London Regional Flood Risk Assessment

Part 1

March 2026

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Executive Summary

The Mayor of London is aware that flood risk is a major issue for London, and the probability of flooding is increasing with climate change. The potential consequences of flooding could also increase as London's population continues to grow. The Regional Flood Risk Assessment (RFRA) provides an overview of all sources of flooding in London and addresses its probability and consequences.

This RFRA:

- has been prepared by the Greater London Authority (GLA) officers in close cooperation with the Environment Agency, Transport for London, London Resilience, and Thames Water. It builds on and updates the versions that were published in August 2014 and September 2018;
- represents important evidence to underpin the new draft London Plan; and
- includes flood risk mapping, incorporating datasets both with and without the climate change scenario to illustrate the differences.

The level of detail of data used and the resulting mapping has been greatly improved compared to the previous RFRA, providing better information and evidence for Local Plans, Opportunity Area Planning Frameworks, and infrastructure providers.

At the centre of this RFRA is the spatial analysis of tidal, fluvial and surface water flood risk against various receptors of flood risk. The RFRA also provides information on other types of flood risk, i.e. sewage flooding, reservoir and ground water flooding. Due to their localised nature, they were not included in the spatial analysis and are expected to be analysed in more detail at the borough level through the strategic flood risk assessments.

Using the baseline scenario[1], 9% of London is at high risk (1 in 30-year event) of tidal, river or surface water flooding and 13% at medium risk (1 in 100-year event).[2]This represents a notable increase from the results of the RFRA published in 2018, of 6% and 11% respectively. With the climate change scenario added to the spatial analysis, the risk of flooding significantly increases to 16% of London being at high risk (1 in 30-year event) of tidal, river or surface water flooding and 22% at medium risk (1 in 100-year event). Surface water flooding drives the increase in flood risk in the climate change scenario.

Spatially, under the climate change scenario, around a third of both Barking and Dagenham and Kensington and Chelsea fall within the area of high flood risk. Flood risk from rivers and sea unsurprisingly is highest in boroughs bounding the Thames, (Tower Hamlets, Bexley, and City of London) though under the climate change scenario Newham and Richmond upon Thames are

[1] This analysis does not include any flood depth variations.
[2] Environment Agency's new National Flood Risk Assessment (NaFRA)

most affected alongside Tower Hamlets. The boroughs of Kensington and Chelsea (25%), Hammersmith and Fulham (18%) and Barking and Dagenham (14%) have the highest proportion of land in the high flood risk area from surface water flooding, with Hackney replacing Barking & Dagenham in the top 3 under the climate change scenario.

Many (London Plan, 2021) **Opportunity Areas (OA)** and even more so, **town centres** are also significantly affected on an individual level by surface water and all sources of flooding. They exhibit a similar pattern of increase in risk from all sources and especially surface water with some OAs seeing up to around 30% of land affected, and some town centres up to around 60%.

In terms of **strategic infrastructure,** transport especially bus depots, stations and underground stations is particularly at risk from all sources but especially surface water flooding, with 80%, 72% and 65% of these respectively at high risk from this in the climate change scenario. Overall public transport network risk (e.g. tracks and roads) whilst lower, is also creeping up, with 20% of the underground network at high risk from surface water flooding in the climate change scenario.

Hospitals and schools are likewise significantly and increasingly affected by flood risk and particularly surface water, as are many emergency services' bases and around 40% of utilities sites. 58% of hospitals (cf. 43% in 2018) and 46% of schools are at high risk of surface water flooding even in the baseline scenario and this increases to 64% and 56% with climate change. And there are a significant number of basements and basement dwellings at risk from flash flooding.

This demonstrates that flood risk, particularly surface water flood risk, is a serious and increasing issue for London. This is recognised in the wide-ranging and recently updated **Thames Estuary 2100 Strategy**, and more recent multi-partner strategic attention being given to surface water as set out in the **2025 London Surface Water Strategy** published by the Flood Ready London partnership. New developments present particular opportunities to help advance these strategies with both on and off-site mitigation benefits. In light of residual risk, it will continue to be important to address flood risk through design and location of new development alongside implementation of community and network measures.

Knowledge and plans for flood risk are continually evolving so it will be important to continue to update the regional flood risk picture as further risk mapping, strategies and mitigation plans evolve.

1. Introduction

The London Regional Flood Risk Assessment (RFRA) presents and analyses flooding data and mapping to identify flood risks to London's strategic development locations and infrastructure assets. The RFRA is used as evidence to support London Plan flood related policy and wider spatial strategy work. With its broad consideration of flood risk across London's borough boundaries, it should also inform local-level strategic flood risk assessments, Local Plans and local flood mitigation strategies across London. It will also be useful for infrastructure providers and others planning for resilience.

The National Planning Policy Framework (NPPF 2024) expects that strategic policies should be informed by a strategic flood risk assessment and should manage flood risk from all sources. It states that they should consider cumulative impacts in, or affecting, local areas susceptible to flooding, and take account of advice from the ENVIRONMENT AGENCY and other relevant flood risk management authorities, such as lead local flood authorities and internal drainage boards (paragraph 171). Given that strategic policies will also be found in Local Plans, The RFRA should also inform the strategic flood risk assessments and plan making across London.

The RFRA update incorporates the latest data notably the new National Flood Risk Assessment (NaFRA) data from the Environment Agency. The probability of flooding is increasing with climate change, and London's growing population means more people are at risk of the consequences of flooding.

The RFRA update comprises two parts. Part one (this document) focuses mainly on updated analysis of risk for the existing key receptors/main infrastructure assets. This will give a baseline understanding of new (or newly understood) flood risk pressures in London and their significance relative to mitigations.

The second part of the RFRA (London RFRA Part 2) will focus more on the spatial element of the emerging London Plan and will be published with the draft plan in 2026.This document will include an appraisal through a flood risk lens of the performance of different spatial and growth options relative to each other and the baseline enabling a meaningful comparison of their sustainability and suitability. It will help inform the development of the preferred spatial strategy and associated list of strategic infrastructure requirements and new London Plan policies regarding flood risk management, where needed to supplement the NPPF and NPPG.

The RFRA needs to be updated now to reflect the changing flood risk landscape. This RFRA update follows a similar format to the 2018 RFRA report. It includes flood risk mapping datasets from NAFRA both with and

without the climate change scenario[3] to illustrate the differences for various receptors.[4]

The objectives of the RFRA update are to:

a) identify any changes and trends in flood risk patterns across the London region since the previous reports and an up-to-date overview of flood risk from all sources;
b) identify the spatial implications for strategic broad locations for growth, including Town Centres and Opportunity Areas as well as greenfield locations, and strategic infrastructure assets; and
c) Provide an overview of implications for policy formulation

Chapter 1 deals with the strategic overview of flood risk in London. Chapter 2 deals with a more detailed analysis of the risk from all six types of flooding that affect London. Chapter 3 then examines flood risk in relation to particular locations, boroughs and important infrastructure. Chapter 4 explores the evolving mitigation picture and Chapter 5 considers implications of the assessment for strategic planning. Appendices provide the related maps and detailed statistics.

1.1 Wider policy background

The Mayor recognises that flood risk is a major issue for London. Since the last publication of the RFRA, the Mayor initiated the London Climate Resilience Review after parts of London received more than twice the average July rainfall in 2021. The Review's analysis indicated climate change could impact London's GDP by 2-3% every year by the 2050s, with costs increasing further late into the century. It also found that government and businesses have not adequately planned for the disruption caused when severe weather impacts "cascade" through critical systems like healthcare, transport, energy and water. For London it highlighted the strategic importance of mitigating flood risks by tackling surface water flooding risks, upgrading flood defences and updating resilience and technical standards to cope with the weather extremes London could expect in the coming decades. It called for enhanced climate adaptation and mitigation in planning.

The issue of flood risk from multiple sources including surface water has become increasingly recognised over recent years and reflected in various new legislation, policy and strategies to help better manage it. These are summarised in **Appendix 1.** Common themes reflected in these are the importance of proactively responding to flood risk in the distribution of growth

[3] The climate change allowances are based on the latest UK Climate Projections (UKCP18) from the Met Office and count for anticipated changes to peak river flow; peak rainfall intensity; sea level rise; offshore wind speed and extreme wave height. For more information please visit: https://environment.data.gov.uk/support/announcements/569147407/568590338

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

and its design and management, as well as attending to existing risks through overall making the environment more resilient and planning for extreme events. This RFRA responds to this as evidence base informing London's spatial development strategy (the London Plan).

The key changes to the policy context since 2018 are a greater focus on surface water, notably through new national (non-statutory) SUDs guidance, a stronger position in the NPPF and in London, the publication of the London Surface Water Strategy (LSWS) in 2025. This was also reflected in the London Plan 2021 which introduced new sustainable drainage requirements.

1.2 National context

Nationwide, the latest Environment Agency modelling shows that around 4.6 million properties are in areas at risk of flooding from surface water, a 43% increase compared with the last time this exercise was carried out in 2018. There are now three times as many properties at high risk of flooding from surface water than from rivers and the sea, according to the [5].

These figures show that surface water is "the most rapidly increasing source" of flood risk[6], fuelled by the much more rapid and intense rainfall that the UK is experiencing due to climate change, which is increasing both the geographic scale and depth of floods. This is particularly significant in large urban areas like London which, due to large areas of impermeable land and engineered drainage systems, are more at risk of surface water flooding.

1.3 Methodology

The RFRA update has been prepared by GLA officers in close cooperation with the Environment Agency, Transport for London, Thames Water and others. Its methodology brings together both quantitative data on flood risk and vulnerability and qualitative analysis of flood impacts and mitigations, considers trends, where possible. The level of detail of data used and the resulting mapping have been improved compared to previous RFRAs, providing better information and evidence.

The core dataset and mapping tools are provided by the Environment Agency such as the flood zone mapping tool, the condition of flood defences database, breach modelling dataset, etc. The improved data from the Environment Agency's National Flood Risk Assessment (NaFRA) report and linked 'Flood zone' data on 'Flood map for planning' and national flood risk maps – available from December 2024– is particularly important. It provides a single picture of current and future flood risk from rivers, the sea and surface water for England, using the best available data both from the Environment

[5] National assessment of flood and coastal erosion risk in England 2024 - GOV.UK
[6] https://www.ashfieldsolutions.com/blog/why-surface-water-flood-risk-is-now-the-fastest-growing-planning-constraint-in-the-uk/#:~:text=These%20surfaces%20prevent%20water%20from,drainage%20constraints%20and%20mitigation%20requirements.

Agency and local authorities. Reasons behind the update include the availability of this data, improved modelling methodologies and an improved assessment of the risk to properties, infrastructure and agricultural land.

For the first time, NaFRA accounts for the latest Met Office UK Climate Projections (UKCP18) and the potential impact of climate change on flood and coastal erosion risk. These projections utilise advanced climate models to simulate potential future climate scenarios, providing detailed insights into variables such as temperature, precipitation, and sea-level rise across the UK

Beyond this, additional information that has been drawn on relates to vulnerability mapping, (population and receptor based) mitigation good practice, and information from Thames Water and London Resilience on flood risk types not covered by NaFRA (sewage, reservoirs and groundwater). This includes data underpinning the Surface Water Strategy, and Climate Resilience Strategy.[7] The Environment Agency has also provided updated information on mitigations that have been progressed since the last RFRA.

1.4 How to use the RFRA

The RFRA is a strategic overview of flood risk across London. It does not represent a detailed analysis of flood risk in relation to any particular areas or sites. It contains a series of maps to illustrate flood risk spatially (**see Appendix 5)**.

Future updates of the RFRA should take place approximately every five years or after a major flooding incident or a major policy shift.

The RFRA should be useful to spatial planners, developers, infrastructure and utility operators and emergency planners. It is a specific aim of this RFRA to give spatial planners and emergency planners a shared understanding and common baseline of information to help inform decisions about the location, size and design of development and investment, and the types of flood risk to be particularly aware of and to plan for.

[7] https://www.london.gov.uk/programmes-strategies/environment-and-climate-change/climate-change/climate-adaptation/london-climate-resilience-review

2. Assessment of different types of flood risk

London is exposed to six different potential sources of flooding. These are analysed below, each has different spatial impacts on London and requires a different set of responses. Some responses relate to the land use planning system, whilst others relate to broader spatial matters or operational considerations for a range of organisations.

Each type of flooding is analysed by examining:

- Nature of the risk in London, including the likely impact of climate change
- Development locations that may be affected
- Information available
- Flood risk management approaches

Chapter 3 goes on to consider flood risk in relation to key locations and infrastructure in London. In this way the RFRA represents an examination of both the potential future flood risk issues and the existing flood risk issues that affect London. By doing this it can make recommendations that fulfil one of two functions. Firstly, how to ensure that future flood risk is minimised and any residual flood risks are managed appropriately. Secondly, to promote new development that will help to reduce and manage existing flood risks. This approach is in line with the revised NPPF.

2.1 Overall picture

Using the base scenario flood risk analysis (without a climate change scenario)[8], 9% of London is at high risk (1 in 30-year event) of tidal, river or surface water flooding and 13% at medium risk (1 in 100-year event) (**see Map 1a**). This represents a notable increase from the results of RFRA in 2018 of 6% and 11% respectively. With the climate change scenario added to the spatial analysis, the risk of flooding significantly increases to 16% of London being at high risk (1 in 30-year event) of tidal, river or surface water flooding and 23% at medium risk (1 in 100-year event) (**see Map 1b**). The scale and distribution of flood risk from all sources is shown **on Maps 1a and 1b.** This is based on up-to-date Environment Agency mapping that combines tidal, fluvial and surface water flood risk.[9]

Within this, surface water flood risk is particularly notable – the NaFRA update shows that nearly a third of a million residential properties in London (319,800), including a significant proportion of basement properties, are at high risk from surface water flooding,[10] [11] This total represents almost 30% of all such at-risk properties in the country and is more than eleven times the number of London properties that are at high risk from river and sea flooding.

[8] This analysis does not include any flood depth variations.
[9] Flood risk mapping, incorporating datasets both with and without the climate change scenario to illustrate the differences.
[10] Environment Agency. 'National assessment of flood and coastal erosion risk in England 2024' 2024
[11] https://www.london.gov.uk/mayor-warns-londoners-basement-flood-risk-lcaw

In addition, around 40% of London's 300,000 commercial properties in London are estimated to be at risk of surface water flooding.[12]

This indicates a significant increase in the numbers at high risk from surface water from (200,000 residential properties in previous modelling). Recent analysis indicates that nearly half (14,780) of London's 33,200 basements in commercial use are at risk of flooding from heavy rain, with the highest number in Westminster. `

According to NaFRA, the changes in the total number of properties in areas at risk of surface water flooding doesn't reflect a real-world increase in risk. It is almost entirely due to improvements in data, modelling and use of technology. However, it is also the case that climate change and the more dispersed nature of surface water flooding mean that extreme rainfall events are becoming more frequent and mitigation strategy is not as mature as that for fluvial and tidal flood risk.

In contrast, according to NaFRA, London is relatively well protected from fluvial and tidal sea flooding. This is largely due to the presence of major flood defences such as the Thames Barrier. The new data shows that 1.2% (51,100) of London properties are at high or medium risk, compared with 1.09% previously, and climate change increases this risk further.

Sewage flood risk, as with surface water flood risk is also increasing with the change in nature of rainfall events[13]. For properties at risk of internal sewer flooding in a 1:30 year rainfall event, the increase in risk to 2050 across London is 54% (to 133 852 properties). For properties that will be at risk of external sewer flooding in a 1:50 year rainfall return period, the increase in risk in London is 30% (to 391, 468 properties). In both cases the number of properties in London is very large due to the population density.

Groundwater flooding in London is a significant risk, particularly in areas built on gravel beds over London Clay, such as Hammersmith, Fulham, Southwark, and Wandsworth and other parts of south London.

Reservoir flood risk is mainly in the north and west of London, with little recent change in risk, (low likelihood, extremely high impact) though a new approach to reservoir safety is being rolled out nationally in light of the 2019 Todbrook incident.

2.2 Tidal Flood Risk

Nature of Risk

The River Thames and the lower reaches of some of the tributary rivers are affected by the tide. The River Thames has a very large tidal range, in excess of 7 metres on spring tides. The tide's influence reaches to Teddington Lock

[12] Zurich UK. 'Two-fifths of London firms at risk of climate-fuelled flash floods' 2022
[13] Thames Water Drainage and Wastewater Management Plan (2023)

on the Thames and up several tributaries, for example as far as the Prescott Channel structure on the River Lee.

Without the current river walls many areas of London alongside the Thames and along the tidal stretches of the tributaries would be inundated twice a day through the normal tidal cycle. River walls have been steadily built up since Roman times to give increasing levels of flood protection and to enable urban development.

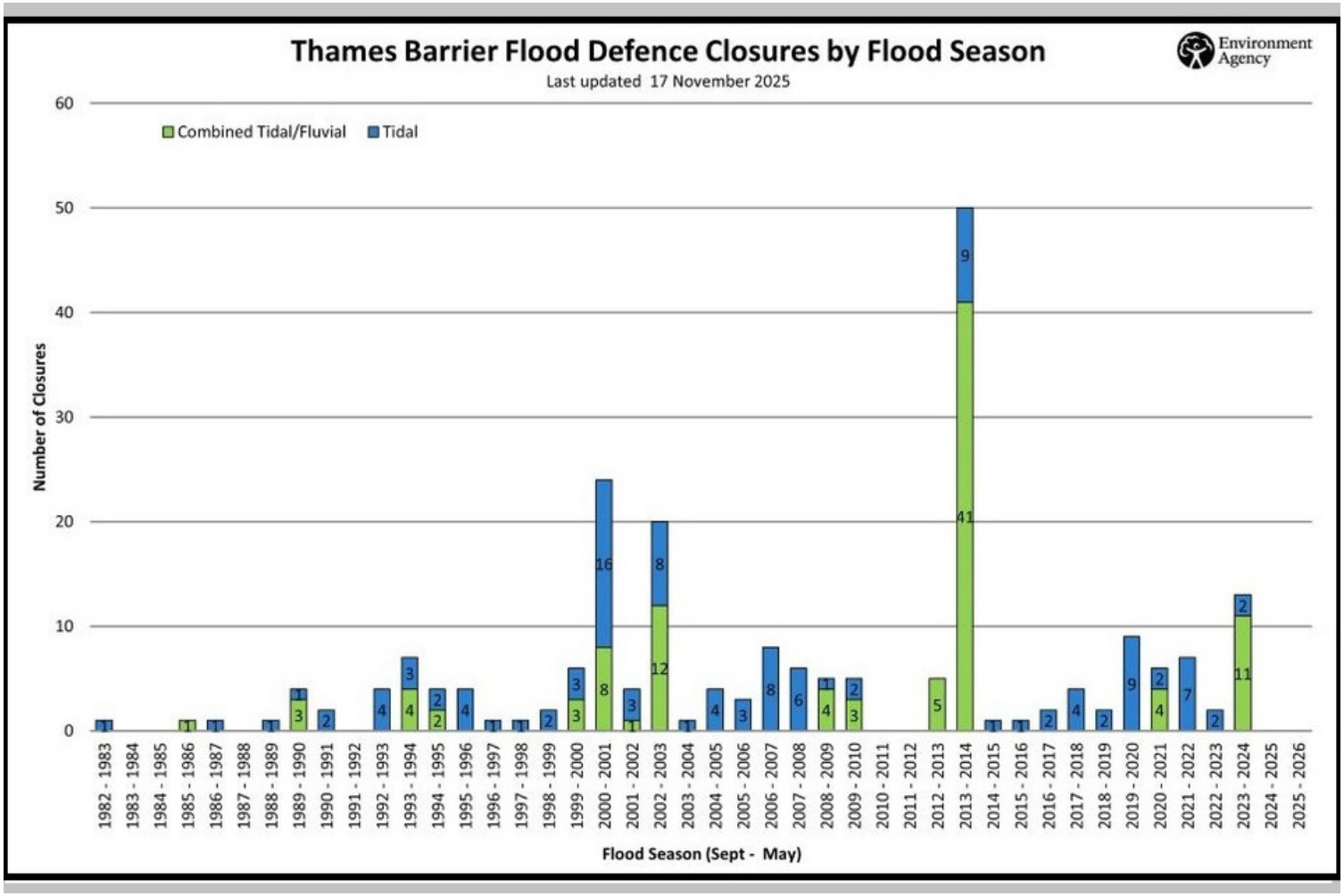
The particular threat that has remained is from tidal surges. The highest of these occur when a combination of high tide, northerly winds and a weather system depression over the North Sea cause the tide levels to increase significantly above the normal tidal range. Records of incidents of this type of flood risk date back to at least 1236. More recently, in 1928, 14 people were drowned in Westminster; this was the last time that central London suffered tidal flooding. In 1953 London was only by chance largely spared the impacts of a devastating tidal flood that cost the lives of over 300 people in the East of England.

Since 1982, tidal surge risk has been mitigated by the Thames Barrier. As of November 2025, the Thames Barrier has been closed 221 times to prevent flooding.[14] Of these closures: 119 were to protect against tidal flooding and 102 were to protect against combined tidal/fluvial flooding. **Diagram 1** indicates that the number of closures per year is fairly variable. However, there is a general increase in the number of closures with a recent peak in the winter 2013/14 due in part to significant flooding on the fluvial Thames, which saw a record number of 50 closures and triggered an investigation by the Environment Agency. It concluded that it is too early to identify whether or not this peak was part of an emerging longer-term trend, but it is not part of an existing trend.

The Environment Agency continues to estimate that a new Thames Barrier is likely to be required towards the end of the century and that overall updated strategies are needed due to accelerated sea level rise[15]. In addition, in order to ensure that the Barrier continues to operate reliably and effectively, the 2023 update to TE2100 set out that the barrier would be closed less often from 2035, i.e. the Environment Agency will not use the Thames Barrier to manage smaller fluvial floods. In practice this means that from 2035 high river levels upstream of Teddington will no longer trigger a Thames Barrier closure. This will result in increases in flood levels in South-West London and Surrey, raising water levels in the Thames in locations such as Richmond, Twickenham, Teddington and Kingston.

[14] For further details see www.gov.uk/guidance/the-thames-barrier
[15] https://www.gov.uk/government/publications/thames-estuary-2100-te2100-monitoring-reviews/thames-estuary-2100-10-year-monitoring-review-2021

Diagram 1



Source: Environment Agency

There are residual risks even given the high standard of flood risk management measures that are in place. These risks are:

- from overtopping of the defences, i.e. a larger event than has been planned for, or
- from a breach in the defences, i.e. a failure, either accidental or deliberate, of the defences.

The likelihood of such residual risks is very small. However, the scale of consequences from rapid inundation and deep water in heavily urbanised areas mean that these residual risks must be considered. Management and mitigation of residual risks in defended parts of London along the tidal Thames are a notable component of site-specific FRAs, with the approach to residual risk depending largely on surrounding ground levels and the type of land use proposed.

Climate Change will have a major impact on the tidal flooding threat. The rising sea level will steadily reduce the level of protection that defences offer. Recent TE2100 reviews undertaken by the Environment Agency confirmed that sea level rise is accelerating, and resulted in the deadline for defence raising upstream of the Thames Barrier being brought forward to 2050.[16] The predictions for how quickly sea level will rise vary considerably depending on the assumptions used about emissions and climate modelling: Up to 2030 existing flood risk management options can continue to provide appropriate risk management for tidal flooding. Beyond 2030 there is more variation in the projections, and it is important that the close monitoring of sea level rise continues.

Locations

The tidal flood risk area through London affects areas to the north and south of the Thames and up some of the tributary rivers, where high tides may combine with high fluvial flows. Given that much of the land alongside the Thames in central and inner London has been in active urban use for centuries, there is a lot of infrastructure already in place, and protection is of a high standard through the combination of flood walls and embankments, the Thames Barrier and other movable gates and barriers.

[16] For details see https://www.gov.uk/government/publications/thames-estuary-2100-te2100-monitoring-reviews/thames-estuary-2100-5-year-review-non-technical-summary-2016 ; https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/research/ukcp/ukcp18-overview-slidepack-notes.ff.pdf

Information available

The Environment Agency Flood Zone mapping is integrated into a mapping tool[17] on the Environment Agency website.[18] It includes the 1 in 1000 (0.1%) tidal flood risk envelope and covers a wide area and is closely related to the 5m land contour.

The condition of flood defences is held on a database by the Environment Agency which carries out regular visual inspections to update condition surveys and take appropriate action either directly or through riparian owners to ensure that structures are in a sound condition. The vast majority of flood defences along the Tidal Thames are in a good structural condition.

In 2017, a comprehensive breach modelling was released by the Environment Agency for the tidal Thames between Teddington and the Thames Barrier. This model is currently being updated as part of the Thames Estuary modelling project, with an expected completion date in autumn 2027, The latest published model should be used when completing a detailed analysis of flood risk in relation to any particular areas or sites.

Particular care will be needed when examining the confluences of tributary rivers with the Tidal Thames given the interaction between the different systems[19]. There may be particularly severe effects when a high tide combines with peak fluvial flows.

Flood Risk Management

Flood defences for the Thames Estuary have been built up over hundreds of years and have tended to respond to flood events by successively raising the height of flood defences walls and embankments. The current system of defences last had a widespread upgrade based on the knowledge of sea-level rise in the 1970s and 1980s and in response to the tidal surge of 1953. This includes the Thames Barrier which has been operational since 1982. There are also around 400 smaller barriers and movable flood gates downstream of the Thames Barrier and over 300 km of river walls and embankments stretching into Essex and Kent that have been raised by up to 2 metres to give additional protection from storm surges. Across the estuary short sections of defences have been upgraded based on more recent understanding of sea level rise, mostly where developments or repairs have taken place. Upgrades to these defences are discussed in Chapter 4.

Upstream of the Thames Barrier, river walls are still necessary to prevent the normal range of high tides from flooding parts of inner and central London.

[17] From 25 March 2025, the Environment Agency's Flood Zones are produced as part of the new NaFRA2 assessment. NaFRA2 brings together national and local flood models, including undefended/defended scenarios, recorded flood outlines, and suitable third-party data. In areas where new models aren't ready yet, the Environment Agency keeps the older Flood Zone data until updates are available: (https://environment.data.gov.uk/support/faqs/778338325)
Flood Zones are mainly for planning, while NaFRA2 also feeds into the separate Long Term Flood Risk service (https://check-long-term-flood-risk.service.gov.uk/map), which shows the likelihood of flooding for different sources (rivers, sea, surface water, reservoirs).
[18] See more detailed tool for planning applications, which e.g. also includes areas benefitting from flood defences and flood storage areas https://flood-map-for-planning.service.gov.uk/
[19] This influence can stretch several miles upstream of the confluence

This system of tidal flood defences made allowance for sea level rise and London is therefore protected to a very high level.

However, the Environment Agency is using the results from the TE2100 modelling report to explore a range of potential interventions to help West London communities adapt to future flood risk related to sea level rise increasing flood levels, and reduced barrier closure post 2035. It is expected that the study phase of this work will be completed by the end of 2026.[20]

2.3 Fluvial Flood Risk

Nature of Risk

London has many tributary rivers leading to the River Thames and the Thames itself is a fluvial river upstream of Teddington Lock. As with any river system there is a possibility that any of these rivers could flood. This could come from either particularly intense rainfall within the catchment or from a blockage or restriction to flow within the river channel.

Within the Thames River Basin District there are 17 river catchments. One of them is the London management catchment which comprises 8 separate river systems. At 1487 km², this management catchment is relatively small but has by far the largest population of any management catchment, with complex, intertwined and conflicting socio-economic pressures. It covers roughly 70% of the Greater London area, extending into Hertfordshire and Essex in the north, and Surrey in the south. North of the River Thames, there are 3 separate river systems. These are the Crane, Brent and Lower Lee. South of the River Thames, there are 5 separate river systems. These are the Hogsmill, Beverley Brook, Wandle, Ravensbourne and Marsh Dykes. More information on the specific nature of risks in these systems is set out in **Appendix 2** and in the Thames Flood Risk Management Plan.[21]

Within a predominantly urban area, London's rivers are often heavily modified from their natural state. This means that rivers have been straightened, deepened, widened and constructed from materials such as concrete. In the case of the River Lee an entire new flood relief channel was constructed along the east side of the Lee Valley in the 1970s. These changes have often been made specifically to reduce the risk of flooding by either increasing the physical size of the river channel or increasing the rate at which it can convey water. However, they have been designed to historic understandings of risks and are not necessarily appropriate in the context of increased flows, meaning they can increase risk elsewhere in the catchment.

The urbanised river environment also contains many bridges, tunnels and culvert structures. These culverts are often underneath roads or railways but sometimes also flow under substantial areas of built-up land. These form potential flood risks as they can become blocked or restricted through fallen tree branches, litter or larger debris such as shopping trolleys, mattresses or even vehicles. Culverts present a particular difficulty in that it is difficult and

[20] https://engageenvironmentagency.uk.engagementhq.com/west-london-communities-project
[21] https://www.gov.uk/government/publications/thames-river-basin-district-flood-risk-management-plan

expensive to determine their condition and to carry out maintenance and repairs. It can also be difficult to ascertain ownership and maintenance responsibility for some culverts, which again may be problematic in the context of increased peak flows.

In London the rate at which rainwater enters urban rivers is significantly higher than normally occurs naturally. This is because a larger proportion of London's surface is covered by hard impermeable surfaces, which are positively drained via surface water sewers into local watercourses and then to larger tributaries. This also increases the absolute volume of rainwater that reaches rivers because there is less chance for water to soak into the ground, be taken up by vegetation or evaporate. Such urban rivers respond very rapidly to rainfall and the opportunity for flood warnings can be as short as 30 minutes, with flooding from these rivers often occurring simultaneously with surface water flooding. In contrast, some larger rivers such as the Lee or the fluvial Thames have much bigger upstream catchments so flood flows can be detected several hours or even days in advance, allowing for reasonable flood warnings to be issued.

London also has many miles of canals. In general, canals pose a low flood risk, as they have limited surface water inputs. However, the Grand Union Canal is linked to large fluvial catchments - including the Colne Valley, the River Lee Navigation, and the River Brent - and may convey flood waters from fluvial sources. A further consideration is that any canal, which is on land higher than the surrounding land, has the potential for a breach. Therefore, consideration of flood risks from canals needs to be factored into Strategic Flood Risk Assessments (SFRAs) and Flood Risk Assessments (FRAs).

Climate change predictions suggest that there will be an increased risk of flooding on tributary rivers due to more intense patterns of rainfall.

Locations

Fluvial flooding affects parts of most London boroughs. As such it affects a number of London Plan 2021 Opportunity Areas, town centres and strategic infrastructure across the city. In general, the scale of risk is more localised than for tidal flooding, but it is more frequent.

Information available

The Environment Agency produce and regularly updates its Flood Zone maps, which are integrated into the mapping tool on the Environment Agency website.[22] There is also detailed floodplain modelling for some of the tributaries. Developers and Risk Management Authorities should use the updated climate change allowances when considering flood risk and methods to reduce risk for the lifetime of their development.' Guidance is available here: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

[22] See https://flood-warning-information.service.gov.uk/long-term-flood-risk/map, and more detailed tool for planning applications, which e.g. also includes areas benefitting from flood defences and flood storage areas https://flood-map-for-planning.service.gov.uk/

The Environment Agency takes a catchment-based approach to flood risk management with further information signposted in the Thames Flood Risk Management Plan.[23]

Flood Risk Management

There are many well-established flood risk management approaches set out in national, London and local planning policy regarding the distribution of growth (including the sequential test) and appropriate design that mitigates flood risk. The actual detail will require careful consideration of the rivers locally and their floodplain characteristics. Mitigations being progressed more strategically are discussed in chapter 4.

Where new development is proposed on sites predicted to be at risk of flooding, storage for floodwater and potential flow routes need to be considered. Development should look to increase available storage or, as a minimum, compensate for any lost storage as a result of increased or altered building footprints or land level changes. On larger sites and where it is feasible to do so this could be achieved by designing the layout to locate buildings and areas of raised ground in the areas considered to be lower risk of flooding, prioritising open space in the higher risk areas to maintain or improve flood storage. Where sites are close to the river, setting back development enables increased flood storage, as well as the opportunity to naturalise the river and its banks.

Efforts to restore damaged river environments, such as lost rivers, also present good opportunities to incorporate natural flood management techniques, including for example small wetlands, ponds, diches, swales and woodlands[24]. This can improve flood risk management and bring other benefits, such as increased biodiversity, improved water quality, amenity and access to watercourses. Such measures may need to be considered in conjunction with neighbouring local authorities. Natural flood risk management in particular in the upper river catchment areas can help to reduce risk in the lower catchments.

Where a residual flood risk remains, flood risk assessments should consider what would happen to the development and its users/occupants if a flood were to occur and how the development would recover from the flooding. This should be integrated with emergency planning.

2.3 Surface Water Flood Risk

Nature of Risk

London is particularly prone to surface water (flash flooding) flooding due to its extensive and growing impermeable surfaces, the increasing frequency and

[24] For details see https://www.gov.uk/flood-and-coastal-erosion-risk-management-research-reports/working-with-natural-processes-to-reduce-flood-risk-2024
[24] For details see https://www.gov.uk/flood-and-coastal-erosion-risk-management-research-reports/working-with-natural-processes-to-reduce-flood-risk-2024

intensity of extreme rainfall and the inability of the drainage system to cope with both of these challenges, meaning rainfall tends to accumulate in low lying areas. Furthermore, predicting intense storm cells and the flow of surface water over land and through London's drainage systems is complicated, making surface water flooding highly localised and difficult to forecast, despite recent improvements in radar and weather modelling. Surface water flooding is the main risk to London, appearing on London's Risk Register. Since the 2018 RFRA significant work has been undertaken to assess, map and understand surface water risks.

An additional consideration is London's ageing Victorian drainage system, designed for a much smaller population and very different rainfall patterns. These assets convey both sewage (foul flows) and rainwater, so when a heavy downpour hits, they can overflow. This often leads to untreated wastewater being released into rivers or even backing up into streets. Surface water flooding can also be caused or exacerbated by blockages to the drainage network. New surface water drainage networks are normally designed to cope with storms of a 1 in 30-year intensity. However, events above the design intensity will occur from time to time and will be expected lead to surface water flooding.

Current predictions anticipate that the intensity of storms is likely to increase with climate change. This will mean that both the likelihood and consequences of surface water flooding will increase as flood waters may be deeper given the higher volumes of rainwater. London is already experiencing more intense and unpredictable rainfall events. Short, sharp storms are now more common, and when they hit a city built largely on impermeable ground with stressed drainage, flash flooding is almost inevitable. In July 2021 for example, severe flooding left some Londoners temporarily homeless as thousands of properties were filled with storm water and sewage after more than a month's rain fell in two hours.

Locations

Surface water flood risks occur in lower lying areas of all London boroughs. Given the complexity of the landform, topography and the drainage network it is very difficult to predict precisely where the risks will lie. Details such as the height of kerbs or level and construction of boundary walls can determine whether surface water flows one way or another. Therefore, any London wide or borough wide mapping must only be taken as a general indication of risk areas.

Generally, in central and inner London, where the natural drainage systems have been largely removed and built over, surface water flood risk tends to occur in lots of small, localized areas of slightly lower ground than the surrounding land. Basement properties and entrances to sub surface car parks, servicing yards etc. can be at particular risk of ingress of water. It should be noted that such basements often house important utilities such as electrical sub stations/meters, lift motors/control gear, back-up power generators or computer servers. Any blockages or failures of the drainage

network will exacerbate such flooding and may even cause flooding in circumstances where the drainage system would otherwise have coped.

In the rest of London where the natural drainage system of rivers and streams more often remains, surface water flooding is often directed to the valleys of those streams which form the naturally lower land areas. Many of these urban rivers are immediately adjacent to built development or even underneath buildings and in such cases those buildings may lie within risk areas. Away from those river corridors surface water will pond in lower lying areas.

Buildings with large roof areas, such as mainline rail terminals, hospitals, schools, retail warehouses are also particularly prone to surface water risks under heavy rainfall situations. For such buildings it will be important to ensure that any new development proposals reduce those risks, and mitigation is retrofitted where possible.

Information available

This RFRA uses the Environment Agency's updated risk of flooding from surface water (RoFSW) map, which is an assessment of where surface water flooding may occur when rainwater does not drain away through the normal drainage systems or soak into the ground, but lies on or flows over the ground instead. It is produced using national scale modelling and enhanced with compatible, locally produced modelling from lead local flood authorities (LLFAs). The RoFSW datasets include information about flooding extents, depths, speed and hazards.

LLFAs have a duty under the Flood & Water Management Act 2010 to maintain a register of any significant flood events. There are still only relatively few well-documented records of surface water flooding. It often occurs and then dissipates quickly, usually within a few hours. Whilst historically this has made it difficult to make a reliable record of such an event, the prevalence of camera phones, social media and CCTV now makes it possible to build up a more accurate picture of such events and in future events are likely to be recorded on a much more consistent basis.

Flood Risk Management

Where development proposals are on brownfield sites, there are real benefits to be gained by making a substantial reduction in the amount of surface water run-off generated through the redevelopment of the site. In cases where sites were used for predominantly industrial purposes the proportion of drained area is often close to 100% of the site. A residential development is likely to be in the range of 40-80% positively drained, leading to a reduction in surface water run-off. Adding in measures such as porous road and parking surfaces, green/blue roofs, storage ponds/tanks, swales and soakaways could reduce run-off further.

For development close to tidal rivers, docks and potentially other water bodies, a direct discharge of clean rainwater to these may be the most sustainable option ideally by using soft engineering or green infrastructure. However, in some cases direct discharge will not be appropriate, for example

discharge into a small stream at the headwaters of a catchment, which may cause flooding.

There is also emerging evidence on rainwater management that relatively extensive green roofs, can have a significant effect in reducing surface water run-off, particularly for lower intensity rainfall events.[25] Rain gardens represent another important green rainwater attenuation option. More recently there have been developments which have used blue roofs, retaining water at roof level for irrigation.

However, given site level limitations particularly on more dense development sites, including competition for roof space, it will be important that steps are taken in the surrounding contributory catchment areas to manage surface water more sustainably. The implementation of the LSWS is therefore important across all of London and not just in identified risk areas (see Chapter 4).

In some specific locations, for example where basements are at risk, there may be options to raise the threshold entrance to those basements. Additionally, as is often recommended for developments within the defended Flood Zone 3a, which meet the Exceptions Test, placing important infrastructure, such as electrical supplies, lift motors, computer servers, within a flood proof room or enclosure may be a viable option.

2.4 Foul Sewer and Combined Sewer Flood Risk

Nature of Risk

Foul sewer flooding occurs where sewers become blocked (e.g. due to wet wipes and cooking fat) or overloaded by heavy rain and properties connected to the sewer system are located at a level below the hydraulic level of the sewage flow. These are often basement flats or premises in low lying areas or where carriageway surcharging floods a property indirectly. Sewer flooding can also arise due to property misconnections (where waste pipes are incorrectly connected to storm drains). It is clearly particularly unpleasant and distressing as its contents are highly contaminated.

At present Thames Water estimates that there are over 10,000 properties which are vulnerable to sewer flooding across the whole of Thames Water's operational area.[26] In July 2021, the local sewer network in Hammersmith was overwhelmed by heavy rain, causing flooding in over 1,500 properties.[27] Climate change is expected to increase the intensity of storm events and therefore increase the likelihood of sewer flooding arising from system overwhelm and misconnections.

Due to the use of combined sewers in much of central and inner London, sewerage overwhelm can also contribute to surface water flooding, and

[25] https://www.sciencedirect.com/science/article/abs/pii/S0925857423000332#:~:text=In%20general%2C%20results%20showed%20that%20green%20roofs,roofs.%20Some%20gaps%20were%20found%20in%20studies.
[26] https://assets.publishing.service.gov.uk/media/6380a45d8fa8f56ea9d462d8/Thames-FRMP-2021-2027.pdf
[27] https://www.standard.co.uk/news/london/london-sewage-thames-water-hammersmith-storm-overflow-b1067959.html

through overflows, pollution of rivers and canals with contaminated surface water from roads, and release of raw sewage into the Thames.

Locations

The locations affected tend to be small discrete sub-catchments on the sewer network rather than any specific patterns or particular locations.

Information available

Detailed records of locations where sewer flooding has been recorded either within a property or within the grounds of a property are held by Thames Water. The locations are generally very sporadic and not suited to mapping on a London-wide basis.

Flood Risk Management

The nature of the problem dictates that the most effective solution is for Thames Water to carry out direct works to those parts of the sewer network linked to the affected property or group of properties. This is an expensive operation – averaging around £150,000 per property for the programme between 2015-2020, however some work is area based, involving retrofit of sustainable drainage and other infrastructure upgrades[28]. This includes actions arising out of the Brent & Harrow Catchment Plan produced jointly between the boroughs of Harrow and Brent, Thames Water and the Environment Agency 2015 and 2017.

2.5 Groundwater Flood Risk

Nature of Risk

Groundwater flooding is water originating from the subsurface and can arise from springs or more diffusely due to a rise in groundwater levels, typically due to heavy rain. The situation in London is complicated as groundwater flooding may either relate to:

- the perched water table caused by the impermeable layer of London clay which prevents deeper drainage from overlying permeable gravel deposits which then become saturated; or
- elsewhere, elevated aquifer levels which were once kept low by industrial abstraction, with base flows affected by situations in the hills to the north and south of London.

In turn flooding mechanisms include high river flows, ‘lost river’ flows being reactivated subsurface and inundation of drainage infrastructure. Flooding events can develop over weeks and months and take a long time to subside. Low-lying and sub-surface structures (e.g. basements, tube lines) are particularly at risk.

Generally, the latter type is now managed, mainly through increased abstraction by Thames Water, supported by regular monitoring.[29] This should enable management in relation to particular climate-related events (e.g.

[28] For details see https://www.thameswater.co.uk/media-library/u14p4pdo/brent-catchment-plan.pdf
[29] Informal partnership originally led by Thames Water, London Underground and the Environment Agency oversee a programme of action to stabilise groundwater levels

prolonged wet periods). The greater risk is likely to be from the perched water table in this situation, especially when combined with surface water events, as even where the ground is technically permeable, saturation may make it impermeable. Incorrectly located (e.g. basins that are too deep) or lined SUDs can also become inundated by groundwater undermining their functionality and cause structural failure.[30]

Locations

Groundwater is known for causing problems in London, particularly in Fulham, Hammersmith, Southwark or Wandsworth as well as many parts of East London, reflecting where clay underlies gravel deposits mostly in the vicinity of the Thames.

Information available

The Environment Agency keeps detailed records of groundwater levels through a comprehensive monitoring regime. All boroughs with historic groundwater flooding records have incorporated them into their SFRAs. In addition, the British Geological Survey's mapping of Susceptibility to Groundwater Flooding maps[31] can be used to highlight areas where there may be an increased potential for groundwater to rise sufficiently to cause flooding. Higher resolution mapping may be available from Local Lead Flood Authorities.

Flood Risk Management

The continued abstraction of water by Thames Water is important to manage groundwater levels in the foreseeable future. This is expected to continue. Ongoing work by Project Groundwater is expected to yield further good practice guidance in 2026[32].

2.6 Reservoir Flood Risk

Nature of Risk

Reservoir flooding is extremely unlikely to happen. There has been no loss of life in the UK from reservoir flooding since 1925. Specific reservoirs must be inspected and supervised by reservoir panel engineers. As the enforcement authority for the Reservoirs Act 1975 in England, the Environment Agency ensures that reservoirs are inspected regularly and essential safety work is carried out.

However, in the unlikely event that a reservoir dam failed, a large volume of water would escape at once and flooding could happen with little or no warning. The resulting high consequence of flooding means that, although flooding from reservoirs is considered to be of very low likelihood, the risk should be considered in SFRAs and FRAs.

[30] Groundwater and the impact on SuDS - Project Groundwater Northumbria ; site_challenges_for_designing_suds_v4.pdf
[31] Susceptibility to Groundwater Flooding | British Geological Survey (BGS)
[32] Tackling groundwater flood risk in planning policy | Championing the power of planning

For offline reservoirs (i.e. reservoirs where water has to be pumped or diverted into the reservoir) it is unlikely that climate change will have a significant impact on reservoir flood risk. For online reservoirs (i.e. reservoirs which have watercourses flowing into and out of them) there could be an increased risk of flooding due to higher inflows. In either case this will be monitored through the above-mentioned strict management arrangements, including other possible risk factors such as drought or waterlogging reducing the stability of reservoir embankments.

The principal risk posed to London is by the King George V and William Girling Reservoirs in LB Enfield as well as the large reservoirs in Surrey located near Heathrow Airport. The impact of any of these reservoirs failing would most likely be catastrophic. A reservoir or dam collapses without warning resulting in almost instantaneous flooding, significant movement of debris (including vehicles) and sediment. Complete destruction of some residential and commercial properties and serious damage of up to 500 properties could be anticipated, and several thousand other properties could be flooded. According to the London Risk Matrix published in the London Risk Register January 2025, reservoir or dam collapse is scored Medium to High due to its potential impact. However, the likelihood of any of these large reservoirs failing is considered extremely rare.

Locations

The reservoirs in the Lower Lee Valley are the largest reservoir area within the GLA boundaries. They are well maintained and monitored. In the unlikely event of a reservoir flood, the Lower Lee Valley downstream from the reservoirs could be significantly affected. Similarly, the large reservoirs to the west of London are well maintained, but in the unlikely event of a failure, parts of west London could be affected. There are a number of other smaller reservoirs, whose areas of potential inundation are shown on Environment Agency mapping (see below).

Information available

Reservoir flood maps are included in the Environment Agency mapping tool on their website.[33] These display information for large reservoirs holding over 25,000 cubic meters of water and show the largest area that might be flooded, if a reservoir were to fail and release the water it holds. They do not display information about how likely any area is to be flooded or about the depth or speed of the flood waters.

Flood Risk Management

The Water Act 2003 amended the Reservoirs Act 1975 and introduced a requirement for reservoir flood plans. Since August 2013 requirements are based on risk and not on size[34]. The Environment Agency has therefore designated specific reservoirs as High Risk. Some of these designations are under review.

[33] For details see https://flood-warning-information.service.gov.uk/long-term-flood-risk/map
[34] The Act applies to reservoirs over 25,000 m3 in England.

The Reservoirs Act requires that reservoir owners undertake all necessary steps to prevent breaches from occurring following regular inspection and reporting. The likelihood of breaching is very low, and therefore, when considering flood risk to new development it is unlikely that any particular mitigation measures will be required, unless a high vulnerability development was proposed immediately downstream of a high-risk reservoir.
However, there may be implications for emergency planning, and it may be necessary to incorporate the following aspects of the relevant reservoir safety plan, (an element of the reservoir flood plan) into emergency plans for new developments:

- a reservoir flood map (Environment Agency map which identifies the extent and severity of flooding which could result from an uncontrolled release of water);
- an on-site reservoir emergency plan (reservoir owner emergency action plan); and
- an off-site reservoir emergency plan - (police-led communications plan in the event of an incident).

3. Assessment of the impacts of flood risk on key receptors

3.1 Introduction

This chapter now examines the updated flood risk picture in relation to existing strategic growth locations (London Plan 2021 Opportunity Areas and Town Centres) and infrastructure assets. **Appendix 5** provides the related maps and detailed statistics. Further information in terms of relevant definitions and assumptions is provided directly on the maps themselves.

3.2 London Plan 2021 Opportunity Areas and Town Centres

The London Plan 2021 continued to identify Opportunity Areas (OAs) as major development locations. These are the places where London will accommodate a significant share of its anticipated growth and where large-scale development is expected to take place over the Plan period. Each of these will involve up to several thousand new dwellings and/or employment space for up to several thousand people and frequently a mix of many different land uses to promote sustainable development.

All OAs, have some form of identified flood risk. **Map 2a** illustrates that, for the base scenario[35], Waterloo, Wood Green/Haringey Heartlands, Kensal Canalside, Colindale/Burnt Oak, and Canada Water have the highest proportion of high flood risk areas from all sources (28%, 23%, 21%, 22% and 21.8% respectively). London Bridge/Bankside, London Riverside and White City follow with more than 15%. On average, using the base scenario, 11% of OAs are at high risk of flooding, compared to 7% in the previous RFRA 2018.

With climate change scenario this changes, with London Riverside, Waterloo, Clapham Junction, Wood Green/Haringey Heartlands, and Kensal Canalside having the highest proportion of land in high flood risk areas (all over 20%)

[35] Scenario without climate change projections.

(**see Map 2b**). On average, in the with climate change scenario, 16% of OAs are at high risk of flooding. It should be noted that in the previous RFRA there was no modelling for a climate change scenario, therefore no trend for climate change scenario is reported in this report.

Looking at the results of modelling of flood risk from difference sources, the baseline scenario shows that Waterloo (26%), Canada Water (18%), and London Bridge/Bankside (13%) have the highest proportion of land in high flood risk area from rivers and sea (1 in 30-year event). Wood Green/Haringey Heartlands (23%), Kensal Canalside (22%), and Colindale/Burnt Oak (16%) have the highest proportion of land in the high flood risk area from surface water flooding.

The climate change scenario shows a further increase in the risk of flooding with Waterloo (26%), Canada Water (18%), and London Bridge/Bankside (13%) OAs having the highest proportion of land in high flood risk area from rivers and sea (1 in 30-year event). Clapham Junction (30%), Wood Green/Haringey Heartlands (28%) and Kensal Canalside (25%) have the highest proportion of land in the high flood risk area from surface water flooding.

On average, using the base scenario, 2.7% of OAs are at high risk of flooding from rivers and sea, which increases to 3% at high risk of flooding from rivers and sea for a climate change scenario. On average, using the base scenario, 7.5% of OAs are at high risk of flooding from surface water flooding, which increases to almost 12% at high risk of surface water flooding for a climate change scenario.

The assessment of the OAs, as key locations for future growth, does not only consider 1 in 30 and 1 in 100-year events (high and medium risk), but also 1 in 1000-year events (lower risk). This approach was agreed with the Environment Agency in lieu of more detailed London-wide modelling. This means that further analysis is required at local level, in particular through SFRAs and site-specific Flood Risk Assessments.

In the baseline scenario Elephant and Castle (22%), London Bridge/Bankside (16%), and Old Kent Road (14%) have the highest proportion of land vulnerable to a fluvial or tidal 1 in 1000-year event. King`s Cross (34%), Clapham Junction (21%) and Vauxhall Nine Elms Battersea (20%) have the highest proportion of land at risk from a 1 in 1000-year surface water flooding event.

In the climate change scenario, Poplar Riverside (20%), Deptford Creek/Greenwich Riverside (17%), and Waterloo (15%) having the highest proportion of land at risk from a 1 in 1000 event from rivers and sea. King`s Cross (30%), White City (29%) and Vauxhall Nine Elms Battersea (28%) have the highest proportion of land at risk from a 1 in 1000 year surface water flood event. While the annual risk is lower, this would be a greater scale of event, so it is significant that largely different OAs are more affected compared to higher risk events.

A brief overview of current assessed flood risk characteristics and scoped mitigation measures for all of them is included in **Chapter 4** (where additional to the general approaches noted in Chapter 2). This provides a framework for more detailed site-level assessment. Developers interested in particular Opportunity Areas should contact the respective borough LLFA(s) at an early stage to identify flood risk and drainage requirements.

The presence of an element of flood risk is something that needs to be understood, planned and managed. Appropriate development, designed with flood risk as a key consideration at an early stage can result in a reduction in flood risk both on site and elsewhere, whilst continuing to meet the objectives of the development.

Town Centres and the Central Activities Zone

Intensification of development at Town Centre locations continues to be an important component of London's sustainable growth given the high levels of public transport accessibility and concentration of facilities.

Given that development in town centres tends to be high density, there are likely to be high run-off rates and limited scope for floodwater or rainwater attenuation in the immediate vicinity. In addition, many new developments will come forward in a piecemeal manner. Therefore, surface water management in constrained town centre sites needs to be considered particularly early in the design process so it can be satisfactorily accommodated and managed.

Map 3a illustrates that, under the base scenario, Mill Hill (67%), Lee Green (56%), and Dagenham Heathway (51%) have the highest proportion of their town centres in areas of high flood risk from all sources. This is followed by West Green Road (45%), Lewisham (45%) and Purley (43%). This represents a significant increase in the proportion of town centres in areas of high flood risk compared to RFRA in 2018, and a quite different set of town centres that are most affected (previously it was Kingston at 34%, Woolwich at 27% Hammersmith 23%, Canary Wharf 22%, and Lewisham 19%).

Using the climate change scenario, Mill Hill (69%), Lee Green (65%) and Dagenham Heathway (63%) have the highest proportion of land in high flood risk areas from all sources (**see Map 3b**).

Looking at different sources of flooding, under the baseline scenario, Woolwich (23%), Greenwich West (22%), and Crayford (22%) are the top three Town Centres with the highest proportion of land in high flood risk area from rivers and sea (1 in 30-year event), while Dagenham Heathway (51%), West Green Road/ Seven Sisters (45%) and Wealdstone (40%) are the top three Town Centres with the highest proportion of land at high risk of surface water flooding with all three having more than 30% of land at risk of surface water flooding. For base scenario, on average 11% of Metropolitan and 13% of Major Town Centres are at high risk of flooding compared to 13% and 9% in the previous RFRA.

The analysis for the climate change scenario indicates a further increase in the risk of flooding with Crayford (34%), Kingston (30%) and Woolwich (24%) being the top three town centres with the highest proportion of land in high flood risk area from rivers and sea flooding (1 in 30-year event). For surface water flood risk, in this scenario the same town centres are most affected as in the baseline, with all three having more than 50% of land at high risk of surface water flooding. Overall, in this scenario, on average 19% of Metropolitan and 13% of Major town centres are at high risk of flooding.

The Central Activities Zone (CAZ) is at risk of tidal flooding from the Thames, which flows through it. Flood risk to the south of the Thames and in particular in the Pimlico/Victoria area is quite extensive. However, the area is defended to a very high standard by a combination of the Thames Barrier and the Thames tidal flood defences.

All individual town centre flood risk issues are included in **Table 2 and Maps 3a and 3b**.

Table 2: Flood Risk in Town Centres

Metropolitan centres	
	Flood Risk Issues
Bromley	Small proportion within the River Ravensbourne floodplain and significant surface water risk areas coinciding with the Ravensbourne floodplain and flow path from the east passing under Bromley South station
Croydon	Partially within the River Wandle floodplain and close to culverted sections of the river and significant surface water risk areas coinciding with the former course of the River Wandle
Ealing	No identified fluvial flood risk issues but surface water flood risk areas have been identified along rail lines
Harrow	No identified fluvial flood risk issues but surface water flood risk areas have been identified along rail lines, and the Town Centre is upstream of an area that suffers significant flood risk
Hounslow	No identified fluvial flood risk issues but some surface water flood risk areas have been identified close to LU rail lines
Ilford	Small proportion within the River Roding floodplain and some relatively minor surface water risks affecting rail lines to the east of the town centre and Northbrook Road to the north
Kingston	Substantially within the floodplains of the River Thames and the Hogsmill River and some localised areas of surface water flood risk
Romford	Partially within the River Rom floodplain, river flows through the Town Centre in a culvert and significant surface water risks following the River Rom and River Ravensbourne corridors through the Town Centre
Shepherd Bush	Small proportion within the River Thames floodplain which is well defended. Some localised areas of surface water risk identified, notably along rail lines and in the vicinity of Tadmor St.
Stratford	Partially within the River Lee floodplain, and some localised surface water risk areas mainly affecting below ground level rail corridors
Sutton	No identified fluvial flood risk issues but surface water flood risk on flow path from the south west with risk areas to the south of the station and on Langley Park Rd under rail lines
Uxbridge	Small proportion within the floodplains of the Frays River, River Colne and Grand Union Canal which flow through the Town Centre. Some localised areas of surface water risk identified, notably along rail lines just outside Station
Wood Green	Particular flood risk from Moselle Brook culvert. Relatively minor surface water flood risks, mainly focused on the public highway network with higher risk areas to the west of the National Rail lines
Major centres	
	Flood Risk Issues
Angel	Regents Canal flows in a tunnel under the Town Centre. No identified fluvial flood risk issues but some localised surface water risks.
Barking	No identified fluvial flood risk issues, but significant surface water risks
Bexleyheath	No identified fluvial flood risk issues, but some localised surface water risks to the west of the town centre
Brixton	Significant surface water flood risk identified through the town centre along the course of the Lost River Effra and continuing north along Brixton Road
Camden Town	Grand Union Canal flows through the Town Centre. No identified fluvial flood risk issues but some localised surface water risks. Opportunities to discharge surface water to the canal
Canary Wharf	Wholly within the Thames tidal floodplain but protected by the Thames tidal defences. Opportunities to discharge surface water to the docks.
Catford	Partially within floodplain of the River Ravensbourne with significant areas of surface water risk along the Ravensbourne corridor
Chiswick	Wholly within the River Thames floodplain - both tidal and fluvial flood risk and some localised surface water risk areas

Clapham Junction	Small proportion within the River Thames floodplain and significant surface water flood risk identified through the town centre along Northcote Rd, St Johns Rd, under railway and affecting a large area to the north of rail lines
Dalston	No identified fluvial flood risk issues, but some localised surface water risks, notably the sub-surface London Overground rail lines
East Ham	No identified flood risk issues
Edgware	Partially within the Silk Stream floodplain with some significant surface water risk areas following the corridors of small local tributary rivers
Eltham	No identified fluvial flood risk issues, but some surface water risks around Well Hall Parade and risks to the A2 below the town centre
Enfield Town	No identified fluvial flood risk issues, but some significant surface water flood risks
Fulham	Wholly within the Thames tidal floodplain but protected by the Thames tidal defences, some localised surface water risks
Hammersmith	Almost entirely within the Thames tidal floodplain but protected by the Thames tidal defences, some areas of surface water flood risk, notably on roads under rail to the north of King St.
Kensington High Street	No identified flood risk issues
Kilburn	No identified fluvial flood risk issues, but some localised surface water risks, mainly affecting public highway
Kings Road East	Small proportion within the River Thames floodplain but well defended
Lewisham	Substantially within the floodplains of the Rivers Ravensbourne and Quaggy with significant areas of surface water risk along the floodplains
Nags Head	No identified fluvial flood risk issues, but some localised surface water risk areas
Orpington	Significantly within the River Cray floodplain with extensive surface water flood risk areas along Sevenoaks Rd- Orpington High St corridor
Peckham	No identified fluvial flood risk issues, but some significant surface water risks, notably to the east of the town centre along the Copeland Rd-Clayton Rd corridor
Putney	Small proportion within the Thames tidal floodplain but protected by Thames Tidal Defences including the Thames Barrier
Queensway/Westbourne Grove	No identified fluvial flood risk issues, but some localised surface water flood risk areas, notably affecting basements
Richmond	Small proportion within the Thames floodplain, some localised surface water risk areas around The Quadrant and affecting the sub surface rail station
Southall	No identified fluvial flood risk issues, but some localised surface water risk areas
Streatham	No identified fluvial flood risk issues, but a significant area of surface water flood risk to the north east of Streatham Station
Tooting	No identified fluvial flood risk issues, but some localised surface water risks, possibly focused on the route of the River Graveney
Walthamstow	No identified fluvial flood risk issues, but some localised surface water flood risk areas
Wandsworth	Significantly within the tidal Thames and River Wandle floodplains and the River Wandle flows through the Town Centre and some significant surface water risk areas focused on the Wandle Floodplain and roads passing under the railway
Wembley	No identified fluvial flood risk issues. Wembley Brook flows in a culvert under part of the Town Centre and some localised surface water risks notably to the east of Lancelot Rd
Wimbledon	No identified fluvial flood risk issues, but some risks to below ground level railway
Woolwich	Partially within the River Thames floodplain and some significant surface water risk areas

3.3 Main Rail Network and Stations

Map 4a shows that for the baseline scenario, there are a total of 449 km of mainline rail corridor, at high risk of tidal/fluvial and/or surface water flooding compared to 87 km in 2018. This is s 16% of London's total, an increase from 11% in 2018. The majority of this is from high-risk flooding from surface water which stands at 15%. In this scenario, 1,122 of London's 1,710 railway stations (65%) are at high risk of surface water flooding.

With climate change, there is a total of 630 km of mainline rail corridor at high risk of tidal/fluvial and/or surface water flooding **(see Map 4b**). This represents 22% of its rail corridor. The majority of this (19%) is from high-risk flooding from surface water. For stations, in this scenario, 1,243 railway stations are at high risk of surface water flooding, 72% of railway stations in Greater London. A key issue is also the vulnerability of power supplies, signalling and communications equipment to flood risk.

A total of 1,710 railway stations in London (65%) is at high risk of surface water flooding **(see Map 4c).** This increases to 1,243 railway stations for climate change scenario, indicating that 72% of railway stations in Greater London are in the high-risk of surface water flooding **(see Map 4d).**

Rail lines cross rivers on bridges, viaducts and embankments. Here the routes are generally at low flood risk. Examples include the elevated rail lines through London Bridge and into Waterloo, Blackfriars and Victoria. Many stations are also on elevated sections of track and therefore at lower risk. In contrast, the rail lines into Liverpool Street and Stratford along the Lee Valley and the C2C lines east of Barking travel through the River Lee and Thames floodplains respectively often at ground level. These have a higher level of flood risk. Rail services within cuttings or stations with large roof areas may be at particular risk from surface water flooding during heavy storms and these are set to increase.

3.4 London Underground & DLR Networks

Map 5a shows that for base scenario, 15% of the Underground Network is at high risk of flooding from all sources compared to 9% in 2018. In this scenario, 281 (58%) of TFL stations are at high risk of flooding from all sources, though nearly from of these (272) are most at risk from surface water flooding.

In the climate change scenario, 20% of the network is at risk, again mostly from surface water flooding. In this scenario, 310 stations (65%) are at high risk from surface flooding **(see Map 5b).**

The majority of high-risk stations are within the tidal Thames floodplain through central London and westwards. The stations on the DLR branch to Stratford and Jubilee line from Stratford to Canning town are also within the River Lee Fluvial floodplain. However, most of the DLR network at flood risk is elevated on raised tracks. There are also some outlying stations and tracks, which are in the floodplain and/or at risk of surface water flooding. However,

notable sections of the tube network are also on raised tracks including for example parts of the District Line (Hammersmith to Acton, Putney Bridge to Wimbledon, around West Ham) as well as Outer London parts of the Central, Piccadilly, Northern and Metropolitan Line.

Flood water getting into underground stations presents a particular hazard and a major engineering problem if the flood waters were to enter tube tunnels. This risk is extended geographically as tunnel portals could act as a conveyance route for flood water from a wide variety of locations, especially in the event of a tidal flood. The tube and DLR lines listed in **Table 3** have tunnel portals within floodplains:

Table 3: Tunnel Portals in Floodplain

Tube Line	Tunnel Portal	Floodplain
Central Line	Eastern Portal	River Lee
London Overground	Southern Portal	Tidal Thames
Jubilee Line	Eastern Portal	Tidal Thames
Victoria Line	Northern Portal	River Lee
DLR Lewisham branch	Thames Tunnel both portals	Tidal Thames
DLR Woolwich branch	Thames tunnel both portals	Tidal Thames

It is acknowledged that the underground location of stations and tracks means that the flood risk may not necessarily be highest in the corresponding flood risk areas of the ground. This is why the portals are highlighted, and there may also be other potential flood routes including emergency access points and ventilation shafts. London Underground is continuing to review flood risk from all sources that may affect its lines, stations, depots and other infrastructure through its LUCRFR (London Underground Comprehensive Review of Flood Risk 2016. London Underground is using the results of the review to prioritise more detailed site-specific analyses involving modelling of the principal flooding hazards (burst water mains and pluvial & sewers) followed by quantitative risk modelling and identification of the sites where risk reduction measures may be cost beneficial.

In addition, TfL is preparing a work programme related to improving the understanding of transport resilience in London. A Transport Sector working group is being established, also in line with related policies set out in the draft London Environment Strategy[36] and Mayor's Transport Strategy[37].

3.5 Main Road Network and Airports

The road network is a critical element of London's infrastructure. The bus network provides around 6.5 million journey stages per day[38] and much of the

[36] Policy 8.1.1
[37] Policy 8 and Proposals 44 and 45
[38] For details see https://tfl.gov.uk/corporate/publications-and-reports/travel-in-london-reports

network is heavily used by private passenger and goods vehicles. The road network is also of critical importance to emergency services. The road network is managed by a combination of Highways England for motorways and some trunk roads, TfL for the Transport for London road network (TLRN) and local boroughs for local roads. The density of the road network in London is likely to mean that alternative routes will be available in localised flood situations. However, the volume of traffic is likely to lead to significant congestion.

Map 6a for base scenario, shows that 13% of the TLRN are at high risk compared to 11% reported in RFRA 2018, the majority of which is tidal due to the tidal floodplain. **Map 6b** illustrates that this rises to 17% for the climate change scenario. Most of the flood risk in this scenario is from surface water flooding.

In the base scenario, 14% of the TFL bus routes are at high risk of flooding from all sources. This rises to 18% for the climate change scenario. Most of the flood risk is from surface water flooding.

However, some important road sections including parts of the A13 and the North Circular are elevated, and TfL has a pro-active monitoring programme of its network to report on flooding incidents, assess risks and implement remedial measures. There is also an opportunity for the relevant Highways Authority, LLFAs, the Environment Agency and Thames Water to work together to ensure that highways infrastructure is designed to convey exceedance flow in a way that protects commercial and residential buildings from flooding as far as practicable.

Tunnels under the Thames have a particular risk as their portals are all within the tidal Thames floodplain. In a similar way to tube tunnels, ventilation shafts or emergency shafts may also present potential routes for the conveyance of flood water. Other underpasses are low points within the road network and are more likely to be at risk of surface water flooding, and a few are also within a Flood Zone. These are listed below:

Subterranean river crossings (road and pedestrian)
Rotherhithe Tunnel
Limehouse Link Tunnel
Greenwich Foot Tunnel
Blackwall Tunnel x2
Woolwich Foot Tunnel
Silvertown Crossing

Road Underpasses
A501 Euston Road
A406 Edmonton – River Lee Floodplain
A406 Stonebridge Park
A406 Crooked Billet
A12 Wanstead/Green Man junction
A102/A11 Bow – River Lee Floodplain

A13 Movers Lane – River Thames Floodplain
A113/A1400 Charlie Browns Roundabout – River Roding Floodplain
A4088 Neasden Lane /A406 underpass
A4 Hyde Park Corner underpass
A214 Trinity Road/East Hill Underpass
A3 Tibbetts Corner underpass
A3 Tolworth Underpass
A3 Hook Road underpass
Heathrow Access Road

Bus Depots

Some of the bus garages serving London's bus operators are within flood risk areas. The results of the analysis suggest that for the baseline scenario there are 105 TFL Bus Depots (65%) are at high risk of flooding from all sources **(see Map 7a).** The majority of these are at high risk from surface flooding (70 depots out of 160 depots in total) which rises to 80 (50%) for the climate change scenario **(see Map 7b).**

A flood affecting a garage may have the direct impact of making buses unusable or may have other indirect impacts for example the loss of electricity supply rendering fuel pumps inactive or employees who are unable to reach work.

Bus depot flood management measures could include ideally a combination of green and blue roofs. There is a good practice example at West Ham, where also rainwater is captured for use in vehicle washing. Other potential measures include for example permeable surfaces and filter strips.

Airports

Heathrow Airport is largely free from flood risk, although some of the peripheral areas to the west of the airport could be affected by large floods on the River Colne system. For the base scenario, nearly 7% of Heathrow Airport is at high risk of flooding from surface water flooding compared to 10% for the climate change scenario.

This is a strategically important area affecting a number of catchments and requires cross border cooperation. It also is a large area of hardstanding with associated surface water flood risk. However, the airport has large surface water attenuation areas, which also provide water quality treatment. Further details are set out in the Heathrow Airport SFRA as well as a subsequent Surface Water Management Plan produced in 2017.

London City Airport is wholly within the floodplain of the tidal Thames. In the base scenario, 3% of London City Airport is at high risk of flooding from surface water flooding compared to 4% for the climate change scenario. However, it is in an area that is close to the Thames Barrier and other defences that protect it to a standard of at least 1 in 1000 years.

3.6 Hospitals and Emergency Services

In 2022, the London Resilience Partnership updated its London Strategic Flood Response Framework.[39] It is important for emergency services to remain operable during major flood events. Localised flooding events should be able to be managed by other supporting emergency services. Major flood events affecting either the tidal Thames or the major tributaries will need consideration and co-operation between several services. This RFRA has identified potentially vulnerable concentrations of emergency service facilities within flood risk areas.

Main Hospitals

In the baseline scenario, there are 96 hospitals that are at high risk of flooding from all sources - 58% of London's hospitals compared to 43% in 2018 (**see Map 8a)**. All flooding is from surface water. For the climate change scenario, this increases to 64% of hospitals (108) at high risk of flooding from surface water **(see Map 8b)**.

This is a high proportion, and therefore mitigation measures may be required. Many hospitals are large complex building structures so more detailed site-specific modelling would be needed to determine whether flooding would actually leave a facility unable to operate.

Fire Stations

Fire stations are likely to be important bases during flood events. **Map 9a** indicates that for the baseline scenario, 36 fire stations (29%) are at high risk of flooding from all sources. The vast majority of these are at high risk from surface flooding (33 stations) which rises to 38 stations (305) for the climate change scenario **(see Map 9b)**. This is a significant increase from the mapped position in 2018 when only 24% of fire stations were at risk of flooding from all sources.

Several such stations are in the central and inner London Thames tidal floodplain and as such have a high degree of flood protection from tidal flooding. They are also generally well covered by other fire stations just outside the Flood Zone.

Ambulance Stations

Map 9a shows that in the baseline scenario there are 36 ambulance stations (41%) at high risk of flooding from all sources compared to 19% reported in 2018. The majority of these are at high risk from surface flooding (31 in total) which rises to 38 (44%) ambulance stations in the climate change scenario **(see Map 9b).**

[39] For details see www.london.gov.uk/about-us/organisations-we-work/london-prepared/planning-emergencies-capital#acc-i-43126

Several are in the central and inner London Thames tidal floodplain and as such have a high degree of flood protection from tidal flooding. They are also generally well covered by other ambulance stations just outside the Flood Zone.

Police Stations

In the base scenario, 73 of London's 227 police stations (32%) are at high risk of flooding from multiple sources **(see Map 9a)**. This rises further to 38% for climate change scenario **(see Map 9b)**. Most of this is from surface water flooding. In 2018, 58 of London's 235 police stations (25%) were either wholly or partially at risk of fluvial/tidal and/or surface water flooding.

Prisons

Finally, for base scenario the results show that 2 of total 6 prisons (33%) in London are at high risk of surface water flooding. This increases to two thirds at risk flooding from surface water for climate change scenario.

Several are within the tidal Thames floodplain and as such have a high degree of flood protection in particular from tidal flooding. However, in the event of a flood issues of safety and security would arise, and therefore detailed emergency plans should be in place for the event of a flood.

3.7 Schools

In the base scenario 1,485 (46%) of London's schools are at high risk of surface water flooding **(see Map 10a).** This rises further to 56% for climate change scenario, more than a half of schools in London (**(see Map 10b).**

Many of schools affected are in central and inner London part of the Thames tidal floodplain and as such have a high degree of flood protection. However, a flood could represent a direct risk to the pupils and staff at schools and could cause longer-term disruption whilst any repairs are made. Schools are also important in terms of managing civil emergencies as they are often used as emergency shelter, food and supply bases. If the emergency is a flood, then this may mean that the school cannot fulfil this function.

3.8 Utilities

This section covers a wide range of utility installations including electricity supply, gas supply, telecommunications, sewage disposal, and water supply. The data about utilities is much more accurate and up-to-date compared to the previous RFRA so figures are not comparable.

In the base scenario 518 of total 1,305 (40%) utility sites in London are at high risk of surface water flooding **(see Map 11a)**. This increases to 609 (46%) utility sites in the climate change scenario **(see Map 11b)**.

The following sections address individual utilities in more detail.

Major Electrical Installations

Many power generation plants are located near rivers or the sea as they require large volumes of water for cooling purposes or transport fuel by water. Therefore, they have an associated flood risk. Most of London's electricity supply is generated outside London and transmitted to London via high voltage power lines, either on pylons or underground. However, London does still have some energy generation capability and also many switching and transformer stations. Major installations in floodplains, potentially affected by flooding from rivers and/or the sea, are listed in **Table 4.**

Table 4: Electrical Installations in Floodplain

Installation	Floodplain
Brimsdown Power Station	Adjacent to River Lee floodplain
Barking Power Station	Wholly within the Thames Tidal floodplain
Greenwich Power Station	Wholly within the Thames Tidal floodplain
Croydon/Beddington Switching Station	Partially within River Wandle floodplain
Edmonton Waste to Energy	Wholly within River Lee floodplain
SELCHP Waste to Energy	Wholly within the Thames Tidal floodplain
Belvedere Waste to Energy	Wholly within the Thames Tidal floodplain

Major Gas Installations

Gasholders and pipelines are unlikely to be directly affected by a flood given that they are gas tight containers and therefore will not let water in. However, in the unlikely event of water entering a gasholder, drying it out again is a difficult and costly process. There may also be issues around ancillary power and access to gas sites.

Water and Sewage Treatment Plants

Water and sewage treatment plants are naturally located close to major rivers in order to abstract water from them and discharge treated sewage effluent into them. It is therefore to be expected that these plants are exposed to a certain level of flood risk. Major plants in floodplains, potentially affected by flooding from rivers and/or the sea, are listed in **Tables 5 and 6**.

A significant flood at a water treatment plant could result in the contamination of drinking water supplies by flood water. This risk may trigger the shutting down of the plant. The operation of the plant may also be affected by ancillary power losses. However, the London Ring Main ensures that water supplies

can be flexibly managed, and supplies derived from several works. Given the geographical spread of the works, they are unlikely all to be affected by one flood. In addition, the four water companies supplying London with drinking water all have operational plans to cope with flooding and are in areas benefiting from defences. Major plants in floodplains, potentially affected by flooding from rivers and/or the sea, are listed in **Table 5.**

Table 5: Water Treatment Plants in Floodplain

Water treatment plant	Flood Risk Zone
Hampton	Substantially within River Thames floodplain
Coppermills	Partially within River Lee floodplain
Walton (outside London but supplying parts of London)	Partially within River Thames floodplain

Thames Water operates all the sewage treatment works in London and has operational plans to cope with flooding. A significant flood at a sewage treatment plant could result in the contamination of rivers and land as the flood spreads untreated or partially treated sewage and effluent from the works. The operation of the works may also be affected by ancillary power losses.

Table 6: Sewage Treatment Plants in Floodplain

Sewage Works	Floodplain
Beckton	Wholly within the Thames Tidal floodplain
Crossness	Wholly within the Thames Tidal floodplain
Riverside	Wholly within the Thames Tidal floodplain
Deephams	Substantially within River Lee floodplain
Beddington Farm	Partially within River Wandle floodplain
Hogsmill	Substantially within Hogsmill Brook floodplain
Long Reach (outside London but treats sewage from parts of London)	Wholly within the Thames Tidal floodplain

In addition to the listed water treatment and sewage works there may also be pumping stations and other installations that relate to water infrastructure. There are also a number of pumping stations to manage surface water. These are particularly relevant to low lying areas such as Thamesmead.

Waste Management Sites

As London has a high number of waste management sites and as a specific online tool is available (the London Waste Map[40]), waste management has been separated from the other utilities.

In the base scenario 225 (56%) of 399 waste sites in London are at high risk of surface water flooding.[41] **(see Map 12a),** indicating that more than a half of waste sites in Greater London are in the high-risk of surface water flooding.

However, many different types of waste management are included, and several sites are likely to be large complex structures so further analysis is required at local level to determine whether flooding would actually leave a facility unable to operate.

Tables 2a and 2b in Appendix 5 illustrate the critical Infrastructure at risk from flooding by source for baseline and climate change scenarios.

3.9 Basements

In the base scenario 69,656 (27%) of London's 255,528 buildings with basements in London are at high risk of flooding from both sources (**see Map 13a).** This rises further to 35% for climate change scenario. Most of this is from surface water flooding **(see Map 13b).**

Recent analysis indicates that nearly half (14,780) of London's 33,200 basements in commercial use are at risk of flooding from heavy rain.[42] Of these, 5,692 basements face a "high" or "extreme" flood risk, with the greatest number of buildings in Westminster, according to Zurich Insurance.[43]

3.10 Other Sites

This RFRA is not intended to provide a comprehensive list of all vulnerable assets, but rather that the extent of flood risk of strategic significance is highlighted as a context to decision making about the distribution of growth and management of risk. Other vulnerable land uses include nursing homes, where the safety and ability to evacuate residents may be difficult, and council service offices, where closure would have an immediate impact on the welfare of local communities, particularly people that depend on face-to-face support. Control of Major Accident Hazards (COMAH) sites, petrol stations and other sources of pollution are also particular risks, as flood water may liberate and spread polluting and/or dangerous substances that could have further impacts over and above the physical impacts of the flood waters.

3.11 Inequalities in risk and likely impact

[40] For details see https://maps.london.gov.uk/waste/
[41] Some baseline "surface water flooding only" sites become "both hazards" under the climate change scenario, which explains the small reduction from 225 to 224 in that specific category.
[42] https://www.london.gov.uk/sites/default/files/london_strategic_flood_response_framework_2022_v5.0_june_2022_-_public_facing.pdf
[43] https://gpsib.com/london-basements-at-risk-following-flash-flooding/

Research shows that surface water and sewer flooding will disproportionately impact those most vulnerable.[44] They are projected to be the most likely to experience flooding, may need more support to evacuate during a flood, and have access to fewer resources to recover quickly from any damage and disruption. These vulnerable individuals and communities were shown to be relatively more likely to live in places where flood risk is highest, and therefore where the potential costs and impacts of flooding may be greatest.

In many parts of the capital, more than 75% of vulnerable people are already at risk of surface water flooding,[45] and exposure to other types of flood risk can also been seen to correlate with different vulnerability indicators[46]. This will mean they are more likely to experience both the direct damage of flooding and, the indirect impacts of stress, higher insurance premiums, and disruption to public services for which they may have greater need. Many of these vulnerabilities relate to protected characteristics (such as disability and age) and income and housing status affected by structural inequalities that arise from discrimination and other unequal access to opportunity/division of responsibility.

Low-income homeowners may be particularly impacted economically, given risks may in some cases render properties uninsurable and un-mortgageable. They may not have building or contents insurance making them further financially vulnerable when flooding does occur. Recent research has found such homeowners nationally face a flood-related 'average annual loss' 3.7 % higher than their neighbours on better incomes, and that this could be expected to increase over time.[47]

The recently published London Community Resilience toolkit[48] developed by the GLA's resilience unit is aimed at voluntary, faith, neighbourhood and community groups who want to develop the resilience of their communities by creating a community emergency plan and associated provisions. This involves mapping out community vulnerabilities (such as basement dwellings) that would need to be particularly attended to in an emergency situation. However, while an important part of overall resilience, it can be no substitute for addressing risk upfront in the distribution and design of growth, and flood risk mitigation design and prioritisation that accounts for these inequalities. This 'vulnerability first' approach is taken by London's Surface Water Strategy.

4. Mitigations and Review of Progress since last RFRA

This chapter identifies known projects that seek to mitigate different types of flood risk in London, and highlights changes since the 2018 RFRA.

[44] Environment Agency. 'Social Deprivation and the Likelihood of Flooding' 2022.
[45] London Surface Water Strategy (2025): https://www.london.gov.uk/programmes-strategies/environment-and-climate-change/climate-change/climate-adaptation/surface-water-flooding/london-surface-water-strategy
[46] London Climate Risk Maps (2022)
[47] https://www.bayes.citystgeorges.ac.uk/news-and-events/news/2025/june/low-income-homeowners-in-flood-zones-risk-becoming-climate-prisoners
[48] The London Community Resilience Toolkit – Communities Prepared

4.1 Overarching flood risk management plans

The Environment Agency has produced Flood Risk Management Plans (FRMPs) to manage flood risk from all sources including fluvial rivers. The FRMP relevant to London is the Thames Flood Risk Management Plan 2021-2027, which was published in December 2022 and aligns with the national Flood and Coastal Erosion Risk Management Strategy roadmap to 2026.[49] It involves a collaborative effort across multiple risk management authorities to deliver a range of national and local measures. This includes aligning measures with the River Basin Management Plans (RBMP) for integrated water management.

Progress is tracked through various reports and local strategy updates. An interim progress report for the 2022-2027 RBMPs[50] (which coordinate with FRMPs) indicates that nationally, 75% of measures are either complete or ongoing as of late 2025. In London, local authorities such as Westminster[51], Lewisham[52], and the City of London[53], have updated their own Local Flood Risk Management Strategies (LFRMS) which detail specific local actions and report on progress. Specific progress highlights from local reports mention:

- Updating Strategic Flood Risk Assessments (SFRAs) using advanced flood modelling.
- Committing funds and implementing SuDS solutions like rain gardens and permeable paving.
- Strengthening town planning processes to ensure new development does not increase flood risk.
- Improving multi-agency flood plans and emergency response coordination.

4.2 Tidal Flood Risk

The TE2100 Plan (2012, updated in 2023) for the first time planned for future flood risk management in anticipation of future flood risk rather than in response to a flood event. It indicates that the present system of flood risk management for tidal flooding can continue to provide an acceptable level of risk management up to 2030 without major alterations. Beyond 2030 more actions will be needed to maintain the 1 in 1000-year risk (0.1%). These actions will be easier, more affordable and more sustainably delivered, if they are planned for from today. The Environment Agency is working with its partners on their implementation[54].

The Thames Estuary 2100 Plan divides the estuary into 23 policy units, which describe the type of flood risk management approach applicable in each area.

[49] https://www.gov.uk/government/publications/thames-river-basin-district-flood-risk-management-plan
[50] https://www.gov.uk/government/publications/river-basin-management-plans-2022-to-2027-interim-progress-report-2025/river-basin-management-plans-2022-to-2027-interim-progress-report-2025
[51] https://www.westminster.gov.uk/residents/floods/local-flood-risk-management-strategy-2024-2030#:~:text=MB%2C%207%20pages-,Overview,to%20be%20monitored%20and%20reviewed.
[52] https://consultation.lewisham.gov.uk/environment/local-flood-risk-managment-strategy/
[53] https://www.cityoflondon.gov.uk/assets/Services-Environment/local-flood-risk-management-strategy-2021-2027.pdf
[54] For further details about the TE2100 Implementation Plan please contact te2100@environment-agency.gov.uk

These policy units each have an assigned flood risk management policy. The relevant policies for the policy units within the area covered by the London plan are shown below:

- Flood Risk Management Policy 3 - A P3 policy means the Environment Agency will maintain flood defences at their current level, accepting that the flood risk will increase with climate change and engaging with communities to prepare for this risk. Policy units with a P3 policy are:
    - Richmond (fluvial flood risk only)
    - Twickenham (fluvial flood risk only)
- Flood Risk Management Policy 4 – A P4 policy means the Environment Agency will take further action to keep up with climate and land use change so that flood risk does not increase. This will require working with other risk management authorities to do more to manage flood risk. Policy units with a P4 policy are:
    - Royal Docks
    - Thamesmead
    - Barking and Dagenham
    - Rainham Marshes
    - Dartford and Erith
- Flood Risk Management Policy 5 – A P5 policy means the Environment Agency and partners need to take further action to reduce the risk of flooding, including upgrading the defences to cope with future sea level rise. Policy units with a P5 policy are:
    - Richmond (tidal flood risk only)
    - Twickenham (tidal flood risk only)
    - Hammersmith
    - Barnes and Kew
    - Wandsworth to Deptford
    - London City
    - Isle of Dogs and Lea Valley
    - Greenwich

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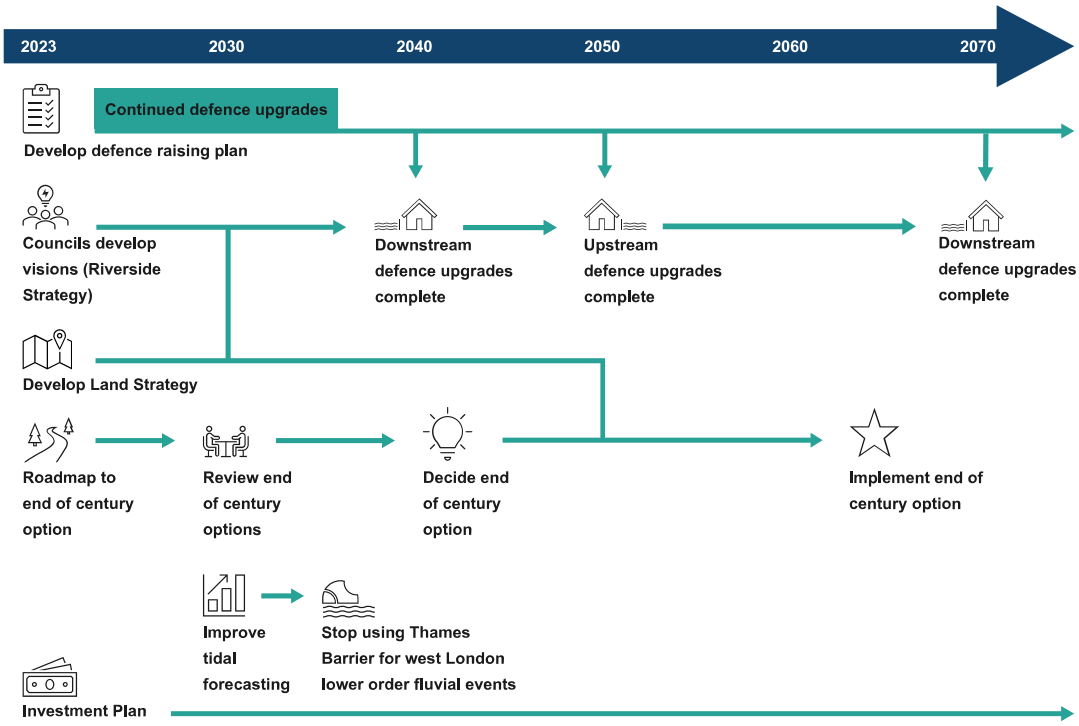
The reduced closures are a planned operational change under the Thames Estuary 2100 (TE2100) Plan to ensure the barrier's reliability for its primary purpose of protecting London from tidal surges as sea levels rise. This means the Barrier will no longer close to manage smaller fluvial (river) floods upstream of Teddington Weir, which will be more likely with climate change. These changes to the Thames Barrier operation will result in higher water levels in the River Thames resulting principally from fluvial flood events. In areas between Richmond and Sunbury, these increases could range from over one metre to as little as a few centimetres during frequent flood events that we expect to see most winters. The Environment Agency have established the West London Communities Project (WLCP) to work with residents, local authorities, and other partners to identify and implement alternative measures that will increase resilience to flooding from 2035 onwards

Some further details from the TE2100 Plan are set out below:

2023 – 2035 actions include:

- By 2030, councils, the Greater London Authority and the Port of London Authority will have worked with communities to co-develop visions for adapting riversides to sea level rise, and LPAs will have embedded these visions into the statutory spatial planning framework.
- By 2030, the Environment Agency will review the end-of-century options ahead of the next Plan update. This may involve altering or discounting options that are no longer viable.
- Work with flood defence owners, developers and infrastructure owners to continue to raise tidal flood defences to meet the required crest levels for 2040 (east of the Thames Barrier) and 2050 (west of the Thames Barrier).
- Between now and 2035, working with west London communities to put alternative flood risk management arrangements in place for post 2035 when they will not be protected by barrier closures during smaller flood as closure will be reduced to prolong the barrier's lifespan.

Figure 1: A timeline for achieving the Thames Estuary 2100 Plan's outcomes between 2023 and 2070



Source: https://www.gov.uk/guidance/what-needs-to-be-done-across-the-estuary-outcomes-thames-estuary-2100

The **TE2100 (Thames Estuary 2100) 10-Year Review[55] (2021)** confirmed the plan is providing significant benefits but highlighted the need for updated flood defence strategies due to accelerated sea-level rise. Key findings show that the barrier offers protection to 1.42 million people and property worth £321

[55] Thames Estuary 2100: 10-year monitoring review (2021) - GOV.UK

billion,[56] and while there has not been a recent increase in barrier closures, this is forecast to happen in the future as sea levels rise. The ability to forecast high tides has been important in managing mitigations, but continued tidal monitoring will be critical in understanding what and when additional mitigations, be it barrier upgrades, and/or upstream defence upgrades need to be carried out. Recommendations from the review include updating the plan with new data and working with partners on a long-term funding solution for barrier replacement and other upgrades.

These measures are part of an adaptive pathway approach to manage flood risk in a changing climate, with a decision on future large-scale options (like a new barrier downstream) to be made by 2040. The Environment Agency published 7 mapped end-of-century options for the future of the flood defense system[57]. These include:

- Upgrading the existing Thames Barrier
- Adding new flood storage areas downstream of the Thames Barrier
- Creating a new barrier in Gravesend Reach
- Creating a new barrier in Long Reach
- Creating a new barrier with lock gates in Gravesend Reach
- Creating a new barrier with lock gates in Long Reach
- Convert the existing Thames Barrier by adding a second set of gates and locks

In addition to the planned work and future interventions specified by the Thames Estuary 2100 plan, the Environment Agency has a number of recently finished or ongoing projects to better protect properties from tidal flood risk. These projects will have better protected 628 properties from tidal flooding upon completion.

4.3 Fluvial Flood Risk

Climate change is predicted to cause sea level rise and more extreme rainfall patterns which, combined with changes to the Thames Barrier operation from 2035, will result in higher water levels in the River Thames. In areas between Richmond and Sunbury, these increases could range from over one metre to as little as a few centimetres during frequent flood events that we expect to see most winters. Sea level rise will progressively increase flood levels in South-West London and Surrey throughout the rest of the century.
The main solutions being investigated and implemented for the affected West London areas include:

- **The River Thames Scheme (RTS)** [58]**:** This major project involves creating new flood channels and making capacity improvements at existing weirs (Sunbury, Molesey, and Teddington) to manage river levels between Egham and Teddington. This is a landscape-led approach to reducing flooding upstream of Teddington but will require a consent under the Nationally Significant Infrastructure Project (NSIP) regime. Current plans include the construction of a new river channel,

[56] Data will be updated in the TE2100 15-Year Review.
[57] https://www.gov.uk/guidance/managing-future-flood-risk-and-thames-barrier-thames-estuary-2100
[58] For details see https://www.gov.uk/government/publications/river-thames-scheme/river-thames-scheme

built in two sections - through Runnymede (between Egham Hythe and Chertsey) and through Spelthorne (between the River Thames at Laleham. This aims to increase river flow capacity downstream of the Desborough Cut in Surrey, as well as establishing new habitats through their construction.

- **Raising upstream defences:** As part of the wider TE2100 plan, a strategy of progressively raising river walls and embankments upstream of the barrier is being implemented to allow higher tides upriver, which in turn reduces the number of times the barrier needs to close for tidal management.[59]
- **The West London Communities Project:** Established by the Environment Agency, this project specifically evaluates and aims to deliver alternative flood risk resilience and adaptation measures to mitigate the change in risk resulting from the updated barrier operation rules. The West London Communities Project is currently an early-stage study focused on understanding future flood risks to properties and critical infrastructure in locations between Richmond and Sunbury, including Twickenham, Teddington and Kingston.
- **Integrated water solutions:** Wider catchment approaches focusing on nature recovery, sustainable drainage systems (SuDS), and resilient infrastructure are being explored to manage surface water and reduce overall flood risk.

The following schemes have either been delivered or are planned, which seek to improve protection for properties at high risk from river flooding[60]:

Project Title	Target/Actual Completion	Properties better protected 2018-25[61]
Barnes FAS	Autumn 2022	307
Cannon Brook and Mad Bess Brook Flood Alleviation Scheme	January 2026	7
Control System Competition Re-initialisation	Spring 2022	10
Folly Brook, Friern Barnet, and Hadley trash screens Flood Alleviation Scheme	Autumn 2022	28
Frog Island Tidal Sluices Penstock Automation		52
Graveney Siphon Initial Assessment		116
Headstone Flood Alleviation Scheme	Autumn 2020	36

[59] The TE2100 plan targets tidal flood risk but will also have benefits in respect of fluvial flood risk.
[60] Projects have been attributed to a single grid reference or location (except for TEAM 2100 where is have been apportioned across the project area of benefit). It does not account for defences spanning more than one geographical boundary and therefore in some instances places may show as having no recorded spend or properties. These projects are all located within the GLA boundary, please note that there may be some projects outside of this boundary that may protect properties within Greater London. There are other Environment Agency business as usual projects, e.g. recovery, repairs, etc. which are not included in this list.
[61] These figures are based on best available information.

Horseshoe Flaps Phase 1 CAP	Summer 2025	188
Marsh Dykes sluice repairs and permanent access works	Autumn 2020	629
Mereway Sluice, Twickenham - Gate Replacement	Autumn 2025	545
Oval Road Pumping Station, Dagenham - Refurbishment	Winter 2018	140
Rainham Tidal Sluice, Rainham - Power Supply	Spring 2019	100
Ruislip PFR Scheme	Spring 2025	38
The Vale trash screen	February 2023	4

In addition, various bodies have been working to identify 'Lost Rivers' and other candidates for river restoration across London[62] with a view to progressing deculverting and other green infrastructure measures that can help (along with attention to surface water runoff) alleviate flood risk and bring other benefits. There are a dozen or so lost rivers that flow through London: the Effra, Fleet, Counter's Creek and Westbourne are just a few examples. Renaturalisation projects include those on the River Beck, Rom and Ravensbourne.

4.4 Surface Water Flood Risk

The Drain London Project, led by the Mayor in partnership with the Environment Agency, Thames Water and London Councils produced surface water flood risk mapping and Surface Water Management Plans (SWMPs) for every London Borough and funded detailed studies into over 20 high flood risk areas. This led to the publication of the **London Sustainable Drainage Action Plan (LSDAP)** in Dec 2016.[63] The LSDAP promoted the retrofitting of SuDS to existing buildings, land and infrastructure and was completed in 2022. It delivered modelling, guidance, training and piloted delivery projects, and influenced London Plan policies to increase the greening and "spongification" of London.

In turn, this work helped to inform subsequent efforts, such as the development of the **London Surface Water Strategy (LSWS)** published in 2025, and the funding of sustainable drainage (SuDS) retrofit projects to better manage flood risk. The LSWS is a collaborative plan by the "Flood Ready London" partnership, formed of the Environment Agency, London Councils, London Fire Brigade, Mayor of London, Thames Water and Transport for London with support from Thames Regional Flood and Coastal Committee. The LSWS's Vision, to *increase London's resilience to surface water flooding through collective action that benefits people, places and the environment*, reflects the city's unique challenges and opportunities and calls for the delivery of transformational change. Through use of a catchment-

[62] See e.g. Thames Water Finding and Managing Culverted Watercourses Lane Rental Industry Publication , Demonstration Projects | the River Restoration Centre What we do - Thames21

[63] For details seehttps://www.london.gov.uk/programmes-and-strategies/environment-and-climate-change/climate-change/surface-water/london-sustainable-drainage-action-plan

based approach, it aims to encourage and incentivise the retrofitting of sustainable drainage measures into the existing urban environment as part of any maintenance/improvement projects planned for existing buildings/sites. It also supports the London Plan in encouraging the inclusion of strategic surface water management in new developments to help address the scale of this real and growing risk. Using funding contributions from Flood Ready London partnership organisations, the first programme of twenty schemes has been committed to for delivery in 2026/27 within the first two (of ten) Surface Water Catchment Partnerships generated in the LSWS. Additional schemes for these and the remaining Surface Water Catchment Partnerships will follow.

SUDS opportunity mapping was released in 2025. The purpose of this was to find viable space for SuDS across all 32 boroughs and the City of London, and identify the locations for SuDS schemes that could achieve the greatest benefits in terms of surface water flood risk resilience, sewer capacity and natural capital. The results can be used by stakeholders, such as Lead Local Flood Authorities, to find out which areas and types of SuDS would be most effective, as a starting point to build on for a Local Flood Risk Management Strategy, feasibility study, more detailed modelling or business case.[64]The results have been mapped across London for six scenarios: all SuDS (present day), all SuDS (climate change), public land SuDS, private land SuDS, green SuDS and grey SuDS. This work could be used to link with the key receptors previously identified that could benefit from SuDS retrofitting.

Developing a market-based approach to deliver SuDS through street works project led by Thames Water in partnership with the GLA, has achieved several key milestones to support the development of a scalable and effective SuDS (Sustainable Drainage Systems) market.[65] This includes completion of a technical review of modelling tools; a global review of SuDs design standards and draft specifications for five typical system types; plus development of a data platform identifying delivery areas and bidding approaches, using a tradeable unit of Reduction in Surface Water Volume. A market simulation in Enfield showed SuDS delivery through the market could achieve cost savings of 19% – 26%.[66] Five sites have been identified to progress three pilot schemes. Contractors and suppliers have been engaged, with plans and designs underway to ensure delivery by April 2026. Planning is ongoing for broader industry engagement and the next phase of development.

2025 also saw the publication of new GLA guidance **Reimagining Rainwater in Highways**, to aid understanding of how SuDS can transform the way we design our highways in a multi-benefit way. And work is ongoing on the London Front Gardens Study which will identify the most effective policy levers to tackle the cumulative impacts of front garden paving.

In addition, **Thames Water's AMP8 (Asset Management Period 8, 2025-2030)** involves a major **Surface Water Management Programme**[67] to tackle

[64] https://data.london.gov.uk/dataset/suds-opportunity-mapping-2025-information-page-2lgng/
[65] https://waterinnovation.challenges.org/winners/market-based-approach-suds/
[66] Ibid.
[67] https://netzerogo.org.uk/funding/thames-water-surface-water-management-programme/#:~:text=Manage%20the%20quantity%20and/or,to%20include%20the%20following%20components

flooding and pollution by integrating SuDS across its region, focusing on runoff management, quality improvement, and biodiversity, building on AMP7 insights, aiming for community benefits and environmental resilience with significant investment.

There is also the **London Drainage Engineers Group (LoDEG),** a joint forum to help and facilitate collaboration between the 33 Lead local flood authorities (LLFAs) within London and other strategic risk management authorities with regards to surface water flood risk and drainage issues.

The following projects have been allocated Local Levy funding to support project delivery as part of the Thames Regional Flood and Coastal Committee's Natural Flood Management (NFM) and PROSPER programmes. The Thames RFCC NFM Programme was set up with the aim of finding a more streamlined and efficient approach to delivering NFM projects in the Thames RFCC area. The aim of PROSPER is to promote the adoption and delivery of SuDS. These projects include public realm improvements, civil highway projects, and in-street utility upgrades to integrate SuDS within the existing urban realm.

Project Title	RMA Name	Completed or ongoing
Brentford North Flood Alleviation Scheme	London Borough of Hounslow	Construction expected Spring 2026.
Chestnuts Showground Flood Alleviation Scheme	London Borough of Waltham Forest	Completed construction November 2024.
Parliament Hill Collaborative SuDs Project	London Borough of Camden	Completed construction early 2024.
Thames RFCC NFM - Bramley Sports Ground Wetlands	London Borough of Enfield	Funding allocated subject to conditions.
Thames RFCC NFM – Duppas Hill NFM	London Borough of Croydon	Construction expected May 2026.
Thames RFCC NFM - Yardley Lane	City of London Corporation	Construction due to complete end of 2025. Chasing for update
Thames RFCC NFM Funding-Claybury NFM	London Borough of Redbridge	Completed construction November 2024.
Thames RFCC NFM Northbrook Park and Network Rail Wetlands and Stream Restoration	London Borough of Lewisham	Completed construction February 2025.
Thames RFCC NFM Park Wood SSSI Natural Flood Management Phase 2	London Borough of Hillingdon	Construction expected January 2026.
Thames RFCC PROSPER – Blythe Road SuDS – Phase 2	London Borough of Hammersmith & Fulham	On track to deliver in 2026.
Thames RFCC PROSPER – Bradstock Road Gateway	London Borough of Hackney	Construction expected early 2026.
Thames RFCC PROSPER - Gipsy Hill	London Borough of Southwark	Construction expected April 2026.
Thames RFCC PROSPER - Goldhurst Terrace Phase 2	London Borough of Camden	On track to deliver in 2026.

Thames RFCC PROSPER - Slowing the Flowing in Notting Dale: Morland House Phase 1a	Royal Borough of Kensington and Chelsea	On track to deliver in 2026.
Thames RFCC PROSPER Allendale Avenue Derwent Road and Kelvin Gardens Junction	London Borough of Ealing	Completed construction September 2025.
Thames RFCC PROSPER Spider Park Daylighting	London Borough of Hillingdon	Constructed expected Spring 2026.
Thames RFCC Prosper - Stoneleigh Road Rain Gardens	London Borough of Redbridge	Construction expected Spring 2026.
Friary Park Flood Alleviation Scheme	London Borough of Barnet	Completed July 2025
Trent Park Wetlands	London Borough of Enfield	Completed June 2025
Holland Park NFM Scheme	Royal Borough of Kensington and Chelsea	Construction due Feb 2026
Enfield Playing Field Wetlands	London Borough of Enfield	Funding allocated subject to conditions.

The following schemes have either been delivered or are planned, which seek to improve protection for properties at high risk from surface water flooding[60]:

Project Title	**Borough**	**Target/Actual Completion**	**Properties better protected 2018-25**[61]
Clayhall Flood Alleviation Scheme	London Borough of Redbridge	Winter 2021	124
East Camberwell FAS Phase 1 - Coleman Road	London Borough of Croydon		6
East Enfield Flood Alleviation Scheme	London Borough of Enfield		77
Enfield Town Flood Alleviation Scheme	London Borough of Enfield	Autumn 2026	16
Green Lanes Flood Alleviation Scheme	London Borough of Enfield	Spring 2024	13
Hazelwood School FAS	London Borough of Enfield	October 2024	11
Larkspur Close Integrated Urban Drainage Scheme	London Borough of Haringey	Summer 2024	6
NFM - FCRM - Clothworkers Wood	Royal Borough of Greenwich		10
Peckham Rye Flood Alleviation Scheme	London Borough of Southwark	Spring 2025	153
Regent Avenue and Elephant Park	London Borough of Hillingdon	Spring 2023	75
Turkey Brook Flood Alleviation Scheme	London Borough of Enfield	Spring 2021	444
Upper Leytonstone Flood Mitigation Project (Wadley Road)	London Borough of Waltham Forest	Spring 2025	20
Wimbledon Park Brook River Restoration Project	London Borough of Merton	December 2022	7

Muswell Hill Catchment Flood Alleviation Scheme	London Borough of Barnet		-

4.5 Foul Sewer and Combined Sewer Flood Risk

The **Thames Tideway Tunnel** is a 25 km "super sewer", which is the last part of the 3-part programme delivered by Thames Water over 15 years, and runs alongside the River Thames from Acton to Beckton (west to east). This new sewerage system adds capacity to prevent the tens of millions of tonnes of pollution being discharged into the River Thames every year. The programme also included major sewage works upgrades and the construction of the Lea Tunnel. To complement the completion of the Thames Tideway Tunnel and support the processing of this and additional wastewater from London's growing population, Thames Water are upgrading Beckton Sewage Treatment Works (STW) to improve resilience and effluent quality.

The Thames Water **Storm Overflow Action Plan 2024** seeks to address the discharge of overflow foul water during high rainfall events more widely over a 25 year period. It has targets for improvements at an increasing number of locations. It has a focus on natural solutions, with more 'green' nature-based solutions, including 8 wetland schemes proposed and 188 surface water removal schemes, utilising SUDS. Many of the plans for overflows are also a combination of green and grey solutions, incorporating increased storage of storm water, SUDS, wetland treatment, sealing of sewers and increasing treatment capacity at our sewage works.[68]

Thames Water's **Sewer Rehabilitation Programme** aims to restore damaged sewers to a good structural condition. Different rehabilitation techniques include:

- Relining the whole length of a sewer between two manholes with an epoxy resin liner
- Covering a small section of damaged pipe with patch repairs
- Excavating and replacing the old pipe with a new section

The **Counters Creek Flood Alleviation Scheme** was completed in 2020, with the objective to protect over 1,000 properties in West London by reducing the risk of basement sewer flooding to properties during a storm event in the catchment. The Counters Creek scheme involved the construction of new local sewer improvements, the installation of FLIP devices, and the installation of SuDS.

The Thames Water Drainage and Waste Waster Management Plan (DWMP23)[69] was the first time a long-term plan had been co-created to deliver a resilient and sustainable wastewater service. We engaged with around 2,000 customers and stakeholders to develop our plan.

[68] https://www.thameswater.co.uk/media-library/5ngkb11h/storm-overflow-action-plan-accompanying-guide.pdf
[69] https://www.thameswater.co.uk/about-us/regulation/drainage-and-wastewater-management/dwmp23/dwmp23-explained

The DWMP23 set out the risks and pressures for our drainage and wastewater service that included:

- A growing population
- Climate change – extreme weather affects everything from the size of our pipes to the water levels of our local rivers
- Protecting and enhancing our environment
- Loss of green spaces – leaving rainwater without anywhere to drain
- Keeping customer bills affordable

DWMP23 detailed the actions needed to tackle these challenges and the risks they create, such as property flooding and storm overflow discharges. This was a shared plan that had partnership-working at its core. Find out more about how we created DWMP23 together.

The **Thames Water Surface Water Management Programme (SWMP)**[70] is an initiative to tackle surface water flooding by funding projects that disconnect rainwater from sewers or slow it down (attenuation), using sustainable drainage systems (SuDS), to protect communities and the environment, often involving collaboration with local authorities and focusing on 'green' solutions and risk reduction in vulnerable areas. It's part of their broader DWMP, responding to climate change impacts like intense storms and population growth, aiming to build future resilience. It also enables the delivery of the aims and ambitions of the London Surface Water Strategy. The SWMP is now shifting towards using more nature-based solutions. This includes the utilisation of SuDS. This approach can help to:

- Manage the quantity and/or rate of runoff of surface water. This will improve flooding resilience, as well as reducing the need for overflows
- Improve the quality of surface water run-off which will reduce the risk of pollution
- Increase the amenity of public spaces as well as wider community benefits
- Help grow the local biodiversity and customers' experience of their local environment

4.6 Groundwater Flood Risk

While principally a project seeking to secure London's drinking water into the future, the Teddington Direct River Abstraction project also offers some potential for the management of groundwater levels in the Thames area through increasing abstraction to reservoirs.

4.7 Reservoir Flood Risk

Since the publication of the last RFRA, there has been a change in thinking around reservoirs following the Todbrook incident in August 2019. The

[70] https://www.thameswater.co.uk/about-us/environment/surface-water-management-programme

Environment Agency is currently carrying out the Reservoir Safety Reform Programme[71] in response.

4.8 Managing/ Mitigating Flood Risk in Opportunity Areas

For consistency with previous London Regional Flood Risk Assessments this section provides an overview of all Opportunity Areas as identified in the London Plan 2021 (Table 2.1).

In most cases Opportunity Areas will bring about the possibility for substantial redesign to incorporate greater flood storage and ideally this would be considered on an area basis.

Many OAs are in TE2100 policy units; some have also had specific flood risk management work scoped, or integrated water management strategies which identify locally-specific actions that can contribute to flood risk mitigation. These are highlighted as relevant below.

Bexley Riverside

- Mainly within Flood Zone 3, downstream of the Thames Barrier, but with a high level of protection from storm surges by raised river walls. Some areas will require additional flood defence raising to maintain their current standard of protection due to sea level rise). Contains several shipping-related industries requiring operational access to the river.
- Also contains parts of the Darent floodplain with a high level of protection by tidal defences.
- A flood risk management asset study for the River Cray has been undertaken[72].
- There are some surface water flood risk areas particularly where there is a dominance of large impermeable areas such as the Darent industrial Estate. This is very low lying land, wholly dependent on tidal flood defences to make it inhabitable, and rising sea levels will make it very challenging to drain sustainably
- There is emerging evidence from LLFA's of surface water drainage issues in the broader catchment, with inappropriate reliance on foul sewers. The scale and extent of the challenge is currently not well understood and is not captured in recent studies or policies.
- The Charlton to Bexley Riverside Integrated Water Management Strategy[73] was produced in 2017.[74] This is currently being updated in respect of the Marsh Dykes catchment in response to surface water concerns raised by the Lead Local Flood Authorities. The systems mapping is a first step to understand interdependencies amongst the actions of various stakeholders that can impact the performance and

[71] https://www.gov.uk/government/publications/reservoir-safety-reform-programme/reservoir-safety-reform-programme
[72] https://www.bexley.gov.uk/sites/default/files/2021-01/Local-Flood-Risk-Management-Strategy.pdf
[73] Charlton to Bexley Riverside Integrated Water Management Strategy
[74] https://www.bexley.gov.uk/sites/default/files/2021-10/Charlton-to-bexley-riverside-integrated-water-management-strategy-2017.pdf

sustainability of these artificial networks of lakes, canals, ditches and dykes.

Canada Water

- Wholly within Flood Zone 3 and with a high level of protection from daily flooding by river walls and from tidal surges by the Thames Barrier. Some areas will require additional flood defence raising to maintain their current standard of protection due to sea level rise.
- There are relatively minor surface water flood risks focused on the London Overground lines around Surrey Quays station, and Rotherhithe Tunnel approach road.

Charlton Riverside

- Mainly within Flood Zone 3 and straddling the Thames Barrier, with a high level of protection from storm surges by raised river walls but with land lying significantly below high tide levels.
- Located in the Greenwich. Some areas will require additional flood defence raising to maintain their current standard of protection due to sea level rise. Importance of open space for flood storage.
- There are notable areas of surface water flood risk around Horn Lane, Westmoor – Eastmoor Streets and at the low point on Bugsbys Way under the freight rail bridge.
- An Integrated Water Management Strategy[75] (2017) has been produced and is in the process of being updated as part of the Marsh Dykes work referenced above. Development close to the Thames can discharge directly to the river.

City Fringe / Tech City

- Mainly within Flood Zone 1, the southern extremes have a high level of protection from daily flooding by river walls and from tidal surges by the Thames Barrier.
- Located in the London City. Some areas will require additional flood defence raising to maintain their current standard of protection due to sea level rise. Open spaces should be retained for potential flood storage and work to flood defences required in future.
- Relatively minor surface water flood risks mainly focused on the public highway network and the sub surface National Rail lines north of Liverpool St Station.

Brent Cross/ Cricklewood/ Staples Corner

- A small proportion of the area is within Flood Zones 2 and 3, with some local flood history on the River Brent. Setbacks and, where possible, increases in land available for flood storage should be incorporated in development.
- There are some surface water flood risk areas with recently recorded flooding history particularly along the River Brent corridor, the A406 where it passes under the A41, the A41 south of the A406, Cricklewood Lane near Crickelwood Station and around Prayle Grove.

[75] Charlton to Bexley Riverside Integrated Water Management Strategy

- Thames Water published the North Brent and Harrow catchment plan in 2018.[76] It focuses on improving sewerage for flooding and pollution, aligning with Thames Water's broader Catchment Strategic Plans (CSPs) and Drainage and Wastewater Management Plans (DWMPs) that use Sustainable Drainage Systems (SuDS) and partner with groups like the Brent Catchment Partnership (BCP) and Thames21.

Croydon

- Part of the area is within Flood Zones 2 and 3 of the River Wandle.
- There are extensive areas of surface water flood risk along the route of the largely buried River Wandle.
- Groundwater flood risk is also an issue.

Deptford Creek / Greenwich Riverside

- Mainly within Flood Zone 3, with a high level of protection from daily tidal flooding and fluvial flooding from the River Ravensbourne by river walls and from tidal surges by the Thames Barrier.
- Located in the Greenwich and Wandsworth to Deptford. Some areas will require additional flood defence raising to maintain their current standard of protection due to sea level rise.
- Localised areas of surface water flood risk with some particular risk areas along the national rail lines through Greenwich Town Centre.

Earls Court and West Kensington

- Partially within Flood Zone 3 and with a high level of protection from storm surges by raised river walls.
- Located in the Hammersmith TE2100 policy unit. Need to consider the role of multipurpose open spaces for flood risk management and management of surface water.
- Documented surface water/sewer flood risk areas and known capacity problems in the Counters Creek catchment affecting thousands of properties. London Overground and Underground rail lines at risk and areas close to large footprint buildings. It is notable that many older properties in the area have basements which will be at a higher risk of overflow from the highway network.
- Kensington & Chelsea's Local Flood Risk Management Strategy (LFRMS) for 2024-2030[77] focuses on empowering communities, creating adaptive places with sustainable drainage, collaborating Thames Water and using evidence to manage increasing risks from intense rainfall for more resilient infrastructure and better public preparedness.

Elephant and Castle

[76] https://www.thameswater.co.uk/media-library/u14p4pdo/brent-catchment-plan.pdf
[77] https://www.rbkc.gov.uk/environment/flooding-and-extreme-weather/flooding/managing-risk-flooding-strategy-and-evidence

- Wholly within Flood Zone 3 and with a high level of protection from daily flooding by river walls and from tidal surges by the Thames Barrier, though TE2100 actions will be required.
- Relatively minor surface water flood risk present focus on the public highway network..

Great West Corridor

- Mainly Flood Zone 1 although eastern parts include Flood Zone 3 from tidal Thames and River Brent floodplains. TE2100 actions will be required in respect of the former.
- Some areas have significant surface water flood risks, mainly to the south of Great West Road.

Greenwich Peninsula

- Wholly within Flood Zone 3 and with a high level of protection from daily flooding by river walls and from tidal surges by the Thames Barrier.
- Contains several shipping related industries requiring operational access to river.
- Located in Greenwich TE2100 policy unit requiring actions including raising river walls.
- Some surface water flood risk areas notably along existing highways.

Wood Green/ Haringey/ Heartlands

- Flood Zone 1 although includes upper reaches of Moselle brook in culvert.
- Relatively minor surface water flood risks, mainly focused on the public highway network with higher risk areas to the west of the National Rail lines.
- Culverts in the area – consideration should be given to opening the culvert for the Moselle Brook,

Harrow and Wealdstone

- Some areas are located in Flood Zone 3 of the Wealdstone Brook floodplain. The Brook flows through the site in culvert.
- Some surface water flood risk areas particularly to the highway network including low lying parts of the High St, Masons Ave and around Kenmore Ave.
- The combination of surface water, sewer and fluvial flooding are of concern and deculverting opportunities should be investigated.

Hayes

- Mainly Flood Zone 1.
- Some areas have significant surface water flood risks, mainly around Hayes town Centre.

Ilford

- Mainly Flood Zone 1 but a very small proportion of area within Flood Zone 3 of the River Roding.

- Relatively minor surface water flood risks, mainly focused on the public highway network with the exception of the Cranbrook corridor along parts of Northbrook Road and parts of the National Rail lines east of Ilford Station where risks are more significant.
- There is ongoing work that the GLA is leading with TfL and the borough to produce an Opportunity Area Planning Framework to guide growth, including shaping development principles to improve access to blue and green spaces, respond to climate risk and ensure well-designed neighbourhoods.
- Roding, Beam & Ingrebourne (RBI) Catchment Partnership sets out how the rivers should be set back in its catchment action plan.[78]

Isle of Dogs and South Poplar

- Mainly within Flood Zone 3 but with a high level of protection from daily flooding by river walls and from tidal surges by the Thames Barrier. Some areas will require additional flood defence raising to maintain their current standard of protection due to sea level rise.
- Development close to the Thames and docks can discharge direct to the river.
- Some localised surface water flood risks, mainly focused on the public highway network.
- An Integrated Water Management Plan (IWMP) (2020) for the Isle of Dogs and South Poplar Opportunity Area prepared by the Greater London Authority in partnership with LB Tower Hamlets, also encompassing the 'East of Borough' area adjacent to the River Lea[79].

Kensal Canalside

- Flood Zone 1. Grand Union Canal runs alongside the site, which development adjacent to may be able to discharge directly to.
- Some localised surface water flood risks, and the area contributes to the already overloaded Counters Creek combined sewer catchment.

Lewisham / Catford / New Cross

- Significant areas located within Flood Zones 2 and 3 within the floodplains of the Ravensbourne, Quaggy and Thames rivers.
- Catford and Lewisham have the River Ravensbourne and its tributaries running through them with locally recorded flooding. A River Ravensbourne River corridor improvement plan is in place[80].
- There is a high level of protection from daily tidal flooding by river walls and from tidal surges by the Thames Barrier.
- Part of the Opportunity Area is located in the Wandsworth to Deptford and Greenwich TE2100 policy units. Defence raising is required on the Thames frontage by 2050 to keep up with climate change and reduce flood risk further. Need to consider the role of multipurpose open spaces within the wider development areas.

[78] Roding, Beam & Ingrebourne (RBI) Catchment Partnership - Thames21
[79] https://data.london.gov.uk/dataset/isle-of-dogs-and-south-poplar-integrated-water-management-plan-em58m/
[80] https://lewisham.gov.uk/myservices/planning/policy/adopted-local-plan/spds/river-corridors-improvement-plan-spd

- Extensive areas of surface water flood risk along the tributary rivers through Catford and Lewisham Town Centres, some of these areas are at risk of deep surface water flooding in extreme events.
- Lewisham is a part of the Civic Partnership Programme (CPP) which is a £12.85m grant-funding programme that funding for includes river naturalisation, tree and shrub planting and Sustainable Drainage Systems.[81]

London Bridge, Borough & Bankside

- Wholly within Flood Zone 3 and with a high level of protection from daily flooding by river walls and from tidal surges by the Thames Barrier. Some areas will require additional flood defence raising to maintain their current standard of protection due to sea level rise.
- Relatively minor surface water flood risks, mainly focused on the public highway network.

London Riverside

- Mainly within Flood Zone 3, downstream of the Thames Barrier and with a high level of protection from daily flooding and storm surges by raised river walls. Tributary rivers of Rainham Creek, Rom/Beam, Gores Brook and River Roding. Relatively few incidences of flooding in the past.
- Located in Barking and Dagenham and Rainham Marshes TE2100 policy units. Raising river walls and embankments required by 2040 to keep up with climate change and keep flood risk at current levels. Open spaces to be retained for potential flood storage.
- The area may have a role for strategic flood storage – notably when tributaries become tide locked.
- Contains many shipping-related industries requiring operational access to river.
- Relatively minor surface water flood risks, mainly focused on the public highway network and around existing water features.

Old Kent Road

- Mainly within Flood Zone 3 and with a high level of protection from daily flooding by river walls and from tidal surges by the Thames Barrier but will require TE2100 actions.
- Mostly relatively minor surface water flood risks but more extensive risk areas in the eastern part of the area close to Ilderton Rd and just outside the Opportunity Area to the south of Old Kent Rd.
- An Integrated Water Management Strategy has been produced[82].

Old Oak

- Wholly within Flood Zone 1, Grand Union Canal runs through the site.

[81] https://www.london.gov.uk/programmes-strategies/shaping-local-spaces/regeneration-funding-opportunities/civic-partnership-programme?ac-242711=242706
[82] https://services.southwark.gov.uk/assets/attach/12826/EIP60-OKR-integrated-Water-management-strategy-2016-.pdf

- Surface water risks generally localised and small scale, although some rail cuttings and road underpasses identified as at risk. The area drains to the already overloaded Counters Creek Catchment.
- An Integrated Water Management Strategy was produced in 2017.[83]

Park Royal

- Part of the area lies along the River Brent to the west of North Circular and is within Flood Zones 2 and 3. Grand Union Canal runs through the site.
- Some areas of localised surface water flood risks focused in areas close to large footprint buildings, A406 underpasses and lower stretches of the rail network.

Investigate opportunities to reduce flood risk from River Brent, including from future impacts of climate change. Set development back from river and canal edges to enable a range of flood risk management options.

Poplar Riverside

- Mainly Flood Zone 3 from tidal Thames and River Lee floodplains but with a high level of protection from daily flooding by river walls and from tidal surges by the Thames Barrier. TE2100 actions will be required. Generally low to medium risks of surface water flooding.
- Opportunities to divert rainwater directly to the River Lee and River Thames.

Royal Docks and Beckton Riverside

- Almost entirely within Flood Zone 3, the area straddles the Thames Barrier so has a high level of protection from storm surges by the Barrier and by raised walls downstream. Various watercourses flow through the area.
- Located in Royal Docks TE2100 policy unit. Raising river walls and embankments required by 2040.
- Relatively minor surface water flood risks, mainly focused on the public highway network including parts of North Woolwich Road and lower parts of Royal Albert Way and lowers DLR lines along Royal Albert Way.
- Development close to the Thames and docks can discharge directly to the river.
- An Integrated Water Management Strategy was produced in 2023.[84]

Southall

- Flood Zone 1 but close to floodplain of Yeading Brook. Grand Union Canal runs alongside the site.
- Some localised surface water flood risks, mainly focused on the public highway network.

[83] https://www.london.gov.uk/sites/default/files/28._integrated_water_management_strategy_0.pdf

[84] https://www.london.gov.uk/sites/default/files/2023-06/Royal%20Docks%20and%20Beckton%20Riverside%20Integrated%20Water%20Management%20Strategy.pdf

- Development close to the Grand Union Canal may be able to discharge directly to the canal.

Thamesmead and Abbey Wood

- Almost entirely within Flood Zone 3 within the tidal Thames floodplain with large areas significantly below high tide level. Parts of the area are dependent on pumping stations and storage reservoirs for continuous flood risk management. Various watercourses flow through the area. Intensity of development should take into account the significant land take required for sustainable drainage systems.
- Located in Thamesmead TE2100 policy unit. Some areas will require additional flood defence raising to maintain their current standard of protection due to sea level rise.
- There are some surface water flood risk areas particularly where the National Rail line embankment acts as an informal flood barrier. There are surface water features within Thamesmead and some areas rely on pumped drainage.
- An Integrated Water Management Strategy has been produced in 2017[85] and new work is currently being scoped to further address drainage concerns.
- Development close to the Thames can discharge directly to the river.

Lee Valley

- Includes extensive areas of Lee Valley floodplain and contains areas of Flood Zone 2 and 3.
- River Lee and tributaries flow through the area, and some options for direct discharge.
- Some notable surface water risk areas around Tottenham Hale and SW of Northumberland Park, Hall Lane and industrial estates close to the A406 and some low-lying parts of the River Lee floodplain.
- Flood risk management approaches should be considered in association with measures across London's boundaries in Herts and Essex.
- Sub-regional integrated water management strategy (2023) for East London covers this area.[86]

Vauxhall / Nine Elms / Battersea

- Mainly Flood Zone 3 and with a high level of protection from daily flooding by river walls and from tidal surges by the Thames Barrier. Located in the Wandsworth to Deptford TE2100 policy unit requiring TE2100 actions to be implemented.
- Contains several shipping related industries requiring operational access to river.
- Relatively minor surface water flood risks, mainly focused on the public highway network with the exception of more significant risks on streets to the north west of Wandsworth Road. The access road into New

[85] https://www.bexley.gov.uk/sites/default/files/2021-10/Charlton-to-bexley-riverside-integrated-water-management-strategy-2017.pdf
[86] https://www.london.gov.uk/sites/default/files/2023-07/Sub-regional%20integrated%20water%20management%20strategy%20East%20London%20-%20July%202023.pdf

Covent Garden under the railway lines is shown at particular risk and should be investigated.
- An Integrated Water Management Strategy has been produced.[87]

Wembley
- Some areas are within Flood Zones 2 and 3 of the Wealstone Brook/River Brent, which flow through the area.
- Relatively minor surface water flood risks focused on the Wealdstone Brook corridor and areas close to large footprint buildings.

White City
- Small part of the area is within Flood Zone 3 and with a high level of protection from daily flooding by river walls and from tidal surges by the Thames Barrier.
- Located partially in the Hammersmith TE2100 policy unit requiring actions to be implemented.
- Some significant surface water risk areas in/close to the area. The area drains to the already overloaded Counters Creek Catchment.

Tottenham Court Road
- Flood Zone 1.
- Relatively minor surface water flood risks.
- It is notable that many older properties in the area have basements which will be at a higher risk of overflow from the highway network.

Kings Cross – St Pancras
- Flood Zone 1.
- Grand Union Canal runs through the site which may offer some drainage options.
- Relatively minor surface water flood risk, mainly focused on the public highway network and sub surface National Rail lines.

Colindale / Burnt Oak
- Part of the area is within Flood Zones 2 and 3 and contains Silk Stream, a River Brent tributary where localised flooding has been recorded.
- Some surface water flood risk areas notably along tributary river corridors, especially in the vicinity of Burnt Oak LU Station.

Euston
- Within Flood Zone 1 with no floodplain identified.
- Relatively minor surface water flood risks, mainly focused on the public highway network with the exception of more significant risks to the sub surface National Rail lines north of Euston Station and Euston Rd underpass.

[87] https://www.susdrain.org/news/articles/lmost_ambitiousr_p14m_sustainable_drainage_scheme_protect_london_flooding.html#:~:text=The%20scheme%20will:%20*%20Capture%20and%20redirect,*%20Remove%20unnecessary%20pressure%20on%20the%20network

Victoria

- Partially within Flood Zone 3 and with a high level of protection from daily flooding by river walls and from tidal surges by the Thames Barrier.
- Located in London City TE2100 policy unit requiring implementation of relevant TE2100 actions
- Some significant surface water flood risk, mainly focused on the public highway network and the National Rail lines into Victoria Station.
- It is also notable that many older properties in the area have basements which will be at a higher risk of overflow from the highway network.

Waterloo

- Wholly within Flood Zone 3 and with a high level of protection from daily flooding by river walls and from tidal surges by the Thames Barrier. Some areas will require additional flood defence raising to maintain their current standard of protection due to sea level rise.
- Relatively minor surface water flood risks, mainly focused on the public highway network with a concentration around Waterloo Station.
- Development close to the Thames can discharge directly to the river.

Paddington

- Wholly within Flood Zone 1.
- Grand Union Canal/Paddington Basin runs through the site. Development close to the Paddington Basin should be able to discharge rainwater to the basin.
- Relatively minor surface water flood risks.
- It is notable that many older properties in the area have basements which will be at a higher risk of overflow from the highway network.

Heathrow

- Relatively small proportion of the area within Flood Zones 2 and 3.
- Relatively minor surface water flood risks, although potentially risks to sub-surface roads/rail. Heathrow benefits from the presence of surface water balancing ponds.

Kingston

- Mainly Flood Zone 1 with some significant areas of Flood Zones 2 and 3, notably around Kingston Town centre and along the Hogsmill River. Strategic approach to site design could increase land available for flood storage.
- Some areas have significant surface water flood risks, mainly to the north of Kingston Town centre and north of new Malden.
- The Environment Agency investigating a Lower Thames Flood Defence scheme, new development should allow for any appropriate interventions.

Wimbledon/Colliers Wood/South Wimbledon

- Mainly Flood Zone 1 with some significant areas of Flood Zones 2 and 3, along the River Wandle corridor. Strategic approach to site design could increase land available for flood storage.
- Some areas have significant surface water flood risks, mainly to the southwest of Wimbledon Chase.

New Southgate

- Mainly Flood Zone 1 with some localised areas of Flood Zones 2 and 3, along Strawberry Vale Brook.
- Some areas have significant surface water flood risks, notably affecting the North Circular Road.
- Potential to utilise large areas of open space for strategic surface water/flood storage.

Sutton

- Flood Zone 1.
- Some areas have significant surface water flood risks, mainly to the south of Sutton Town centre.

Woolwich

- Mainly within Flood Zone 3, downstream of the Thames Barrier and with a high level of protection from storm surges by raised river walls but with land lying significantly below high tide levels.
- Located in the Thamesmead TE2100 policy unit. Some areas will require additional flood defence raising to maintain their current standard of protection due to sea level rise.
- Some parts of Woolwich Town Centre, notably the national rail lines are at risk of surface water flooding with flows running off the ridgeline to the south.
- Within the Marsh Dykes catchment area which is currently subject to integrated water management investigations following concerns about drainage.

Bromley

- Partially within Flood Zones 2 and 3 with fluvial flood risks along River Ravensbourne to the west of town centre and a tributary watercourse running close to Bromley South Station.
- Surface water risks broadly follow fluvial floodplains with some areas at risk of deep surface water flooding in extreme events.

Romford

- Mainly Flood Zone 1 with some localised areas of Flood Zones 2 and 3.
- Some areas have significant surface water flood risks, notably around Romford Town centre.
- The Havering Flood Investigation report 2022[88] focuses on eight groupings of reported flooding locations across the borough. The findings of this investigation suggest that the primary cause of flooding

[88] https://www.havering.gov.uk/downloads/file/6454/havering_2022_flood_investigation_report.pdf

experienced on 25th June 2021 was the volume and intensity of the rainfall experienced. It is estimated that one third of June average rainfall fell across the borough over 24 hours. Hydrological analysis indicates an event frequency for the 25th of June flood event of 20% (1 in 5) annual exceedance probability.

Clapham Junction

- Mainly within Flood Zone 3 but with a high level of protection from daily flooding by river walls and from tidal surges by the Thames Barrier, though residual breach risk should be considered.
- Located in the Wandsworth to Deptford TE2100 policy unit, raising river walls is required by 2050 to keep up with climate change and reduce flood risk further; also setting development back from river's edge.
- Some areas of significant surface water flood risk, notably to the north of Clapham Junction station.

5. Conclusions and Look ahead

Flood Risk is a serious issue for London. It is important that the capital's future is planned for and delivered in the fullest knowledge of flood risk and how it is likely to change and increase in future. That knowledge is advancing rapidly, and it will be important to keep this RFRA under regular review.

This RFRA provides an updated overview of broad flood risk issues in each of these locations and a framework of potential mitigation measures on which the relevant partners can build locally. In terms of flood risk for London's key growth areas, infrastructure and services this RFRA illustrates these risks spatially and identifies mechanisms to investigate, monitor and address flood risk of current and new infrastructure and services in cooperation with relevant partners. The lens of vulnerability due to protected characteristics can also be helpful in understanding consequences of a do-nothing approach, plus planning and prioritising proactive and emergency responses.

The update reveals that the main flooding issues in London are surface water flooding (flash floods) resulting from heavy rain overwhelming outdated drainage; sea level rises and tidal flooding from storm surges in the Thames; and river/fluvial flooding from high river flows. These are exacerbated by the city's extensive hard surfaces, Victorian-era sewers not designed for modern rainfall intensity, and the increased frequency of extreme weather events due to climate change. Therefore, any increase in built environment and in combination with increasing frequency of heavy rains will likely exacerbate the risk of surface water and sewage flooding further, putting at risk London's critical infrastructure and affecting the most vulnerable.

Furthermore, the TE2100 – planned changes to the operation of the Thames Barrier by 2035 driven by the need to stop using the Barrier to manage

flooding upstream of Teddington in order to manage the time available for maintenance and repairs may result in West London being more vulnerable to fluvial flooding. This is not reflected in the flood risk modelling set out in this report, which doesn't include any defences, but is a change for the development context, though catchment scale mitigations are being scoped.

Taking into account that flood risk inequality in London is significant, given particular vulnerabilities, flood policy and management at all levels should continue to develop in ways which recognise that the social impacts of flooding on different social groups.

5.1 Implications of findings for strategic land use and infrastructure planning and monitoring

In this context, flood risk management measures designed in or otherwise enabled (e.g. funded off site) by new development will continue to be important once the limits of the sequential test approach (at a borough level) have been reached. Whilst the sequential test continues to be important, in the context of a brownfield first approach that takes in all otherwise sustainably located opportunities in order to meet needs, it will quickly reach the limits of what it can achieve.

New development represents one of the key opportunities to reduce overall flood risk, notably through improved management of surface water, separation of combined sewers and allowing space for future maintenance and upgrade of flood defences. Development in areas of flood risk needs to consider flood storage - setting back from the river may be one way this can be achieved.

Consideration should also be given to the residual risk should the defences fail or be breached. This includes locating significant infrastructure and more vulnerable types of development in areas at lowest risk or implementing flood resilience measures. In addition, developments with basements should consider the safety, continuity of services and recovery from a flood, should one occur.

Furthermore, development proposals for utility services should be designed to remain operational under flood conditions and buildings should be designed for quick recovery following a flood.

For surface water, in the context of constrained development sites and a desire to optimise density, catchment-based approaches should be considered, particularly in town centres and other Opportunity Areas. Surface water management, including the installation of SuDS and separation of combined sewers, are important for London to help it be more resilient and adapt to extreme weather and reduce the impacts of climate change across all catchments, but particularly for Beam and Ingrebourne, South East London, North West London, and Central London.

There is increasing evidence of Sustainable Drainage techniques, such as SuDs retrofit map[89] being implemented in high density locations to achieve significant reductions in rainwater discharge rates, and it is important that the policy impetus provided by existing London Plan policies is continued. Green roofs[90] and rainwater harvesting systems[91] can be economically viable for commercial and residential development even within the CAZ, as demonstrated by them coming forward on many referrable schemes.

Beyond this, the recommendations in the previous RFRA relating to flood risk management both within and beyond land use planning remain relevant in respect of growth that is currently being planned for. These are reproduced in **Appendix 4**, with any information on what has already been achieved or where strategies have been updated.

London Boroughs – Strategic Flood Risk Assessments

Strategic Flood Risk Assessments (SFRAs) are crucial tools for UK Local Planning Authorities (LPAs) to understand and manage flood risk across their areas, informing land use policies and development decisions to minimize flood impact, ensuring new developments are safe, and guiding site-specific assessments by considering all flood sources (river, sea, surface water, groundwater).

Most London boroughs have some extent of identified flood risk **(see Appendix 5, tables 1a and 1b).**

All boroughs have SFRAs in place, but these will need to be updated to support the evidence base of Local Plans. For specific strategic purposes joint SFRAs have been produced, including one for East London, one for West London[92] and one for North London to support the respective Waste Plans. Co-ordination with authorities outside of London may also be important in some cases given catchment areas extend across boundaries.

It is important for SFRAs to identify areas where there are particular flood risks to help refine the planned distribution of growth in an area (e.g. through a sequential test), site allocation requirements and master planning. Where appropriate they should also reflect this in borough-specific flood risk management policies.

Complementing this planning specific tool, the London boroughs also have to produce – in their role as LLFAs - Local Flood Risk Management Strategies (LFRMSs) based on the F&WM Act 2010 requirements. All boroughs have at least draft strategies in place, with many in the process of updating their initial strategies from around 2015 to reflect new challenges and guidance. As part of the FWMA requirements they also have to maintain a flood asset register.

[89] https://apps.london.gov.uk/suds/#10/51.5072/-0.1276
[90] https://diadem.com/the-financial-and-environmental-benefits-of-green-roofs-insights-from-a-mediterranean-study/
[91] https://www.ciwem.org/policy-reports/sustainable-drainage
[92] https://westlondonsfra.london/

For further information the LLFAs should be contacted directly across London about LFRMSs.

Appendix 1: Plans and Policy Review

The Flood and Water Management Act (2010) sets out measures to ensure that risk from all sources of flooding is managed more effectively. This includes: incorporating greater resilience measures into the design of new buildings; utilising the environment in order to reduce flooding; identifying areas suitable for inundation and water storage to reduce the risk of flooding elsewhere; rolling back development in coastal areas to avoid damage from flooding or coastal erosion; and creating sustainable drainage systems (SuDS). It also established the role of Lead Local Flood Authorities (LLFAs) – the boroughs in London – with designated responsibility for local surface water flood risk management and for maintaining a flood risk management asset register. They produce Local Flood Risk Management Strategies (LFRMSs).

The National Planning Policy Framework (NPPF)[93] and the Planning Practice Guidance on Flood Risk and Coastal Change[94] set out the currently relevant planning requirements at national level. They retain the importance of flood risk management considerations that had been introduced through the planning policy in 2006 (PPS25).

National Flood and Coastal Erosion Risk Strategy[95] published by the Environment Agency, sets a long-term vision (to 2100) for a nation resilient to flood and coastal change, focusing on climate resilience, infrastructure, and preparedness through 2026 and beyond.

The Environment Agency's Thames River Basin District Flood Risk Management Plan[96] is part of a collaborative and integrated approach to catchment planning for water. It has drawn on evidence set out in the Thames Catchment Flood Management Plan[97]. It notes that making space for water when considering development proposals is particularly important where there is significant exposure to flood risk along tributaries and at the tidal-fluvial interface.

The Thames Estuary 2100 Plan (TE2100) was developed by the Environment Agency and approved by Government in November 2012 and last updated in 2023[98] It provides strategic direction for managing flood risk in the Thames Estuary to the end of the century. TE2100 is an adaptive plan, which considers different long-term options for managing tidal flood risk depending upon changes in several factors that determine the risk, including sea-level rise. These changes are reported on an interim basis (5 yearly) and full basis

[93] www.gov.uk/government/uploads/system/uploads/attachment_data/file/6077/2116950.pdf - see in particular paragraphs –155 - 165
[94] https://www.gov.uk/guidance/flood-risk-and-coastal-change#full-publication-update-history
[95] https://www.gov.uk/government/publications/national-flood-and-coastal-erosion-risk-management-strategy-for-england--2
[96] For details see www.gov.uk/government/publications/thames-river-basin-district-flood-risk-management-plan
[97] For details See Section 2.2 on fluvial flood risk.
[98] https://www.gov.uk/guidance/major-updates-to-thames-estuary-2100-from-2012-to-2023

(10 yearly). The Environment Agency published a full basis review in 2021[99] the implications of which are set out in more detail in **Section 2.2.**

Key elements of London's response to surface water include the London Surface Water Strategy (LSWS)(2025), which outlines a vision for increased resilience and adaptation to surface water flooding through collaborative efforts within surface water catchments. This focus on a solutions hierarchy, prioritising early rain capture through SuDS, promoting nature-based solutions, and improving public awareness and emergency response.

In addition, individual Local Flood Risk Management Strategies (LFRMSs) developed by London boroughs.

The London Resilience Partnership Strategy[100] was published in 2020. This seeks to co-ordinate emergency services and emergency planners across London in the event of a major flood. In addition, in 2022 the London Strategic Flood Response Framework[101] was updated and includes greater consideration of social drivers of vulnerability to flooding (not just modelling data) and a more proactive response arrangement across the resilience partnership.

The London Climate Resilience Review July 2024 provides an assessment of London's climate resilience and makes 50 recommendations for action to guide London's preparations for more frequent and intense climate impacts. It identifies that London has not adequately planned for cascading impacts of climate change on critical systems like transport, healthcare, and energy. The review offers 50 recommendations for the Mayor of London, the UK government, and key agencies to improve resilience to extreme heat, flooding, and other climate risks.

In 2025, the Government published new non-statutory National standards for sustainable drainage systems detailed design standards.[102] The Government has fallen short on giving them the mandate that would realise their many benefits. Where previous guidance often framed SuDS as a technical necessity, the 2025 standards take a holistic, place-based approach. SuDS are now firmly positioned as multifunctional green infrastructure, expected to contribute not only to surface water management but also to public space, biodiversity, and climate resilience. While the standards represent a progressive leap, one key limitation remains: they are non-statutory.

[99] For details see: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/558630/TE2100_5_Year_Review.pdf
[100] For details see https://www.london.gov.uk/sites/default/files/london_resilience_partnership_strategy_2020-2023_v3.4.pdf
[101] For details see: https://www.london.gov.uk/sites/default/files/london_strategic_flood_response_framework_2022_v5.0_june_2022_-_public_facing.pdf

[102] https://www.gov.uk/government/publications/national-standards-for-sustainable-drainage-systems

Appendix 2: River Systems

Crane: In the upper parts of the Crane system there is a high risk of combined fluvial and surface water flooding, due to the steep, urbanised upper tributaries with heavily modified channels. In the middle reaches, the river is still in a semi-natural state. Here, the river flows through an undeveloped corridor, where out-of-bank flow does not cause major problems, and the risk has already been reduced through the provision of flood storage and bypass channels. Where the Crane joins the River Thames at Isleworth, upstream of the Thames Barrier, the risk of flooding from the river is compounded by tidal flood risk. The Thames Barrier currently provides a certain level of protection to the Crane catchment during storm surges, reducing the risk of tidal flooding. However, if high flows on the Crane coincide with high tide, tidal water can flow into the River Crane, further increasing the amount of water in the channel and increasing the potential for flooding from the river.

Brent: In the upper parts of the Brent system, there is a relatively steep gradient and large impermeable areas which result in a rapid response to rainfall. High flows can occur shortly after the onset of a rainfall event. The catchment is particularly susceptible to summer thunderstorms. Surface water flooding can also occur independently of the river system during storm events. The Brent catchment is heavily developed, particularly in the upper and middle reaches. Flooding can therefore result from channel capacity being exceeded, either from large flows or reduced capacity from blockages. Often these types of flooding happen together, which can make it difficult to determine the source.

Lower Lee: The Lower Lee is a complex river system comprising the Lee Flood Relief Channel and the associated sluice gates, radial gates and weirs which control the system. We have reviewed how we manage fluvial flood risk, the flood risk associated with rivers, in the Lower Lee catchment.

Hogsmill: The upper part of the Hogsmill catchment is steep, and relatively suburban with large areas of open space. The river flows in a deep, fairly wide channel and properties are located away from the banks. The lower reaches of the Hogsmill including Surbiton Stream, a major tributary, are more developed right up to the edge of the river channel which is mostly modified. The Hogsmill joins the Thames upstream of the tidal limit at Teddington and is not tidally influenced. However, if high flows on the Hogsmill coincide with high flows on the Thames it can exacerbate flooding, and a number of properties in the catchment are at risk from flooding from both the River Thames and the River Hogsmill.

Beverley Brook: The Beverley Brook catchment is steep and impermeable, so it is particularly susceptible to flooding during intense summer thunderstorms. The run-off rates are high, and flooding can happen very quickly after a rainfall event, giving very little time to warn people of flooding. Blockages can exacerbate flooding locally from the Beverley Brook and its tributaries. At high tide, there is also a risk that the brook might not be able to drain away which can cause flooding in the area upstream of the confluence with the Thames.

To reduce this risk there is a tidal barrier and storm bypass culverts that prevent tidal water from flowing into the lower stretches of the brook and provide additional storage during periods when the high tide prevents water in the brook from draining into the Thames.

Wandle: The River Wandle catchment covers large parts of South London and the North Downs. At source, there are two main branches, the Carshalton Branch and Beddington Branch. Here in the chalky upper catchment, the river channel remains natural in most places and there is negligible surface water run-off into the Wandle. The lower catchment has more urban characteristics with underlying clay which mean that run-off rates are high and flooding can happen very quickly after a rainfall event, giving very little time to warn people of flooding. The Graveney catchment, a major tributary, is particularly susceptible to flooding during intense summer thunderstorms. The potential increases in risk will come from urban development, land use change and climate change. Caterham Bourne, an ephemeral watercourse which feeds into the Beddington Branch, flows on average every seven years and poses a risk of groundwater flooding to local area when the groundwater level is high.

Ravensbourne: The Ravensbourne and its tributaries flood when the banks overtop; either because the channel's capacity is exceeded during high flows, or blockages reduce the channel capacity. The river is heavily modified, with lots of culverts and structures which are susceptible to blockages, particularly in the upper section. Other sources of flooding in the catchment are overflowing surface drains; the inundation of sewers, and rapid run-off arising from urban expansion. Often these types of flooding happen together, which can make it difficult to determine the cause. At the bottom of the Ravensbourne catchment at the confluence with the Thames there is also a risk from tidal flooding or a combination of tidal and river flooding.

Marsh Dykes: The Marsh Dykes are located in the London Boroughs of Greenwich and Bexley and consists largely of low-lying reclaimed land from the Thames estuary floodplain defended by the Thames tidal flood defences, a series of large embankments along the tidal frontage. The former Greater London Council constructed a system of lakes and canals, together with surface water pumping stations to drain the low-lying area of Thamesmead and Belvedere. Some areas are drained to the combined sewers that flow into Crossness Sewerage Treatment works.

Appendix 3: Abbreviations

CAZ	Central Activities Zone
CCFAS	Counters Creek Flood Alleviation Scheme
CFMP	Catchment Flood Management Plan
COMAH	Control of Major Accident Hazards
DWMP	Drainage and Wastewater Management Plan
EA	Environment Agency
F&WM Act	Flood and Water Management Act
FRA	Flood Risk Assessment
FRMP	Flood Risk Management Plan
GLA	Greater London Authority
IPEG	Indicative Potential for Elevated Groundwater
IWMS	Integrated Water Management Strategy
LB	London borough
LoDEG	London Drainage Engineers Group
LFRMS	Local Flood Risk Management Strategy
LLFA	Lead Local Flood Authority
LSDAP	London Sustainable Drainage Action Plan
LSFP	London Strategic Flood Plan
LSWS	London Surface Water Strategy
LUCRFR	London Underground Comprehensive Review of Flood Risk)
NaFRA	National Flood Risk Assessment (Published 2024)
NPPF	National Planning Policy Framework
OA	Opportunity Area
PPG	Planning Practice Guidance
RFRA	Regional Flood Risk Assessment
RoFSW	Risk of flooding from surface water
SFRA	Strategic Flood Risk Assessment
SHLAA	Strategic Housing Land Availability Assessment
SuDS	Sustainable Drainage System
SWMP	Surface Water Management Plan
TE2100	Thames Estuary 2100 Plan
TfL	Transport for London
TLRN	Transport for London Road Network

Appendix 4: 2018 RFRA recommendations progress

Recommendation 1 – Tidal Flood Risk

The London boroughs should address relevant tidal flood risk mitigation measures set out in the Thames Estuary 2100 Plan in their Local Plans, as supported by Policy SI12 of the London Plan. They include setting back development and defences from the banks of watercourses, raising defences and creating flood storage.

The development of Riverside Strategies to support the delivery of Thames Estuary 2100 should be led by the London boroughs.

Progress against recommendation

TE2100 has continued to be implemented, mainly through riverside development opportunities which present the opportunity to incorporate raised river walls and additional setbacks etc. Joint Thames Strategy partnership including the Thames Estuary Partnership, Thames RFCC and London Borough of Richmond is hosting the work to identify five Thames Strategies based on character which provides guidance for riverside development.

Recommendation 2 – Fluvial Flood Risk

Regeneration and redevelopment on London's river corridors offer a crucial opportunity to reduce fluvial flood risk. Strategic Flood Risk Assessments (SFRA) and planning policies should focus on making the most of this opportunity through appropriate location, layout and design of development as set out in the Thames Flood Risk Management Plan (FRMP). Opportunities should be sought to set development from the river edge; ensure that developments with residual flood risk are designed to be flood compatible and/or flood resilient; and maximise the use of open spaces to make space for flood water in line with policy SI12 of the London Plan and the requirements of the NPPF. Opportunities for benefits related to river restoration should be maximised as well.

Progress against recommendation

Led by the Environment Agency in partnership with GiGL, Zoological Society of London (ZSL), Thames21 (T21) and the River Partnerships in London (RiPL), with support from a steering group, an interactive online map has been made to bring together river restoration opportunities across London. The map includes projects that aim to restore rivers and streams, excluding canals, covering actions such as reconnecting rivers to floodplains, improving river habitats, creating wetlands, and more.[103]

Recommendation 3 – Surface Water Flood Risk

Developments all across London should reduce surface water discharge in line with the Sustainable Drainage Hierarchy set out in Policy SI13 of the London Plan. .

[103] https://www.gigl.org.uk/2025/06/19/river-restoration-opportunities-in-london/

Since 2018, London's developments implemented the London Sustainable Drainage Action Plan (LSDAP) 2016, supported by the London Plan policy on sustainable drainage, resulting in significant discharge reductions and a shift towards greener solutions like green roofs and permeable surfaces. Good progress was made on the LSDAP which finished in 2022, but there are new, more collaborative actions in the London Surface Water Flooding Strategy and action plan published in 2025, that supersede the LSDAP to accelerate SuDS rollout and including through additional funding.

Recommendation 4 – Sewer Flood Risk

Thames Water should work collaboratively with LLFAs and the Environment Agency to facilitate the attenuation of surface water, removing it from the foul sewer. For the combined sewer system surface water has to be attenuated at source and discharged into the combined sewer at a lower rate.

Progress against recommendation

Thames Water is working on reducing storm overflows via its Drainage and Wastewater Management Plan (DWMP 2025-2050), focusing on 'attenuation at source' (Sustainable Drainage Systems - SuDS) and infrastructure upgrades like the Tideway Tunnel. Thames Water's AMP8 (Asset Management Period 8, 2025-2030) involves a major Surface Water Management Programme to tackle flooding and pollution by integrating SuDS across its region, focusing on runoff management, quality improvement, and biodiversity, building on AMP7 insights, aiming for community benefits and environmental resilience with significant investment. The progress also involves implementing a long-term strategy using both large tunnels (like Tideway) and local SuDS solutions to control surface water runoff and reduce combined sewer overflow, a major environmental issue.

Recommendation 5 – Groundwater Flood Risk

The groundwater flood risk in identified locations (see IPEG map) should be considered in Strategic Flood Risk Assessments (SFRAs) and Flood Risk Assessments (FRAs).

Progress against recommendation

By 2025, London Boroughs identify groundwater flooding in their Strategic Flood Risk Assessments (SFRAs) through dedicated mapping layers, data analysis, and collaboration with agencies like the Environment Agency, using these tools to guide development away from high-risk zones, plan for climate change impacts, and implement site-specific solutions for sources like the Thames and sewer systems, ensuring development considers all flood types, including groundwater. Councils use data from the Environment Agency and their own assessments to understand groundwater levels and potential flood extents, as highlighted in updates for boroughs like Richmond upon Thames. London Boroughs are using updated SFRAs with advanced mapping and data to pinpoint groundwater risks, integrating this knowledge into policy to protect new developments and manage flood risk holistically.

Recommendation 6 – Reservoir Flood Risk

The reservoir flood risk in identified locations (see reservoir flood map) should be considered in Strategic Flood Risk Assessments (SFRAs) and Flood Risk Assessments (FRAs). Appropriate emergency plans should be put in place.

Progress against recommendation
Since 2018, London boroughs' SFRAs/FRAs have increasingly integrated reservoir flood risk, driven by the 2018 Regional Flood Risk Appraisal (RFRA) and updated guidance, focusing on site-specific analysis, climate change impacts (up to 2125), and managing residual risks, ensuring new developments use Sequential & Exception Tests and Sustainable Drainage (SuDS) for safer design, though detailed modelling for all risk types still evolves. Boroughs like City of London and Ealing conduct detailed site assessments, identifying infrastructure at risk and ensuring safe access/egress, incorporating reservoir failure scenarios alongside fluvial/tidal risks.

The London Resilience Partnership (LRP) has a Strategic Flood Response Framework (SFRF) for coordinated responses to major floods, including reservoir failures, using levels (1-4) for preparation to severe impact, linking to plans like the London Resilience Partnership Strategy (2025) and Drought Response, while concurrently, water companies (Thames, Southern, Affinity) are developing the South East Strategic Reservoir Option (SESRO), a new major water storage project (Abingdon area), recently reaching a key funding decision stage (Gate 3) with regulator Ofwat (the Water Services Regulation Authority) in late 2025 for water security. The Environment Agency is currently carrying out the Reservoir Safety Reform Programme.

Recommendation 7 – Flood Risk to Opportunity Areas and Town Centres

Where required, detailed flood risk assessments for individual major development locations and town centre development sites should be undertaken by developers at an early stage. They should work with relevant LLFA(s). Opportunities to reduce flood risk should be maximised where possible.

Progress against recommendation
Please refer to Chapter 4.8 for detailed information on the progress for specific Opportunity Areas.

Recommendation 8 – Flood Risk to Transport Infrastructure

Relevant transport authorities and operators should examine and regularly review their infrastructure assets including their networks, stations, depots, underpasses and tunnels for potential flooding locations and flood risk reduction measures.

Appropriate mitigation measures include flood warning systems, emergency procedures, sustainable drainage systems, temporary flood storage areas, pumping stations, back-up power supply and the relocation of sensitive electrical/telecommunications equipment and potentially polluting materials (e.g. fuel and oils) above potential flood levels.

For large stations and depots, solutions should be sought to attenuate or disperse rainwater from heavy storms including green roofs.

Highways flood management measures should also include diversionary routes, highways drainage attenuation and exceedance flow routing as part of traffic calming schemes.
For tunnel portals and ventilation shafts physical barriers such as flood gates and vent covers should be considered.

Progress against recommendation
London Underground is using the results of the London Underground Comprehensive Review of Flood Risk (LUCRFR) prepared in 2016 to prioritise more detailed site-specific analyses involving modelling of the principal flooding hazards (burst water mains and pluvial & sewers) followed by quantitative risk modelling and identification of the sites where risk reduction measures may be cost beneficial.

In 2024, TfL published its TfL Adaptation Reporting Power[104] submission, which focused on significant changes since the last report, highlighting new risks and progress in adaptation strategies, including green infrastructure and systemic resilience. The accompanying interdependencies project highlighted risks with surface water flooding and linked risks (potential for cascading failures) associated with the power grid and telecoms.

Recommendation 9 – Flood Risk to Emergency Services

Emergency service authorities and operators covering hospitals, ambulance, fire and police stations as well as prisons should ensure that emergency plans in particular for facilities in high flood risk areas are in place and regularly reviewed, so that they can cope in the event of a major flood. These plans should put in place cover arrangements through other suitable facilities. Emergency services should also consider flood protection and sustainable drainage and other measures to reduce flood risk to their sites in the longer term through the development planning process including site-specific Flood Risk Assessments.

Progress against recommendation
Since 2018, London's flood response has seen progress via better forecasting (Environment Agency/Met Office), improved multi-agency planning (Local Resilience Forums), investment in property resilience (£2.9m in 2018), protecting utilities, and focusing on long-term, catchment-based solutions, though challenges remain with integrating development, nature-based solutions, and sufficient funding for a truly strategic, integrated system. The London Fire Brigade spent £5.8m on floods since 2018 and advocates for more investment in climate resilience and tools.

Recommendation 10 – Flood Risk to Schools

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Education authorities should ensure that emergency plans in particular for facilities in flood risk areas are in place and regularly reviewed so that they can cope in the event of a major flood. These plans should put in place cover arrangements through other suitable facilities.
Education authorities should also consider flood protection and sustainable drainage and other measures to reduce flood risk to their sites in the longer term through the development planning process including site-specific Flood Risk Assessments.

Progress against recommendation
Since 2018, London's educational authorities, alongside wider government efforts, have focused on better flood risk integration into planning, developing strategic frameworks (like the GLA's Strategic Flood Response Framework), and improving multi-agency coordination (Flood Ready London), though specific progress for schools involves incorporating these into local planning and ensuring new developments meet strict flood resilience standards, with a shift towards proactive risk management and community involvement.

In 2022/23, the Mayor of London partnered with the Department for Education and Thames Water[105] to make up to 100 London schools more resilient to the impacts of climate change. Measures include improving water efficiency, reducing surface water flood risk, helping schools create climate adaptation plans and teaching children the importance of climate adaptation.

The Climate Resilient Schools project has targeted those most vulnerable to the impacts of climate change, prioritising the top 10 per cent of schools with highest surface water flood risk and that fall within the worst bands of the **Climate Risk Map**. Flooding can have a major impact on schools. In the summer of 2007, flooding in England resulted in widespread school closures that amounted to 400,000 lost pupil school days, at an estimated economic cost of £12m.

Recommendation 11 – Flood Risk to Utility Infrastructure

Operators of electricity, gas, water, sewerage, and waste utility sites should maintain an up-to-date assessment of the flood risk to their installations and, considering the likely impacts of failure, establish any necessary protection measures including flood warning, emergency procedures, sustainable drainage systems and secondary flood defences.

Progress against recommendation
Since 2018, UK utility operators, including those in London, have been driven by mandates like the Adaptation Reporting Power (ARP) to assess and report on climate risks, including flooding. This has led to better implementation of flood resilience measures, with key efforts focusing on updating national risk assessments (like NaFRA) and individual infrastructure. However, overall adaptation remains slow, and data gaps persist.

[105] https://www.london.gov.uk/programmes-strategies/environment-and-climate-change/climate-change/climate-adaptation/climate-resilient-schools

Appendix 5: Flood Risk Maps

Map 1a: Flood Risk in Greater London 2025
Map 1b: Flood Risk in Greater London 2025 - Climate Change Scenario
Map 2a: Opportunity Areas and Flood Risk 2025
Map 2b: Opportunity Areas and Flood Risk 2025 - Climate Change Scenario
Map 3a: Town Centres and Flood Risk 2025
Map 3b: Town Centres and Flood Risk 2025 - Climate Change Scenario
Map 4a: Mainline Rail Network and Flood Risk 2025
Map 4b: Mainline Rail Network and Flood Risk 2025 - Climate Change Scenario
Map 4c: Railway stations and Flood Risk 2025
Map 4d: Railway stations and Flood Risk 2025 - Climate Change Scenario
Map 5a: TfL Underground Network with Stations and Flood Risk 2025
Map 5b: TfL Underground Network with Stations and Flood Risk 2025 - Climate Change Scenario
Map 6a: TfL Road Network and Flood Risk 2025
Map 6b: TfL Road Network and Flood Risk 2025 - Climate Change Scenario
Map 7a: TfL Bus Depots with Bus Routes and Flood Risk 2025
Map 7b: TfL Bus Depots with Bus Routes and Flood Risk 2025 – Climate Change Scenario
Map 8a: Hospitals and Flood Risk 2025
Map 8b: Hospitals and Flood Risk 2025 - Climate Change Scenario
Map 9a: Emergency Services and Flood Risk 2025
Map 9b: Emergency Services and Flood Risk 2025 - Climate Change Scenario
Map 10a: Schools and Flood Risk 2025
Map 10b: Schools and Flood Risk 2025 - Climate Change Scenario
Map 11a: Utilities Infrastructure and Flood Risk 2025
Map 11b: Utilities Infrastructure and Flood Risk 2025 - Climate Change Scenario
Map 12a: Waste or Treatment Sites and Flood Risk 2025
Map 12b: Waste or Treatment Sites and Flood Risk 2025 - Climate Change Scenario
Map 13a: Basements and Flood Risk 2025
Map 13b: Basements and Flood Risk 2025 - Climate Change Scenario

Table 1a: Risk from Flooding by Borough 2025 – baseline
Table 1b: Risk from Flooding by Borough 2025 - climate change scenario
Table 2a: Critical Infrastructure at risk from flooding by source - baseline scenario, 2026
Table 2b: Critical Infrastructure at risk from flooding by source - climate change scenario, 2026