 30-year event (3.3% chance)</td><td>1 in 100-year event (1% chance)</td><td>1 in 1000-year event (0.1% chance)</td></tr>
<tr><td>Number of Communities</td><td>0</td><td>3</td><td>10</td></tr>
<tr><td>Properties at Risk</td><td>79</td><td>220</td><td>919</td></tr>
</table>

CDA	037 – River Ravensbourne			
	Critical Infrastructure at Risk	2	2	7
	Description	There are three Communities at Risk in the 1 in 100-year surface water flooding scenario. They are located on Laburnum Avenue, Saunton Road, and Lyndhurst Road. The community at risk on Laburnum Avenue has 25 properties at risk, Saunton Road has 30 properties at risk and Lyndhurst Road has 24 properties at risk.		
Validation	There have been nine reports of flooding since 2007. The most frequently flooded roads are Abbs Cross Lane and Pinecroft. Abbs Cross Lane has three reports of flooding form 2012-2016. In 2014 one residential property was flooded internally and in 2016 the highway was flooded; these were both caused by surface water flooding. Pinecroft has three reports of flooding in 2012 showing that the highways were flooded but only on two occasions it was caused by sewer flooding. The other highways with reported flooding are Hill Crescent and Albany Road. There have been no reports of flooding within the 1 in 100-year Communities at Risk.			

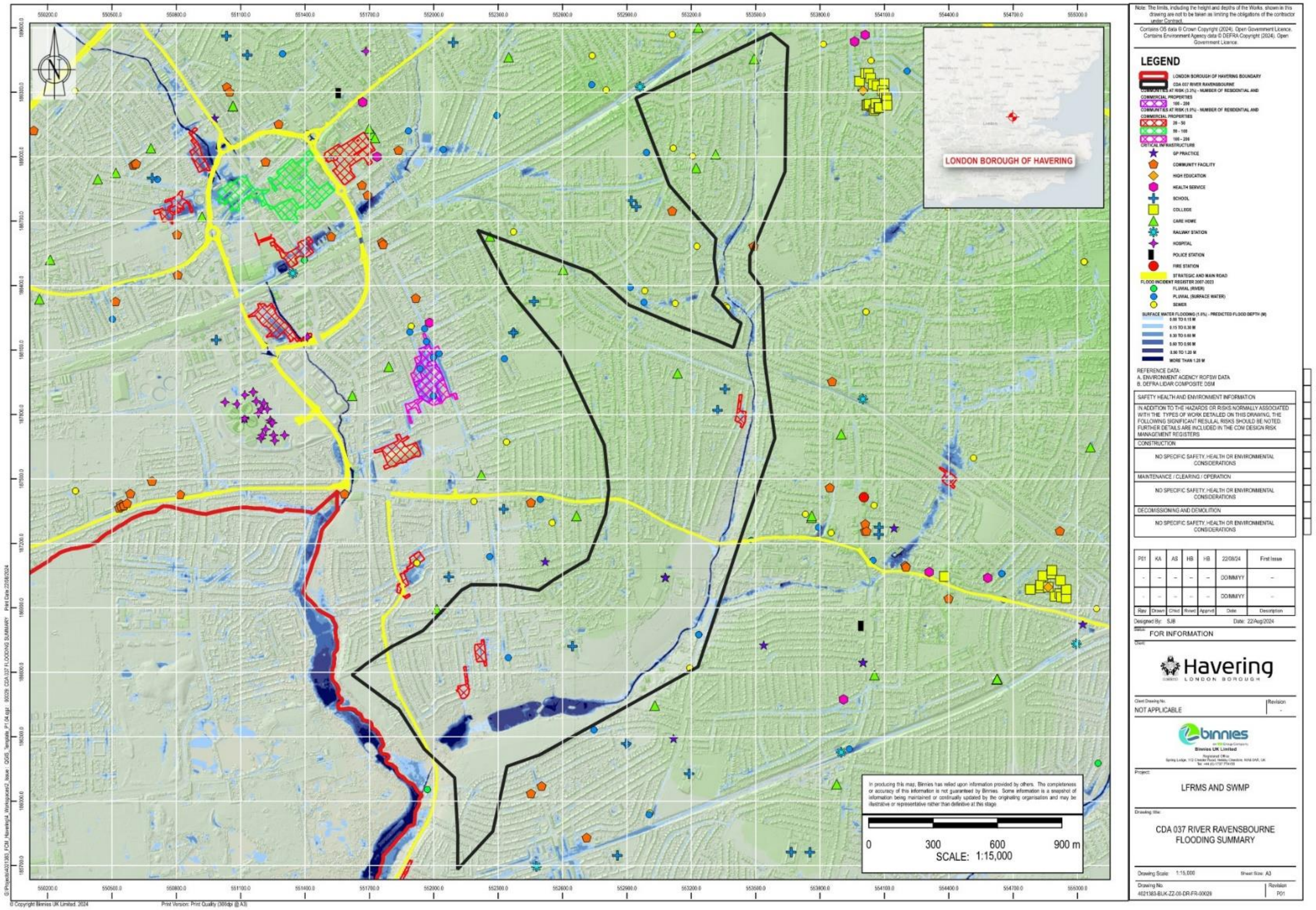

Figure C.12-1: CDA 037 River Ravensbourne Flooding Summary (not to scale, see A3 scaled maps in Appendix G)

C.13 CDA 038 – Heath Park North

Table C.13.1: Flooding in the Heath Park North CDA

CDA	038 - Heath Park North			
Potential Receptors (Critical Infrastructure and Homes)	Infrastructure		Number	
	Public/Community Facility		1	
	College		0	
	GP Surgery		0	
	Care/Nursing Home		1	
	Health Centres		2	
	Higher/Further Education		2	
	Major Roads		1	
	Schools		0	
	Strategic Sites Allocated		2	
	Fire Stations		0	
	Railway Stations		0	
	Police Stations		0	
	Hospitals		0	
	Properties		1,359	
Modelled Flooding	Surface Water	The EA risk of flooding from surface water maps show that surface water flooding impacts highways across the CDA and properties in the centre and south of the CDA. Highways shown to be impacted in all 1 in 30-, 100- and 1000-year surface water flooding scenarios are South Street, Clydesdale Road, Longfield Avenue, Allandale Road, Craigdale Road, Douglas Road, Park Lane, Albert Road, and Brentwood Road. The maximum flood depth across these roads is 0.6 metres.		
	Groundwater	The risk of flooding from groundwater varies across the CDA. The west of the CDA has a higher than 75% risk, the northeast is 25-50% risk and the southeast are less than 25%.		
	River and Sea	The risk of flooding from rivers and sea is in the south of the CDA. There is a small area of medium and high risk from the river Rom on the boundary of the CDA.		
Communities at Risk	Scenario	**1 in 30-year event** (3.3% chance)	**1 in 100-year event** (1% chance)	**1 in 1000-year event** (0.1% chance)
	Number of Communities	1	2	2
	Properties at Risk	129	268	621

CDA	038 - Heath Park North			
	Critical Infrastructure at Risk	2	2	3
	Description	In a 1 in 30-year surface water event scenario there is one community at risk located on Douglas Road with 108 properties at risk. In a 1 in 100-year surface water event, the number of properties increases to 192. The other community at risk in the 1 in 100-year event is on Clydesdale Road and has 22 properties at risk.		
Validation	There have been 8 reports of flooding in this CDA since 2007. All the flooding reports are within three highways: Brentwood Road, Douglas Road, and Park Lane. Four of the flooding reports are within the community at risk on Douglas Road. The surface water flooding event occurred on 25th June 2021 and 4 properties were flooded internally and externally. There all been three other surface water flooding events reported near Douglas Road community at risk.			

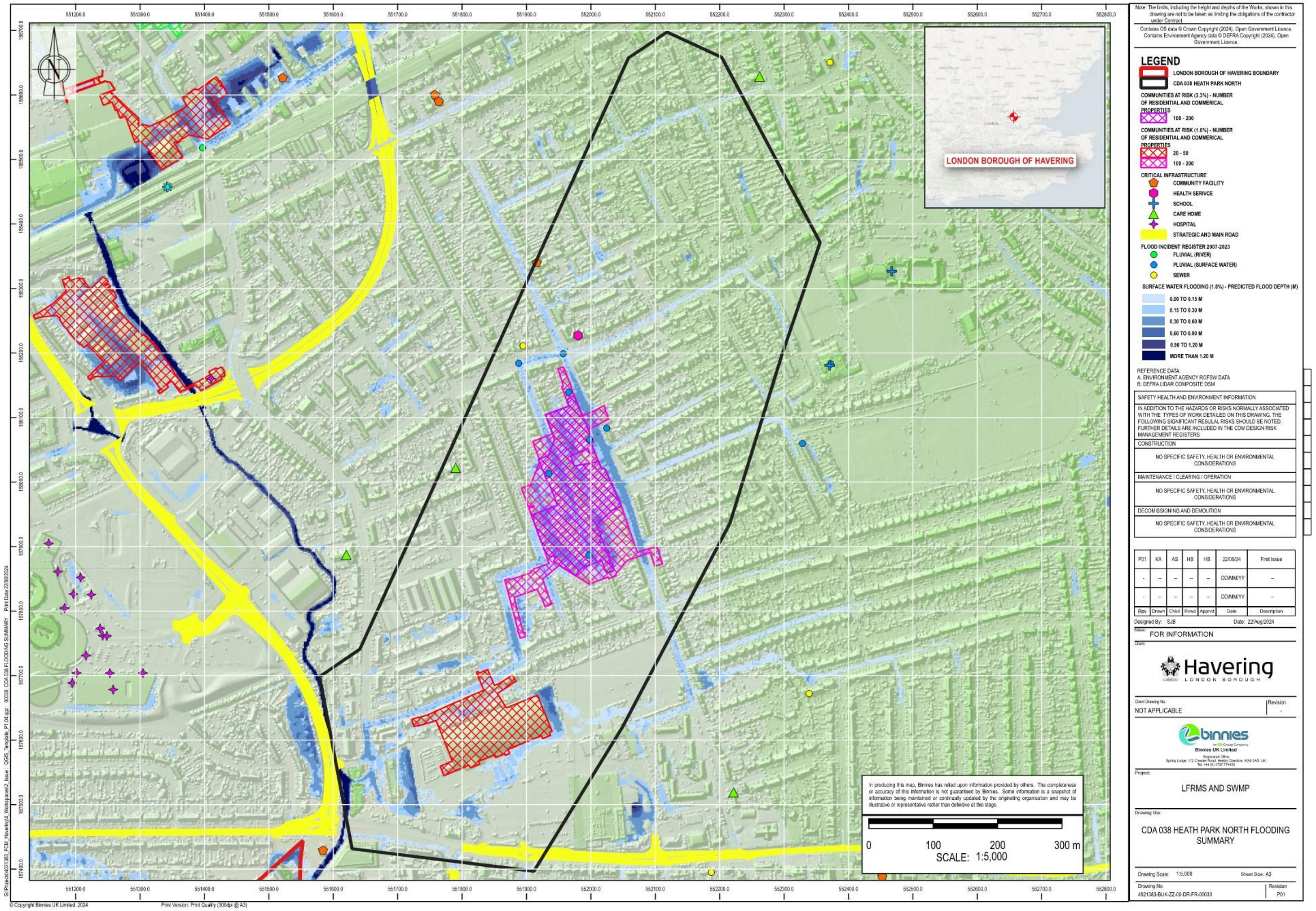

Figure C.13-1: CDA 038 Heath Park North Flooding Summary (not to scale, see A3 scaled maps in Appendix G)

C.14 CDA 039 – Heath Park South

Table C.14.1: Flooding in the Heath Park South CDA

<table>
<tr><th>CDA</th><th colspan="4">039 – Heath Park South</th></tr>
<tr><td rowspan="15">Potential Receptors (Critical Infrastructure and Homes)</td><td colspan="2">Infrastructure</td><td colspan="2">Number</td></tr>
<tr><td colspan="2">Public/Community Facility</td><td colspan="2">1</td></tr>
<tr><td colspan="2">College</td><td colspan="2">0</td></tr>
<tr><td colspan="2">GP Surgery</td><td colspan="2">1</td></tr>
<tr><td colspan="2">Care/Nursing Home</td><td colspan="2">3</td></tr>
<tr><td colspan="2">Health Centres</td><td colspan="2">1</td></tr>
<tr><td colspan="2">Higher/Further Education</td><td colspan="2">0</td></tr>
<tr><td colspan="2">Major Roads</td><td colspan="2">2</td></tr>
<tr><td colspan="2">Schools</td><td colspan="2">3</td></tr>
<tr><td colspan="2">Strategic Sites Allocated</td><td colspan="2">1</td></tr>
<tr><td colspan="2">Fire Stations</td><td colspan="2">0</td></tr>
<tr><td colspan="2">Railway Stations</td><td colspan="2">0</td></tr>
<tr><td colspan="2">Police Stations</td><td colspan="2">0</td></tr>
<tr><td colspan="2">Hospitals</td><td colspan="2">0</td></tr>
<tr><td colspan="2">Properties</td><td colspan="2">2,375</td></tr>
<tr><td rowspan="3">Modelled Flooding</td><td>Surface Water</td><td colspan="3">The EA risk of flooding from surface water maps show that various roads and highways are impacted by surface water flooding. Hornchurch road which is both a strategic and main highway is impacted by surface water flooding in all 1 in 30-, 100-, and 1000-year event scenarios. Other highways impacted in all scenarios are Bush Elms Road, Park Lane, Maygreen Crescent, Albany Road, Rainsford Way, Strathmore Gardens and Gordon Avenue.</td></tr>
<tr><td>Groundwater</td><td colspan="3">The risk of flooding from groundwater varies across the CDA. The west is at a higher risk than 75%, the north is at 25-50% and the east is at less than 25% risk.</td></tr>
<tr><td>River and Sea</td><td colspan="3">There is no risk of flooding from rivers and sea.</td></tr>
<tr><td rowspan="4">Communities at Risk</td><td>Scenario</td><td>1 in 30-year event (3.3% chance)</td><td>1 in 100-year event (1% chance)</td><td>1 in 1000-year event (0.1% chance)</td></tr>
<tr><td>Number of Communities</td><td>0</td><td>1</td><td>5</td></tr>
<tr><td>Properties at Risk</td><td>53</td><td>122</td><td>470</td></tr>
<tr><td>Critical Infrastructure at Risk</td><td>2</td><td>4</td><td>5</td></tr>
</table>

<table>
<tr><th>CDA</th><th colspan="2">039 – Heath Park South</th></tr>
<tr><td></td><td>Description</td><td>There is one community at risk in the 1 in 100-year surface water flood scenario. It has 35 properties at risk and is located across Upper Rainham Road and Strathmore Gardens. The number properties at risk increases to 97 in the 1 in 1000-year surface water flooding scenario.</td></tr>
<tr><td>Validation</td><td colspan="2">There have been 8 reports of flooding in this CDA since 2007, 50% of the reports were caused by surface water. One of the reports is in Strathmore Gardens, within the community at risk. In 2009, four residential properties and the highways were impacted by sewer flooding. Other highways which have flooded are Albany Road, Hornchurch Road, Granger Road, Globe Road, Strathmore Gardens, Norman Road and Babington Road.</td></tr>
</table>

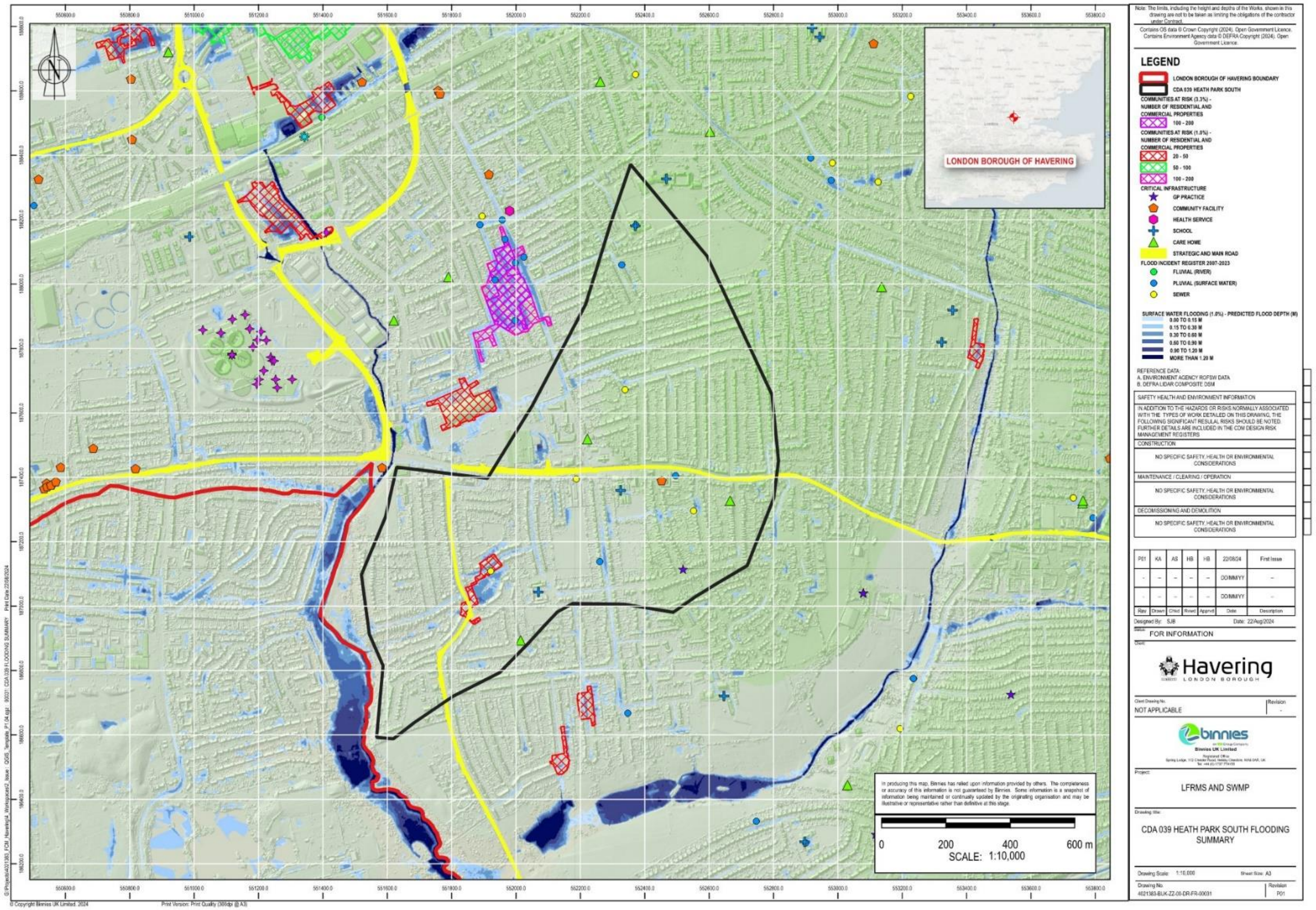

Figure C.14-1: CDA 039 Heath Park South Flooding Summary (not to scale, see A3 scaled maps in Appendix G)

C.15 CDA 040 – Harold Hill South

Table C.15.1: Flooding in the Harold Hill South CDA

CDA	040 – Harold Hill South			
Potential Receptors (Critical Infrastructure and Homes)	**Infrastructure**		**Number**	
	Public/Community Facility		4	
	College		0	
	GP Surgery		4	
	Care/Nursing Home		1	
	Health Centres		1	
	Higher/Further Education		0	
	Major Roads		0	
	Schools		3	
	Strategic Sites Allocated		1	
	Fire Stations		0	
	Railways Stations		0	
	Police Stations		0	
	Hospitals		0	
	Properties		1,643	
Modelled Flooding	**Surface Water**	The EA risk of flooding from surface water maps show that various highways and properties would be impacted by surface water flooding. Highways flooded in all surface water events scenarios are straight road, Hilldene Avenue, Chatteris Avenue, West Dene Drive, East Dene Drive, Chippenham Road, and Gooshays Drive.		
	Groundwater	The risk of flooding from groundwater is less than 25% across the entire CDA.		
	River and Sea	There is risk of flooding from rivers and sea in the east of the CDA, with a high to medium risk within green space around Paine's Brook.		
Communities at Risk	**Scenario**	**1 in 30-year event** (3.3% chance)	**1 in 100-year event** (1% chance)	**1 in 1000-year event** (0.1% chance)
	Number of Communities	0	4	6
	Properties at Risk	110	250	573
	Critical Infrastructure at Risk	1	5	7
	Description	There are 4 Communities at Risk in the 1 in 100-year surface water event scenario. They are located across		

CDA	**040 – Harold Hill South**	
		Hilldene Avenue, Daventry Road, Chatteris Avenue, Quilter Way, and Chippenham Road. The largest community at risk is located across Chippenham Road and Quilter Way and has 47 properties at risk.
Validation	There have been 3 reported flooding events in the CDA since 2007. One sewer flooding event was on Chatteris close, near the community at risk located on the same road. The flooding event was reported in 2012 when the highway was flooded. Surface water flooding was reported in Grange Road in 2016 when one property was flooded internally and externally. The stakeholders reported localised flooding caused by blocked gullies. Currently gully maintenance and clearing is conducted on a risk-based approach.	

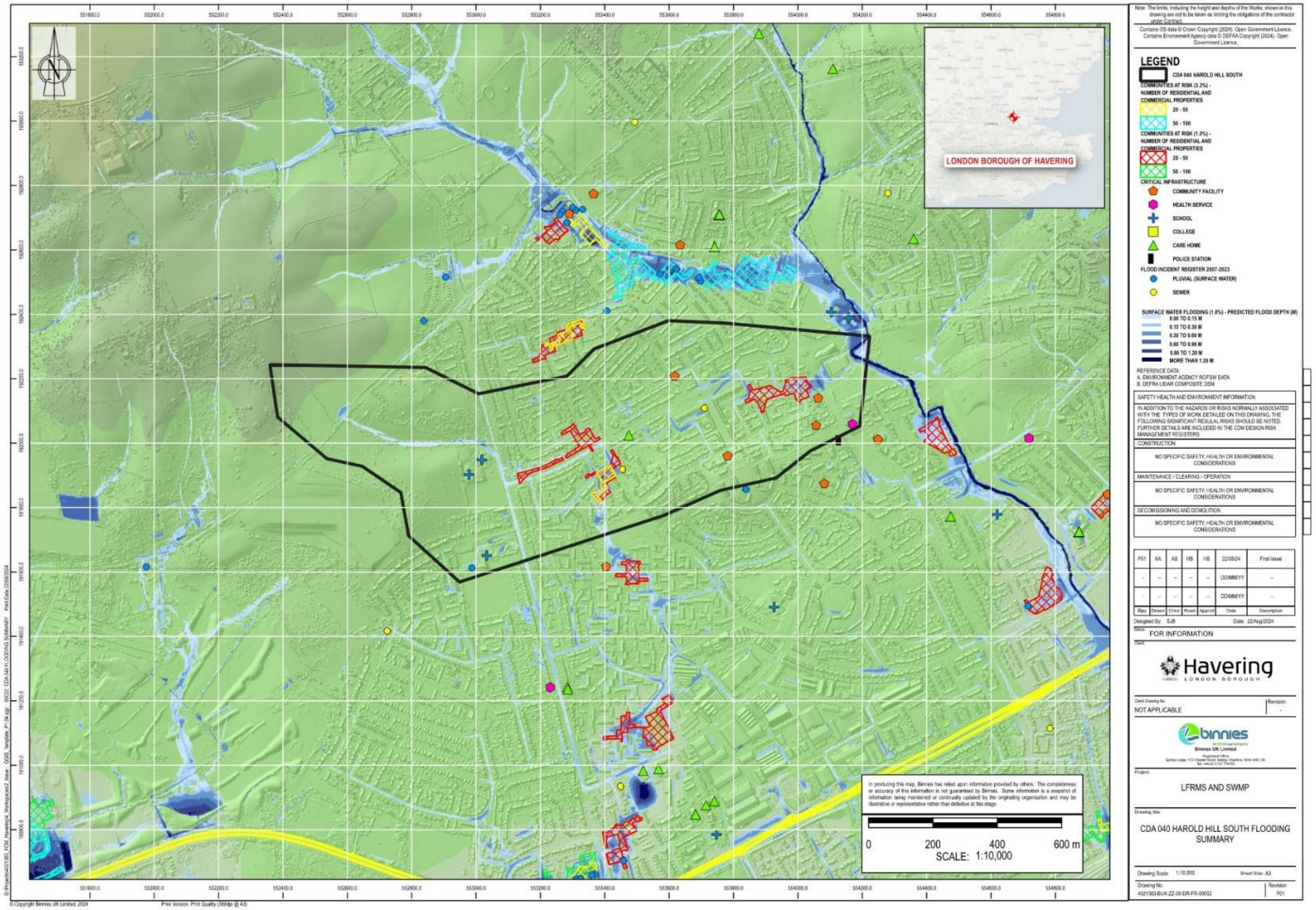

Figure C.15-1: CDA 040 Harold Hill South Flooding Summary (not to scale, see A3 scaled maps in Appendix G)

Appendix D: Multi Criteria Analysis

D.1 Multi Criteria Analysis Guidelines

Table D.1.1: Multi Criteria Analysis Guidelines

	Technical		Economic				Social	Environmental		Carbon	Objectives
	Is the measure technically effective in reducing flood risk?	*Is the measure practical to implement? (Buildability)*	*Is the measure expensive to implement? What is the cost per property?*	*Is long-term maintenance required and how significant are these costs?*	*Could the measure attract partnership funding contributions?*	*Would the measure reduce flooding to critical infrastructure, including the critical highways network?*	*Are there wider community benefits (e.g., footpaths, recreation, education, social cohesion)?*	*Are there opportunities to deliver wider ecological and BNG benefits?*	*Is the measure resilient to the impacts of climate change?*	*Carbon footprint*	*Will it help achieve the objectives of the SWMP?*
Score +2	Local reduction of flood risk by more than one risk band with no third party or downstream impacts.	Two or more of: good access, public land, within the council Highways capability		Significantly reduces maintenance relative to existing and costs	Very likely - Local stakeholders able to contribute AND in current RFCC programme.	Yes, reduces flooding to the A road network and/ or a major facility such as a hospital or school	Potential improvement to recreation, footpaths, or social cohesion more widely	Potentially improves designated site or protected species	Measure can be designed to cope with predicted extreme rainfall intensities	Potential for carbon sequestration (e.g., NFM measures)	Measure meets 5 or more of the objectives including the highways objective
Score +1	Local reduction of flood risk by up to one risk band with no third party or downstream impacts.	One of: good access, public land, within the council Highways capability		Reduces maintenance relative to existing and costs	Likely - Local stakeholders able to contribute OR in current RFCC programme.	Yes, reduces flooding to the local road network	Potential improvement to recreation, footpaths, or social cohesion locally	Potentially creates or improves habitat or non-protected species	Measure can be designed to cope with predicted severe rainfall intensities	Low carbon footprints - by including mitigation and offsetting opportunities	Measure meets less than 5 of the objectives (plus highway objectives)
Score 0	No change locally or downstream.	Option does not require physical implementation	No additional cost.	No change relative to existing maintenance regime.	Unlikely/unsure - No local stakeholders can contribute OR not in current RFCC programme.	No change/unsure	No change/unsure	No change/unsure	Measure can be designed to cope with designed rainfall intensities	Low carbon footprint - (NFM, local materials, local workforce, no movement of material)	Measure meets lets than 5 of the objectives (not highway objectives)
Score -1	Potential local reductions to flood risk but may increase risk downstream by up to one risk band.	One of: difficult access, work on private land, requires external contractor, working at height or in confined spaces	Low capital cost *less than £10k* (can be implemented by in-house workforce)	Requires additional intermittent maintenance relative to existing maintenance regime.	Potential detriment to critical infrastructure locally		Potential detriment to recreation, footpaths, or social cohesion locally	Potentially detriment to habitat or non-protected species	Measure likely to fail with predicted severe rainfall intensities.	Medium carbon footprints - 1 of the following plus low carbon actions (use of concrete, mortars & cement; metals; plastic, transport or material, use of quarried material, plant emissions, Waste removal)	Measure meets few of the objectives
Score -2	Potential local reductions to flood risk but may increase risk downstream by more than one risk band.	Two or more of: difficult access, work on private land, requires external contractor, working at height or in confined spaces	High capital cost *more than £10k* (will require a contractor)	Requires additional regular maintenance relative to existing maintenance regime.	Potential detriment to critical infrastructure more widely		Potential detriment to recreation, footpaths, or social cohesion more widely	Potentially detriment to designated site or protected species	Measure likely to fail with predicted extreme rainfall intensities.	Large carbon footprint - 2 or more (use of concrete, mortars & cement; metals; plastic, transport or material, use of quarried material, plant emissions, Waste removal)	Measure meets none of the objectives

D.2 LFRMS measures codes

Table D.2.1: LFRMS measures codes

LFRMS Aims	Code	Objective
Supporting communities to be more flood resilient	A1	• To increase awareness of flood risk in the Borough with internal and external stakeholders and members of the public. • To work with Local Resilience Forum partners to improve our preparedness, resilience, and response to flood events. • To take a risk-based and affordable approach to managing flood risk across the Borough.
Working with others to reduce flood risk	A2	• To work together with internal and external stakeholders to manage flooding from all sources in the Borough. • To increase understanding internally and externally of the Lead Local Flood Authority role. • To work with internal and external stakeholders to take a consistent and prioritised approach managing drainage and flood risk assets in the Borough, with an emphasis to maintenance of existing drainage infrastructure, including watercourses.
Making places flood resilient	A3	• To deliver a prioritised programme of works to alleviate flooding, including natural flood management measures. • To embed actions to reduce flood risk into our approach to manage the highways network. • To integrate policies and guidance to reduce flood risk through new development into our approach as a Local Planning Authority.

D.3 CDA 005 Ardleigh Green East

Table D.3.1: CDA 005 Ardleigh Green East Multi Criteria Analysis

Ref.	Option/Measure	LBH Aims	Description/Examples	Technical		Economic				Social	Environmental			Objectives	Total Viability Score	Comments
				Is the measure technically effective in reducing flood risk?	Is the measure practical to implement?	Is the measure expensive to implement?	Is long-term maintenance required and how significant are these costs?	Could the measure attract partnership funding contributions?	Would the measure reduce flooding to critical infrastructure, including the critical highways network?	Are there wider community benefits?	Are there wider ecological and BNG benefits?	Is the measure resilient to the impacts of climate change?	Carbon footprint	Will it help achieve the objectives of the SWMP?		
Mitigation Measures - Non-Structural Actions (management and maintenance)																
NS1	Self-help – Property-level protection and resilience	P3, F3	Measures that prevent water entry or reduce the amount of floodwater that enters a property e.g., flood doors, flood gates, self-closing air bricks.	1	1	0	-1	1	0	0	0	-1	-1	0	0	Property level resilience is likely to reduce flood risk by one band, assuming maximum protection to 0.6m, however the reduction is very localised to the properties effected and where the measures are implemented. Practical to implement because they are individual properties but would have to communicate with owners. Property level protection has no mapping already implemented. In climate change flooding scenario the depth flood depth is 0.3-0.6 meters. Typical cost of property level protection £10 -15k per property. Withstand up until 0.6m, anything above needs a structural survey to extend up to 0.9m.
NS2	Asset management and maintenance	L1, F3, H1, A1, P3	Existing culvert running through communities at risk (Great Nelmes Chase)	0	-2	0	0	0	0	0	0	-1	0	1	-2	Scoring could vary by the conveyance element implemented, however in this CDA there is limited space got environmental elements e.g., swales to be implemented.
NS3	Relocation of properties or infrastructure away from flood risk areas	P3, F3, H1, F2	Proposing new developments in areas with low flood risk and having availability to move existing critical infrastructure to low flood risk areas.	0	-2	-2	0	0	0	-1	0	0	-2	1	-6	No strategic or regeneration development areas are located within the CDA. This would not be feasible to implement.
NS4	Watercourse management and maintenance	F2, F3, P3, H1	Maintenance to ensure optimal functionality and prevent degradation e.g., keeping growth of vegetation under control, free of debris and reducing excess silt.	1	-1	-1	-1	0	0	0	0	1	-1	0	-2	The entirety of the watercourse is culverted so maintenance would require working in confined spaces. The river is entirely culverted, so this is not feasible
Mitigation Measures - Structural Actions																
S1	Infiltration (and evaporation) for managing 'everyday rain'	E1, F3, P3, H1	An engineering structure to collect rainwater from impermeable services e.g., rain gardens.	0	-1	-1	-1	1	1	1	1	0	-1	1	1	Limited space for implementation and no future developments, only potential would be at school or college. No known projects for this to be included. Not resilient to climate change but we acknowledge that it could reduce climate change impacts Wider implementation could reduce flood risk to strategic roads but would not cause an effect on its own.
S2	Conveyance for managing 'usual rainfall'	E1, F3, P3	Designed to collect, delay, and convey rainfall using green infrastructure techniques. This is generally above ground management. E.g., filter strips and swales etc	0	-1	-1	-1	0	1	1	0	0	-1	1	-1	Scoring could vary by the conveyance element implemented, however in this CDA there is limited space for environmental elements e.g., swales to be implemented.
S3	Storage for managing 'extreme rainfall'	E1, F3, P3	Designed to collect, delay, and convey rainfall using green infrastructure techniques. This is generally above ground management e.g., swales and wet ponds.	0	-1	-1	-1	1	1	1	1	2	-2	1	2	There is lack of space in the CDA for large scale attenuation for extreme rainfall.

Ref.	Option/Measure	LBH Aims	Description/Examples	Technical: Is the measure technically effective in reducing flood risk?	Technical: Is the measure practical to implement?	Economic: Is the measure expensive to implement?	Economic: Is long-term maintenance required and how significant are these costs?	Economic: Could the measure attract partnership funding contributions?	Economic: Would the measure reduce flooding to critical infrastructure, including the critical highways network?	Social: Are there wider community benefits?	Environmental: Are there wider ecological and BNG benefits?	Environmental: Is the measure resilient to the impacts of climate change?	Environmental: Carbon footprint	Objectives: Will it help achieve the objectives of the SWMP?	Total Viability Score	Comments
S4	Restoring urban watercourse	E1, F3	This technique aims to mimic natural processes as much as possible without increasing flood risk e.g., in channel enhancements, larger scale river restoration and SuDS.	0	-2	-2	0	0	-1	-1	1	0	-2	0	-7	Heavily modified culverted watercourse which is very unlikely to be able to be restored. Would cause a significant impact to the community. Would cause increase biodiversity in the river channel and surrounding areas. Large scale construction would be needed. Meets two objectives excluding the highways objectives.
S5	Urban watercourse engineering	F3, H1, P3	Hard engineering flood techniques e.g., storage, embankments, water and diversion channels.	0	-2	-2	-1	0	0	-2	-1	0	-2	1	-9	Unlikely to be an option for this CDA, no space available and mainly in private property. Hard engineering techniques could be damaging to ecology and would have a high carbon footprint. Meets three objectives including the highway objective. Would cost more than £10k. Would need to be maintained to remain effective.
S6	Run-off reduction strategy	P1, F3, P3	A long-term plan for making whole urban areas greener and more permeable, this uses green infrastructure techniques to allow increased infiltration.	1	-1	-2	-1	0	1	0	1	0	-1	0	-2	Most built up areas and the green spaces available are parks or school fields so unlikely to be an option. Meet four objectives including the highway's objective. Would cost more £10k. The increase of more greenspaces could increase recreation in the CDA. Reduce runoff would also impact runoff on the local road network.
S7	Reducing surface water in the sewer	F3	Infiltration and storage can be used to reduce water in sewers e.g. soakaways and reducing impermeable surfaces. Section 19 - Investigate scope to increase surface water sewer capacity in the locations affected by flooding.	0	-1	-1	-1	0	0	0	1	1	-1	1	-1	There is a wide range of benefits depending on the type of measures e.g., green/grey measures implemented Would cost more than £10k. Could have a high carbon footprint due to the use and transport of materials, workforce and machinery used. Meets one objective excluding the highways objective.
S8	Land management	P1, H1, F3, E1, P3	Implementing land management actions will reduce the volume of run-off, to reduce the flood risk further downstream.	1	-1	-2	-1	0	1	-1	-1	1	-1	2	-2	We believe this would be more targeted for rural areas, limited available space. Would need to be maintained so it is fully effective. Potentially would reduce the volume of surface water on the local highways. Would cost more than £10k. Meets five objectives including the highways objective.
S9	Underground storage	P2, F3, H1	Divert surface water to storage tanks or by providing storage in the existing drainage / flood management network.	1	-2	-2	-1	0	1	0	-1	1	-2	1	-4	Unlikely to be feasible - stakeholders did not inform of projects in this CDA. Available space across the CDA. Would need to be maintained so it is fully effective. Potentially would reduce the volume of surface water on the local highways. Would cost more than £10k. Meets three objectives including the highways objective.
S10	Underground conveyance	P2, F3, H1	Increase capacity or build new underground pipes for surface water.	1	-2	-2	-1	0	1	0	-1	1	-2	1	-4	Unlikely to be feasible - stakeholders did not inform of projects in this CDA. Available space across the CDA. Would need to be maintained so it is fully effective. Potentially would reduce the volume of surface water on the local highways. Would cost more than £10k. Meets three objectives including the highways objective.
S11	Modification of culverted watercourses	P2, F3, H1	Aims to increase the capacity of culverted watercourses or divert culverted watercourses.	1	-2	-2	-1	0	1	-1	0	1	-2	1	-4	Could be added under the increasing surface water sewer capacity - S7. Meets three objectives including the highways objective. Would cost more than £10k. Increased capacity in the culverts would reduce the volume of run off on the local road network. Material would be used and transported with machinery emissions would create a high carbon footprint.

D.4 CDA 014 – River Rom and Beam River

Table D.4.1: CDA 014 River Rom and Beam River Multi Criteria Analysis

Ref.	Option/Measure	LBH Aims	Description/Examples	Technical		Economic				Social	Environmental			Objectives	Total Viability Score	Comments
				Is the measure technically effective in reducing flood risk?	Is the measure practical to implement?	Is the measure expensive to implement?	Is long-term maintenance required and how significant are the costs?	Could the measure attract partnership funding contributions?	Would the measure reduce flooding to critical infrastructure, including the critical highways network?	Are there wider community benefits?	Are there wider ecological and BNG benefits?	Is the measure resilient to the impacts of climate change?	Carbon footprint	Will it help achieve the objectives of the SWMP?		
Mitigation Measures - Non-Structural Actions (management and maintenance)																
NS1	Self-help – Property-level protection and resilience	P3, F3	Measures that prevent water entry or reduce the amount of floodwater that enters a property e.g., flood doors, flood gates, self-closing air bricks.	1	1	-2	-1	1	0	0	0	-2	-2	0	-4	Would be beneficial for most properties in the communities at risk across the CDA. Some would have undergone a structural survey before. Would not be effective in climate change scenario. Would have a high carbon footprint because of the use and transport of materials. Would cost more than £10k.
NS2	Asset management and maintenance	L1, F3	Having a register of all existing assets and maintenance plan which includes frequency of maintenance.	0	-2	-2	-1	0	1	0	0	1	0	1	-2	Long term regular maintenance would be required as part of the plan and maintenance could be increased to adapt to climate change scenario. Meets three objectives including highway's objective. Implementing and actioning the plan could involve working in confined spaces. River Rom is culverted in some locations so would involve working in confined spaces
NS3	Relocation of properties or infrastructure away from flood risk areas	P3, F3, H1	Proposing new developments in areas with low flood risk and having availability to move existing critical infrastructure to low flood risk areas.	1	-2	-2	0	0	0	-1	-1	1	-2	1	-5	Would cost more than £10k. Meets three objectives including the highway's objective. Infrastructure could be relocated to an area which would not be flooded in a climate change scenario. High carbon footprint from transport and use of materials, construction, and machinery. Relocating to a greenspace, detrimental impacts to the existing habitats. Reduces the space in the CDA for recreation.
NS4	Watercourse management and maintenance	F2, F3, P3	Maintenance to ensure optimal functionality and prevent degradation e.g., keeping growth of vegetation under control, free of debris and reducing excess silt.	1	-1	-1	-1	0	1	0	0	1	-1	0	-1	Would be implemented for accessible locations along the river Rom Would need to be continuously maintained. Meets three objectives excluding the highways objective. Maintenance could be increased to meet the increased flow from climate change.
Mitigation Measures - Structural Actions																
S1	Infiltration (and evaporation) for managing 'everyday rain'	E1, F3, P3	An engineering structure to collect rainwater from impermeable services e.g., rain gardens.	1	1	-1	-1	1	1	0	1	0	0	1	4	Available accessible space across the CDA. Meets four objectives excluding the highway objective. Would cost less than £10k. Low carbon footprint from the use of local workforce and materials. Would be more effective if works alongside other green infrastructure techniques.
S2	Conveyance for managing 'usual rainfall'	E1, F3, P3, H1	Designed to collect, delay, and convey rainfall using green infrastructure techniques. This is generally above ground management.	1	1	-1	-1	1	1	-1	1	0	-1	1	2	Available accessible space across the CDA. Meets objectives including the highways objective. Would be more effective if works alongside other green infrastructure techniques. Would cost less than £10k. Medium carbon footprint as material would need to be transported.
S3	Storage for managing 'extreme rainfall' Investigate opportunities to provide storage at the Cross Road decommissioned Flood Storage Area	E1, F3, P3, H1	Designed to collect, delay, and convey rainfall using green infrastructure techniques. This is generally above ground management e.g., swales and wet ponds.	1	1	-1	-1	1	1	-1	1	1	-1	1	3	Available accessible space across the CDA. Meets four objectives including the highways objective. Would be more effective if works alongside other green infrastructure techniques. Would cost less than £10k. Medium carbon footprint as material would need to be transported. Could be adapted to store larger volumes of water caused by climate change scenarios.
S4	Restoring urban watercourse	E1, F3	This technique aims to mimic natural processes as much as possible without increasing flood risk e.g. in channel enhancements, larger scale river restoration and SuDS.	1	-2	-2	0	0	-2	1	1	0	-1	0	-4	Would encourage the natural processes of the river Rom. Meets two objectives excluding the highways objective. Would cost more than £10k. Potentially could affect community benefits for example pathways and land near the river Rom being more accessible. Encourages natural ecological and biodiversity processes on the watercourse.
S5	Urban watercourse engineering	F3, H1, P3	Hard engineering flood techniques e.g. storage, embankments, water and diversion channels.	1	-2	-2	1	0	1	-1	-1	1	-2	1	-3	Meets three objectives including the highways objective. Potentially could use to protect schools and critical infrastructure near watercourses. High carbon footprint from many factors including the use and transport of materials, potential quarried materials. Would cost more than £10k. Measure could be adapted to meet the needs to protect against a climate change flooding scenario. Depending on the scale it could impact community and ecological benefits negatively.

				Technical		Economic				Social	Environmental			Objectives		
Ref.	**Option/Measure**	**LBH Aims**	**Description/Examples**	**Is the measure technically effective in reducing flood risk?**	**Is the measure practical to implement?**	**Is the measure expensive to implement?**	**Is long-term maintenance required and how significant are the costs?**	**Could the measure attract partnership funding contributions?**	**Would the measure reduce flooding to critical infrastructure, including the critical highways network?**	**Are there wider community benefits?**	**Are there wider ecological and BNG benefits?**	**Is the measure resilient to the impacts of climate change?**	**Carbon footprint**	**Will it help achieve the objectives of the SWMP?**	**Total Viability Score**	**Comments**
S6	Run-off reduction strategy	P1, F3, P3	A long-term plan for making whole urban areas greener and more permeable, this uses green infrastructure techniques to allow increased infiltration.	1	1	-2	-1	0	2	1	1	0	-1	1	3	This CDA would be an ideal location to implement this measure because it stretches the entire length of LBH and the river Rom, water could be held in the north of the CDA and delayed before reaching impermeable surfaces in the centre. Pathways could be introduced through the permeable areas. Meets four objectives including the highways objective. The removal and transport of materials creates a medium carbon footprint.
S7	Reducing surface water in the sewer	F3	Infiltration and storage can be used to reduce water in sewers e.g., soakaways and reducing impermeable surfaces. Measure from previous section 19: Investigate scope to increase surface water sewer capacity in the locations affected by flooding.	1	1	-2	-1	0	0	0	0	0	-2	-1	-4	Introducing soakaways could impact pathways and recreational areas. Available space to implement across the CDA, larger greenspaces in the north or south. Meets one objective excluding the highways objective. Unlikely to be able to cope with climate change scenarios. Would cost more than £10k.
S8	Land management	P1, H1, F3, E1, P3	Implementing land management actions will reduce the volume of run-off, to reduce the flood risk further downstream. Measure from previous section 19: Investigate opportunities for land management and flow management in the upper reaches of each catchment.	1	1	-2	-1	0	0	-1	-1	0	-1	2	-2	This CDA would be an ideal location to implement this measure because it stretches the entire length of LBH and the river Rom. Could impact the community and ecology of the CDA negatively depending on the scale and location.
S9	Underground storage	P2, F3, H1	Divert surface water to storage tanks or by providing storage in the existing drainage / flood management network.	1	-2	-2	-1	0	1	0	-1	1	-2	1	-4	Available space across the CDA. Would need to be maintained so it is fully effective. Potentially would reduce the volume of surface water on the local highways. Would cost more than £10k. Meets three objectives including the highways' objective.
S10	Underground conveyance	P2, F3, H1	Increase capacity or build new underground pipes for surface water.	1	-2	-2	-1	0	1	0	-1	1	-2	1	-4	Available space across the CDA. Would need to be maintained so it is fully effective. Potentially would reduce the volume of surface water on the local highways. Would cost more than £10k. Meets three objectives including the highways' objective.
S11	Modification of culverted watercourses	P2, F3, H1	Aims to increase the capacity of culverted watercourses or divert culverted watercourses.	1	-2	-2	-1	0	1	0	0	1	-2	1	-3	Would be beneficial to increase the capacity to be able to cope with climate change scenarios. Meet three objectives including the highways' objective. Would cost more than £10k. The removal, use and transport of materials creates a high carbon footprint.
S12	Specific planning policy	H1	A new planning policy aiming to provide a considerable improvement of surface water runoff for development in strategic sites and redevelopment areas. Green infrastructure should be favoured over grey.	1	1	0	0	0	2	1	1	1	-1	1	7	This measure is not a structural measure, it will lead to implementation on the ground for SuDS and other runoff reduction measures. Although these measures would not be built in public land, they will need to be considered as there would be a planning policy requirement. Analysing the impact of the policy rather than the policy itself. Regarding to carbon - there would be a lot of construction involved but this policy will work alongside other carbon reduction policy which is likely to offset some of the carbon footprint of the development over its lifetime. This measure would support the objectives H1

Ref.	Option/Measure	LBH Aims	Description/Examples	Technical		Economic				Social	Environmental			Objectives	Total Viability Score	Comments
				Is the measure technically effective in reducing flood risk?	Is the measure practical to implement?	Is the measure expensive to implement ?	Is long-term maintenance required and how significant are the costs?	Could the measure attract partnership funding contributions?	Would the measure reduce flooding to critical infrastructure, including the critical highways network?	Are there wider community benefits?	Are there wider ecological and BNG benefits?	Is the measure resilient to the impacts of climate change?	Carbon footprint	Will it help achieve the objectives of the SWMP?		
Mitigation Measures - Carried Over																
C1	Implement feasibility study to understand opportunities to provide storage in greenspace, parks and regeneration and developments areas (Romford strategic development area and industrial strategic area)	H1	A new planning policy aiming to provide a considerable improvement of surface water runoff for development in strategic sites and redevelopment areas. Green infrastructure should be favoured over grey. Implement feasibility study to understand opportunities to provide storage in greenspace, parks and regeneration and developments areas (Romford strategic development area and industrial strategic area)	1	0	-1	-1	2	1	1	1	1	-1	2	6	This measure is not a structural measure, it will lead to implementation on the ground for SuDS and other runoff reduction measures. Although these measures would not be built in public land, they will need to be considered as there would be a planning policy requirement. Analysing the impact of the policy rather than the policy itself. Regarding to carbon - there would be a lot of construction involved but this policy will work alongside other carbon reduction policy which is likely to offset some of the carbon footprint of the development over its lifetime. This measure would support the objectives H1 Feasibility of increasing capacity in greenspace, parks and regeneration and developments areas (Romford strategic development area and industrial strategic area). This analysis is of the effects of the study and the potential impacts. Assuming that projects implemented are the short list of the study.

D.5 CDA 015 – Havering Park

Table D.5.1: CDA 015 Havering Park Multi Criteria Analysis

				Technical		Economic				Social	Environmental			Objectives		
Ref.	**Option/Measure**	**LBH Aims**	**Description/Examples**	**Is the measure technically effective in reducing flood risk?**	**Is the measure practical to implement?**	**Is the measure expensive to implement?**	**Is long-term maintenance required and how significant are the costs?**	**Could the measure attract partnership funding contributions?**	**Would the measure reduce flooding to critical infrastructure, including the critical highways network?**	**Are there wider community benefits?**	**Are there wider ecological and BNG benefits?**	**Is the measure resilient to the impacts of climate change?**	**Carbon footprint**	**Will it help achieve the objectives of the SWMP?**	**Total Viability Score**	**Comments**
Mitigation Measures - Non-Structural Actions (management and maintenance)																
NS1	Self-help – Property-level protection and resilience	P3, F3	Measures that prevent water entry or reduce the amount of floodwater that enters a property e.g. flood doors, flood gates, self-closing air bricks.	1	1	-2	-1	1	0	0	0	-1	-2	0	-3	Majority of the community at risk properties is located in flood depth of less than 0.6 metres and more between 0.6 and 0.9 metres in a 1 in 100-year flood events, with the highest depths of between 0.9 and >1.2 metres in the middle of the road. This option could be used for some properties but would not be beneficial for all. The properties with flood depth between 0.6 and 0.9 would need structural surveys completed. This measure would not mitigate flooding on the highways network. Use of metal and concrete which has been transported. Does not provide an environmental, community and BNG benefit for the local area as each measure is implemented directly onto a household.
NS2	Asset management and maintenance	L1, F3	Having a register of all existing assets and maintenance plan which includes frequency of maintenance.	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-22	There is no watercourse flowing through the CDA
NS3	Relocation of properties or infrastructure away from flood risk areas	P3, F3, H1	Proposing new developments in areas with low flood risk and having availability to move existing critical infrastructure to low flood risk areas.	2	1	-2	0	0	2	1	-1	2	-2	1	4	The measure could be implemented so that the infrastructure is relocated to an area which is outside a climate change flooding scenario extent. The part of the CDA which is inside the Havering boundary is over 50% green space which could potentially be used for relocation of infrastructure. Rebuilding infrastructure and moving materials means that there would be no positive social or environmental impacts.
NS4	Watercourse management and maintenance	F2, F3, P3	Maintenance to ensure optimal functionality and prevent degradation e.g., keeping growth of vegetation under control, free of debris and reducing excess silt.	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-22	There is no watercourse flowing through the CDA
Mitigation Measures - Structural Actions																
S1	Infiltration (and evaporation) for managing 'everyday rain'	E1, F3, P3	An engineering structure to collect rainwater from impermeable services e.g., rain gardens.	1	1	-1	-1	1	1	0	1	0	-1	0	2	The part of the CDA which is inside the Havering boundary is over 50% green space which could potentially be used for rain gardens and green conveyance techniques, as well as green space on Walton Road. Flood risk will be reduced more by the measure working alongside other green measures.
S2	Conveyance for managing 'usual rainfall'	E1, F3, P3, H1	Designed to collect, delay, and convey rainfall using green infrastructure techniques. This is generally above ground management.	1	1	-1	-1	1	1	0	1	0	-1	1	3	The part of the CDA which is inside the Havering boundary is over 50% green space which could potentially be used for rain gardens and green conveyance techniques, as well as green space on Walton Road. Flood risk will be reduced more by the measure working alongside other green measures.
S3	Storage for managing 'extreme rainfall'	E1, F3, P3, H1	Designed to collect, delay, and convey rainfall using green infrastructure techniques. This is generally above ground management e.g., swales and wet ponds. (Create detention basins in the land to the west of Frinton Road) Previous SWMP measure: Create detention basins in the land to the west of Frinton Road.	1	1	-1	-1	1	1	0	1	1	-1	1	4	The part of the CDA which is inside the Havering boundary is over 50% green space which could potentially be used for storage techniques, as well as green space on Walton Road.
S4	Restoring urban watercourse	E1, F3	This technique aims to mimic natural processes as much as possible without increasing flood risk e.g., in channel enhancements, larger scale river restoration and SuDS.	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-22	There is no watercourse flowing through the CDA
S5	Urban watercourse engineering	F3, H1, P3	Hard engineering flood techniques e.g. storage, embankments, water and diversion channels.	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-22	There is no watercourse flowing through the CDA
S6	Run-off reduction strategy	P1, F3, P3, H1	A long-term plan for making whole urban areas greener and more permeable, this uses green infrastructure	1	1	-1	0	1	1	1	1	0	-1	1	5	The plan could cover the need to keep green spaces were possible and reduce development. Possibility to reduce impermeable surfaces and replace with permeable surface on wide pavements.

Ref.	Option/Measure	LBH Aims	Description/Examples	Technical		Economic				Social	Environmental			Objectives	Total Viability Score	Comments
				Is the measure technically effective in reducing flood risk?	Is the measure practical to implement?	Is the measure expensive to implement?	Is long-term maintenance required and how significant are the costs?	Could the measure attract partnership funding contributions?	Would the measure reduce flooding to critical infrastructure, including the critical highways network?	Are there wider community benefits?	Are there wider ecological and BNG benefits?	Is the measure resilient to the impacts of climate change?	Carbon footprint	Will it help achieve the objectives of the SWMP?		
			techniques to allow increased infiltration.													
S7	Reducing surface water in the sewer	F3, H1, P3	Infiltration and storage can be used to reduce water in sewers e.g. soakaways and reducing impermeable surfaces.	1	1	-1	-1	1	0	-1	-1	-1	-2	1	-3	Soakaways can be used in residential areas. Soakaways would use quarried and transported materials. Implementation of soakaways could potentially need working in confined spaces.
S8	Land management	P1, H1, F3, E1, P3	Implementing land management actions will reduce the volume of run-off, to reduce the flood risk further downstream.	1	1	-1	-1	1	1	2	1	-1	-1	1	4	Potentially can be implemented in the greenspace of the CDA, could be used to hold and slow water away from more residential areas.
S9	Underground storage	P2, F3, H1	Divert surface water to storage tanks or by providing storage in the existing drainage / flood management network.	1	-1	-1	-1	0	1	0	0	0	-2	1	-2	This measure would include working in confined spaces. The pipes would be adapted to meet the increased flow due to climate change. The measure would include using machinery, materials, and transport. Assuming it would not be practical and expensive to implement due to having to have contactor and being in a residential area.
S10	Underground conveyance	P2, F3, H1	Increase capacity or build new underground pipes for surface water.	1	-2	-2	-1	0	1	0	0	1	-2	1	-3	This measure would include working in confined spaces. The pipes would be adapted to meet the increased flow due to climate change. The measure would include using machinery, materials, and transport. Assuming it would not be practical and expensive to implement due to having to have contactor and being in a residential area.
S11	Modification of culverted watercourses	P2, F3, H1	Aims to increase the capacity of culverted watercourses or divert culverted watercourses.	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-22	There is no watercourse flowing through the CDA

D.6 CDA 016 Rise Park West

Table D.6.1:CDA 016 Rise Park West Multi Criteria Analysis

Ref.	Option/Measure	LBH Aims	Description/Examples	Technical: Is the measure technically effective in reducing flood risk?	Technical: Is the measure practical to implement?	Economic: Is the measure expensive to implement?	Economic: Is long-term maintenance required and how significant are the costs?	Economic: Could the measure attract partnership funding contributions?	Economic: Would the measure reduce flooding to critical infrastructure, including the critical highways network?	Social: Are there wider community benefits?	Environmental: Are there wider ecological and BNG benefits?	Environmental: Is the measure resilient to the impacts of climate change?	Environmental: Carbon footprint	Objectives: Will it help achieve the objectives of the SWMP?	Total Viability Score	Comments
Mitigation Measures - Non-Structural Actions (management and maintenance)																
NS1	Self-help – Property-level protection and resilience	P3, F3	Measures that prevent water entry or reduce the amount of floodwater that enters a property e.g., flood doors, flood gates, self-closing air bricks.	1	1	-2	-1	1	2	0	0	0	-2	0	0	The measure would be beneficial for the community at risk in the north of the CDA because the flood depth is around 0.3 metres. This measure would also be resilient for climate change impacts. In the lower community at risk, it would be beneficial to come properties because the flood depth is between 0.3 and 0.9 metres. This means that for some properties that the measure can be used but the property would need a structural survey first. This measure would not be resilient to climate change impacts because the flood depth would exceed the height of the structure.
NS2	Asset management and maintenance	L1, F3	Having a register of all existing assets and maintenance plan which includes frequency of maintenance.	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-22	There is no watercourse flowing through the CDA
NS3	Relocation of properties or infrastructure away from flood risk areas	P3, F3, H1	Proposing new developments in areas with low flood risk and having availability to move existing critical infrastructure to low flood risk areas.	0	-2	-2	0	0	0	-1	0	0	-2	1	-6	No strategic or regeneration development areas are located within the CDA. This would not be feasible to implement.
NS4	Watercourse management and maintenance	F2, F3, P3	Maintenance to ensure optimal functionality and prevent degradation e.g., keeping growth of vegetation under control, free of debris and reducing excess silt.	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-22	There is no watercourse flowing through the CDA
Mitigation Measures - Structural Actions																
S1	Infiltration (and evaporation) for managing 'everyday rain'	E1, F3, P3	An engineering structure to collect rainwater from impermeable services e.g., rain gardens.	1	1	-1	-1	1	1	0	1	0	-1	0	2	There are a few green spaces and parks, potentially this measure would be more beneficial in the north of the CDA where the elevation is highest to hold the surface water. Would reduce flood impacts if worked alongside other techniques.
S2	Conveyance for managing 'usual rainfall'	E1, F3, P3, H1	Designed to collect, delay, and convey rainfall using green infrastructure techniques. This is generally above ground management.	1	1	-1	-1	1	1	0	1	0	-1	1	3	Would cost less than £10k and would require maintenance. Could be more beneficial if implemented alongside other green infrastructure techniques. Low carbon footprint because it is a NFM technique which could use local workforce. Meets three objectives excluding the highways objective.
S3	Storage for managing 'extreme rainfall'	E1, F3, P3, H1	Designed to collect, delay, and convey rainfall using green infrastructure techniques. This is generally above ground management e.g., swales and wet ponds.	1	1	-1	-1	1	1	1	1	1	-1	1	5	There are a few green spaces and parks which can be used for storage and reduce the amount of surface water on impermeable surfaces and in surface water sewers. Would cost less than £10k and would require maintenance. Could be more beneficial if implemented alongside other green infrastructure techniques. Low carbon footprint because it is a NFM technique which could use local workforce. Meets three objectives excluding the highways objective.
S4	Restoring urban watercourse	E1, F3	This technique aims to mimic natural processes as much as possible without increasing flood risk e.g., in channel enhancements, larger scale river restoration and SuDS.	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-22	There is no watercourse flowing through the CDA
S5	Urban watercourse engineering	F3, H1, P3	Hard engineering flood techniques e.g., storage, embankments, water	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-22	There is no watercourse flowing through the CDA

Ref.	Option/Measure	LBH Aims	Description/Examples	Technical: Is the measure technically effective in reducing flood risk?	Technical: Is the measure practical to implement?	Economic: Is the measure expensive to implement?	Economic: Is long-term maintenance required and how significant are the costs?	Economic: Could the measure attract partnership funding contributions?	Economic: Would the measure reduce flooding to critical infrastructure, including the critical highways network?	Social: Are there wider community benefits?	Environmental: Are there wider ecological and BNG benefits?	Environmental: Is the measure resilient to the impacts of climate change?	Environmental: Carbon footprint	Objectives: Will it help achieve the objectives of the SWMP?	Total Viability Score	Comments
			and diversion channels.													
S6	Run-off reduction strategy	P1, F3, P3	A long-term plan for making whole urban areas greener and more permeable, this uses green infrastructure techniques to allow increased infiltration.	1	1	-1	0	1	1	0	1	0	-1	0	3	Increase permeable surfaces where possible in the locations where the communities at risk are located and in the surrounding areas e.g., greenspace on wide pavements. Would reduce flood impacts if worked alongside other techniques.
S7	Reducing surface water in the sewer	F3, H1, P3	Infiltration and storage can be used to reduce water in sewers e.g. soakaways and reducing impermeable surfaces.	1	1	-1	-1	1	0	-1	0	0	-2	1	-1	Would include the used of quarried materials and transported materials We believe this would be more targeted for rural areas, limited available space. Would need to be maintained so it is fully effective. Potentially would reduce the volume of surface water on the local highways. Would cost more than £10k. Meets five objectives including the highways' objective.
S8	Land management	P1, H1, F3, E1, P3	Implementing land management actions will reduce the volume of run-off, to reduce the flood risk further downstream.	1	-1	-2	-1	0	1	-1	-1	1	-1	2	-2	We believe this would be more targeted for rural areas, limited available space. Would need to be maintained so it is fully effective. Potentially would reduce the volume of surface water on the local highways. Would cost more than £10k. Meets five objectives including the highways' objective.
S9	Underground storage	P2, F3, H1	Divert surface water to storage tanks or by providing storage in the existing drainage / flood management network.	1	-1	-1	-1	0	1	0	0	1	-2	1	-1	This measure would include working in confined spaces. The pipes could be adapted to meet the increased flow due to climate change. The measure would include using machinery, materials and transport. Assuming it would not be practical and expensive to implement due to having to have contactor and being in a residential area.
S10	Underground conveyance	P2, F3, H1	Increase capacity or build new underground pipes for surface water.	1	-1	-2	-1	0	1	0	-1	1	-2	1	-3	This measure would include working in confined spaces. The pipes would be adapted to meet the increased flow due to climate change. The measure would include using machinery, materials and transport. Assuming it would not be practical and expensive to implement due to having to have contactor and being in a residential area.
S11	Modification of culverted watercourses	P2, F3, H1	Aims to increase the capacity of culverted watercourses or divert culverted watercourses.	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-22	There is no watercourse flowing through the CDA
Mitigation Measures - Carried Over																
C1	Investigate the function and effectiveness of the existing pond at the rear of Moray Way.		The investigation would further inform what maintenance is needed for the existing pond.	1	-1	1	-1	0	0	0	0	0	-1	0	-1	Cannot locate the existing pond. Depending on how effective the pond is currently, there is potential that it would need to be maintained more often to increase its effectivity a helping reduces flood risk.

D.7 CDA 017 – Rise Park

Table D.7.1: CDA 017 Rise Park Multi Criteria Analysis

Ref.	Option/Measure	LBH Aims	Description/Examples	Technical		Economic				Social	Environmental			Objectives	Total Viability Score	Comments
				Is the measure technically effective in reducing flood risk?	Is the measure practical to implement?	Is the measure expensive to implement?	Is long-term maintenance required and how significant are the costs?	Could the measure attract partnership funding contributions?	Would the measure reduce flooding to critical infrastructure, including the critical highways network?	Are there wider community benefits?	Are there wider ecological and BNG benefits?	Is the measure resilient to the impacts of climate change?	Carbon footprint	Will it help achieve the objectives of the SWMP?		
Mitigation Measures - Non-Structural Actions (management and maintenance)																
NS1	Self-help – Property-level protection and resilience	P3, F3	Measures that prevent water entry or reduce the amount of floodwater that enters a property e.g., flood doors, flood gates, self-closing air bricks.	1	1	-2	-1	1	0	0	0	0	-2	0	-2	The measure would be able to protect the majority of the properties in the community at risk as the flood depth is below 0.6m, the properties in flood depth higher than 0.6m would need to be undergo a structural survey. Meets two objectives but not the highways objective. High carbon footprint due to materials being used and the transport
NS2	Asset management and maintenance	L1, F3, H1	Having a register of all existing assets and maintenance plan which includes frequency of maintenance.	1	-1	-1	-1	0	1	0	0	1	0	1	1	The river is partially culverted in the lower part on the CDA. Maintenance can be increased to accommodate for increased for from climate change. Maintenance can be increased to reduce risk of increased flooding from climate change. To facilitate this measure working in confined spaces would be needed. In the south of the CDA there is a strategic rood which is at risk of flooding. Would prevent blockages of culvert near strategic roads and communities at risk.
NS3	Relocation of properties or infrastructure away from flood risk areas	P3, F3, H1	Proposing new developments in areas with low flood risk and having availability to move existing critical infrastructure to low flood risk areas.	1	-2	-2	0	0	2	-1	-1	1	-2	1	-3	Infrastructure can be relocated to higher elevated green space in the north of the CDA where there is no risk of flooding, but it is very impractical unless it is new infrastructure. This would involve working at height, confined spaces and require a contractor. Strategic road in the CDA which is a risk of flooding. Relocation to greenspace would mean there is less green space to be used by the public and could harm the ecological environment by introducing impermeable surfaces. Would have a high carbon footprint due to use of machinery, materials and transported materials. Meets three objectives including highways objectives.
NS4	Watercourse management and maintenance	F2, F3, P3, H1	Maintenance to ensure optimal functionality and prevent degradation e.g., keeping growth of vegetation under control, free of debris and reducing excess silt.	1	1	-1	-1	0	2	0	1	1	0	1	5	The watercourse is in accessible land and would help prevent watercourse blockages near communities at risk and strategic road in the south part of the CDA. Maintenance of the watercourse could help promote an improvement of ecological status. Potentially maintenance could be adapted/increased to address an increased flow from climate change impacts. Four objectives will be achieved including the highways objectives. The watercourse banks are highly vegetated where it is not culverted.
Mitigation Measures - Structural Actions																
S1	Infiltration (and evaporation) for managing 'everyday rain'	E1, F3, P3	An engineering structure to collect rainwater from impermeable services e.g., rain gardens.	1	2	-1	-1	1	2	0	1	0	0	0	5	Many potential suitable sites where rain gardens could be implemented, upstream to hold/delay water from flowing down into the flood risk areas and strategic roads. Assuming it would not have enough impacts to reduce flooding on a strategic road. Products used could promote ecological and biodiversity benefits. Uses local materials and natural flood management. Meets three objectives but not the highways objective.
S2	Conveyance for managing 'usual rainfall'	E1, F3, P3, H1	Designed to collect, delay, and convey rainfall using green infrastructure techniques. This is generally above group management.	1	1	-1	-1	1	2	0	1	0	0	1	5	Many potential suitable sites where their measures could be implemented to hold and delay water from flowing downstream into the high-risk flooding areas and strategic roads. Meets four objectives including the highways objective. Assuming the use for local green materials in construction.
S3	Storage for managing 'extreme rainfall'	E1, F3, P3, H1	Designed to collect, delay, and convey rainfall using green infrastructure techniques. This is generally above ground management e.g., swales and wet ponds.	1	1	-1	-1	1	2	0	1	0	-1	1	4	Many potential suitable sites where their measures could be implemented to hold and delay water from flowing downstream into the high-risk flooding areas and strategic roads. Material would need to move away from site and potential other material to be used in the construction of the storage area.
S4	Restoring urban watercourse	E1, F3	This technique aims to mimic natural processes as much as possible without increasing flood risk e.g., in channel enhancements, larger scale river restoration and SuDS.	1	-2	-2	1	1	1	1	1	0	-1	0	1	This would not be suitable for all the length of the river, more appropriate in the upper reach of the river. Measure meets two objectives excluding the highways objective.

				Technical		Economic				Social	Environmental			Objectives		
Ref.	**Option/Measure**	**LBH Aims**	**Description/Examples**	**Is the measure technically effective in reducing flood risk?**	**Is the measure practical to implement?**	**Is the measure expensive to implement?**	**Is long-term maintenance required and how significant are the costs?**	**Could the measure attract partnership funding contributions?**	**Would the measure reduce flooding to critical infrastructure, including the critical highways network?**	**Are there wider community benefits?**	**Are there wider ecological and BNG benefits?**	**Is the measure resilient to the impacts of climate change?**	**Carbon footprint**	**Will it help achieve the objectives of the SWMP?**	**Total Viability Score**	**Comments**
S5	Urban watercourse engineering	F3, H1, P3	Hard engineering flood techniques e.g., storage, embankments, water and diversion channels.	1	-1	-2	-1	0	0	-1	-1	2	-2	1	-4	Storage, embankments and channel diversions could be detrimental to community and ecological benefits, assuming that they are rediverted through existing parks and green spaces. The measures could be adapted to be suitable for the increased flow which could be caused by climate change. This could have a large carbon footprint because of the materials used, transport of material in and out for site and the machinery used. This measure meets three objectives including the highways objective.
S6	Run-off reduction strategy	P1, F3, P3, H1	A long-term plan for making whole urban areas greener and more permeable, this uses green infrastructure techniques to allow increased infiltration.	1	1	-1	-1	1	2	0	1	0	0	1	5	This measure potentially could be implemented across this CDA to further increase the amount of green permeable areas, this would help reduce the volume of water which flows downstream into the south of the CDA where there is a community at risk and a strategic road. Measure meets four objectives including the highways objective.
S7	Reducing surface water in the sewer	F3	Infiltration and storage can be used to reduce water in sewers e.g., soakaways and reducing impermeable surfaces.	1	1	-1	-1	1	1	0	1	0	-1	-1	1	Potential to increase the amount of permeable front gardens. Soakaways require quarried materials and transport of materials to and from the site. Meets one objective.
S8	Land management	P1, H1, F3, E1, P3	Implementing land management actions will reduce the volume of run-off, to reduce the flood risk further downstream.	1	1	-2	-1	0	1	0	1	0	-1	2	2	Potentially due to the scale of the measure it could be expensive to implement. This would help reduce the depth of surface water on the local road network. This measure meets 5 objectives including the highways objective.
S9	Underground storage	P2, F3, H1	Divert surface water to storage tanks or by providing storage in the existing drainage / flood management network.	1	-2	-2	-1	0	1	0	0	1	-2	1	-3	Due to the measure being underground this means that it is difficult to access, and it would require working in confined spaces. Would have a large carbon footprint because of the materials use, machinery and transport. Meets three objectives including the highways objective.
S10	Underground conveyance	P2, F3, H1	Increase capacity or build new underground pipes for surface water.	1	-2	-2	-1	-1	1	-1	-1	1	-2	1	-6	Building underground would cause disruption to the community and ecological environment. Pipe could be adapted to be able to facilitate extra surface water from climate change. Moving water underground would reduce the volume of surface water on the local road network. Meets three objectives including the highways objective.
S11	Modification of culverted watercourses	P2, F3, H1	Aims to increase the capacity of culverted watercourses or divert culverted watercourses.	1	-2	-2	-1	-1	2	-1	-1	1	-2	1	-5	Possible issues with the culvert under the strategic road which is causing deep flood depths in the community at risk.
Mitigation Measures - Carried Over																
	Implement feasibility study to understand opportunities to provide storage in greenspace, parks and regeneration and developments areas (Romford strategic development area and industrial strategic area)			1	0	-1	-1	2	1	1	1	1	-1	2	6	Feasibility of increasing capacity in greenspace, parks and regeneration and developments areas (Romford strategic development area and industrial strategic area). This analysis is of the effects of the study and the potential impacts. If projects implemented are the short list of the study.
FRMP 2	Work with Land of the Fanns to carry out flood modelling and scope potential natural flood management options in			1	-1	-2	-1	1	1	0	1	0	1	0	1	Would help support other potential measures by assessing what would be effective at reducing flood risk. Low carbon footprint because of the NFM use and local materials. When the measure is implemented it helps creates habitats.

Ref.	Option/Measure	LBH Aims	Description/Examples	Technical		Economic				Social	Environmental			Objectives	Total Viability Score	Comments
				Is the measure technically effective in reducing flood risk?	Is the measure practical to implement?	Is the measure expensive to implement?	Is long-term maintenance required and how significant are the costs?	Could the measure attract partnership funding contributions?	Would the measure reduce flooding to critical infrastructure, including the critical highways network?	Are there wider community benefits?	Are there wider ecological and BNG benefits?	Is the measure resilient to the impacts of climate change?	Carbon footprint	Will it help achieve the objectives of the SWMP?		
	Bedfords Park local nature reserve															
FRMP 2	Work together to carry out flood modelling to scope options for flood alleviation projects and natural flood management options in the Rise Park Critical Drainage Area			1	-1	-2	-1	1	1	0	1	0	1	0	1	Would help support other potential measures by assessing what would be effective at reducing flood risk. Low carbon footprint because of the NFM use and local materials. When the measure is implemented it helps creates habitats.

D.8 CDA 018 – Cranham

Table D.8.1: CDA 018 Cranham Multi Criteria Analysis

Ref.	Option/Measure	LBH Aims	Description/Examples	Technical		Economic				Social	Environmental			Objectives	Total Viability Score	Comments
				Is the measure technically effective in reducing flood risk?	Is the measure practical to implement?	Is the measure expensive to implement?	Is long-term maintenance required and how significant are the costs?	Could the measure attract partnership funding contributions?	Would the measure reduce flooding to critical infrastructure, including the critical highways network?	Are there wider community benefits?	Are there wider ecological and BNG benefits?	Is the measure resilient to the impacts of climate change?	Carbon footprint	Will it help achieve the objectives of the SWMP?		
Mitigation Measures - Non-Structural Actions (management and maintenance)																
NS1	Self-help – Property-level protection and resilience	P3, F3	Measures that prevent water entry or reduce the amount of floodwater that enters a property e.g., flood doors, flood gates, self-closing air bricks.	1	1	-2	-1	1	0	0	0	1	-2	0	-1	Flood depth in the communities a risk is at a height that this measure could protect the properties and they could potentially be adapted to be suitable for climate change. Meets two objectives excluding the highways objective.
NS2	Asset management and maintenance	L1, F3	Having a register of all existing assets and maintenance plan which includes frequency of maintenance.	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-22	There is no watercourse flowing through the CDA
NS3	Relocation of properties or infrastructure away from flood risk areas	P3, F3, H1	Proposing new developments in areas with low flood risk and having availability to move existing critical infrastructure to low flood risk areas.	2	-2	-2	-1	0	1	-1	-1	1	-2	1	-4	The strategic road could potentially be north of the CDA where there is lower flood risk. Relocation would cause harm to existing community and ecological environment because potentially the areas would have been previously used for recreation and construction could cause ecological harm.
NS4	Watercourse management and maintenance	F2, F3, P3	Maintenance to ensure optimal functionality and prevent degradation e.g., keeping growth of vegetation under control, free of debris and reducing excess silt.	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-22	There is no watercourse flowing through the CDA
Mitigation Measures - Structural Actions																
S1	Infiltration (and evaporation) for managing 'everyday rain'	E1, F3, P3	An engineering structure to collect rainwater from impermeable services e.g., rain gardens.	1	1	-1	-1	1	1	0	1	0	0	0	3	Potential suitable sites located in the north and east of the CDA and a few small greenspaces throughout the CDA which could be more beneficial. If the measure would not have enough impact to reduce the flooding to critical infrastructure. Measure would ideally use local materials and natural flood management. Meets three objectives excluding the highways' objective.
S2	Conveyance for managing 'usual rainfall'	E1, F3, P3, H1	Designed to collect, delay, and convey rainfall using green infrastructure techniques. This is generally above ground management.	1	1	-1	-1	1	1	0	1	0	0	1	4	Meets three objectives including the highways' objective. There would be opportunities for this measure the in north and east rural sections of the CDA which could potentially limit the flow of water south through the urban section of CDA and causing flooding in the south of CDA where there is a community at risk.
S3	Storage for managing 'extreme rainfall'	E1, F3, P3, H1	Designed to collect, delay, and convey rainfall using green infrastructure techniques. This is generally above ground management e.g. swales and wet ponds.	1	1	-1	-1	1	1	0	1	0	-1	1	3	Meets three objectives including the highways objective. There would be opportunities for this measure the in north and east rural sections of the CDA which could potentially hold, delay and limit the flow of water south through the urban section of CDA and causing flooding in the south of CDA where there is a community at risk.
S4	Restoring urban watercourse	E1, F3	This technique aims to mimic natural processes as much as possible without increasing flood risk e.g. in channel enhancements, larger scale river restoration and SuDS.	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-22	There is no watercourse flowing through the CDA
S5	Urban watercourse engineering	F3, H1, P3	Hard engineering flood techniques e.g. storage, embankments, water and diversion channels.	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-22	There is no watercourse flowing through the CDA

Ref.	Option/Measure	LBH Aims	Description/Examples	Technical		Economic				Social	Environmental			Objectives	Total Viability Score	Comments
				Is the measure technically effective in reducing flood risk?	Is the measure practical to implement?	Is the measure expensive to implement?	Is long-term maintenance required and how significant are the costs?	Could the measure attract partnership funding contributions?	Would the measure reduce flooding to critical infrastructure, including the critical highways network?	Are there wider community benefits?	Are there wider ecological and BNG benefits?	Is the measure resilient to the impacts of climate change?	Carbon footprint	Will it help achieve the objectives of the SWMP?		
S6	Run-off reduction strategy	P1, F3, P3, H1	A long-term plan for making whole urban areas greener and more permeable, this uses green infrastructure techniques to allow increased infiltration.	1	-1	-1	-1	0	1	0	1	0	-1	1	0	Meets five objectives including the highways objectives. Reducing the volume of runoff will reduce the volume of surface water on the highways. Potentially would only be effective up to a certain volume of water and could be overwhelmed with higher volume of water.
S7	Reducing surface water in the sewer	F3	Infiltration and storage can be used to reduce water in sewers e.g. soakaways and reducing impermeable surfaces.	1	1	-1	0	0	1	0	0	0	-1	0	1	Soakaways may not be suitable as the urban area is densely populated but encouraging the use of permeable driveways could be beneficial to limit the water flow through the CDA to the south community at risk.
S8	Land management	P1, H1, F3, E1, P3	Implementing land management actions will reduce the volume of run-off, to reduce the flood risk further downstream. Recommended actions from section 19 report: Investigate opportunities for land management and flow management in the upper reaches of each catchment.	1	1	-2	-1	0	1	0	0	0	-1	2	1	Implementing land management techniques into the upper part for the CDA would potentially hold the water and slow the flow of surface water through the urban part of the catchment, this could lower the flood depth and risk of flooding to both communities at risk.
S9	Underground storage	P2, F3, H1	Divert surface water to storage tanks or by providing storage in the existing drainage / flood management network.	1	-2	-2	-1	0	1	0	0	1	-2	1	-3	Underground storage location would be assessed, could be introduced in the playing fields/wood areas around the perimeter of the urban area to limit the volume of surface water. High carbon footprint due to construction, transport, and use of materials.
S10	Underground conveyance	P2, F3, H1	Increase capacity or build new underground pipes for surface water.	1	-2	-2	-1	0	1	0	-1	1	-2	1	-4	Within the urban development there would be limited feasibility for new underground pipes due to the densely urbanised characteristics.
S11	Modification of culverted watercourses	P2, F3, H1	Aims to increase the capacity of culverted watercourses or divert culverted watercourses. Recommended action from section 19: Investigate scope to increase bridge clearance/culvert capacity at locations where overtopping occurred due to capacity exceedance.	1	-2	-2	-1	0	0	0	0	1	-2	1	-4	Increasing the capacity of the culvert under the railway line in the very south of the CDA would be beneficial to reduce the risk of surface water flooding in the local area, causing the large community a risk.
Mitigation Measures - Carried Over																
	Implement feasibility study to understand opportunities to provide storage in greenspace, parks and regeneration and developments areas (Romford strategic development area and industrial strategic area)			1	0	-1	-1	2	1	1	1	1	-1	2	6	Feasibility of increasing housing. This analysis is of the effects of the study and the potential impacts. If projects implemented are the short list of the study.

D.9 CDA 023 – Elm Park

Table D.9.1: CDA 023 Elm Park Multi Criteria Analysis

				Technical		Economic				Social	Environmental			Objectives		
Ref.	**Option/Measure**	**LBH Aims**	**Description/Examples**	**Is the measure technically effective in reducing flood risk?**	**Is the measure practical to implement?**	**Is the measure expensive to implement?**	**Is long-term maintenance required?**	**Could the measure attract partnership funding contributions?**	**Would the measure reduce flooding to critical infrastructure, including the critical highways network?**	**Are there wider community benefits?**	**Are there wider ecological and BNG benefits?**	**Is the measure resilient to the impacts of climate change?**	**Carbon footprint**	**Will it help achieve the objectives of the SWMP?**	**Total Viability Score**	**Comments**
Mitigation Measures - Non-Structural Actions (management and maintenance)																
NS1	Self-help – Property-level protection and resilience	P3, F3	Measures that prevent water entry or reduce the amount of floodwater that enters a property e.g. flood doors, flood gates, self-closing air bricks.	1	1	-2	-1	1	0	0	0	0	-1	0	-1	This measure meets two objectives excluding the highways objectives. In both communities at risk in the CDA the measures will be effective at protecting properties. For both communities at risk the measure would not be effective, the flood depth modelled would overtop the height of the flood doors. This measure includes the transport and use of materials. Potentially could exceed £10k cost.
NS2	Asset management and maintenance	L1, F3	Having a register of all existing assets and maintenance plan which includes frequency of maintenance.	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-22	There is no watercourse flowing through the CDA.
NS3	Relocation of properties or infrastructure away from flood risk areas	P3, F3, H1	Proposing new developments in areas with low flood risk and having availability to move existing critical infrastructure to low flood risk areas.	0	-2	-2	-1	0	0	-1	-1	-2	-2	1	-10	There is no feasible location to relocate infrastructure in the CDA. Meets three objectives including the highways objectives. High carbon footprint due to the materials used, transport of materials and machinery used. Movement of infrastructure and construction could potentially impact the community space and harm the ecological environment where is relocated to. Would exceed £10k cost.
NS4	Watercourse management and maintenance	F2, F3, P3	Maintenance to ensure optimal functionality and prevent degradation e.g. keeping growth of vegetation under control, free of debris and reducing excess silt.	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-22	There is no watercourse flowing through the CDA
Mitigation Measures - Structural Actions																
S1	Infiltration (and evaporation) for managing 'everyday rain'	E1, F3, P3	An engineering structure to collect rainwater from impermeable services e.g. rain gardens.	1	1	-1	-1	1	1	-1	1	0	0	0	2	The location where the measure could be implemented potentially would not benefit the communities at risk in the CDA. On a small scale rain gardens could be implemented in school fields to reduce the surface water flooding at low depths to schools in the CDA e.g. Scargill Junior School, The RJ Mitchell Primary School and Why Bridge Infant School. Would cost less than £10k and would require maintenance. Could be more beneficial if implemented alongside other green infrastructure techniques. Low carbon footprint because it is a NFM technique which could use local workforce. Meets three objectives excluding the highways objective.
S2	Conveyance for managing 'usual rainfall'	E1, F3, P3, H1	Designed to collect, delay, and convey rainfall using green infrastructure techniques. This is generally above ground management.	1	1	-1	-1	1	1	-1	1	0	-1	1	2	Could be more beneficial if implemented alongside other green infrastructure techniques. Meets three objectives excluding the highways objective. Would cost less than £10k and would require maintenance. Potentially could reduce the volume of water in community at risk.
S3	Storage for managing 'extreme rainfall'	E1, F3, P3, H1	Designed to collect, delay, and convey rainfall using green infrastructure techniques. This is generally above ground management e.g. swales and wet ponds.	1	1	-1	-1	1	1	-1	1	1	-1	1	3	Could be more beneficial if implemented alongside other green infrastructure techniques. Meets three objectives excluding the highways objective. Would cost less than £10k and would require maintenance. Potentially could reduce the volume of water in community at risk. Construction would be needed, meaning an increased carbon footprint as materials would need to be reduce from the site.
S4	Restoring urban watercourse	E1, F3	This technique aims to mimic natural processes as much as possible without increasing flood risk e.g. in channel enhancements, larger scale river restoration and SuDS.	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-22	No watercourse flowing through the CDA.
S5	Urban watercourse engineering	F3, H1, P3	Hard engineering flood techniques e.g. storage, embankments, water and diversion channels.	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-22	No watercourse flowing through the CDA.

Ref.	Option/Measure	LBH Aims	Description/Examples	Technical		Economic				Social	Environmental			Objectives	Total Viability Score	Comments
				Is the measure technically effective in reducing flood risk?	Is the measure practical to implement?	Is the measure expensive to implement?	Is long-term maintenance required?	Could the measure attract partnership funding contributions?	Would the measure reduce flooding to critical infrastructure, including the critical highways network?	Are there wider community benefits?	Are there wider ecological and BNG benefits?	Is the measure resilient to the impacts of climate change?	Carbon footprint	Will it help achieve the objectives of the SWMP?		
S6	Run-off reduction strategy	P1, F3, P3	A long-term plan for making whole urban areas greener and more permeable, this uses green infrastructure techniques to allow increased infiltration.	0	-1	-1	-1	0	1	1	1	0	-1	0	-1	The opportunities for this measure to implement permeable surface would be to encourage permeable driveway and permeable surface along residential pathways. Medium carbon footprint would because caused by machinery and removing debris from the site. Increase in green surfaces will increase ecological benefits. Meets three objectives excluding highways objective.
S7	Reducing surface water in the sewer	F3	Infiltration and storage can be used to reduce water in sewers e.g. soakaways and reducing impermeable surfaces.	1	-1	-1	-1	0	0	0	0	0	-2	-1	-5	Limited availability of where the measure can be implemented. If the measure was implemented it has a high carbon footprint because of the use and transport of materials. Meets one objective, excluding highways objective.
S8	Land management	P1, H1, F3, E1, P3	Implementing land management actions will reduce the volume of run-off, to reduce the flood risk further downstream.	1	-2	-2	-1	0	1	-1	-1	0	-1	2	-4	Land management techniques could be used on greenspace or recreational spaces. Access to these spaces may be potentially reduced or have an impact on the ecological environment. Would reduce the surface water flooding on the local road network. Limited access of where the measure could be implemented due to the urban environment. Potentially would not be beneficial in climate change scenarios. Meets five objectives excluding the highways objective.
S9	Underground storage	P2, F3, H1	Divert surface water to storage tanks or by providing storage in the existing drainage / flood management network.	1	-2	-2	-1	0	1	0	-1	1	-2	1	-4	Limited access of where the measure could be implemented due to the urban environment. Would need to be maintained so it is fully effective. Potentially would reduce the volume of surface water on the local highways. Would cost more than £10k. Meets three objectives including the highways objective.
S10	Underground conveyance	P2, F3, H1	Increase capacity or build new underground pipes for surface water.	1	-2	-2	-1	0	1	0	-1	1	-2	1	-4	Limited access of where the measure could be implemented due to the urban environment. Would need to be maintained so it is fully effective. Potentially would reduce the volume of surface water on the local highways. Would cost more than £10k. Meets three objectives including the highways objective.
S11	Modification of culverted watercourses	P2, F3, H1	Aims to increase the capacity of culverted watercourses or divert culverted watercourses.	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-22	No culverted watercourse flowing through the CDA.
Mitigation Measures - Carried Over																
	Implement feasibility study to understand opportunities to provide storage in greenspace, parks and regeneration and developments areas (Romford strategic development area and industrial strategic area)			1	0	-1	-1	2	1	1	1	1	-1	2	6	Feasibility of increasing housing. This analysis is of the effects of the study and the potential impacts. If projects implemented are the short list of the study.

D.10 CDA 025 – Gallows Corner

Table D.10.1: CDA 025 Gallows Corner Multi Criteria Analysis

Ref.	Option/Measure	LBH Aims	Description/Examples	Technical		Economic				Social	Environmental			Objectives	Total Viability Score	Comments
				Is the measure technically effective in reducing flood risk?	Is the measure practical to implement?	Is the measure expensive to implement?	Is long-term maintenance required?	Could the measure attract partnership funding contributions?	Would the measure reduce flooding to critical infrastructure, including the critical highways network?	Are there wider community benefits?	Are there wider ecological and BNG benefits?	Is the measure resilient to the impacts of climate change?	Carbon footprint	Will it help achieve the objectives of the SWMP?		
Mitigation Measures - Non-Structural Actions (management and maintenance)																
NS1	Self-help – Property-level protection and resilience	P3, F3	Measures that prevent water entry or reduce the amount of floodwater that enters a property e.g. flood doors, flood gates, self-closing air bricks.	1	1	-2	-1	1	0	0	0	-2	-2	0	-4	Would be effective for some properties but others would need to be structurally surveyed to see if they can be protected to a higher depth. Meets two objectives excluding the highways' objective. The use and transport of materials would mean it has a large carbon footprint. The measure would not be suitable for a climate change scenario. The cost would likely exceed £10k. Prospect properties with no impact on the local road network.
NS2	Asset management and maintenance	L1, F3	Having a register of all existing assets and maintenance plan which includes frequency of maintenance.	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-22	There is no watercourse flowing through the CDA.
NS3	Relocation of properties or infrastructure away from flood risk areas	P3, F3, H1	Proposing new developments in areas with low flood risk and having availability to move existing critical infrastructure to low flood risk areas.	1	-2	-2	-1	0	0	-1	-1	0	-2	1	-7	There is no feasible location for infrastructure major road to be relocated to within the CDA. The cost would exceed £10k cost. Major roads are at risk of surface water flooding within this CDA. Large carbon footprint due to construction, transport and use of materials and machinery used.
NS4	Watercourse management and maintenance	F2, F3, P3	Maintenance to ensure optimal functionality and prevent degradation e.g., keeping growth of vegetation under control, free of debris and reducing excess silt.	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-22	There is no watercourse flowing through the CDA.
Mitigation Measures - Structural Actions																
S1	Infiltration (and evaporation) for managing 'everyday rain'	E1, F3, P3	An engineering structure to collect rainwater from impermeable services e.g. rain gardens.	1	1	-1	-1	1	1	-1	1	0	0	0	2	Few small permeable greenspaces where the measure could be implemented across the CDA. Meets three objectives excluding the highways objective. Could be more effective at reducing flood risk by working alongside other green infrastructure techniques. Ideally would use local workforce and materials as a natural flood management technique. Potentially could cost less than £10k.
S2	Conveyance for managing 'usual rainfall'	E1, F3, P3, H1	Designed to collect, delay, and convey rainfall using green infrastructure techniques. This is generally above ground management.	1	1	-1	-1	1	1	-1	1	0	-1	1	2	Meets three objectives including the highways objective. Could be more effective at reducing flood risk by working alongside other green infrastructure techniques. Would cost less than £10k and would require maintenance. Potentially could limit the volume of water in the CDA which is creating the community at risk in the centre of the CDA.
S3	Storage for managing 'extreme rainfall'	E1, F3, P3, H1	Designed to collect, delay, and convey rainfall using green infrastructure techniques. This is generally above ground management e.g. swales and wet ponds.	1	1	-1	-1	1	1	-1	1	1	-1	1	3	Meets three objectives including the highways objective. Could be more effective at reducing flood risk by working alongside other green infrastructure techniques. Would cost less than £10k and would require maintenance. Potentially could limit the volume of water in the CDA which is creating the community at risk in the centre of the CDA. Potentially could have a higher carbon footprint due to the use and transport of materials. Depending on the scale there a few small spaces where the measure could be implemented.
S4	Restoring urban watercourse	E1, F3	This technique aims to mimic natural processes as much as possible without increasing flood risk e.g. in channel enhancements, larger scale river restoration and SuDS.	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-22	There is no watercourse flowing through the CDA.
S5	Urban watercourse engineering	F3, H1, P3	Hard engineering flood techniques e.g. storage, embankments, water and diversion channels.	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-22	There is no watercourse flowing through the CDA.

Ref.	Option/Measure	LBH Aims	Description/Examples	Technical		Economic				Social	Environmental			Objectives	Total Viability Score	Comments
				Is the measure technically effective in reducing flood risk?	Is the measure practical to implement?	Is the measure expensive to implement?	Is long-term maintenance required?	Could the measure attract partnership funding contributions?	Would the measure reduce flooding to critical infrastructure, including the critical highways network?	Are there wider community benefits?	Are there wider ecological and BNG benefits?	Is the measure resilient to the impacts of climate change?	Carbon footprint	Will it help achieve the objectives of the SWMP?		
S6	Run-off reduction strategy	P1, F3, P3	A long-term plan for making whole urban areas more green and permeable, this uses green infrastructure techniques to allow increased infiltration.	1	-1	-1	-1	0	1	0	1	0	-1	0	-1	Could benefit the local road network by reducing the volume and depth of surface water in the CDA. Potentially could be a challenge to implement as the majority of the CDA is highly urbanised and residential. Would include the transport and removal of material meaning a higher carbon footprint. Meets three objectives excluding the highway objective.
S7	Reducing surface water in the sewer	F3	Infiltration and storage can be used to reduce water in sewers e.g. soakaways and reducing impermeable surfaces. Measure from the last SWMP: Investigate the creation of detention basin between Farringdon Avenue and Bideford Close	1	-1	-1	-1	0	0	0	0	0	-2	-1	-5	Limited availability of where the measure could be implemented because the CDA is highly urbanised and residential. The use and transport of materials results in a high carbon footprint. Meets one objective excluding the highways' objective. Detention basin would be beneficial in the green space at the rear of Bideford Close, the RoFSW show high depth of surface water flooding at the site and is to the north of gallows corner which experiences flooding.
S8	Land management	P1, H1, F3, E1, P3	Implementing land management actions will reduce the volume of run-off, to reduce the flood risk further downstream.	1	-2	-2	-1	0	1	-1	-1	0	-1	2	-4	Limited access of where the measurement could be implemented due to the urban and residential environment. Would need to be maintained so it is fully effective. Potentially could reduce the volume of surface water on the local road network. Meets five objectives including the highways' objective. Potentially could cost more than £10k. Depending on the actions the measure could have a medium to high carbon footprint.
S9	Underground storage	P2, F3, H1	Divert surface water to storage tanks or by providing storage in the existing drainage / flood management network.	1	-2	-2	-1	0	1	0	-1	1	-2	1	-4	Potential for underground storage in the greenspace rear to Bideford Road and north of the A12/A127. Meets three objectives including highway's objective. Potentially could be damaging to the ecological environment. Would have a high carbon footprint due to construction, transport of material and machinery. Would reduce the volume of surface water on the local road network in the CDA.
S10	Underground conveyance	P2, F3, H1	Increase capacity or build new underground pipes for surface water.	1	-2	-2	-1	0	1	0	-1	1	-2	1	-4	Limited availability to implement this measure into the CDA due the highly urbanised and residential area. This would include working in a confined space and the need for contractors meaning it would be less practical to implement. Could be adapted to facilitate increase volumes of surface water from climate change conditions. Would cost more than £10k. Meets three objectives including the highways' objective.
S11	Modification of culverted watercourses	P2, F3, H1	Aims to increase the capacity of culverted watercourses or divert culverted watercourses.	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-22	There is no watercourse flowing through the CDA.
Mitigation Measures - Carried Over																
	Implement feasibility study to understand opportunities to provide storage in greenspace, parks and regeneration and developments areas (Romford strategic development area and industrial strategic area)			1	0	-1	-1	2	1	1	1	1	-1	2	6	Feasibility of increasing strategic industrial locations This analysis is of the effects of the study and the potential impacts. If projects implemented are the short list of the study.

D.11 CDA 026 – Harold Hill North

Table D.11.1: CDA 026 Harold Hill North Multi Criteria Analysis

Ref.	Option/Measure	LBH Aims	Description/Examples	Technical		Economic				Social	Environmental			Objectives	Total Viability Score	Comments
				Is the measure technically effective in reducing flood risk?	Is the measure practical to implement?	Is the measure expensive to implement?	Is long-term maintenance required?	Could the measure attract partnership funding contributions?	Would the measure reduce flooding to critical infrastructure, including the critical highways network?	Are there wider community benefits?	Are there wider ecological and BNG benefits?	Is the measure resilient to the impacts of climate change?	Carbon footprint	Will it help achieve the objectives of the SWMP?		
Mitigation Measures - Non-Structural Actions (management and maintenance)																
NS1	Self-help – Property-level protection and resilience	P3, F3	Measures that prevent water entry or reduce the amount of floodwater that enters a property e.g. flood doors, flood gates, self-closing air bricks.	1	1	-2	-1	1	0	0	0	-2	-2	0	-4	Would be beneficial for most properties in the community at risk in the east of the CDA. Some would have to undergo a structural survey before. No all actions would be effective in protecting properties in climate change scenario as high flood depths have been modelled in the community at risk. Would have a high carbon footprint because of the use and transport of materials. Would cost more than £10k.
NS2	Asset management and maintenance	L1, F3	Having a register of all existing assets and maintenance plan which includes frequency of maintenance.	0	-1	-2	-1	0	1	0	0	1	0	0	-2	The maintenance plan would be practical to have in place. Half of the river is culverted so implementation of maintaining would be challenging. Some sections would be easy to maintain and other would involve working in confined and/or difficult to access spaces. Maintenance plan could be adapted to climate change scenario. Meets two objectives excluding highway's objective.
NS3	Relocation of properties or infrastructure away from flood risk areas	P3, F3, H1	Proposing new developments in areas with low flood risk and having availability to move existing critical infrastructure to low flood risk areas.	2	-2	-2	0	0	2	1	-1	2	-2	1	1	Would cost more than £10k. Meets three objectives including the highways' objective. This measure would reduce flooding for Drapers Brookside Primary School in the very east of the CDA which experiences flooding by relocating the east of the CDA where there is limited surface water flooding. Infrastructure could be relocated to an area which would not be flooded in a climate change scenario. High carbon footprint from transport and use of materials, construction, and machinery. Relocating to a greenspace could cause detrimental impacts to the existing habitats.
NS4	Watercourse management and maintenance	F2, F3, P3	Maintenance to ensure optimal functionality and prevent degradation e.g. keeping growth of vegetation under control, free of debris and reducing excess silt.	1	-1	-1	-1	0	0	0	0	0	-1	0	-3	Would be implemented in the upper section of the watercourse before it is culverted through the residential area, would help prevent backlog of debris before the culvert. Would need to be continuous maintained. Meets three objectives excluding the highways' objective.
Mitigation Measures - Structural Actions																
S1	Infiltration (and evaporation) for managing 'everyday rain'	E1, F3, P3	An engineering structure to collect rainwater from impermeable services e.g. rain gardens.	1	1	-1	-1	1	1	0	1	0	0	0	3	Large area of greenspace to the east and throughout the CDA which can be for this measure. Meets three objectives excluding the highway objective. Would cost less than £10k. Low carbon footprint from the use of local workforce and materials. Would be more effective if works alongside other green infrastructure techniques. Implemented on accessible land.
S2	Conveyance for managing 'usual rainfall'	E1, F3, P3, H1	Designed to collect, delay, and convey rainfall using green infrastructure techniques. This is generally above ground management. New Action: Create earth bund on NW boundary of Sunset Drive to give flood protection.	1	1	-1	-1	1	1	-1	1	0	-1	1	2	Meets three objectives including the highways' objective. Would be more effective if works alongside other green infrastructure techniques. Would cost less than £10k. Medium carbon footprint as material would need to be transported. Holding and delaying water will limit the volume of surface water on the local road network.
S3	Storage for managing 'extreme rainfall'	E1, F3, P3, H1	Designed to collect, delay, and convey rainfall using green infrastructure techniques. This is generally above ground management e.g. swales and wet ponds. Previous SWMP action: Create ponds within a considerable open area northwest of Noak Hill.	1	1	-1	-1	1	1	-1	1	1	-1	1	3	Meets three objectives including the highways' objective. Would be more effective if works alongside other green infrastructure techniques. Would cost less than £10k. Medium carbon footprint as material would need to be transported. Could be apart to store larger volumes of water caused by climate change scenarios. Holding and delaying water will limit the volume of surface water on the local road network.

Ref.	Option/Measure	LBH Aims	Description/Examples	Technical		Economic				Social	Environmental			Objectives	Total Viability Score	Comments
				Is the measure technically effective in reducing flood risk?	Is the measure practical to implement?	Is the measure expensive to implement?	Is long-term maintenance required?	Could the measure attract partnership funding contributions?	Would the measure reduce flooding to critical infrastructure, including the critical highways network?	Are there wider community benefits?	Are there wider ecological and BNG benefits?	Is the measure resilient to the impacts of climate change?	Carbon footprint	Will it help achieve the objectives of the SWMP?		
S4	Restoring urban watercourse	E1, F3	This technique aims to mimic natural processes as much as possible without increasing flood risk e.g. in channel enhancements, larger scale river restoration and SuDS.	0	-2	-2	0	0	-1	-1	1	0	-2	0	-7	The more urban section of watercourse is culverted would be unlikely that it would be restored. Would cost more than £10k. A school is located adjacent to the river. Would cause a significant impact to the community. Would cause increase biodiversity in the river channel and surrounding areas. Large scale construction would be needed. Meets two objectives excluding the highways objectives.
S5	Urban watercourse engineering	F3, H1, P3	Hard engineering flood techniques e.g. storage, embankments, water and diversion channels.	1	1	-2	-1	0	2	0	-1	0	-2	0	-2	Potentially would be beneficial for the flooding issues at Drapers Brookside Primary school, as the watercourse runs alongside the school. Hard engineering techniques could be damaging to ecology and would have a high carbon footprint. Meets three objectives including the highway objective. Would cost more than £10k. Would need to be maintained to remain effective.
S6	Run-off reduction strategy	P1, F3, P3, H1	A long-term plan for making whole urban areas greener and more permeable, this uses green infrastructure techniques to allow increased infiltration.	1	-1	-2	-1	0	1	0	1	0	-1	0	-2	Meet four objectives including the highways' objective. Would cost more £10k. The increase of more greenspaces could increase recreation in the CDA. Reduce runoff would also impact runoff on the local road network.
S7	Reducing surface water in the sewer	F3	Infiltration and storage can be used to reduce water in sewers e.g. soakaways and reducing impermeable surfaces.	1	1	-2	-1	0	0	0	0	0	-2	-1	-4	Space available to implement the measure. Would cost more than £10k. Could have a high carbon footprint due to the use and transport of materials, workforce and machinery used. Meets one objective excluding the highways' objective.
S8	Land management	P1, H1, F3, E1, P3	Implementing land management actions will reduce the volume of run-off, to reduce the flood risk further downstream. Section 19 recommended action: Investigate opportunities for land management and flow management in the upper reaches of each catchment.	1	-1	-2	-1	0	1	-1	-1	1	-1	2	-2	Meets five objectives including the highways' objective. Potentially could be beneficial for reducing increased runoff as a result of climate change. Potential movement of materials to and from the site which creates a medium carbon footprint. Could cost more than £10k. Could limit the volume of runoff to the community at risk and critical infrastructure in the southeast of the CDA.
S9	Underground storage	P2, F3, H1	Divert surface water to storage tanks or by providing storage in the existing drainage / flood management network.	1	-2	-2	-1	0	1	0	-1	1	-2	1	-4	Available space across the CDA. Would need to be maintained so it is fully effective. Potentially would reduce the volume of surface water on the local highways. Would cost more than £10k. Meets three objectives including the highways' objective.
S10	Underground conveyance	P2, F3, H1	Increase capacity or build new underground pipes for surface water.	1	-2	-2	-1	0	1	0	-1	1	-2	1	-4	Available space across the CDA. Would need to be maintained so it is fully effective. Potentially would reduce the volume of surface water on the local highways. Would cost more than £10k. Meets three objectives including the highways' objective.
S11	Modification of culverted watercourses	P2, F3, H1	Aims to increase the capacity of culverted watercourses or divert culverted watercourses.	1	-2	-2	-1	0	1	-1	0	1	-2	1	-4	The river is culverted under s residential area so would impact the community if I was to be undertaken. Meets three objectives including the highways' objective. Would cost more than £10k. Increased capacity in the culverts would reduce the volume of run off on the local road network. Material would be used and transported with machinery emissions would create a high carbon footprint.
Mitigation Measures - Carried Over																
FRMP 2	Carry out flood modelling of main river and adjacent educational facility in the Harold Hill Critical Drainage Area		Provides information about what could be the outcome of flooding scenarios in the Harold Hill location.	1	-1	-2	-1	1	1	0	1	0	1	0	1	Would help support other potential measures by assessing what would be effective at reducing flood risk. Low carbon footprint because of the NFM use and local materials. When the measure is implemented it helps creates habitats.

D.12 CDA 034 – Thames

Table D.12.1: CDA 034 Thames Multi Criteria Analysis

Ref.	Option/Measure	LBH Aims	Description/Examples	Technical		Economic				Social	Environmental			Objectives	Total Viability Score	Comments
				Is the measure technically effective in reducing flood risk?	Is the measure practical to implement?	Is the measure expensive to implement?	Is long-term maintenance required?	Could the measure attract partnership funding contributions?	Would the measure reduce flooding to critical infrastructure, including the critical highways network?	Are there wider community benefits?	Are there wider ecological and BNG benefits?	Is the measure resilient to the impacts of climate change?	Carbon footprint	Will it help achieve the objectives of the SWMP?		
Mitigation Measures - Non-Structural Actions (management and maintenance)																
NS1	Self-help – Property-level protection and resilience	P3, F3	Measures that prevent water entry or reduce the amount of floodwater that enters a property e.g. flood doors, flood gates, self-closing air bricks.	1	1	-2	-1	1	2	0	0	-1	-2	0	-1	Would be effective at protecting properties in a flood event and could be effective in a climate change flooding scenario but the properties would have to undergo a structural survey to increase the height of the barriers. Meets two objectives excluding the highways' objective. Could be implemented for Newtons Primary school which is predicted to experience flooding in 100 year flood and climate change scenarios. Would have a high carbon footprint because of the use and transport of materials. Would cost more than £10k.
NS2	Asset management and maintenance	L1, F3, H1	Having a register of all existing assets and maintenance plan which includes frequency of maintenance.	0	-1	-2	-1	0	1	0	0	1	0	1	-1	This CDA is in the very south of LBH meaning that several watercourses flow through it and in the river Thames. The A13 run across the CDA meaning many of the rivers are culverted under that major road, maintenance of the assets would prevent blockages and flooding risk to the major roads. Long term regular maintenance would be required as part of the plan. Meets three objectives including highway's objective. Implementing and actioning the plan could involve working in confined spaces.
NS3	Relocation of properties or infrastructure away from flood risk areas	P3, F3, H1	Proposing new developments in areas with low flood risk and having availability to move existing critical infrastructure to low flood risk areas.	1	-2	-2	0	0	2	1	-1	1	-2	1	-1	Would cost more than £10k. Meets three objectives including the highways' objective. This measure would reduce flooding for schools are risk, would not be feasible for major road networks. Infrastructure could be relocated to an area which would not be flooded in a climate change scenario. High carbon footprint from transport and use of materials, construction, and machinery. Relocating to a greenspace in the act of the borough could cause detrimental impacts to the existing habitats.
NS4	Watercourse management and maintenance	F2, F3, P3, H1	Maintenance to ensure optimal functionality and prevent degradation e.g. keeping growth of vegetation under control, free of debris and reducing excess silt.	1	-1	-1	-1	0	2	0	0	1	-1	0	0	Would be implemented to all watercourses in the south of the CDA, would help prevent backlog of debris before the culvert and increase the capacity of the watercourses Would need to be continuous maintained. Meets three objectives excluding the highways' objective. Maintenance could be increased to meet the increased flow from climate change.
Mitigation Measures - Structural Actions																
S1	Infiltration (and evaporation) for managing 'everyday rain'	E1, F3, P3, H1	An engineering structure to collect rainwater from impermeable services e.g. rain gardens.	1	1	-1	-1	1	1	0	1	0	0	1	4	Area of greenspace to the east and throughout the CDA which can be used for this measure. Meets four objectives excluding the highway objective. Would cost less than £10k. Low carbon footprint from the use of local workforce and materials. Would be more effective if works alongside other green infrastructure techniques. Implemented on accessible land. Potentially could more effective if implemented in the east and centre of the CDA.
S2	Conveyance for managing 'usual rainfall'	E1, F3, P3, H1	Designed to collect, delay and convey rainfall using green infrastructure techniques. This is generally above ground management.	1	1	-1	-1	1	1	-1	1	0	-1	1	2	Meets objectives including the highways' objective. Would be more effective if works alongside other green infrastructure techniques. Would cost less than £10k. Medium carbon footprint as material would need to be transported. Area of greenspace to the east and throughout the CDA which can be used for this measure.
S3	Storage for managing 'extreme rainfall'	E1, F3, P3, H1	Designed to collect, delay, and convey rainfall using green infrastructure techniques. This is generally above ground management e.g. swales and wet ponds.	1	1	-1	-1	1	1	-1	1	1	-1	1	3	Meets four objectives including the highways' objective. Would be more effective if works alongside other green infrastructure techniques. Would cost less than £10k. Medium carbon footprint as material would need to be transported. Could be apart to store larger volumes of water caused by climate change scenarios. Area of greenspace to the east and throughout the CDA which can be used for this measure.

Ref.	Option/Measure	LBH Aims	Description/Examples	Technical		Economic				Social	Environmental			Objectives	Total Viability Score	Comments
				Is the measure technically effective in reducing flood risk?	Is the measure practical to implement?	Is the measure expensive to implement?	Is long-term maintenance required?	Could the measure attract partnership funding contributions?	Would the measure reduce flooding to critical infrastructure, including the critical highways network?	Are there wider community benefits?	Are there wider ecological and BNG benefits?	Is the measure resilient to the impacts of climate change?	Carbon footprint	Will it help achieve the objectives of the SWMP?		
S4	Restoring urban watercourse	E1, F3	This technique aims to mimic natural processes as much as possible without increasing flood risk e.g. in channel enhancements, larger scale river restoration and SuDS.	1	1	-2	0	0	-1	1	1	0	-1	0	0	The watercourse does not look to be highly urbanised, but measures could be implemented to increase the natural processes. Meets two objectives excluding the highways' objective. Would cost more than £10k. Potentially could affect community benefits for example pathways and land near the river being more accessible. Encourages natural ecological processes on the watercourse. Would cause increase biodiversity in the river channel and surrounding areas.
S5	Urban watercourse engineering	F3, H1, P3	Hard engineering flood techniques e.g. storage, embankments, water and diversion channels.	1	-1	-2	1	0	1	0	0	1	-2	1	0	Meets three objectives including the highways' objective. Potentially could limit the overflow from rivers which could impact the local road network. High carbon footprint from many factors including the use and transport of materials, potential quarried materials. Would cost more than £10k. Potential access and location issues. Measure could be adapted to meet the needs to protect against a climate change flooding scenario.
S6	Run-off reduction strategy	P1, F3, P3, H1	A long-term plan for making whole urban areas greener and more permeable, this uses green infrastructure techniques to allow increased infiltration.	1	-1	-2	-1	0	1	1	1	0	-1	1	0	There is already a wide range of permeable surfaces across the CDA, this could be increased to further improve the benefits. Pathways could be introduced through the permeable areas. Meets four objectives including the highways' objective. The removal and transport of materials creates a medium carbon footprint.
S7	Reducing surface water in the sewer	F3	Infiltration and storage can be used to reduce water in sewers e.g. soakaways and reducing impermeable surfaces.	1	1	-2	-1	0	0	0	0	0	-2	-1	-4	Introducing soakaways could impact pathways and recreational areas. Spaces available to facilitate the measures. Meets one objective excluding the highways' objective. Unlikely to be able to cope with climate change scenarios. Would cost more than £10k.
S8	Land management	P1, H1, F3, E1, P3	Implementing land management actions will reduce the volume of run-off, to reduce the flood risk further downstream.	0	-1	-2	-1	0	0	-1	-1	0	-1	2	-5	This CDA is in south of LBH where watercourses join the River Thames so it would not be the most beneficial as most watercourses flow through greenspace. The impact of this measure in the other CDAs could impact this area positively.
S9	Underground storage	P2, F3, H1	Divert surface water to storage tanks or by providing storage in the existing drainage / flood management network.	1	-2	-2	-1	0	1	0	-1	1	-2	1	-4	Available space across the CDA. Would need to be maintained so it is fully effective. Potentially would reduce the volume of surface water on the local highways. Would cost more than £10k. Meets three objectives including the highways' objective.
S10	Underground conveyance	P2, F3, H1	Increase capacity or build new underground pipes for surface water.	1	-2	-2	-1	0	1	0	-1	1	-2	1	-4	Available space across the CDA. Would need to be maintained so it is fully effective. Potentially would reduce the volume of surface water on the local highways. Would cost more than £10k. Meets three objectives including the highways' objective.
S11	Modification of culverted watercourses	P2, F3, H1	Aims to increase the capacity of culverted watercourses or divert culverted watercourses.	1	-2	-2	-1	0	2	0	0	1	-2	1	-2	The water is culverted under the A13 in several locations, increasing the capacity for the water to flow through the culvert could prevent water backlogging and causing issues to the major road. This potentially could be adapted so that they are increased for facilitate increased volumes of water caused by climate change, when this scenario is modelled to occur. Meet three objectives including the highways objective. Would cost more than £10k. The removal, use and transport of materials creates a high carbon footprint.
Mitigation Measures - Carried Over																
	Implement feasibility study to understand opportunities to provide storage in greenspace, parks and regeneration and developments areas (Romford strategic development area and industrial strategic area)			1	0	-1	-1	2	1	1	1	1	-1	2	6	Feasibility of increasing strategic industrial and development locations This analysis is of the effects of the study and the potential impacts. Assuming that projects implemented are the short list of the study.

Ref.	Option/Measure	LBH Aims	Description/Examples	Technical		Economic				Social	Environmental			Objectives	Total Viability Score	Comments
				Is the measure technically effective in reducing flood risk?	Is the measure practical to implement?	Is the measure expensive to implement?	Is long-term maintenance required?	Could the measure attract partnership funding contributions?	Would the measure reduce flooding to critical infrastructure, including the critical highways network?	Are there wider community benefits?	Are there wider ecological and BNG benefits?	Is the measure resilient to the impacts of climate change?	Carbon footprint	Will it help achieve the objectives of the SWMP?		
Last SWMP	Work with the EA on its new strategy for the Thames and local watercourses.			1	0	-1	-1	1	0	0	0	0	-1	0	-1	
S19	Cross-agency Water Management Plan for the marshes and surrounding areas.			1	0	-1	-1	1	0	0	0	0	-1	0	-1	
	Undertake South Rainham flood study and review recommendations.			1	0	-1	-1	1	0	0	0	0	-1	0	-1	

D.13 CDA 036 – Ingrebourne

Table D.13.1: CDA 036 Ingrebourne Multi Criteria Analysis

Ref.	Option/Measure	LBH Aims	Description/Examples	Technical		Economic				Social	Environmental			Objectives	Total Viability Score	Comments
				Is the measure technically effective in reducing flood risk?	Is the measure practical to implement?	Is the measure expensive to implement?	Is long-term maintenance required?	Could the measure attract partnership funding contributions?	Would the measure reduce flooding to critical infrastructure, including the critical highways network?	Are there wider community benefits?	Are there wider ecological and BNG benefits?	Is the measure resilient to the impacts of climate change?	Carbon footprint	Will it help achieve the objectives of the SWMP?		
Mitigation Measures - Non-Structural Actions (management and maintenance)																
NS1	Self-help – Property-level protection and resilience	P3, F3	Measures that prevent water entry or reduce the amount of floodwater that enters a property e.g. flood doors, flood gates, self-closing air bricks.	1	1	-2	-1	1	2	0	0	-1	-2	0	-1	Would only be effective for three communities at risk in the very north of the CDA as the other communities at risk are in areas where surface water flood depth would exceed the height of defences. Would not be effective in climate change scenarios due to high depths. Could be effective at protecting Emerson Park Academy and Mead Primary School. Would have a high carbon footprint because of the use and transport of materials. Would cost more than £10k. Meets two objectives excluding the highways objective.
NS2	Asset management and maintenance	L1, F3	Having a register of all existing assets and maintenance plan which includes frequency of maintenance.	0	-1	-2	-1	0	1	0	0	1	0	1	-1	Long term regular maintenance would be required as part of the plan and maintenance could be increased to adapt to climate change scenario. Meets three objectives including highway's objective. Implementing and actioning the plan could involve working in confined spaces. River Ingrebourne is relatively accessible and flows north to south of the CDA.
NS3	Relocation of properties or infrastructure away from flood risk areas	P3, F3, H1	Proposing new developments in areas with low flood risk and having availability to move existing critical infrastructure to low flood risk areas.	1	-2	-2	0	0	2	-1	-1	1	-2	1	-3	Would cost more than £10k. Meets three objectives including the highways' objective. This measure would reduce flooding for schools are risk, would not be feasible for major road networks. Infrastructure could be relocated to an area which would not be flooded in a climate change scenario. High carbon footprint from transport and use of materials, construction, and machinery. Relocating to a greenspace in the north and south of the borough could cause detrimental impacts to the existing habitats. Reduces the space in the CDA for recreation.
NS4	Watercourse management and maintenance	F2, F3, P3	Maintenance to ensure optimal functionality and prevent degradation e.g. keeping growth of vegetation under control, free of debris and reducing excess silt.	1	-1	-1	-1	0	1	0	0	1	-1	0	-1	Would be implemented for the entire stretch for the river Ingrebourne. Would need to be continuously maintained. Meets three objectives excluding the highways' objective. Maintenance could be increased to meet the increased flow from climate change. River Ingrebourne is relatively accessible.
Mitigation Measures - Structural Actions																
S1	Infiltration (and evaporation) for managing 'everyday rain'	E1, F3, P3	An engineering structure to collect rainwater from impermeable services e.g. rain gardens.	1	2	-1	-1	1	1	0	1	0	0	1	5	Available accessible space across the CDA. Meets four objectives excluding the highway objective. Would cost less than £10k. Low carbon footprint from the use of local workforce and materials. Would be more effective if works alongside other green infrastructure techniques.
S2	Conveyance for managing 'usual rainfall'	E1, F3, P3, H1	Designed to collect, delay, and convey rainfall using green infrastructure techniques. This is generally above ground management.	1	2	-1	-1	1	1	-1	1	0	-1	1	3	Available accessible space across the CDA. Meets objectives including the highways' objective. Would be more effective if works alongside other green infrastructure techniques. Would cost less than £10k. Medium carbon footprint as material would need to be transported.
S3	Storage for managing 'extreme rainfall'	E1, F3, P3, H1	Designed to collect, delay and convey rainfall using green infrastructure techniques. This is generally above ground management e.g. swales and wet ponds. Measure from previous SWMP: Investigate detention basins at several locations in open spaces along the course of the Ingrebourne.	1	2	-1	-1	1	1	-1	1	1	-1	1	4	Available accessible space across the CDA. Meets four objectives including the highways' objective. Would be more effective if works alongside other green infrastructure techniques. Would cost less than £10k. Medium carbon footprint as material would need to be transported. Could be adapted to store larger volumes of water caused by climate change scenarios.
S4	Restoring urban watercourse	E1, F3	This technique aims to mimic natural processes as much as possible without increasing flood risk e.g. in channel enhancements, larger scale river restoration and SuDS.	1	1	-2	0	0	-2	1	1	0	-1	0	-1	The watercourse does not look to be highly urbanised, but measures could be implemented to increase the natural processes. Meets two objectives excluding the highways' objective. Would cost more than £10k. Potentially could affect community benefits for example pathways and land near the river Ingrebourne being more accessible. Encourages natural ecological and biodiversity processes on the watercourse.

Ref.	Option/Measure	LBH Aims	Description/Examples	Technical		Economic				Social	Environmental			Objectives	Total Viability Score	Comments
				Is the measure technically effective in reducing flood risk?	Is the measure practical to implement?	Is the measure expensive to implement?	Is long-term maintenance required?	Could the measure attract partnership funding contributions?	Would the measure reduce flooding to critical infrastructure, including the critical highways network?	Are there wider community benefits?	Are there wider ecological and BNG benefits?	Is the measure resilient to the impacts of climate change?	Carbon footprint	Will it help achieve the objectives of the SWMP?		
S5	Urban watercourse engineering	F3, H1, P3	Hard engineering flood techniques e.g. storage, embankments, water and diversion channels.	1	-2	-2	1	0	1	0	0	1	-2	1	-1	Meets three objectives including the highways' objective. Potentially could use to protect schools and critical infrastructure near watercourses. High carbon footprint from many factors including the use and transport of materials, potential quarried materials. Would cost more than £10k. Measure could be adapted to meet the needs to protect against a climate change flooding scenario.
S6	Run-off reduction strategy	P1, F3, P3	A long-term plan for making whole urban areas greener and more permeable, this uses green infrastructure techniques to allow increased infiltration.	1	1	-2	-1	0	2	1	1	0	-1	1	3	This CDA would be an ideal location to implement this measure because it stretches the entire length of LBH and the river Ingrebourne. Pathways could be introduced through the permeable areas. Meets four objectives including the highways' objective. The removal and transport of materials creates a medium carbon footprint.
S7	Reducing surface water in the sewer	F3	Infiltration and storage can be used to reduce water in sewers e.g. soakaways and reducing impermeable surfaces. Recommendation from Section 19: Investigate scope to increase surface water sewer capacity in the locations affected by flooding.	1	1	-2	-1	0	0	0	0	0	-2	-1	-4	Introducing soakaways could impact pathways and recreational areas. Available space to implement across the CDA. Meets one objective excluding the highways' objective. Unlikely to be able to cope with climate change scenarios. Would cost more than £10k.
S8	Land management	P1, H1, F3, E1, P3	Implementing land management actions will reduce the volume of run-off, to reduce the flood risk further downstream.	1	1	-2	-1	0	0	-1	-1	0	-1	2	-2	This CDA would be an ideal location to implement this measure because it stretches the entire length of LBH and the river Ingrebourne.
S9	Underground storage	P2, F3, H1	Divert surface water to storage tanks or by providing storage in the existing drainage / flood management network.	1	-2	-2	-1	0	1	0	-1	1	-2	1	-4	Available space across the CDA. Would need to be maintained so it is fully effective. Potentially would reduce the volume of surface water on the local highways. Would cost more than £10k. Meets three objectives including the highways' objective.
S10	Underground conveyance	P2, F3, H1	Increase capacity or build new underground pipes for surface water.	1	-2	-2	-1	0	1	0	-1	1	-2	1	-4	Available space across the CDA. Would need to be maintained so it is fully effective. Potentially would reduce the volume of surface water on the local highways. Would cost more than £10k. Meets three objectives including the highways' objective.
S11	Modification of culverted watercourses	P2, F3, H1	Aims to increase the capacity of culverted watercourses or divert culverted watercourses.	1	-2	-2	-1	0	2	0	0	1	-2	1	-2	Would be beneficial for three culverts under the railway line where it has been modelled to be a backlog which is creating a community and risk as well as impacting the local road network. This potentially could be adapted so that they are increased for facilitate increased volumes of water caused by climate change, when this scenario is modelled to occur. Meet three objectives including the highways objective. Would cost more than £10k. The removal, use and transport of materials creates a high carbon footprint.
Mitigation Measures - Carried Over																
	Implement feasibility study to understand opportunities to provide storage in greenspace, parks and regeneration and developments areas (Romford strategic development area and industrial strategic area)			1	0	-1	-1	2	1	1	1	1	-1	2	6	Feasibility of increasing Housing regeneration This analysis is of the effects of the study and the potential impacts. If projects implemented are the short list of the study.

D.14 CDA 037 – River Ravensbourne

Table D.14.1: CDA 037 River Ravensbourne Multi Criteria Analysis

Ref.	Option/Measure	LBH Aims	Description/Examples	Technical		Economic				Social	Environmental			Objectives	Total Viability Score	Comments
				Is the measure technically effective in reducing flood risk?	Is the measure practical to implement?	Is the measure expensive to implement?	Is long-term maintenance required?	Could the measure attract partnership funding contributions?	Would the measure reduce flooding to critical infrastructure, including the critical highways network?	Are there wider community benefits?	Are there wider ecological and BNG benefits?	Is the measure resilient to the impacts of climate change?	Carbon footprint	Will it help achieve the objectives of the SWMP?		
Mitigation Measures - Non-Structural Actions (management and maintenance)																
NS1	Self-help – Property-level protection and resilience	P3, F3	Measures that prevent water entry or reduce the amount of floodwater that enters a property e.g. flood doors, flood gates, self-closing air bricks.	1	1	-2	-1	1	0	0	0	1	-2	0	-1	Measure would be effective to protect all communities at risk in the CDA. Structural surveys would have to be completed to increase the height to protect against climate change scenario depth. Hornchurch high school has low depth flooding so this measure would not be appropriate. Meets two objectives excluding highway's objective. Would cost more than £10k. Would have a high carbon footprint because of the use and transport of materials.
NS2	Asset management and maintenance	L1, F3, H1	Having a register of all existing assets and maintenance plan which includes frequency of maintenance.	1	-1	-2	-1	1	0	0	0	1	0	0	-1	This CDA the River Ravensbourne flow the entire length of the CDA, maintenance of the assets would prevent blockages and flooding risk to the local road network Long term regular maintenance would be required as part of the plan. Meets three objectives including highways objective. Potentially could require a contractor.
NS3	Relocation of properties or infrastructure away from flood risk areas	P3, F3	Proposing new developments in areas with low flood risk and having availability to move existing critical infrastructure to low flood risk areas.	-2	-2	-2	0	0	-1	0	-1	-1	-2	0	-11	Only land which would be available for future development would be along the floodplain on the River Ravensbourne which would cause other issues of fluvial flooding. Meets two objectives excluding the highways objectives. High carbon footprint from transport and use of materials, construction and machinery. Relocating to a greenspace could cause detrimental impacts to the existing habitats.
NS4	Watercourse management and maintenance	F2, F3, P3	Maintenance to ensure optimal functionality and prevent degradation e.g. keeping growth of vegetation under control, free of debris and reducing excess silt.	1	1	-1	-1	0	0	0	1	1	-1	0	1	Meets three objectives excluding the highways' objective. Would help prevent blockages which would limit the impacts of flooding to residential areas and increase the volume watercourse can hold. Measure could be adapted to take into account climate change scenario. Removal of waste creates a medium carbon footprint.
Mitigation Measures - Structural Actions																
S1	Infiltration (and evaporation) for managing 'everyday rain'	E1, F3, P3	An engineering structure to collect rainwater from impermeable services e.g. rain gardens.	1	1	-1	-1	1	1	0	1	0	0	1	4	Measure could be implemented in residential areas or in Harrow Lodge Park and Haynes Park. Meets three objectives excluding the highway objective. Would cost less than £10k. Low carbon footprint from the use of local workforce and materials. Would be more effective if works alongside other green infrastructure techniques.
S2	Conveyance for managing 'usual rainfall'	E1, F3, P3, H1	Designed to collect, delay and convey rainfall using green infrastructure techniques. This is generally above ground management.	1	1	-1	-1	1	1	-1	1	0	-1	1	2	Meets objectives including the highways' objective. Would be more effective if works alongside other green infrastructure techniques. Would cost less than £10k. Measure could be implemented in residential areas or in Harrow Lodge Park and Haynes Park. Medium carbon footprint as material would need to be transported.
S3	Storage for managing 'extreme rainfall'	E1, F3, P3, H1	Designed to collect, delay and convey rainfall using green infrastructure techniques. This is generally above ground management e.g. swales and wet ponds. Measure from previous SWMP: Investigate the creation of detention basins at several locations in open spaces along the course of the river Ravensbourne.	1	1	-1	-1	1	1	-1	1	1	-1	1	3	Meets four objectives including the highways' objective. Would be more effective if works alongside other green infrastructure techniques. Would cost less than £10k. Medium carbon footprint as material would need to be transported. Could be adapted to store larger volumes of water caused by climate change scenarios. Measure could be implemented in residential areas or in Harrow Lodge Park and Haynes Park.
S4	Restoring urban watercourse	E1, F3	This technique aims to mimic natural processes as much as possible without increasing flood risk e.g. in channel enhancements, larger	1	1	-2	0	1	0	1	1	0	-1	0	2	Would be implemented where the River Ravensbourne flows through Harrow Lodge Park and Haynes Park, either encourage or enhance the natural processes. Meets two objectives excluding the highway objective. Would cause increase biodiversity in the river channel and surrounding areas.

				Technical		Economic				Social	Environmental			Objectives		
Ref.	Option/Measure	LBH Aims	Description/Examples	Is the measure technically effective in reducing flood risk?	Is the measure practical to implement?	Is the measure expensive to implement?	Is long-term maintenance required?	Could the measure attract partnership funding contributions?	Would the measure reduce flooding to critical infrastructure, including the critical highways network?	Are there wider community benefits?	Are there wider ecological and BNG benefits?	Is the measure resilient to the impacts of climate change?	Carbon footprint	Will it help achieve the objectives of the SWMP?	Total Viability Score	Comments
			scale river restoration and SuDS.													Would cost more than £10k. This would not be feasible where the river course is through residential estate.
S5	Urban watercourse engineering	F3, H1, P3	Hard engineering flood techniques e.g. storage, embankments, water and diversion channels.	1	-1	-2	1	0	0	0	0	1	-2	1	-1	Meets three objectives including the highways' objective. Potentially could limit surface water by storing it. High carbon footprint from many factors including the use and transport of materials, potential quarried materials. Would cost more than £10k. Potential access and location issues. Measure could be adapted to meet the needs to protect against a climate change flooding scenario.
S6	Run-off reduction strategy	P1, F3, P3, H1	A long-term plan for making whole urban areas more green and permeable, this uses green infrastructure techniques to allow increased infiltration.	1	-1	-2	-1	0	1	1	1	0	-1	1	0	Green infrastructure techniques introduced in a residential area will limit runoff and surface water. Surface water is mainly found on the local road network in this CDA. Meets four objectives including the highways' objective. The removal and transport of materials creates a medium carbon footprint.
S7	Reducing surface water in the sewer	F3	Infiltration and storage can be used to reduce water in sewers e.g. soakaways and reducing impermeable surfaces. Section 19 recommendation: Investigate scope to increase surface water sewer capacity in the locations affected by flooding.	1	1	-2	-1	0	0	0	0	0	-2	-1	-4	Introducing soakaways could impact pathways and recreational areas. Impermeable surface can be reduced boroughwide and soakaways in Harrow Lodge Park and Haynes Park. Meets one objective excluding the highways' objective. Unlikely to be able to cope with climate change scenarios. Would cost more than £10k. The removal and transport of materials and machinery produces a high carbon footprint.
S8	Land management	P1, H1, F3, E1, P3	Implementing land management actions will reduce the volume of run-off, to reduce the flood risk further downstream.	1	-1	-2	-1	0	0	-1	-1	0	-1	2	-4	A variety of areas would have to be accessible to implement this measure. Would cost more than £10k. Changing land use and management will impact the community and ecology of the CDA. May is not able to cope with climate change scenario. Medium carbon footprint depending on the action used. Meets five objectives including the highways objective.
S9	Underground storage	P2, F3, H1	Divert surface water to storage tanks or by providing storage in the existing drainage / flood management network.	1	-2	-2	-1	0	1	-1	-1	1	-2	1	-5	Available space in Harrow Lodge Park and Haynes Park Would need to be maintained so it is fully effective. Potentially would reduce the volume of surface water on the local highways. Would cost more than £10k. Meets three objectives including the highways' objective. Potentially could reduce community benefits short term.
S10	Underground conveyance	P2, F3, H1	Increase capacity or build new underground pipes for surface water.	1	-2	-2	-1	0	1	-1	-1	1	-2	1	-5	Available space Harrow Lodge Park and Haynes Park Potentially would reduce the volume of surface water on the local highways. Would cost more than £10k. Meets three objectives including the highways' objective. Potentially could reduce community benefits short term.
S11	Modification of culverted watercourses	P2, F3, H1	Aims to increase the capacity of culverted watercourses or divert culverted watercourses.	1	-2	-2	-1	0	1	0	0	1	-2	1	-3	This measure would be needed where the watercourse flows under the railway line, this culvert capacity would need to be increased to cope with the increased flow from climate change because the current modelling shows that local road network before the culvert would be flooded. High carbon footprint due to use, transport and removal of materials and the machinery needed. Meets three objectives including the highways objective.
Mitigation Measures - Carried Over																
	Implement feasibility study to understand opportunities to provide storage in greenspace, parks and regeneration and developments areas (Romford strategic development area and industrial strategic area)			1	0	-1	-1	2	1	1	1	1	-1	2	6	Feasibility of increasing Housing regeneration This analysis is of the effects of the study and the potential impacts. Assuming that projects implemented are the short list of the study.

D.15 CDA 038 – Heath Park North

Table D.15.1: CDA 038 Heath Park North Multi Criteria Analysis

Ref.	Option/Measure	LBH Aims	Description/Examples	Technical: Is the measure technically effective in reducing flood risk?	Technical: Is the measure practical to implement?	Economic: Is the measure expensive to implement?	Economic: Is long-term maintenance required?	Economic: Could the measure attract partnership funding contributions?	Economic: Would the measure reduce flooding to critical infrastructure, including the critical highways network?	Social: Are there wider community benefits?	Environmental: Are there wider ecological and BNG benefits?	Environmental: Is the measure resilient to the impacts of climate change?	Environmental: Carbon footprint	Objectives: Will it help achieve the objectives of the SWMP?	Total Viability Score	Comments
Mitigation Measures - Non-Structural Actions (management and maintenance)																
NS1	Self-help – Property-level protection and resilience	P3, F3	Measures that prevent water entry or reduce the amount of floodwater that enters a property e.g. flood doors, flood gates, self-closing air bricks.	1	1	-2	-1	1	0	0	0	1	-2	0	-1	Measure would be effective to protect both communities at risk in the CDA, also would be suitable for climate change scenario. Meets two objectives excluding highway's objective. Would cost more than £10k. Would have a high carbon footprint because of the use and transport of materials. Would need to be maintained to remain effective.
NS2	Asset management and maintenance	L1, F3	Having a register of all existing assets and maintenance plan which includes frequency of maintenance.	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-22	There is no watercourse flowing through the CDA.
NS3	Relocation of properties or infrastructure away from flood risk areas	P3, F3, H1	Proposing new developments in areas with low flood risk and having availability to move existing critical infrastructure to low flood risk areas.	-2	-2	-2	0	0	-1	-1	-1	-1	-2	0	-12	Very small CDA and it is highly urbanised so this measure would not be feasible.
NS4	Watercourse management and maintenance	F2, F3, P3	Maintenance to ensure optimal functionality and prevent degradation e.g. keeping growth of vegetation under control, free of debris and reducing excess silt.	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-22	There is no watercourse flowing through the CDA.
Mitigation Measures - Structural Actions																
S1	Infiltration (and evaporation) for managing 'everyday rain'	E1, F3, P3	An engineering structure to collect rainwater from impermeable services e.g. rain gardens.	1	-1	-1	-1	1	1	0	1	0	0	1	2	In this CDA it would need to be implemented across the urbanised area, potentially in gardens and recreational areas. Meets three objectives excluding the highway objective. Would cost less than £10k. Low carbon footprint from the use of local workforce and materials. Would be more effective if works alongside other green infrastructure techniques.
S2	Conveyance for managing 'usual rainfall'	E1, F3, P3	Designed to collect, delay, and convey rainfall using green infrastructure techniques. This is generally above ground management.	1	-2	-1	-1	1	1	-1	1	0	-1	1	-1	Potentially no/limited space for this measure. Meets three objectives excluding the highway objective. Would cost less than £10k. Low carbon footprint from the use of local workforce and materials. Would be more effective if works alongside other green infrastructure techniques.
S3	Storage for managing 'extreme rainfall'	E1, F3, P3	Designed to collect, delay and convey rainfall using green infrastructure techniques. This is generally above ground management e.g. swales and wet ponds.	1	-2	-1	-1	1	1	-1	1	1	-1	1	0	Potentially no/limited space for this measure. Meets three objectives excluding the highway objective. Would cost less than £10k. Low carbon footprint from the use of local workforce and materials. Would be more effective if works alongside other green infrastructure techniques.
S4	Restoring urban watercourse	E1, F3	This technique aims to mimic natural processes as much as possible without increasing flood risk e.g. in channel enhancements, larger scale river restoration and SuDS.	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-22	There is no watercourse flowing through the CDA.
S5	Urban watercourse engineering	F3, H1, P3	Hard engineering flood techniques e.g. storage, embankments, water and diversion channels.	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-22	There is no watercourse flowing through the CDA.
S6	Run-off reduction strategy	P1, F3, P3, H1	A long-term plan for making whole urban areas greener and more permeable, this uses green infrastructure	1	-2	-2	-1	0	1	1	1	0	-1	1	-1	Measure would have to implemented across the urban/residential area. Surface water is mainly found on the local road network in this CDA. Meets four objectives including the highways' objective. The removal and transport of materials creates a medium carbon footprint.

Ref.	Option/Measure	LBH Aims	Description/Examples	Technical		Economic				Social	Environmental			Objectives	Total Viability Score	Comments
				Is the measure technically effective in reducing flood risk?	Is the measure practical to implement?	Is the measure expensive to implement?	Is long-term maintenance required?	Could the measure attract partnership funding contributions?	Would the measure reduce flooding to critical infrastructure, including the critical highways network?	Are there wider community benefits?	Are there wider ecological and BNG benefits?	Is the measure resilient to the impacts of climate change?	Carbon footprint	Will it help achieve the objectives of the SWMP?		
			techniques to allow increased infiltration.													
S7	Reducing surface water in the sewer	F3	Infiltration and storage can be used to reduce water in sewers e.g. soakaways and reducing impermeable surfaces.	1	-1	-2	-1	0	0	0	0	0	-2	-1	-6	Measure would have to implemented across the urban/residential area. Meets one objective excluding the highways objective. Unlikely to be able to cope with climate change scenarios. Would cost more than £10k. The removal and transport of materials and machinery produces a high carbon footprint.
S8	Land management	P1, H1, F3, E1, P3	Implementing land management actions will reduce the volume of run-off, to reduce the flood risk further downstream. Recommendation from previous Section 19 report: Investigate opportunities for land management and flow management in the upper reaches of each catchment.	1	-2	-2	-1	0	0	-1	-1	0	-1	2	-5	Potentially the CDA is too small and urbanised for this measure to be implemented and to be effective, so may not be practical to implement. Meets five objectives including highway's objective. Would cost more than £10k. Changing land use and management will impact the community and ecology of the CDA. May is not able to cope with climate change scenario. Medium carbon footprint depending on the action used.
S9	Underground storage	P2, F3, H1	Divert surface water to storage tanks or by providing storage in the existing drainage / flood management network.	1	-2	-2	-1	0	1	-1	-1	1	-2	1	-5	Limited to no space where this measure could be implemented as it is a highly urbanised area. Would need to be maintained so it is fully effective. Potentially would reduce the volume of surface water on the local highways. Would cost more than £10k. Meets three objectives including the highways' objective. Potentially could reduce community benefits short term.
S10	Underground conveyance	P2, F3, H1	Increase capacity or build new underground pipes for surface water.	1	-2	-2	-1	0	1	-1	-1	1	-2	1	-5	Limited to no space where this measure could be implemented as it is a highly urbanised area. Would need to be maintained so it is fully effective. Potentially would reduce the volume of surface water on the local highways. Would cost more than £10k. Meets three objectives including the highways' objective. Potentially could reduce community benefits short term.
S11	Modification of culverted watercourses	P2, F3, H1	Aims to increase the capacity of culverted watercourses or divert culverted watercourses.	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-22	There is no watercourse flowing through the CDA.
Mitigation Measures - Carried Over																
	Implement feasibility study to understand opportunities to provide storage in greenspace, parks and regeneration and developments areas (Romford strategic development area and industrial strategic area)			1	0	-1	-1	2	1	1	1	1	-1	2	6	Feasibility of increasing Housing regeneration and strategic development This analysis is of the effects of the study and the potential impacts. Assuming that projects implemented are the short list of the study.

D.16 CDA 039 – Heath Park South

Table D.16.1: CDA 039 Heath Park South Multi Criteria Analysis

				Technical		Economic				Social	Environmental			Objectives		
Ref.	Option/Measure	LBH Aims	Description/Examples	Is the measure technically effective in reducing flood risk?	Is the measure practical to implement?	Is the measure expensive to implement?	Is long-term maintenance required?	Could the measure attract partnership funding contributions?	Would the measure reduce flooding to critical infrastructure, including the critical highways network?	Are there wider community benefits?	Are there wider ecological and BNG benefits?	Is the measure resilient to the impacts of climate change?	Carbon footprint	Will it help achieve the objectives of the SWMP?	Total Viability Score	Comments
Mitigation Measures - Non-Structural Actions (management and maintenance)																
NS1	Self-help – Property-level protection and resilience	P3, F3	Measures that prevent water entry or reduce the amount of floodwater that enters a property e.g. flood doors, flood gates, self-closing air bricks.	1	1	-2	-1	1	0	0	0	1	-2	0	-1	Measure would be effective to protect the communities at risk in the CDA, a structural survey would need to be completed to raise the height to protect against climate change scenarios. Meets two objectives excluding highways objective. Would cost more than £10k. Would have a high carbon footprint because of the use and transport of materials. Would need to be maintained to remain effective. Schools in the CDA experience shallow flooding so may not be an appropriate measure for these properties.
NS2	Asset management and maintenance	L1, F3	Having a register of all existing assets and maintenance plan which includes frequency of maintenance.	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-22	There is no watercourse flowing through the CDA.
NS3	Relocation of properties or infrastructure away from flood risk areas	P3, F3, H1	Proposing new developments in areas with low flood risk and having availability to move existing critical infrastructure to low flood risk areas.	-1	-1	-2	0	0	-1	-1	-1	-1	-2	0	-10	Very limited space where properties could be relocated to. Meets two objectives excluding the highways objectives. High carbon footprint from transport and use of materials, construction and machinery. Relocating to a greenspace could cause detrimental impacts to the existing habitats. Would cost more than £10k.
NS4	Watercourse management and maintenance	F2, F3, P3	Maintenance to ensure optimal functionality and prevent degradation e.g. keeping growth of vegetation under control, free of debris and reducing excess silt.	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-22	There is no watercourse flowing through the CDA.
Mitigation Measures - Structural Actions																
S1	Infiltration (and evaporation) for managing 'everyday rain'	E1, F3, P3	An engineering structure to collect rainwater from impermeable services e.g. rain gardens.	1	1	-1	-1	1	1	0	1	0	0	0	3	In this CDA it would need to implement across the urbanised area, potentially in gardens and recreational areas. Meets three objectives excluding the highway objective. Would cost less than £10k. Low carbon footprint from the use of local workforce and materials. Would be more effective if works alongside other green infrastructure techniques.
S2	Conveyance for managing 'usual rainfall'	E1, F3, P3, H1	Designed to collect, delay and convey rainfall using green infrastructure techniques. This is generally above ground management.	1	-1	-1	-1	1	1	-1	1	0	-1	1	0	Potentially limited space for this measure. Meets three objectives excluding the highway objective. Would cost less than £10k. Low carbon footprint from the use of local workforce and materials. Would be more effective if works alongside other green infrastructure techniques.
S3	Storage for managing 'extreme rainfall'	E1, F3, P3, H1	Designed to collect, delay and convey rainfall using green infrastructure techniques. This is generally above ground management e.g. swales and wet ponds.	1	-1	-1	-1	1	1	-1	1	1	-1	1	1	Potentially limited space for this measure. Meets three objectives excluding the highway objective. Would cost less than £10k. Low carbon footprint from the use of local workforce and materials. Would be more effective if works alongside other green infrastructure techniques.
S4	Restoring urban watercourse	E1, F3	This technique aims to mimic natural processes as much as possible without increasing flood risk e.g. in channel enhancements, larger scale river restoration and SuDS.	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-22	There is no watercourse flowing through the CDA.
S5	Urban watercourse engineering	F3, H1, P3	Hard engineering flood techniques e.g. storage, embankments, water and diversion channels.	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-22	There is no watercourse flowing through the CDA.

Ref.	Option/Measure	LBH Aims	Description/Examples	Technical		Economic				Social	Environmental			Objectives	Total Viability Score	Comments
				Is the measure technically effective in reducing flood risk?	Is the measure practical to implement?	Is the measure expensive to implement?	Is long-term maintenance required?	Could the measure attract partnership funding contributions?	Would the measure reduce flooding to critical infrastructure, including the critical highways network?	Are there wider community benefits?	Are there wider ecological and BNG benefits?	Is the measure resilient to the impacts of climate change?	Carbon footprint	Will it help achieve the objectives of the SWMP?		
S6	Run-off reduction strategy	P1, F3, P3	A long-term plan for making whole urban areas greener and more permeable, this uses green infrastructure techniques to allow increased infiltration.	1	-1	-2	-1	0	2	1	1	0	-1	1	1	Measure would have to implemented across the urban/residential area. Would help reduce the surface water on the major roads and local road network. Meets four objectives including the highways' objective. The removal and transport of materials creates a medium carbon footprint.
S7	Reducing surface water in the sewer	F3	Infiltration and storage can be used to reduce water in sewers e.g. soakaways and reducing impermeable surfaces.	1	-1	-2	-1	0	1	0	0	0	-2	-1	-5	Measure would have to implemented across the urban/residential area. Meets one objective excluding the highways' objective. Unlikely to be able to cope with climate change scenarios. Would cost more than £10k. The removal and transport of materials and machinery produces a high carbon footprint.
S8	Land management	P1, H1, F3, E1, P3	Implementing land management actions will reduce the volume of run-off, to reduce the flood risk further downstream.	1	-2	-2	-1	0	2	-1	-1	0	-1	2	-3	Limited availability to implement this measure Would help reduce the surface water on the A124 and local road network. Meets five objectives including highway's objective. Would cost more than £10k. Changing land use and management will impact the community and ecology of the CDA. May is not able to cope with climate change scenario. Medium carbon footprint depending on the action used.
S9	Underground storage	P2, F3, H1	Divert surface water to storage tanks or by providing storage in the existing drainage / flood management network.	1	-1	-2	-1	0	2	-1	-1	1	-2	1	-3	Would help reduce the surface water on the A124 and local road network. Limited space to implement this measure as it is urbanised. Would cost more than £10k. Meets three objectives including the highways' objective. Potentially could reduce community benefits short term. Would need to be maintained so it is fully effective.
S10	Underground conveyance	P2, F3, H1	Increase capacity or build new underground pipes for surface water.	1	-1	-2	-1	0	2	-1	-1	1	-2	1	-3	Would help reduce the surface water on the A124 and local road network. Limited space to implement this measure as it is urbanised. Would cost more than £10k. Meets three objectives including the highways' objective. Potentially could reduce community benefits short term. Would need to be maintained so it is fully effective.
S11	Modification of culverted watercourses	P2, F3, H1	Aims to increase the capacity of culverted watercourses or divert culverted watercourses.	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-22	There is no watercourse flowing through the CDA.
Mitigation Measures - Carried Over																
	Implement feasibility study to understand opportunities to provide storage in greenspace, parks and regeneration and developments areas (Romford strategic development area and industrial strategic area)			1	0	-1	-1	2	1	1	1	1	-1	2	6	Feasibility of increasing Housing regeneration This analysis is of the effects of the study and the potential impacts. Assuming that projects implemented are the short list of the study.

D.17 CDA 040 – Harold Hill South

Table D.17.1: CDA 040 Harold Hill South Multi Criteria Analysis

Ref.	Option/Measure	LBH Aims	Description/Examples	Technical		Economic				Social	Environmental			Objectives	Total Viability Score	Comments
				Is the measure technically effective in reducing flood risk?	Is the measure practical to implement?	Is the measure expensive to implement?	Is long-term maintenance required?	Could the measure attract partnership funding contributions?	Would the measure reduce flooding to critical infrastructure, including the critical highways network?	Are there wider community benefits?	Are there wider ecological and BNG benefits?	Is the measure resilient to the impacts of climate change?	Carbon footprint	Will it help achieve the objectives of the SWMP?		
Mitigation Measures - Non-Structural Actions (management and maintenance)																
N+10:18S1	Self-help – Property-level protection and resilience	P3, F3	Measures that prevent water entry or reduce the amount of floodwater that enters a property e.g. flood doors, flood gates, self-closing air bricks.	1	1	-2	-1	1	0	0	0	1	-2	0	-1	Measure would be effective to protect the communities at risk in the CDA, a structural survey would need to be completed to raise the height to protect against climate change scenarios. Meets two objectives excluding highways objective. Would cost more than £10k. Would have a high carbon footprint because of the use and transport of materials. Would need to be maintained to remain effective. St Ursula Catholic Primary School experience shallow flooding so may not be an appropriate measure for these properties.
NS2	Asset management and maintenance	L1, F3	Having a register of all existing assets and maintenance plan which includes frequency of maintenance.	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-22	There is no watercourse flowing through the CDA.
NS3	Relocation of properties or infrastructure away from flood risk areas	P3, F3, H1	Proposing new developments in areas with low flood risk and having availability to move existing critical infrastructure to low flood risk areas.	1	-1	-2	0	0	-1	-1	-1	-1	-2	1	-7	Greenspace is located in the east of the CDA, this space potentially could be used for relocating critical infrastructure. Meets two objectives excluding the highways objectives. High carbon footprint from transport and use of materials, construction, and machinery. Relocating to a greenspace could cause detrimental impacts to the existing habitats. Would cost more than £10k.
NS4	Watercourse management and maintenance	F2, F3, P3	Maintenance to ensure optimal functionality and prevent degradation e.g. keeping growth of vegetation under control, free of debris and reducing excess silt.	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-22	There is no watercourse flowing through the CDA.
Mitigation Measures - Structural Actions																
S1	Infiltration (and evaporation) for managing 'everyday rain'	E1, F3, P3	An engineering structure to collect rainwater from impermeable services e.g. rain gardens.	1	1	-1	-1	1	1	0	1	0	0	0	3	This measure could be implemented in greenspace in urban areas across the CDA. Meets three objectives excluding the highway objective. Would cost less than £10k. Low carbon footprint from the use of local workforce and materials. Would be more effective if works alongside other green infrastructure techniques.
S2	Conveyance for managing 'usual rainfall'	E1, F3, P3, H1	Designed to collect, delay and convey rainfall using green infrastructure techniques. This is generally above ground management.	1	1	-1	-1	1	1	-1	1	0	-1	1	2	This measure could be implemented in greenspace in urban areas across the CDA. Meets three objectives excluding the highway objective. Would cost less than £10k. Low carbon footprint from the use of local workforce and materials. Would be more effective if works alongside other green infrastructure techniques.
S3	Storage for managing 'extreme rainfall'	E1, F3, P3, H1	Designed to collect, delay and convey rainfall using green infrastructure techniques. This is generally above ground management e.g. swales and wet ponds.	1	1	-1	-1	1	1	-1	1	1	-1	1	3	Greenspace is located in the east of the CDA, this space potentially could be used for relocating critical infrastructure. Meets three objectives excluding the highway objective. Would cost less than £10k. Low carbon footprint from the use of local workforce and materials. Would be more effective if works alongside other green infrastructure techniques.
S4	Restoring urban watercourse	E1, F3	This technique aims to mimic natural processes as much as possible without increasing flood risk e.g. in channel enhancements, larger scale river restoration and SuDS.	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-22	There is no watercourse flowing through the CDA.
S5	Urban watercourse engineering	F3, H1, P3	Hard engineering flood techniques e.g. storage, embankments, water and diversion channels.	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-22	There is no watercourse flowing through the CDA.

Ref.	Option/Measure	LBH Aims	Description/Examples	Technical: Is the measure technically effective in reducing flood risk?	Technical: Is the measure practical to implement?	Economic: Is the measure expensive to implement?	Economic: Is long-term maintenance required?	Economic: Could the measure attract partnership funding contributions?	Would the measure reduce flooding to critical infrastructure, including the critical highways network?	Social: Are there wider community benefits?	Environmental: Are there wider ecological and BNG benefits?	Environmental: Is the measure resilient to the impacts of climate change?	Environmental: Carbon footprint	Objectives: Will it help achieve the objectives of the SWMP?	Total Viability Score	Comments
S6	Run-off reduction strategy	P1, F3, P3	A long-term plan for making whole urban areas more green and permeable, this uses green infrastructure techniques to allow increased infiltration.	1	1	-2	-1	0	2	1	1	0	-1	1	3	Holding and delaying water in the east of the CDA, would help reduce the surface water on the local road network and towards the primary school. Meets four objectives including the highways' objective. The removal and transport of materials creates a medium carbon footprint. Would cost more than £10k
S7	Reducing surface water in the sewer	F3	Infiltration and storage can be used to reduce water in sewers e.g. soakaways and reducing impermeable surfaces.	1	1	-2	-1	0	1	0	0	0	-2	-1	-3	Several locations where the measure could be added across the CDA. Meets one objective excluding the highways' objective. Unlikely to be able to cope with climate change scenarios. Would cost more than £10k. The removal and transport of materials and machinery produces a high carbon footprint.
S8	Land management	P1, H1, F3, E1, P3	Implementing land management actions will reduce the volume of run-off, to reduce the flood risk further downstream.	1	1	-2	-1	0	2	-1	-1	0	-1	2	0	Meets five objectives including highway's objective. Would cost more than £10k. Changing land use and management will impact the community and ecology of the CDA. May is not able to cope with climate change scenario. Medium carbon footprint depending on the action used. Would reduce the surface water flooding risk to the primary schools in the CDA.
S9	Underground storage	P2, F3, H1	Divert surface water to storage tanks or by providing storage in the existing drainage / flood management network.	1	1	-2	-1	0	1	-1	-1	1	-2	1	-2	Would help reduce the surface water on the A124 and local road network. Limited space to implement this measure as it is urbanised. Would cost more than £10k. Meets three objectives including the highways' objective. Potentially could reduce community benefits short term. Would need to be maintained so it is fully effective. Would help reduce surface water flood risk to the local road network and two primary schools.
S10	Underground conveyance	P2, F3, H1	Increase capacity or build new underground pipes for surface water.	1	1	-2	-1	0	1	-1	-1	1	-2	1	-2	Would help reduce surface water flood risk to the local road network and two primary schools. Would help reduce the surface water on the A124 and local road network. Limited space to implement this measure as it is urbanised. Would cost more than £10k. Meets three objectives including the highways objective. Potentially could reduce community benefits short term. Would need to be maintained so it is fully effective.
S11	Modification of culverted watercourses	P2, F3, H1	Aims to increase the capacity of culverted watercourses or divert culverted watercourses.	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-22	There is no watercourse flowing through the CDA.
Mitigation Measures - Carried Over																
	Implement feasibility study to understand opportunities to provide storage in greenspace, parks and regeneration and developments areas (Romford strategic development area and industrial strategic area)			1	0	-1	-1	2	1	1	1	1	-1	2	6	Feasibility of increasing Housing regeneration This analysis is of the effects of the study and the potential impacts. If projects implemented are the short list of the study.

Appendix E: Cost Benefit Analysis – Option affordability assessment

E.1 Calculation of flood damages

The calculation of damages from flooding has used the 'overview appraisal' approach as detailed in the Multi-Coloured Handbook and manual (MCM) 2023 [47], Flood and Coastal Risk Management - A Manual for Economic Assessment (Flood Hazard Research Centre 2013) and guidance from the 'Green Book' [48]. This assessment considered the categories of flood damages presented in the table below, together with details as to how they have been included at this stage:

Table E.1.1: Damage assessment methodology

Damages	Option Affordability Assessment
Property (direct damages)	Estimated based on EA Flood Maps
Indirect losses to non-residential properties (NRP)	3% of the direct damages to the non-residential properties
Evacuation & Accommodation	Assumed property flood depth based on SoP and event rarity
Mental health	Assumed property flood depth based on SoP and event rarity
Emergency services & recovery costs	5.6% of the direct damages to buildings
Parked vehicles	Average value for vehicle at 42% of flooding Residential Property
Intangible effects of flooding	Defra's risk reduction matrix
Social Grade	Average applied based on the Index of Multiple Deprivation (IMD) of the flooding properties
Risk to life	Not calculated due to lack of data
Transport delay damages	Estimated based on data provided by LBH
Infrastructure damages	Not calculated due to lack of data

The following flooding damages are not considered at this stage, as these would require detailed modelled data and property information:

- Risk to life.
- Property valuation and capping application.

E.2 Events/Return periods used in damage assessment

To estimate the annual average damages, it is necessary to consider the number of properties at flood risk across different events/return periods. This approach considers the probability of

[47] Penning-Rowsell E, *Handbook For Economic Appraisal*, 2023, https://www.mcm-online.co.uk/handbook/
[48] HM Treasury, *The Green Book*, 2022, https://www.gov.uk/government/publications/the-green-book-appraisal-and-evaluation-in-central-government/the-green-book-2020

flooding for each event to estimate the potential impact of flooding on properties over time in terms of depth, which is then translated into associated damages based on depth-damage curves provided in MCM (2023).

The annual exceedance probabilities (AEP) and return periods (included in brackets) considered for the damage assessment were: 100% (1-year), 20% (5-years), 10% (10-years), 5% (20-years), 3.3% (30-years), 1.3% (75-years), 1% (100-years), and 0.5% (200-years). As the baseline flood risk data used (EA Risk of Flooding from Surface Water) only provides data for the 3.3%, 1% and 0.1% AEPs, data for other return periods were interpolated and extrapolated.

E.3 Discount Rates

The main role of discounting is to put interventions with different time spans and benefit cost profiles on to a common "present value" basis.

The discount rates used are in line with standard discounting rates used for FCERM projects[49], are presented in Evacuation and temporary accommodation, Emergency services and recovery costs, Impacts to mental health and Intangible effects of flooding.

Table E.3.1: Green Book long-term discount rates

Project Year	Direct FCERM Benefits and Cost	People-related FCERM Benefits
0 to year 30	3.50%	1.50%
31 to year 49	3.00%	1.29%
50 to year 99	2.50%	1.07%

. The lower discount rates are applied to people related benefits: Evacuation and temporary accommodation, Emergency services and recovery costs, Impacts to mental health and Intangible effects of flooding.

Table E.3.1: Green Book long-term discount rates

Project Year	Direct FCERM Benefits and Cost	People-related FCERM Benefits
0 to year 30	3.50%	1.50%
31 to year 49	3.00%	1.29%
50 to year 99	2.50%	1.07%

E.4 Climate Change

As a result of climate change, future rainfall events are expected to become both more frequent and more intense. Therefore, it is expected that the number of properties at risk of flooding in any particular scenario will increase, as will the extent of damage/ severity of flooding to those already at risk.

Unfortunately, no flood risk data was available within Havering to determine the impact of climate change on the extent of flood risk, to inform this analysis. Therefore, for this assessment, it has been assumed for the 2045-2073 epoch that 20% of properties currently at risk will have increased flood damages as result of climate change and therefore have been

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49 Green Book Supplementary Guidance: Discount Factors https://www.gov.uk/government/publications/the-green-book-appraisal-and-evaluation-in-central-governent

moved up a flood band, and an additional 10% properties have been added. The impact is applied twice for the higher epoch 2074-2123.

For example, if there are 250 properties currently at risk in the 1% AEP event, 20% of these properties are moved to the 1.3% AEP event, 20% of the properties at risk in the 0.5% event are moved to the 1% AEP event, and the total number of properties at risk is increased by 10%. This results in an increase of approximately 75% of properties at risk from the 1% AEP event in the 2045-2073 epoch and 150% increase in the 2074-2123 epoch.

E.5 Direct damages to properties

The available data has been used to carry out an 'overview assessment' to identify the number of properties at risk of flooding for each return period based on several assumptions. At this stage, this assessment is considered proportionate to the stage of the project and as options are taken forward for further development of detailed appraisal, these estimations would be revisited.

As part of the 'overview assessment', damages for each return period were estimated using the weighted annual average damage approach described in the MCH Chapter 4. This approach provides annual average damages for residential and non-residential properties based on the standard of protection and warning lead time. Direct damages are calculated based on the estimated number of properties at risk based on each return period of the EA risk of flooding from surface water maps. These values can be extrapolated and interpolated to estimate direct damages for different return periods.

The final step to define the direct damages from flooding is to determine the number of properties affected for each of the considered options: 'Do nothing', 'Do minimum' and 'Do something' scenarios. The following assumptions have been made to define each of the scenarios.

- **'Do nothing'** option introduces an allowance to increase the number of properties at risk and increased risk, due to the deterioration of the sewer network caused by a lack of maintenance or interventions.
- **'Do minimum'** option considers the distribution of properties being at flood risk described previously based on available information.
- **'Do something'** option assumes that each of the proposed options will provide a standard of protection (defined for each option) across the considered CDA and, therefore, no properties will be at flood risk for this storm rarity or more frequent. Properties at flood risk for more extreme events remain the same as the estimated for the 'Do minimum' option.

The obtained number of properties affected by flooding for each of the scenarios have been used to determine the direct damages to properties.

Direct damages to properties, as estimated above, has been used to calculate damages related to evacuation and temporary accommodation and impacts to mental health. For instance, properties with an onset of flooding of 1-year are assumed to experience deeper flooding during extreme rainfall events when compared to those with a later onset of flooding, as they would experience flooding for a longer period. This assumption is implemented across all properties, resulting in a distribution of flood depths based on property onset of flooding and rainfall rarity.

E.6 Indirect losses to non-residential properties

As indicated in Chapter 5, section 5.7 of the MCM[50] indirect losses for commercial properties are taken as 3% of the direct damages to the non-residential properties. This is to capture:

- the loss of business to overseas competitors and,
- the additional costs of seeking to respond to the threat of disruption or to disruption itself which fall upon firms when flooded.

Other costs calculated using available guidance were:

- Evacuation and accommodation (including costs of temporary accommodation, food, additional transport costs and loss of earnings).
- Impacts to mental health (depending on depths and averaging number of people per household).
- Emergency services & recovery costs (5.6% of direct damages to buildings).
- Parked vehicles (considering that approximately 42% of residential properties include damaged vehicles as a result of flooding incidents).
- Intangible effects of flooding (linked to how much households are willing to pay per year to avoid health impacts).
- Social Grade (calculated based on Index of Multiple Deprivation (IMD) maps sourced from the Consumer Data Centre[51]
- Road closure disruption damages (calculated using frequently flooded roads information provided by LBH and estimated costs based on the number of vehicles delayed per hour, the cost per vehicle -provided in the MCM- and the flood duration).
- Infrastructure damages.

The method set out above for calculation of indirect losses to non-residential properties requires data on the depth of flooding within the properties. As this data is not available, it was assumed that all properties affected would be flooded to between 0 and 250mm depending on the return period considered. It should be noted that this assumption only applies to some elements of the indirect losses and not to the weighted annual average damage used to assess direct damages.

The benefits (or avoided damages) provided by each 'Do Something option' have been estimated by assigning a standard of protection based on guidance, experience and engineering judgement, as well as a design life. Residual damages for each 'Do Something option' are based on Do Minimum damages.

E.7 Assumptions and Limitations

Estimating damages is a complex task due to the intricate nature of the affected communities, their specific characteristics, and their variability over time. Even when following standard methodologies and guidelines, estimating damages requires agreeing on a significant number of assumptions and estimations to accurately reflect the potential damages that flooding events may cause in a particular community.

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[50] Penning-Rowsell E, *Handbook For Economic Appraisal*, 2023, https://www.mcm-online.co.uk/handbook/

[51] CDRC, Index of Multiple Deprivation, https://data.cdrc.ac.uk/dataset/index-multiple-deprivation-imd

In this specific case and at this early stage, only published information is available to carry out the assessment. The assessment requires a number of assumptions about flood depths, standard of protection afforded by each option, effects of climate change and cessation of maintenance. Consequently, there a significant amount of uncertainty in the results and should be used cautiously as a rough estimate at this preliminary feasibility stage.

- The developed methodology uses a logarithmic distribution to fill in the missing data related to the number of properties at risk of surface water flooding. The available data for 3.33%, 1%, and 0.1% Annual Exceedance Probability (AEP) introduces uncertainties when estimating the number of properties at risk for the most frequent events, which carry the most weight in flood damage estimation.
- The impact of climate change is estimated by assuming an increase in the frequency of flooding and the number of properties at risk across three different epochs. This assumption adds further uncertainties to the damage estimation.
- The 'Do Minimum' scenario is considered as the baseline scenario. The number of properties affected by flooding in this scenario is based on estimates from the Environment Agency maps.
- The 'Do Nothing' scenario takes the number of properties at risk from the 'Do Minimum' scenario and assumes a gradual degradation of the existing network. This results in an increase in the frequency of flooding and the number of properties at risk across three different epochs.
- The 'Do Something' scenario assumes that the implemented measures each provide a specific standard of protection and that all flooding is addressed up to this AEP. This is a significant simplification of the potential outcomes of the proposed option; however, it provides the maximum benefit that can be achieved from the proposed option.

E.8 Damages Estimation Table

Table E.8.1: Damages Estimation

No.	CDA	Option	Total Damages (PV) Do Nothing	Total Damages (PV) Do Minimum	Total Damages (PV) Do Something	Benefits based on Do Nothing	SoP	Design Life	#Properties	Benefit/Property	Area of CDA	Benefits/ha
1	CDA 005	Infiltration (and evaporation) for managing 'everyday rain'	£26,113,897	£20,325,772	£12,340,747	£13,773,150	5	50	46	£299,416	275	£50,115
2	CDA 005	Storage for managing 'extreme rainfall'	£28,948,391	£22,489,155	£968,513	£27,979,879	100	50	298	£93,892	275	£101,808
3	CDA 014	Infiltration (and evaporation) for managing 'everyday rain'	£184,721,222	£143,900,880	£82,788,766	£101,932,455	5	50	358	£284,728	2405	£42,375
4	CDA 014	Conveyance for managing 'usual rainfall'	£184,721,222	£143,900,880	£62,706,042	£122,015,180	10	50	512	£238,311	2405	£50,724
5	CDA 014	Storage for managing 'extreme rainfall'	£204,243,985	£159,058,940	£5,937,145	£198,306,840	100	50	1964	£100,971	2405	£82,439
6	CDA 014	Run-off reduction strategy	£185,628,729	£144,649,038	£23,416,816	£162,211,914	30	50	756	£214,566	2405	£67,434
7	CDA 014	Specific planning policy	£184,721,222	£143,900,880	£62,706,042	£122,015,180	10	50	512	£238,311	2405	£50,724
8	CDA 015	Relocation of properties or infrastructure away from flood risk areas	£16,040,857	£12,937,646	£1,400,639	£14,640,218	30	100	72	£203,336	174	£84,282
9	CDA 015	Infiltration (and evaporation) for managing 'everyday rain'	£15,956,260	£12,867,163	£7,122,381	£8,833,878	5	50	34	£259,820	174	£50,856
10	CDA 015	Conveyance for managing 'usual rainfall'	£15,956,260	£12,867,163	£5,007,386	£10,948,874	10	50	49	£223,446	174	£63,032
11	CDA 015	Storage for managing 'extreme rainfall'	£17,291,742	£13,967,509	£288,790	£17,002,952	100	50	113	£150,469	174	£97,884
12	CDA 015	Run-off reduction strategy	£16,040,857	£12,937,646	£1,400,639	£14,640,218	30	50	72	£203,336	174	£84,282
13	CDA 015	Land management	£15,956,260	£12,867,163	£5,007,386	£10,948,874	10	50	49	£223,446	174	£63,032
14	CDA 016	Self-help – Property-level protection and resilience	£15,275,422	£12,170,568	£5,714,957	£9,560,465	10	20	51	£187,460	80	£119,072
15	CDA 016	Infiltration (and evaporation) for managing 'everyday rain'	£19,556,513	£15,334,586	£9,094,663	£10,461,851	5	50	36	£290,607	80	£130,298
16	CDA 016	Conveyance for managing 'usual rainfall'	£19,556,513	£15,334,586	£6,864,857	£12,691,656	10	50	51	£248,856	80	£158,069
17	CDA 016	Storage for managing 'extreme rainfall'	£21,534,295	£16,867,177	£626,329	£20,907,966	100	50	201	£104,020	80	£260,400
18	CDA 016	Run-off reduction strategy	£19,647,359	£15,409,384	£2,525,421	£17,121,938	30	50	76	£225,289	80	£213,247
19	CDA 017	Asset management and maintenance	£15,058,219	£12,264,801	£7,634,701	£7,423,518	5	10	46	£161,381	269	£27,610
20	CDA 017	Watercourse management and maintenance	£15,058,219	£12,264,801	£7,634,701	£7,423,518	5	10	46	£161,381	269	£27,610
21	CDA 017	Infiltration (and evaporation) for managing 'everyday rain'	£21,721,304	£17,436,593	£9,451,567	£12,269,737	5	50	46	£266,733	269	£45,634
22	CDA 017	Conveyance for managing 'usual rainfall'	£21,721,304	£17,436,593	£6,619,010	£15,102,293	10	50	66	£228,823	269	£56,169
23	CDA 017	Storage for managing 'extreme rainfall'	£23,538,162	£18,933,133	£390,981	£23,147,181	100	50	150	£154,315	269	£86,089
24	CDA 017	Restoring urban watercourse	£21,838,265	£17,533,956	£1,844,779	£19,993,487	30	50	98	£204,015	269	£74,360
25	CDA 017	Run-off reduction strategy	£21,838,265	£17,533,956	£1,844,779	£19,993,487	30	50	98	£204,015	269	£74,360
26	CDA 017	Reducing surface water in the sewer	£21,838,265	£17,533,956	£1,844,779	£19,993,487	30	50	98	£204,015	269	£74,360
27	CDA 017	Land management	£21,721,304	£17,436,593	£6,619,010	£15,102,293	10	50	66	£228,823	269	£56,169
28	CDA 017	Specific planning policy	£21,721,304	£17,436,593	£6,619,010	£15,102,293	10	50	66	£228,823	269	£56,169
29	CDA 017	Work with Land of the Fanns to carry out flood modelling and scope potential natural flood management options in Bedfords Park local nature reserve	£21,721,304	£17,436,593	£6,619,010	£15,102,293	10	50	66	£228,823	269	£56,169
30	CDA 017	Work together to carry out flood modelling to scope options for flood alleviation projects and natural flood management options in the Rise Park Critical Drainage Area	£21,721,304	£17,436,593	£6,619,010	£15,102,293	10	50	66	£228,823	269	£56,169
31	CDA 018	Infiltration (and evaporation) for managing 'everyday rain'	£36,547,342	£28,251,296	£17,260,353	£19,286,990	5	50	64	£301,359	471	£40,928
32	CDA 018	Conveyance for managing 'usual rainfall'	£36,547,342	£28,251,296	£13,451,913	£23,095,429	10	50	92	£251,037	471	£49,010

			Total Damages (PV)			Benefits based on						
No.	CDA	Option	Do Nothing	Do Minimum	Do Something	Do Nothing	SoP	Design Life	#Properties	Benefit/Property	Area of CDA	Benefits/ha
33	CDA 018	Storage for managing 'extreme rainfall'	£40,677,853	£31,390,646	£1,375,727	£39,302,126	100	50	446	£88,121	471	£83,402
34	CDA 018	Run-off reduction strategy	£36,711,277	£28,385,473	£5,414,642	£31,296,635	30	50	136	£230,122	471	£66,414
35	CDA 018	Reducing surface water in the sewer	£36,711,277	£28,385,473	£5,414,642	£31,296,635	30	50	136	£230,122	471	£66,414
36	CDA 018	Land management	£36,547,342	£28,251,296	£13,451,913	£23,095,429	10	50	92	£251,037	471	£49,010
37	CDA 018	Specific planning policy	£36,547,342	£28,251,296	£13,451,913	£23,095,429	10	50	92	£251,037	471	£49,010
38	CDA 023	Infiltration (and evaporation) for managing 'everyday rain'	£38,785,897	£29,390,579	£19,728,084	£19,057,812	5	50	56	£340,318	613	£31,091
39	CDA 023	Conveyance for managing 'usual rainfall'	£38,785,897	£29,390,579	£16,350,181	£22,435,716	10	50	81	£276,984	613	£36,602
40	CDA 023	Storage for managing 'extreme rainfall'	£43,781,436	£33,011,844	£2,490,534	£41,290,902	100	50	574	£71,935	613	£67,363
41	CDA 023	Specific planning policy	£38,785,897	£29,390,579	£16,350,181	£22,435,716	10	50	81	£276,984	613	£36,602
42	CDA 025	Infiltration (and evaporation) for managing 'everyday rain'	£70,888,464	£55,211,533	£31,915,532	£38,972,931	5	50	136	£286,566	369	£105,595
43	CDA 025	Conveyance for managing 'usual rainfall'	£70,888,464	£55,211,533	£24,146,155	£46,742,308	10	50	194	£240,940	369	£126,645
44	CDA 025	Storage for managing 'extreme rainfall'	£78,308,054	£60,967,547	£2,253,637	£76,054,417	100	50	748	£101,677	369	£206,064
45	CDA 025	Specific planning policy	£70,888,464	£55,211,533	£24,146,155	£46,742,308	10	50	194	£240,940	369	£126,645
46	CDA 026	Relocation of properties or infrastructure away from flood risk areas	£57,937,025	£46,154,830	£4,539,571	£53,397,454	30	100	271	£197,039	221	£241,967
47	CDA 026	Infiltration (and evaporation) for managing 'everyday rain'	£57,614,595	£45,887,643	£24,133,845	£33,480,749	5	50	128	£261,568	221	£151,716
48	CDA 026	Conveyance for managing 'usual rainfall'	£57,614,595	£45,887,643	£16,795,005	£40,819,590	10	50	183	£223,058	221	£184,971
49	CDA 026	Storage for managing 'extreme rainfall'	£62,516,547	£49,924,477	£935,998	£61,580,550	100	50	400	£153,951	221	£279,048
50	CDA 026	Carry out flood modelling of main river and adjacent educational facility in the Harold Hill Critical Drainage Area	£57,614,595	£45,887,643	£16,795,005	£40,819,590	10	50	183	£223,058	221	£184,971
51	CDA 034	Asset management and maintenance	£11,832,792	£9,294,821	£6,591,010	£5,241,782	5	10	26	£201,607	2560	£2,048
51	CDA 034	Watercourse management and maintenance	£11,832,792	£9,294,821	£6,591,010	£5,241,782	5	10	26	£201,607	2560	£2,048
52	CDA 034	Infiltration (and evaporation) for managing 'everyday rain'	£17,672,931	£13,451,852	£9,035,518	£8,637,413	5	50	26	£332,208	2560	£3,375
53	CDA 034	Conveyance for managing 'usual rainfall'	£17,672,931	£13,451,852	£7,351,059	£10,321,872	10	50	37	£278,970	2560	£4,033
54	CDA 034	Storage for managing 'extreme rainfall'	£19,871,420	£15,067,646	£918,966	£18,952,454	100	50	257	£73,745	2560	£7,405
55	CDA 034	Restoring urban watercourse	£17,739,683	£13,506,107	£3,340,577	£14,399,106	30	50	55	£261,802	2560	£5,626
56	CDA 034	Urban watercourse engineering	£19,871,420	£15,067,646	£918,966	£18,952,454	100	100	257	£73,745	2560	£7,405
57	CDA 034	Run-off reduction strategy	£17,739,683	£13,506,107	£3,340,577	£14,399,106	30	50	55	£261,802	2560	£5,626
58	CDA 034	Specific planning policy	£17,672,931	£13,451,852	£7,351,059	£10,321,872	10	50	37	£278,970	2560	£4,033
59	CDA 036	Infiltration (and evaporation) for managing 'everyday rain'	£97,269,393	£75,567,820	£44,233,495	£53,035,898	5	50	183	£289,814	3690	£14,373
60	CDA 036	Conveyance for managing 'usual rainfall'	£97,269,393	£75,567,820	£33,823,494	£63,445,899	10	50	262	£242,160	3690	£17,195
61	CDA 036	Storage for managing 'extreme rainfall'	£107,698,785	£83,595,772	£3,478,377	£104,220,408	100	50	1058	£98,507	3690	£28,245
62	CDA 036	Run-off reduction strategy	£97,734,766	£75,950,979	£13,103,867	£84,630,900	30	50	387	£218,684	3690	£22,936
63	CDA 036	Specific planning policy	£97,269,393	£75,567,820	£33,823,494	£63,445,899	10	50	262	£242,160	3690	£17,195
64	CDA 037	Watercourse management and maintenance	£14,182,044	£11,386,091	£7,578,443	£6,603,602	5	10	37	£178,476	268	£24,596
65	CDA 037	Infiltration (and evaporation) for managing 'everyday rain'	£20,694,640	£16,218,133	£9,910,577	£10,784,063	5	50	37	£291,461	268	£40,166
66	CDA 037	Conveyance for managing 'usual rainfall'	£20,694,640	£16,218,133	£7,594,664	£13,099,976	10	50	53	£247,169	268	£48,792

			Total Damages (PV)			Benefits based on						
No.	CDA	Option	Do Nothing	Do Minimum	Do Something	Do Nothing	SoP	Design Life	#Properties	Benefit/Property	Area of CDA	Benefits/ha
67	CDA 037	Storage for managing 'extreme rainfall'	£22,857,618	£17,879,957	£835,355	£22,022,262	100	50	220	£100,101	268	£82,023
68	CDA 037	Restoring urban watercourse	£20,788,227	£16,295,673	£2,990,621	£17,797,606	30	50	79	£225,286	268	£66,288
69	CDA 037	Run-off reduction strategy	£20,788,227	£16,295,673	£2,990,621	£17,797,606	30	50	79	£225,286	268	£66,288
70	CDA 037	Specific planning policy	£20,694,640	£16,218,133	£7,594,664	£13,099,976	10	50	53	£247,169	268	£48,792
71	CDA 038	Infiltration (and evaporation) for managing 'everyday rain'	£30,111,113	£23,908,149	£13,479,980	£16,631,133	5	50	61	£272,642	51	£324,735
72	CDA 038	Storage for managing 'extreme rainfall'	£32,977,523	£26,198,112	£730,068	£32,247,455	100	50	268	£120,326	51	£629,655
73	CDA 038	Specific planning policy	£30,111,113	£23,908,149	£9,843,755	£20,267,358	10	50	87	£232,958	51	£395,735
74	CDA 039	Infiltration (and evaporation) for managing 'everyday rain'	£13,762,683	£10,764,979	£6,416,278	£7,346,404	5	50	25	£293,856	109	£67,580
75	CDA 039	Conveyance for managing 'usual rainfall'	£13,762,683	£10,764,979	£4,760,522	£9,002,161	10	50	36	£250,060	109	£82,811
76	CDA 039	Storage for managing 'extreme rainfall'	£15,052,360	£11,764,096	£452,915	£14,599,446	100	50	122	£119,668	109	£134,301
77	CDA 039	Run-off reduction strategy	£13,827,457	£10,818,021	£1,704,399	£12,123,057	30	50	53	£228,737	109	£111,520
78	CDA 039	Land management	£13,762,683	£10,764,979	£4,760,522	£9,002,161	10	50	36	£250,060	109	£82,811
79	CDA 039	Specific planning policy	£13,762,683	£10,764,979	£4,760,522	£9,002,161	10	50	36	£250,060	109	£82,811
80	CDA 040	Self-help – Property-level protection and resilience	£20,412,734	£16,445,460	£7,374,074	£13,038,660	10	20	74	£176,198	86	£151,943
81	CDA 040	Infiltration (and evaporation) for managing 'everyday rain'	£26,370,218	£20,894,836	£11,930,382	£14,439,836	5	50	52	£277,689	86	£168,271
82	CDA 040	Conveyance for managing 'usual rainfall'	£26,500,979	£21,003,302	£2,971,485	£23,529,494	10	50	74	£317,966	86	£274,195
83	CDA 040	Storage for managing 'extreme rainfall'	£28,947,460	£22,931,772	£677,424	£28,270,036	100	50	250	£113,080	86	£329,438
84	CDA 040	Run-off reduction strategy	£26,500,979	£21,003,302	£2,971,485	£23,529,494	30	50	110	£213,904	86	£274,195
85	CDA 040	Specific planning policy	£26,370,218	£20,894,836	£8,810,801	£17,559,417	10	50	74	£237,289	86	£204,624

Appendix F: Action Plan (see separate document)

Appendix G: A3 Scaled Maps (see separate document)