Surface Water Management Plan

Prepared for London Borough of Richmond Upon Thames

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EXECUTIVE SUMMARY

A Surface Water Management Plan (SWMP) is a document produced by Lead Local Flood Authorities (LLFAs), in this case the London Borough of Richmond (LB Richmond). It outlines the preferred methodology for managing the risk of flooding from local flood sources for a given area. A SWMP should influence future capital investment, drainage maintenance, public engagement and understanding, land use planning, emergency planning and future developments. A SWMP study is undertaken in consultation with key stakeholders and partners who are responsible for surface water management and drainage in their area. Engagement with stakeholders and partners encourages the development of innovative solutions and practices. More information can be found in *Section 1* of this document.

Predicted flood risks from all sources are summarised within *Section 2*. Within the SWMP Technical Guidance (DEFRA 2010) the main sources of flooding studied within a SWMP are identified. These include flooding from overland runoff, sewers, drains, groundwater, ordinary watercourses and ditches as a result of heavy rainfall:

- Sewer flooding occurs when the piped network (predominantly public sewers maintained by Thames Water) is no longer able to contain flows and starts spilling over into its immediate environment.
- Groundwater flooding occurs when the natural groundwater levels within aquifers rise to the surface. While groundwater levels are impacted by rainfall, they may not have instantaneous impacts upon watercourses.
- Surface water flooding describes flooding caused by overland runoff from short duration, high intensity storms causing the permeable land to quickly become saturated, preventing the water from infiltrating below ground or be drained through the existing drainage systems.

This new SWMP has a different structure to the 2011 SWMP to make the document more user friendly and the information easy to find, and adopts a different approach from the current Critical Drainage Areas (CDAs) and Local Flood Risk Zones. *Table A.1* provides information on six basins within which ten catchments have been defined, with more information available in *Section 3*. Two further catchments, BB_D4 and THLMP_E3 Tudor Drive, were identified outside of these Basins.

Table A.1 Basins and catchments

Code	Basin	Catchment No.	Code	Catchment	Cross-boundary Authority
A (Hounslow Basin C)	Hounslow Basin C – River Crane East	1	H5	Hounslow	LB Hounslow
		2	H6	Isleworth & North Twickenham	LB Hounslow
B	Thames River West	3	H10	Hanworth & South Twickenham	LB Hounslow
		4	R01	Hampton	
C	Thames River South – Richmond	5	R02	Kew	
		6	R03	North Sheen	
D	Thames River East	7	R04	Petersham	RB Kingston
E	Beverley Brook	8	R05	East Sheen	RB Kingston

Code	Basin	Catchment No.	Code	Catchment	Cross-boundary Authority
		9	R07/W02	Putney Heath	LBs Wandsworth & Merton
F	Thames River South & Beverley Brook	10	R06/W01	Putney	LB Wandsworth
N/A	N/A	11	BB_D4	Coombe	RB Kingston
	N/A	12	THLMP_E3	Tudor Drive	RB Kingston

Sections 4 to 15 of the new SWMP consists of information on each of the catchments. Each include the following:

- **Updates since the 2011 SWMP** – summary of any local flood risk modelling and / or investigative work carried out on any of the areas within the catchment.
- **Catchment extents** – a summary of local flood risks, general topography and a map of the catchment boundary.
- **Properties at risk** – the number of properties predicted to be at risk of surface water flooding within the catchment. See *Appendix A* - Methodology for properties at risk of surface water floodingfor more detail on the method used.
- **Historic flood records** – summary of any records of flooding incidents the LB Richmond holds and high-level comments about their alignment with the mapped predicted areas at risk of surface water flooding.
- **Hotspots** – defined using the Environment Agency's Risk of Flooding from Surface Water 1 in 100-year event dataset extents and a minimum of 15 residential properties predicted to be at risk of flooding.
- **Flood Incident Areas –** defined through evaluation of flood incident reports and are areas which have two or more flood incidents recorded within them.

Section 16 contains the description of the options proposed across the borough at hotspot level. Compared to 2011, the new SWMP proposes options at a hotspot level which replaces the previous CDA approach. Three types of options have been identified following the source-pathway-receptor method. **Source** options include swales, detention basins, or wetlands which could be used to attenuate small or large volumes of surface water upstream of catchments. **Pathway** options include improving maintenance regimes, managing overland flow through preferential flow paths, or de-culverting watercourses to provide flood mitigation along flood corridors. **Receptor** options include planning policies to influence development and social change, education and awareness, to propose mitigation through the end user's experience. Wherever possible, green, sustainable options have been identified.

An opportunity assessment has been carried out using a 'red amber green' (RAG) method. *Table 16-1* lists the different types of mitigation options assessed. The options proposed are initial attempts to identify potential opportunities to reduce surface water flood risk across the borough. The number of properties at risk in the 1 in 100-year return period was assessed for each Hotspot, which was subsequently given a risk level (Low, Medium, High):

- If the number of properties at risk in the 1 in 100-year return period are up to 30, a 'Low' risk has been assigned.

- If the number of properties at risk in the same return period are between 31 to 50 inclusive, a 'Medium' risk has been assigned.
- If the number is 51 or greater, a 'High' risk has been assigned.

This document has identified seven Hotspots from a total of 31 across the borough with a 'High' risk rating. From these, the seven Hotspots which have a 'High' risk rating (shown in *Table A-2*) have been shortlisted as being the greatest priority hotspots for the LB Richmond LLFA to investigate further.

Table A-2 Shortlisted high-risk Hotspots

Hotspot ID	Type	Number of properties at risk	Option Description
R01_03 (Refer to *Section 4* and *Figure 4-2*)	Source	162	Permeable paving in car parks. Rain gardens or planters implemented in footways. Residents encouraged to use rainwater harvesting. Retrofit flat roofs with green/blue roofs.
R06_W01_01 (Refer to *Section 9* and *Figure 9-2*)	Combination of source and pathway	134	Permeable paving in car parks. Planters or raingardens in footways. Encourage residents and business owners to use rainwater harvesting. Separation of foul and surface water sewers could also be implemented. Retrofit flat roofs with green/blue roofs.
R05_05 (Refer to *Section 8* and *Figure 8-2*)	Source	113	Rain gardens or swales in open areas. Rain gardens or planters in footways. Permeable paving in car parks. Encourage residents to use rainwater harvesting. Retrofit flat roofs with green/blue roofs.
R02_02 (Refer to *Section 5* and *Figure 5-2*)	Combination of source and pathway	98	Rain gardens, swales, wetlands, detention basins, ponds, or management of overland flow (online storage and preferential flow paths) in open areas. Rain gardens and planters in footways. Permeable paving in car parks. Encourage residents to use rainwater harvesting. Retrofit flat roofs with green/blue roofs.
H10_03 (Refer to *Section 12* and *Figure 12-2)*	Source	62	Permeable paving in car parks. Rain gardens or swales in open areas. Planters or raingardens in footways. Encourage residents to use rainwater harvesting. Retrofit flat roofs with green/blue roofs.
H10_01 (Refer to *Section 12* and *Figure 12-2)*	Source	59	Permeable paving in car parks. Planters or raingardens in footways. Encourage residents and business owners to use rainwater harvesting. Retrofit flat roofs with green/blue roofs.
R06_W01_02 (Refer to *Section 9* and *Figure 9-2*)	Source	53	Rain gardens or swales in open areas. Encourage residents to use rainwater harvesting. Retrofit flat roofs with green/blue roofs.

An action plan has been written as part of this SWMP to define activities recommended to take forward the findings of this SWMP, aligning to any associated LLFA requirements under the Flood and Water Management Act 2010. It sets out the tasks and priority ranking for managing surface water across the borough through the following timeframes: short term (1 – 2 years), medium term (2 – 5 years and long term (5 – 10 years). The authorities responsible for implementing actions, as well as

primary stakeholder support are clearly stated. A RAG progress tracker is displayed within the Action Plan. Green actions are those which LB Richmond have already implemented and they will continue to implement these. Amber actions are those which LB Richmond are planning to carry out, and red actions are those which are not currently in progress. The full action plan is included within *Appendix C* – Action PlanThe SWMP action plan should be reviewed and updated every two or three years to capture updates, for example investigatory works being carried out or changes occurring which may influence the surface water flood risk within Richmond. It should also be used during future updates of the LB Richmond LLFA's Local Flood Risk Management Strategy to underpin future work programmes and overarching aims and objectives.

Sections 17 and 18 detail the recommendations and conclusions from the new SWMP. The recommendations propose that standalone feasibility studies are carried out for the Catchments containing the shortlisted Hotspots, in order of risk ranking. The next steps for these studies are as follows:

1. Use the outputs of this new SWMP (prioritised Catchment and Hotspot information) to create sub-Catchments (where necessary for individual Hotspots to enable inclusion of the contributing and benefitting areas).
2. Gather further information about significant recorded flood incidents and validate against predicted surface water flood risks extents.
3. Identify potential benefactors and constraints.
4. Conduct locally-specific long-list and short-listing exercises to identify potential mitigation options.
5. Determine the feasibility of each potential mitigation option using a multi-criteria decision matrix.
6. Conduct an economic appraisal for the options identified for each Catchment through cost benefit analysis. This should include identification of flood and non-flood risk related benefits, flood damage calculations, and consideration of whole life costs. This should also define the benefitting area and identify the volume of surface water that could be stored in a 1 in 30-year surface water flood event for each option.
7. Use the results of the economic appraisal to revise the current risk rating for each Catchment. The options with the highest refined rating which are shown to be feasible could then be prioritised for further detailed investigation.
8. Options which are prioritised for further detailed investigation should undergo detailed modelling and a business case should be prepared and submitted to determine potential for continuation through detailed design to construction.

Additional recommendations identified through this SWMP include:

- The LB Richmond LLFA should continue to work with neighbouring boroughs, building on engagement made during this SWMP, where catchments overlap political boundaries to manage the flood risks holistically.
- Ensure that flood incidents are recorded consistently and accurately and conduct investigations of repeat or significant flood incidents which have occurred in Hotspots and Flood Incident Areas.
- Conduct regular maintenance of gullies and drains, prioritising those within Hotspots or Flood Incident Areas.

- Liaise with Richmond's Planning team to ensure that new developments incorporate rainwater harvesting and green blue infrastructure, particularly within Hotspots or Flood Incident Areas.
- Liaise with Richmond's Climate Change Group (within the Communications team) and contribute to projects which help to reduce the impacts of climate change, reduce carbon emissions and work to becoming carbon neutral, in line with Richmond's Climate Emergency Strategy.

Along with the main and additional recommendations, it is advised that this document is updated as significant work in reducing flood risk is completed and / or when significant improvements in the knowledge and understanding of local flood risks are identified.

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ACRONYMS AND ABBREVIATIONS

Abbreviation	Definition
CDA	Critical Drainage Area
CFMP	Catchment Flood Management Plan
DEFRA	Department for Environment, Food and Rural Affairs
DTM	Digital Terrain Model
EA	Environment Agency
FRMP	Flood Risk Management Plan
FRR	Flood Risk Regulations
FWMA	Flood and Water Management Act
GLA	Greater London Authority
LB Hammersmith & Fulham	London Borough of Hammersmith and Fulham
LB Hounslow	London Borough of Hounslow
LB Richmond	London Borough of Richmond upon Thames
LB Wandsworth	London Borough of Wandsworth
LFRMS	Local Flood Risk Management Strategy
LLFA	Lead Local Flood Authority
PFRA	Preliminary Flood Risk Assessment
RB Kingston	Royal Borough of Kingston upon Thames
RFRA	Regional Flood Risk Appraisal
RoFSW	Risk of Flooding from Surface Water
SFRA	Strategic Flood Risk Assessment
Surrey CC	Surrey County Council
SWMP	Surface Water Management Plan
TfL	Transport for London
TWUL	Thames Water Utilities Limited

1 INTRODUCTION

1.1 Introduction to the SWMP

1.1.1 What is a Surface Water Management Plan?

A Surface Water Management Plan (SWMP) is produced by the Lead Local Flood Authority (LLFA), in this case the London Borough of Richmond upon Thames (LB Richmond). A SWMP sets out how flood risk from various sources will be managed within a given area. It should influence future capital investment, drainage maintenance, public engagement and understanding, land use planning, emergency planning and future development.

The benefits of undertaking a SWMP study are as follows:

- Increased understanding of the causes, probability, and consequences of surface water flooding.
- Spatial and emergency planning functions can be informed by increased understanding of where surface water flooding will occur.
- Partners and stakeholders are identified to enable the establishment of co-ordinated plans to tackle surface water flooding.
- Opportunities to implement Sustainable Drainage Systems (SuDS) to manage surface water flood risk are identified.
- An action plan can be generated based on information on surface water flood risk and potential flood mitigation options gathered as part of the SWMP study.

The SWMP acts in alignment with the LB Richmond Local Flood Risk Management Strategy (LFRMS), which considers key legislation and industry drivers. This new SWMP will replace the previous SWMP delivered as part of the Tier 2 package of works of the Drain London Project in 2011. The SWMP has been updated to ensure that it captures the most up to date flood risk mapping, as well as information on properties and infrastructure at risk and potential flood alleviation schemes. GIS analysis was used to create drainage Basins and surface water Catchments, within which localised areas of flood risk have been identified, referred to as Hotspots and Flood Incident Areas (*Section 3.3)*. Potential borough-wide mitigation options have also been identified and updated stakeholder engagement and action plans have been produced.

1.1.2 SWMP process

The framework for undertaking a SWMP is illustrated through the Department for Environment, Food and Rural Affairs' (DEFRA) SWMP process wheel diagram (*Figure 1-1*). It has four main phases: **Preparation; Risk Assessment; Options; and Implementation and Review**. The first three phases involve planning and creating the SWMP report, and the fourth phase involves producing and implementing an action plan based on information gathered in the SWMP report. It is based on a widely adopted generic approach to evidence and risk-based decision making which is outlined in the SWMP technical guidance (DEFRA, 2010).

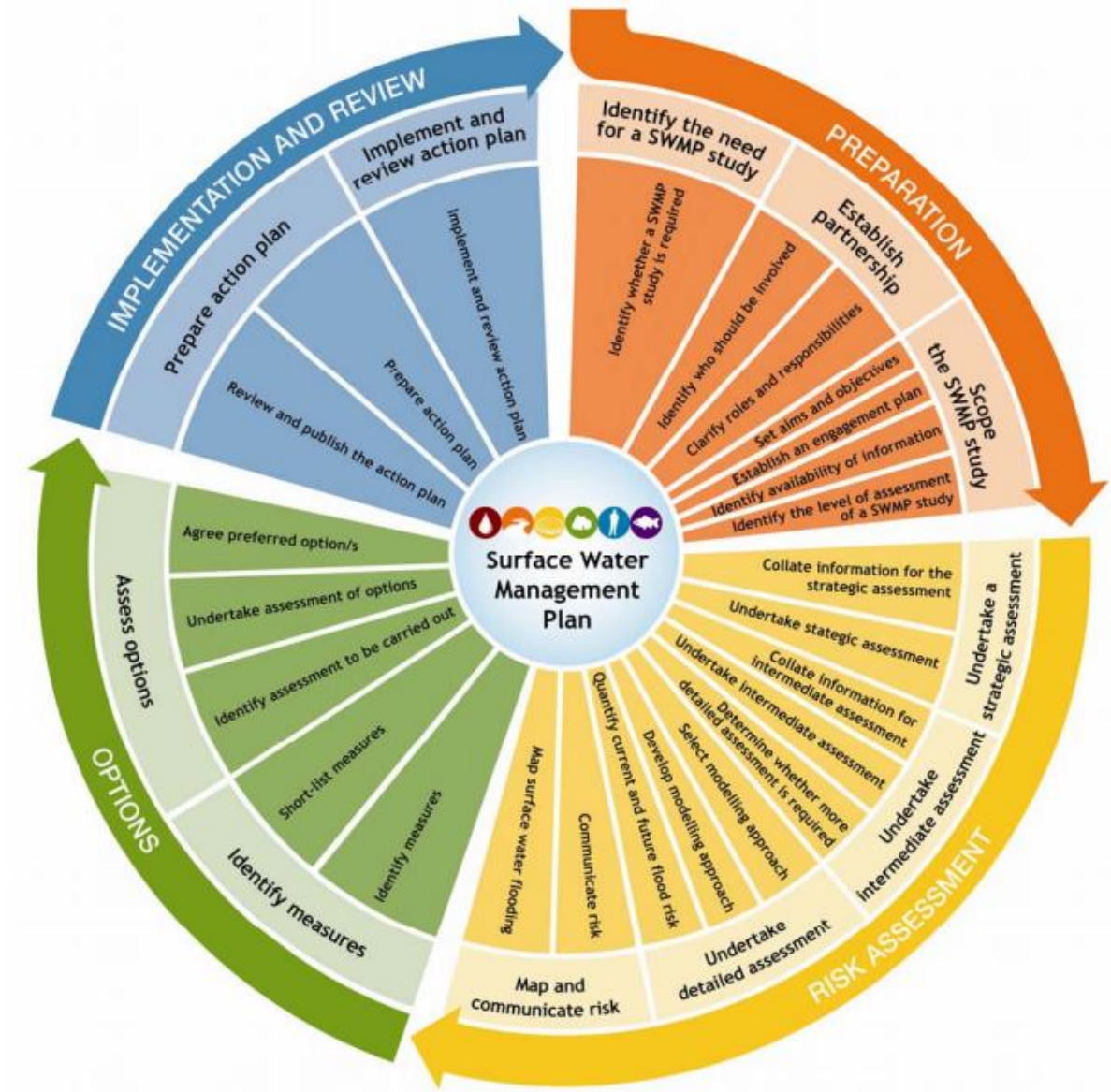

Figure 1-1 Recommended SWMP process (DEFRA, 2010)

1.1.3 Objectives

This SWMP has the following objectives:

- Apply the most appropriate guidance and include the most relevant information from the existing 2011 SWMP, signposting other strategic and guidance-based documents at local, regional and national levels.
- Apply a similar approach to neighbouring Local Authorities to help develop cross-boundary authority collaboration on future projects.

- Provide a new structure to make the document more user friendly for the end user.
- Include up-to-date information about at-risk properties and infrastructure.
- Identify Hotspots at a surface water Catchment level.
- Identify Flood Incident Areas using historic reports of flooding and local knowledge.
- Set out a plan for managing surface water at a borough-wide level.
- Provide guidance on how different partners and stakeholders will need to be involved to successfully deliver the SWMP's Action Plan.
- Enable engagement with key partners and stakeholders on developing an effective and achievable Action Plan for managing surface water flood risks.

1.1.4 LLFA responsibilities

The Flood and Water Management Act (FWMA) 2010 and the Flood Risk Regulations (FRR) 2009 set out responsibilities and statutory duties belonging to LLFAs. The role of LLFAs is to prepare and maintain a strategy for managing local flood risk. They must coordinate with other Risk Management Authorities (RMAs) and the public to deliver area-wide benefits and reduce the risk of flooding. The SWMP enables the LLFA to carry out their responsibilities by proposing potential mitigation measures and an Action Plan to reduce flood risk in the area, as well as suggesting methods for working collaboratively with partners and stakeholders.

Working collaboratively will also help LB Richmond apply guidance from the recently published 2021 update of the National Flood and Coastal Erosion Risk Management Strategy Action Plan. This outlines that LLFAs must do more to engage with communities to help reduce the risk of flooding through improving resilience. Engaging with LB Richmond's local community is key in further reducing the risk of flooding, and will help deliver additional social, economic, and environmental benefits to the borough. This SWMP proposes appropriate measures in the mitigation options and Action Plan to achieve this objective.

1.1.5 Links to other plans

Local Flood Risk Management Strategy (LFRMS) 2015:
The FWMA 2010 requires each LLFA to produce a LFRMS to assess the local flood risk, set out objectives for managing it, define the costs and benefits of the proposed measures, and how the measures are proposed to be paid for. LB Richmond is currently updating its LFRMS. The new SWMP will act in alignment with the LFRMS and be used as an evidence base to deliver more flood investigation and option assessments into areas identified to be at risk, subject to available resources.

Preliminary Flood Risk Assessment (PFRA) 2011 and addendum in 2017:
PFRAs are required as part of the FRR 2009 which implement the requirements of the European Parliament Floods Directive (2007). Originally produced for each London Borough LLFA as part of Tier 1 of the Drain London Project, it gives an overview of all local sources of flood risk. The information gathered for this SWMP will benefit future revisions of the PFRA document.

Regional Flood Risk Appraisal (RFRA) 2018:

The RFRA is produced by the Greater London Authority and gives a regional overview of flooding from all sources.

Strategic Flood Risk Assessment (SFRA) 2020:

The SFRA assesses flood risk from all sources in the present and future, considering the impact of climate change. The SFRA is designed to help address local requirements, manage development requirements, and manage the risk of flooding posed to residents and property from all sources.

Thames Catchment Flood Management Plan (CFMP) 2009:

Published by the Environment Agency (EA), the CRMP sets out policies for the sustainable management of flood risk across the whole Thames Catchment over the next 50 to 100 years, taking climate change into account. The CFMP emphasises the role of the floodplain as an important asset for the management of flood risk and the need to re-create river corridors so that rivers can flow and flood more naturally.

Thames River Basin District Flood Risk Management Plan (FRMP) 2015 – 2021 and 2021 - 2027:

The Thames River Basin District FRMP sets out the risk of flooding from all sources within the London Flood Risk Area and how RMAs will manage flood and coastal risk over a six-year period. The FRMP sets out specific objectives and measures for RMAs which aim to prevent risk within the Thames River Basin District. LB Richmond LLFA holds a list of these objectives and measures.

The second cycle of the Thames River Basin District FRMP was in consultation phase during the formation of this report. A draft copy of the document was evaluated by LB Richmond LLFA and its content has informed the proposed measures and Action Plan within this report.

Thames Estuary 2100 Plan (TE2100) 2011 and review in 2021:

The TE2100 plan sets out how the tidal flood risk will be managed in the Thames Estuary until 2100. This document is produced by the Environment Agency and looks at how they will protect 1.4 million people and around £320 billion worth of property from tidal flood risk. The River Thames is tidal until Teddington Lock in LB Richmond, so these plans directly influence LB Richmond.

1.1.6 Links to climate change

Surface water management practices identified throughout the SWMP and Action Plan contribute to increasing the borough's resilience to climate change. The frequency and intensity of rainfall events is predicted to change as the climate changes. It is predicted by the International Panel on Climate Change that there will be an increase in the intensity and frequency of precipitation events as the climate warms. This results in greater potential for surface water flooding as explained further in *Section 2.3.2*. Therefore, any measures to reduce the risk of surface water flooding will increase the boroughs resilience to this potential effect from climate change.

1.2 Document overview

1.2.1 Structure

The 2011 SWMP was delivered as part of Tier 2 of the Drain London Project. The structure of the 2011 SWMP followed the four-phase approach as set out in DEFRAs SWMP Technical Guidance and discussed in *Section 1.1.2* (*Figure 1-1*).

Each Catchment section and its figures have been retained within the main body of the report to limit the number of appendices and ensure that the document is user-friendly.

This SWMP adopts a different approach to the previous SWMP because it uses a Basin and Catchment-based approach rather than establishing Critical Drainage Areas (CDAs). Hydrological analysis of the borough and surrounding areas was undertaken using a digital terrain model (DTM) and watercourse information to define surface water Basins. These Basins were split into smaller Catchments using the existing sewer infrastructure, watercourses and overland features such as railway tracks. Flood Hotspots and Flood Incident Areas have been defined within these Catchments. More information about the new Basin (and Catchment)-based approach is available in *Section 2.1*. A comparison of the contents of the 2011 SWMP and 2021 SWMP can be found in *Table 1-1.*

Table 1-1 Comparison of the 2011 and the new SWMP structures

DEFRA SWMP Process	Relevant section in:	
	2011 SWMP	New SWMP
Preparation	Section 2: Phase 1 Preparation	Section 1.2: Document overview Section 1.4: Stakeholder engagement Section 3: Basin-based approach
Risk Assessment	Section 3: Phase 2 Risk Assessment	Section 2: Flood risk overview Sections 4-15: Catchment-specific risk
Options	Section 4: Phase 3 Options	Section 16: Borough-wide Options and Action Plan
Implementation and Review	Section 5 Phase 4 Implementation and Review	Section 17: Recommendations

Sections 4 to 15 of this document contain Catchment sections which provide information on each of the newly identified Catchments. The following is included in each Catchment section:

- **Updates since the 2011 SWMP** – a summary of previous CDAs and any changes in the Catchment, including any local flood risk modelling that has been carried out within the Catchment.
- **Catchment Extents** – a summary of the physical Catchment including topography, key infrastructure, surface water overland flow paths and other notable features.
- **Properties at risk and Hotspots** – the number of properties predicted to be at risk for 1 in 30-year, 100-year and 1000-year events according to the EA's "Properties at Risk of Flooding from Surface Water" mapping. Information about flood Hotspot areas defined

using the EA's Risk of Flooding from Surface Water (RoFSW) mapping, particularly the 1 in 100-year event extents and a minimum of 15 residential properties predicted to be at risk of flooding, is included.

- **Historic flood records and Flood Incident Areas** – a summary of any surface water flood incidents held by the LB Richmond and Thames Water Utilities Limited (TWUL). Information about Flood Incident Areas defined through the evaluation of flood incident reports and local knowledge is included. These areas were created with input from LB Richmond's LLFA team, councillors, and Highways maintenance officers. They are defined as areas which have two or more flood incidents recorded within them.

Section 16 summarises potential borough-wide flood mitigation options that have been identified. These options are aligned to the source-pathway-receptor model of risk mitigation. It also contains an Action Plan covering the next ten years for local flood risk management. A stakeholder engagement plan is also provided which identifies priority stakeholders that could aid the delivery of the SWMP Action Plan and high-level mitigation options.

1.2.2 Relevant Projects

Since the 2011 SWMP, several projects have been undertaken to tackle surface water flooding in Richmond. There are also some projects currently underway.

In 2016, consultants were commissioned by LB Richmond to complete a detailed flood management study to review factors causing surface water flooding in the borough and identify solutions to reduce flood risk. The assessment consisted of two elements. The first part investigated potential flood alleviation measures for specific flooding issues at eight locations in the borough. Preferred solutions were then developed into outline designs. The second part of the assessment involved a review of potential flood alleviation options identified within the seven CDAs defined in the 2011 SWMP. It provided an in-depth analysis of the short-listed options which could be taken forward and developed into flood alleviation schemes. LB Richmond have secured funding to progress with flood alleviation schemes in the following CDAs identified in the 2011 SWMP:

- CDA 3 Strawberry Hill, and
- CDA 6 Teddington

LB Richmond currently have ongoing projects in Strawberry Vale and Marlow Crescent which are investigating the potential for SuDS installation at these locations. LB Richmond have also secured up to £6 million funding to deliver flood resilience through innovative actions in the Beverley Brook river catchment over a six-year delivery period (2021-2026). LB Richmond aims to improve resilience to flooding through this project using a blend of nature-based solutions and integrated water management measures, working cooperatively with a wide range of partners and stakeholders to achieve this.

1.3 Data overview

The data used to produce the new SWMP was obtained from relevant authorities and stakeholders. Key stakeholders within LB Richmond and external stakeholders such as TWUL were approached to contribute data. Freely available data was also obtained for the project. Knowledge from past LLFA

projects and programmes aided this data collection. The data sources used for this SWMP are listed in *Table 1-2.*

Table 1-2 Data Sources

Source	Data	Use in SWMP
British Geological Survey (BGS)	Geological Map	To understand and map the geological context
	Groundwater Flooding Susceptibility	To understand and map the flood risk from groundwater
DEFRA	LIDAR Composite DTM 2019 – 2m	To understand and map the topographical context
EA	Detailed River Network	To understand and map the fluvial context
	Properties at Risk of Flooding for the 1 in 30, 1 in 100 and 1 in 100-year return periods (2014)	To understand and map flood risk from multiple sources
	RoFSW Flood Extent 1 in 30, 1 in 100 and 1 in 1000 years (2020)	
	Flood Map for Planning Rivers and Seas Zones 2 and 3 (2020)	
	Recorded Flood Outlines (2020)	
	Reservoir Flooding Max Depth-WMS	
LB Richmond	Richmond Flood Incident Data	To understand and visually represent the flood risk as well as validate the EA's RoFSW data
	Local Authority Administrative Boundaries	For representation in mapping
	2011 SWMP CDA dataset	As comparative basis for new Catchments and Hotspots
	Asset Register	As comparative basis for SWMP mapping
	Open-Source Sites by Land Use	To understand and map the land use context
Thames Water	Drainage Asset Data	To understand the sewer network and define the Basins and Catchments
	Sewer Flooding Incident Data (at district level post code only)	To understand and map the flood risk from sewers

1.4 Stakeholder engagement

The delivery of this SWMP has been made possible through the active involvement and collaboration of stakeholders. Relevant stakeholders and their involvement in the SWMP are summarised in *Table 1-3.*

Table 1-3 Stakeholders List

Stakeholder	Involvement
LB Richmond departments	
LLFA	• Acted as main liaison throughout the formation of the SWMP document. • Attended a stakeholder engagement meeting which outlined the reasons for updating the SWMP, delivery approach, proposed draft structure and programme. • Attended a stakeholder engagement meeting to review the new Basins and Catchments created and to ensure that known areas of flood risk are being captured and represented correctly. • Provided information on proposed and ongoing schemes since 2011 for incorporation into relevant Basin and Catchment sections. • Provided relevant datasets listed in *Table 1-2*.
Highways	• Attended a stakeholder engagement meeting which outlined the reasons for updating the SWMP, delivery approach, proposed draft structure and programme.
Parks and Open Spaces	• Attended a stakeholder engagement meeting which outlined the reasons for updating the SWMP, delivery approach, proposed draft structure and programme.
Environmental Services	• Invited to a stakeholder engagement meeting which outlined the reasons for updating the SWMP, delivery approach, proposed draft structure and programme.
Development Management	• Invited to a stakeholder engagement meeting which outlined the reasons for updating the SWMP, delivery approach, proposed draft structure and programme.
Transport	• Invited to a stakeholder engagement meeting which outlined the reasons for updating the SWMP, delivery approach, proposed draft structure and programme.
Key Organisations	
EA	• Provided relevant datasets listed in *Table 1-2*. • Provided information on proposed and ongoing schemes since 2011 for inclusion in. relevant Basin and Catchment sections.
TWUL	• Provided relevant datasets listed in *Table 1-2*. • Provided information on proposed and ongoing schemes since 2011 for inclusion in relevant Basin and Catchment sections.
Cross-boundary boroughs	
LB Hammersmith & Fulham	• Engaged to review the new Catchments and Basins created and to ensure that known areas of flood risk are being captured and represented correctly.
LB Hounslow LLFA	• Engaged to review the new Catchments and Basins created and to ensure that known areas of flood risk are being captured and represented correctly.
RB Kingston LLFA	• Engaged to review the new Catchments and Basins created and to ensure that known areas of flood risk are being captured and represented correctly.

2 FLOOD RISK OVERVIEW

2.1 Borough overview

2.1.1 Characteristics

Located in west London, the LB Richmond is the only London borough to bisect the River Thames. It is bounded by LB Hounslow to the northwest, LB Hammersmith & Fulham to the north, LB Wandsworth to the east and RB Kingston to the southeast. The River Thames lies on its southern boundary where the borough borders Elmbridge within Surrey County Council (Surrey CC).

Elevations peak on the western boundary of the borough in the vicinity of Whitton, where levels reach approximately 16mAOD to 18mAOD; they then fall to the River Thames floodplain in Strawberry Hill and Hampton Wick to the east. In the east of the borough elevations are highest around Richmond Park and Richmond town centre, resulting in some steep slopes that can form flow paths for surface water runoff. These topographical features are shown in *Figure 2-1*.

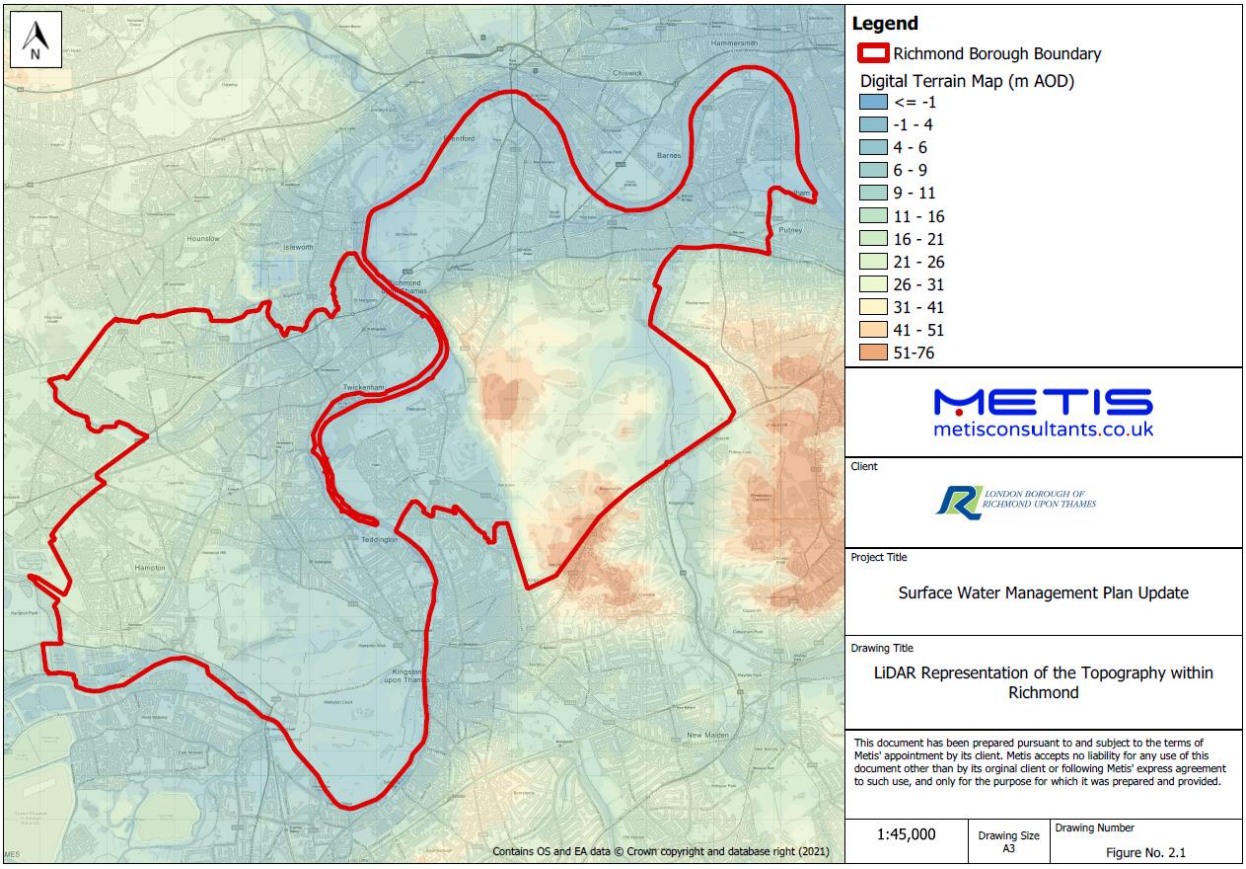

Figure 2-1 LiDAR representation of the topography in LB Richmond

The borough contains the following significant infrastructure and amenity areas:

- Network Rail (South Western Railway line), London Underground (District Line) and London Overground railway lines cross the borough, with a multitude of associated Railway Stations and maintenance assets.
- The main town centre is Richmond; there are four district centres at East Sheen, Teddington, Twickenham, and Whitton as well as many smaller centres.
- The borough is characterised by large open spaces such as Richmond Park in the east of the borough, Bushy Park in the southwest of the borough and Kew Gardens in the north.
- Aside from the large parks, the borough is made up of urban areas as well as the Wildfowl and Wetlands Trust (WWT)'s London Wetlands Centre in Barnes *(Figure 2-2).*
- There are sixteen A-roads passing through LB Richmond which connect the borough to central London and wider southeast England.

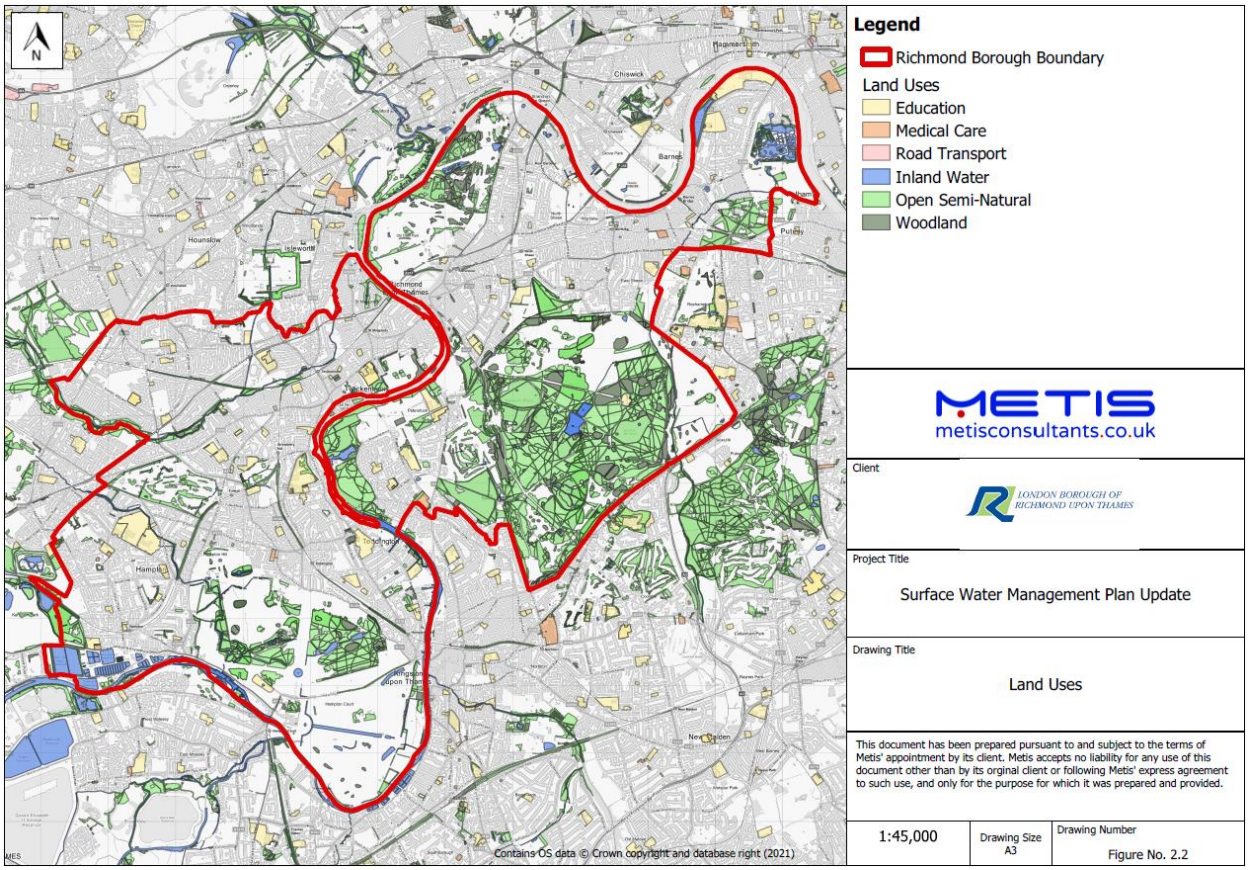

Figure 2-2 Land Uses in LB Richmond

2.1.2 Interactions with Neighbouring Local Authorities

The South West London Strategic Flood Group was set up during the creation of the 2011 SWMPs by Drain London. It includes the LBs of Croydon, Merton, Richmond Upon Thames, Sutton, Wandsworth, and RB Kingston. The South West London Strategic Flood Group reports to the Thames Regional Flood and Coastal Committee through a representative Councillor for the sub-region (currently from LB Richmond). It has met every three months since March 2011 and

continues with the aim of ensuring collaborative working across the boroughs and relevant stakeholders.

2.1.3 Flooding interactions

DEFRA's 2010 guidance on SWMPs identifies the main sources of flooding to be studied within a SWMP, which include surface water runoff, groundwater, sewers, open-channel and culverted watercourses, and overland flows from groundwater.

Surface water flooding, also known as pluvial flooding, generally describes runoff and flooding caused by high intensity rainfall. The high intensity rainfall often leads to permeable land quickly becoming saturated. As a result, the water is unable to infiltrate below ground or be drained through the existing drainage systems which may be at capacity. In urban areas such as much of LB Richmond, the majority of the land is impermeable meaning the water cannot infiltrate into the ground and can quickly overwhelms the existing drainage system. Surface water flood incidents typically affect localised low-lying areas, and it is not uncommon for groundwater or sewer flood incidents to be mistaken for surface water, due to the numerous and complex interactions between natural and manmade drainage networks.

Sewer flooding occurs when the capacity of the network is exceeded due to heavy rainfall, resulting in flows spilling over into the immediate environment. Surface water sewers can be affected by high water levels in the receiving watercourse because hydraulic pressure from the river prevents outlet flaps from releasing the surface water runoff. This can cause surface water to back up and cause flooding by overwhelming the drainage network.

Groundwater flooding occurs when the natural groundwater levels within aquifers rise to the surface. This may lead to the flooding of areas that are normally dry, particularly during periods of persistent rainfall. Groundwater levels are impacted by rainfall but may not have instantaneous impact upon watercourses.

2.2 Fluvial flood risk

A watercourse will be categorized as either a main river or an ordinary watercourse based on its local and hydrological importance. The flood risk from main rivers is termed 'fluvial' and may have the potential to cause high levels of damage or a wide impact. The FWMA 2010 defines any watercourse that is not a main river, as an ordinary watercourse, including ditches, dykes, and drains but excluding public sewers. Flood risk from ordinary watercourses falls under surface water flooding. The EA has duties, powers and responsibility in relation to main rivers while Local Authorities have rights and responsibilities relating to ordinary watercourses and maintains spatial information on them. The flood risk from ordinary watercourses is covered in *Section 2.3.1*.

The main rivers in LB Richmond include:

- The River Thames which runs through the centre of the borough, extending from Hampton to Barnes. It is tidal downstream of Teddington Lock.
- The River Crane which is situated in the west of the borough, north of the River Thames. It flows east through the borough and joins the River Thames in St Margarets.

- The Beverley Brook which is situated south of the River Thames and flows northwards, along the borough boundary with the LB Wandsworth, before its confluence with the River Thames at Barn Elms.

The fluvial Flood Zones are areas predicted to be at risk from river flooding. In the borough, areas within Flood Zone 2 are predicted to have between a 1 in 100 and 1 in 1,000 annual probability of river flooding; or land having between a 1 in 200 and 1 in 1,000 annual probability of sea flooding. Areas within Flood Zone 3 are predicted to be at a 1 in 100 or greater annual probability of river flooding; or Land having a 1 in 200 or greater annual probability of sea flooding. *Figure 2-3* identifies the main rivers in the borough and more information can be found in *Section 5.2* of LB Richmond's Level 1 Strategic Flood Risk Assessment (SFRA).

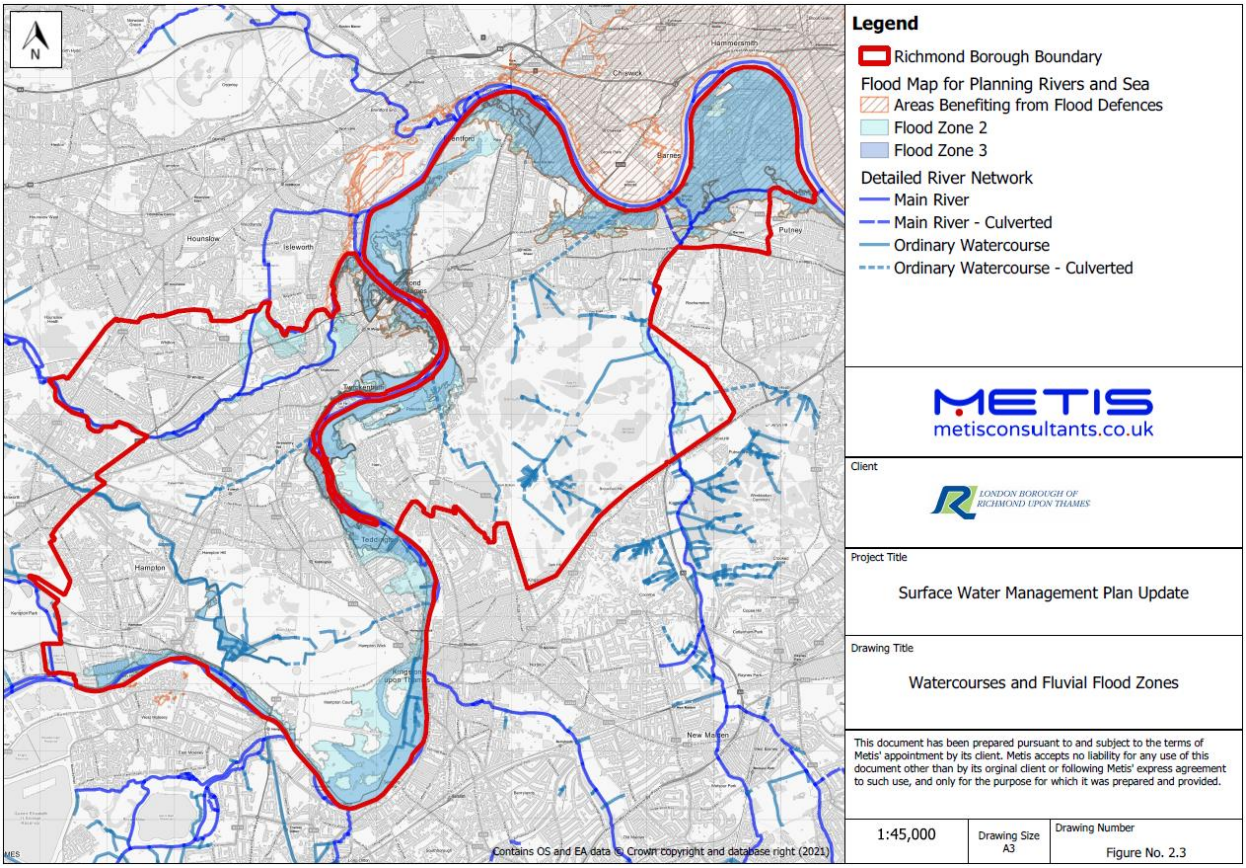

Figure 2-3 Watercourses and Fluvial Flood Zones

2.3 Surface Water flood risk

2.3.1 Ordinary Watercourse Flooding

An ordinary watercourse is defined in the Land Drainage Act 1991 as a watercourse that does not form part of a main river. Similar to main rivers, ordinary watercourses flood when the capacity of the channel is exceeded, causing the water level to over-top its banks and into adjacent land. They are typically faster responding watercourses with rainfall playing a big part in controlling water depths. There are several ordinary watercourses in Richmond which are tributaries to the main

rivers identified in *Section 2.2*. Flood risk from ordinary watercourses is included in the EA's RoFSW maps (*Figure 2-4*).

2.3.2 Surface Water Flooding

Surface water flooding occurs in areas when short duration, intense rainfall cannot infiltrate below ground or enter drainage systems, and consequently runs overland. It is further intensified when soils are saturated, or in urban areas with impermeable ground. The excess water can pond at local low points and often form flow pathways along roads, built up areas or open spaces. The volume and rate of surface water runoff in an area can increase based on the extent of impermeable surfaces such as roads and car parks.

Surface water flooding is much flashier than fluvial flooding (i.e. occurs sooner and quicker) due to the impermeable urban environment, which prevents water from draining into the ground. High magnitude, short duration rainfalls are typical in the summer, and these can cause rapid flooding. Flooding often occurs around gullies and sewers which can become blocked or reach capacity. Surface water flooding tends to have less serious consequences compared to other forms of flooding, such as fluvial flooding, due to its short duration. However, it can still cause significant local damage and disruption particularly in sudden, intense rainfall events.

The EA RoFSW dataset is based upon national-scale modelling to identify surface water flood risk areas. This is based upon topography and a catchment-based rainfall loss estimation. The RoFSW extents have been used in this SWMP to validate the flood incident records at a Catchment-wide scale, and these incidents are displayed alongside the EA's RoFSW within *Figure 2-4*.

More information on flood risk from surface water and ordinary watercourses can be found in Section 5.4 of LB Richmond's Level 1 SFRA.

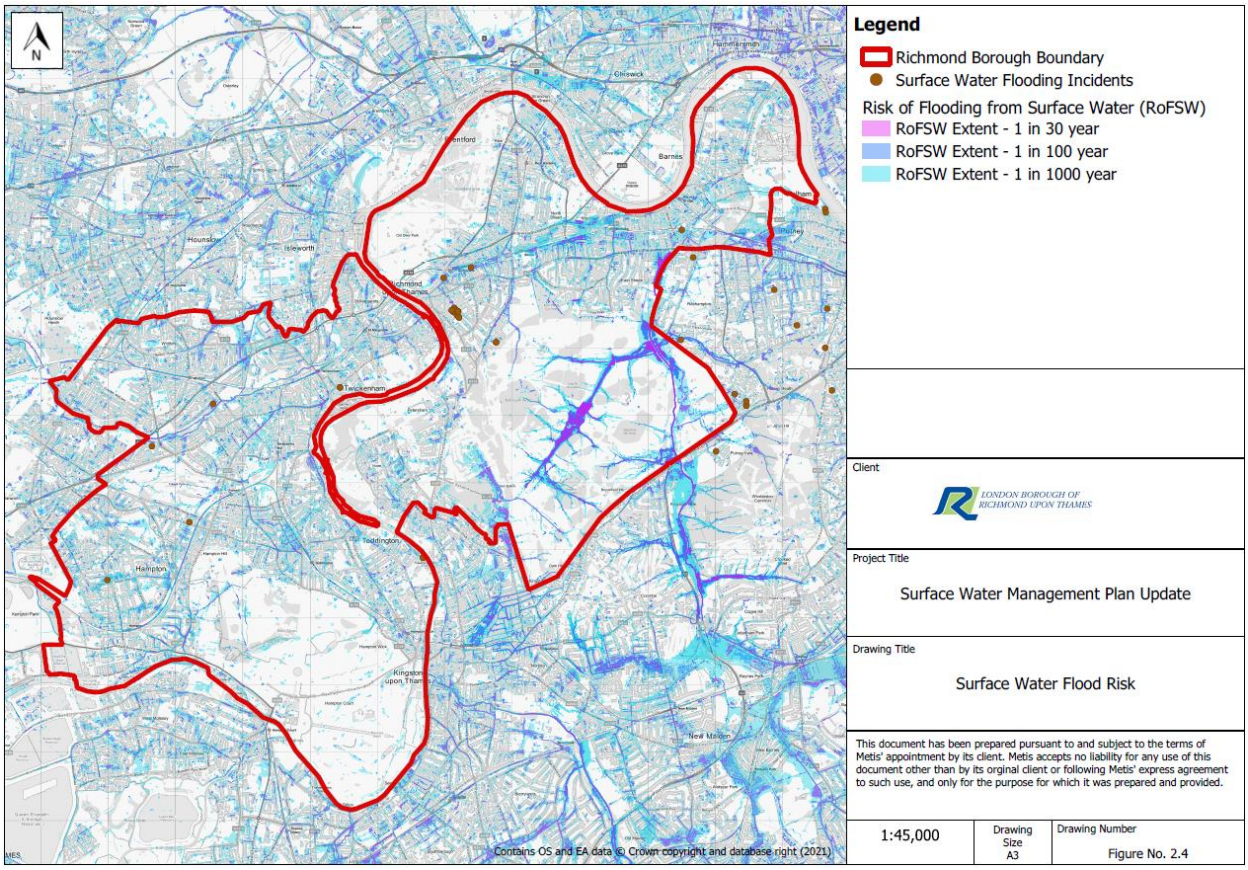

Figure 2-4 Surface Water Flood Risk

2.4 Groundwater flood risk

Groundwater flooding is caused when water from sub-surface permeable strata emerges above ground. It is dependent on local variations in topography and geology, and generally stems from a rise in groundwater level which then inundates low-lying land. Groundwater flooding usually develops over long periods, with its effects potentially lasting weeks or months. It can be difficult to immediately differentiate groundwater flooding from other sources such as surface water or sewer flooding, and local groundwater levels can also impact on the levels within watercourses.

The bedrock geology for LB Richmond is Thames Group comprising clay, sand, silt and gravel. This rock type has low hydraulic conductivity (poor drainage). As a result, ponding can occur where permeable strata are located uphill of areas underlain by Thames Group compromising clay. The superficial geology consists of a range of river terrace deposits, including alluvium deposits below main rivers, Black Park Gravel Member, Boyn Hill Gravel Member, Kempton Park Gravel Member and Taplow Gravel Member, which are all comprised of sand and gravel. The Langley Silt Member is also present and is comprised of clay and silt. The geology of LB Richmond can be seen in *Figure 2-5*.

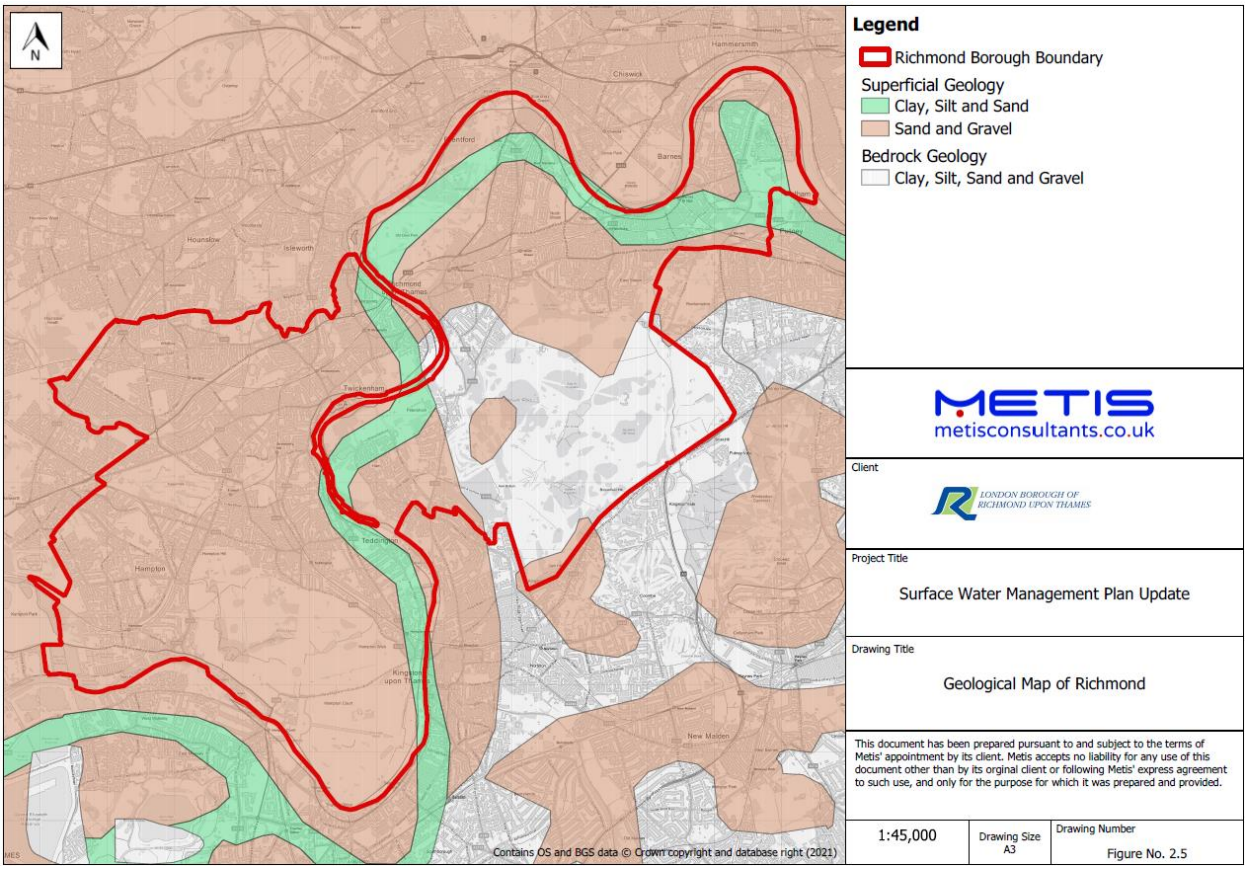

Figure 2-5 Geological Map of Richmond

Areas susceptible to groundwater flooding include the northeast of the borough around Sheen and Barnes, and parts of the borough located west of the River Thames including Teddington, St Margarets and Whitton (*Figure 2-6*). Further information on groundwater flood risk and geology can be found in *Section 5.6* of Richmond's Level 1 SFRA.

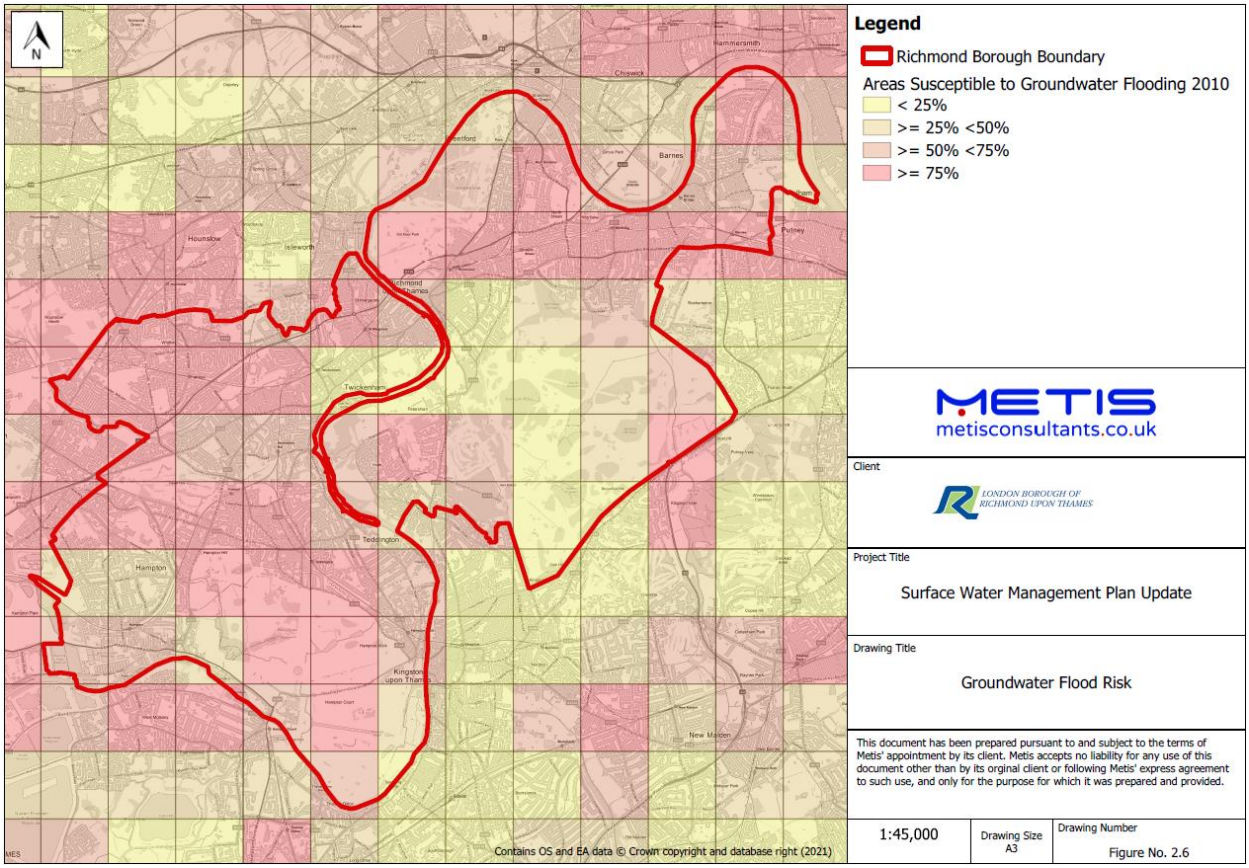

Figure 2-6 Groundwater Flood Risk

2.5 Sewer flood risk

Sewer flooding occurs when the volume of rainfall entering the sewer network is too large to be contained. A lack of capacity in the sewer networks may be due to:

- An increase in flow (such as climate change impacts on rainfall and/or new developments);
- Having to sustain events larger than the system-designed event;
- The failure of key infrastructure such as pumps or valves;
- A watercourse having been culverted or incorporated into the drainage network;
- A lack of maintenance which can sometimes lead to total blockage;
- Groundwater infiltration into pipe networks in poor condition; and
- Limited outflow from the sewer network due to high water levels in receiving watercourses.

The impact of sewer flooding is usually restricted locally but can be rapid and unpredictable. Flood waters from sewers are also often contaminated with sewage which can be harmful to health.

In LB Richmond, wastewater sewerage is serviced by TWUL. Foul and surface water drainage are mostly separated within the sewer system. Some areas, particularly in the centre of the borough around Richmond-upon-Thames town, use an older combined system in which foul sewage and surface water are drained through the same pipes. The sewer system and associated infrastructure is

dated and not built to withstand high intensity rainfall such as a 1 in 100-year event. This results in associated sewer flooding where the assets cannot cope with the volume of water. *Figure 2-7* shows sewer flood risk based on the number of such recorded flood incidents reported to TWUL. More information on sewer flood risk can be found in *Section 5.7* of Richmond's Level 1 SFRA.

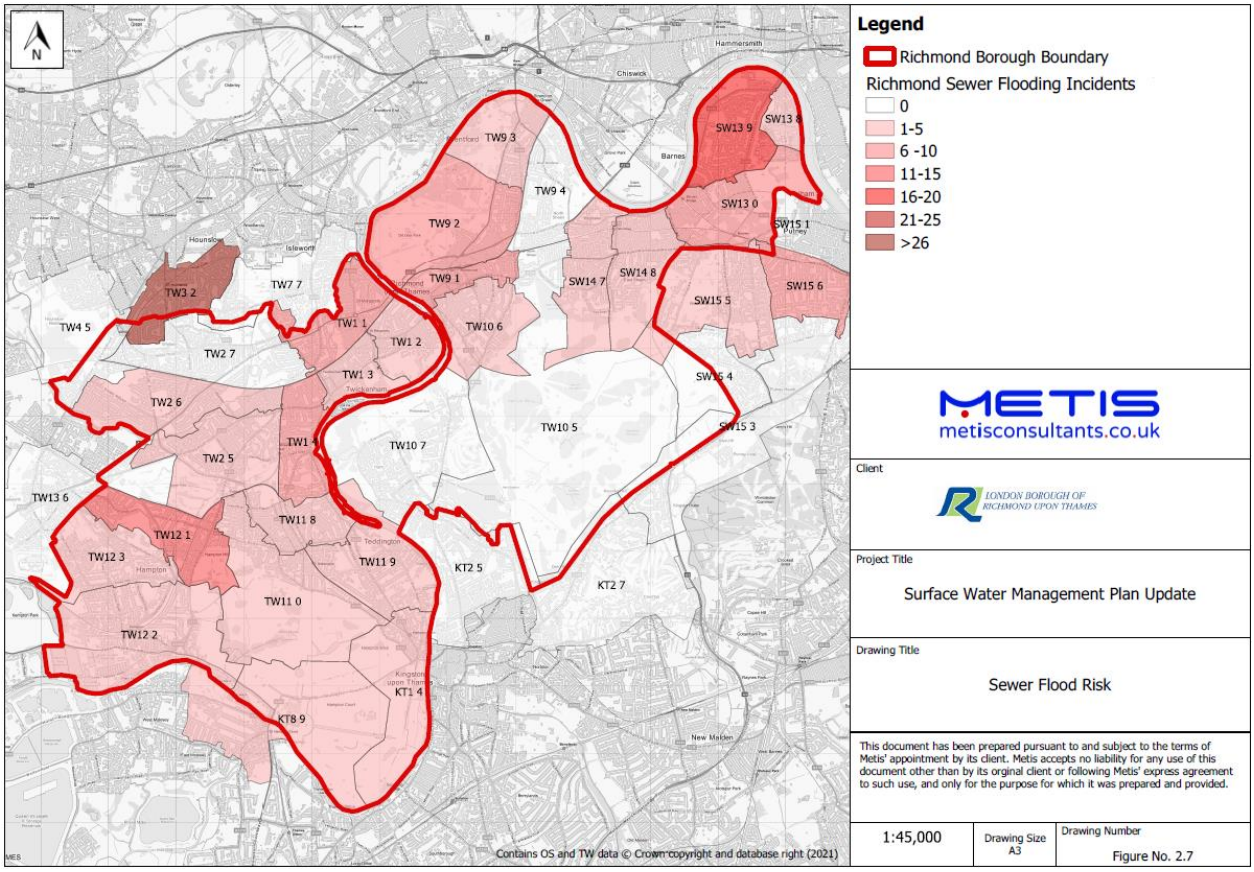

Figure 2-7 Sewer Flood Risk in LB Richmond

2.6 Flood risk from other sources (tidal and artificial)

Tidal flooding can occur during extreme high tide or storm surges. In LB Richmond, the River Thames is tidal downstream of Teddington Lock, and non-tidal upstream. These areas also benefit from flood defences, particularly large areas of Barnes and Mortlake (*Figure 2-3*).

Artificial flooding occurs as a result of infrastructure failure or human interaction. Typical flood sources can include reservoirs or canals. The EA's Risk of Flooding from Reservoirs mapping shows the extents of flooding from artificial sources (*Figure 2-8*).

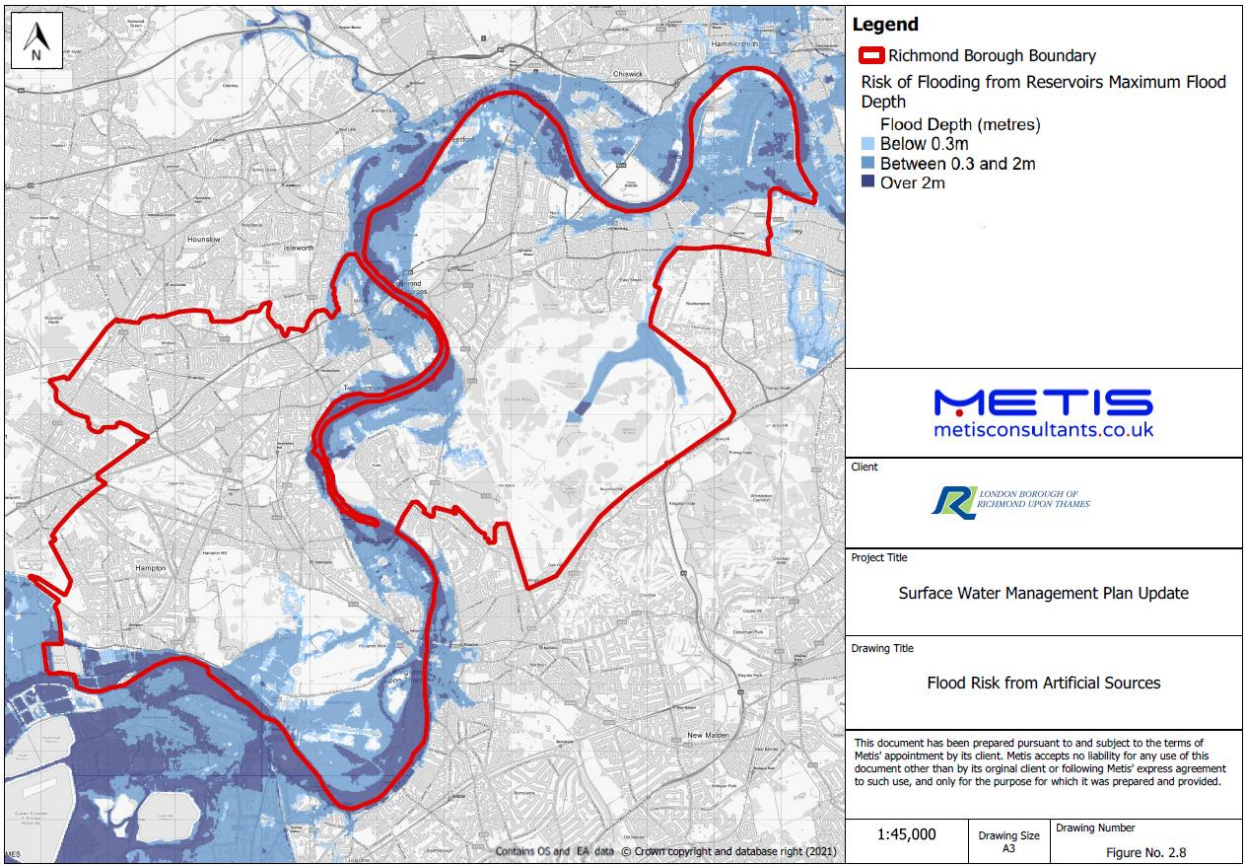

Figure 2-8 Flood risk from artificial sources

2.7 Properties at risk within the borough

There are 2,853 properties predicted to be at risk across Richmond during the 1 in 100-year surface water flood event (*Table 2-1*). The EA's Properties at Risk of Flooding for the 1 in 30, 1 in 100 and 1 in 1000-year events (2014) dataset has been used across the whole borough. Currently, no local flood risk modelling in the borough has been refined enough to be submitted to the EA for updates to the RoFSW mapping. Modelling of properties at risk in the 1 in 100-year flood event have been presented in *Figure 2-9*. It is recommended that as more detailed local modelling is undertaken, the resultant mapping and property counts should be incorporated into future updates of the SWMP (and RoFSW) to ensure it is consistent with the current level of understanding of flood risk across the borough.

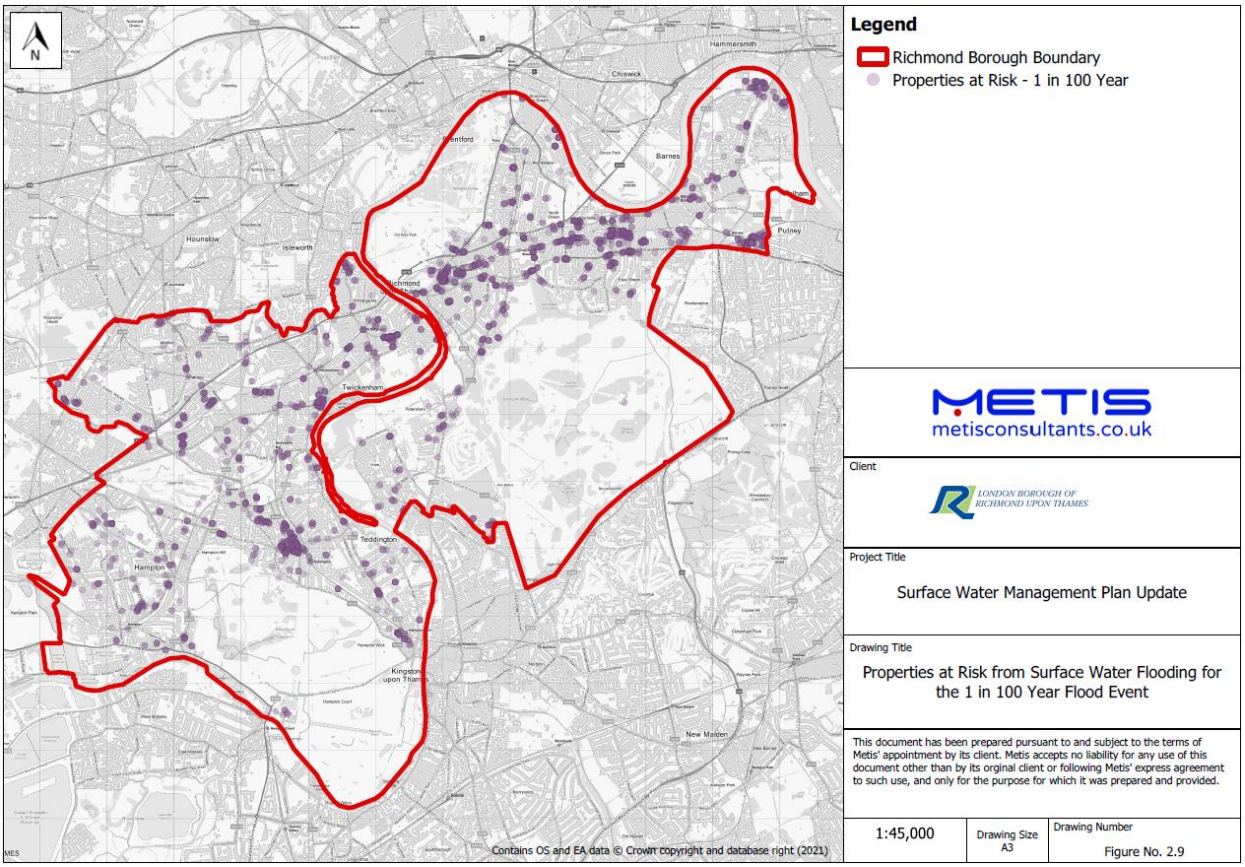

Figure 2-9 Properties at Risk from Surface Water Flooding in the 1 in 100-year flood event

Property counts for individual Catchments can be found in Sections 4 to 15. For comparison, the 2011 SWMP analysis of the number of properties at risk of flooding for the 1 in 100-year event demonstrated that 31,219 properties in LB Richmond could be at risk of flooding with a greater than 0.03m depth. Since the 2011 SWMP, the RoFSW has been remodelled by the EA for the area. The number of properties at risk has reduced drastically in this SWMP as the depth threshold for internal property flooding was increased by the EA modelling. The modelled ground level was raised within building footprints by an average of 0.3 metres to represent the way that the average building would not flood internally until water outside is 0.3m deep. Once the modelled water level reaches that threshold, the buildings are flooded.

In *Table 2-1*, 'Residential' properties are accounted for while the 'Other' section includes information about commercial, transport, or other infrastructural properties. The 'Unclassified' section refers to properties which have been mapped and are at risk of flooding but have not been identified under a specific use due to a lack of information. The EA periodically reviews the 'Unclassified' properties when new information is provided to them.

Table 2-1 Properties at Risk of Surface Water Flooding

	Residential	Other	Unclassified
Within 30-year surface water extent	481	172	68
Within 100-year surface water extent	2,063	535	255
Within 1000-year surface water extent	11,788	2,177	1,137

2.8 Recorded flooding history within the borough

LB Richmond collects information on flood incidents and keeps a record of historic flood incidents. This information includes all sources of flooding and is not limited to significant incidents. This helps to build up a clear picture of flooding across the borough and can also aid in understanding of how flood risk changes, particularly with issues such as climate change. Currently, LB Richmond have 27 recorded flood incidents from November 2020 to 30th July 2021 across the borough, sourced from the online reporting tool. Flood reports made before this date are held by the LB Richmond but could not be included in the analysis for this SWMP due to a lack of data surrounding each incident and inconsistency in how they were recorded, meaning they could not be validated. Flood incidents recorded after 30th July 2021 could not be included in the report as the data analysis began before this date, and more reports could not be added without interfering with the methodology. It should be noted that data is limited as many residents do not report flood incidents. Where available, reports of

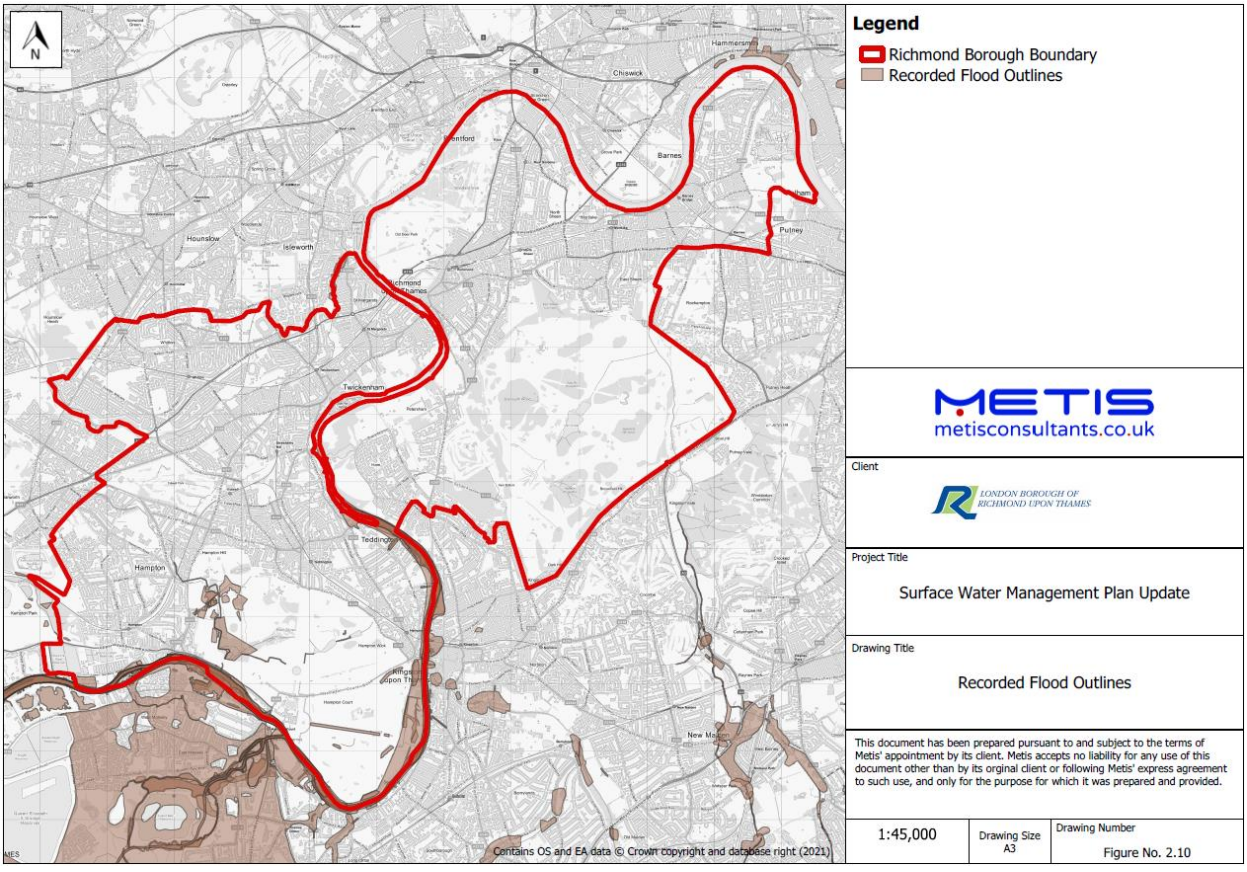

Figure 2-10 Recorded Flood Outlines (EA)

surface water flood incidents were used to help validate the EAs RoFSW mapping, and the Hotspots creation. Residents are encouraged to report flood incidents to Richmond's online flood reporting tool.

Recorded flood event and extent data has also been provided by the EA (*Figure 2-10, Figure 2-11*). This shows that LB Richmond has experienced floods in areas surrounding the Thames in the southwest of the borough, as well as along the Longford River in Bushy Park, and near where the River Crane meets the River Thames on the border between LB Richmond and LB Hounslow.

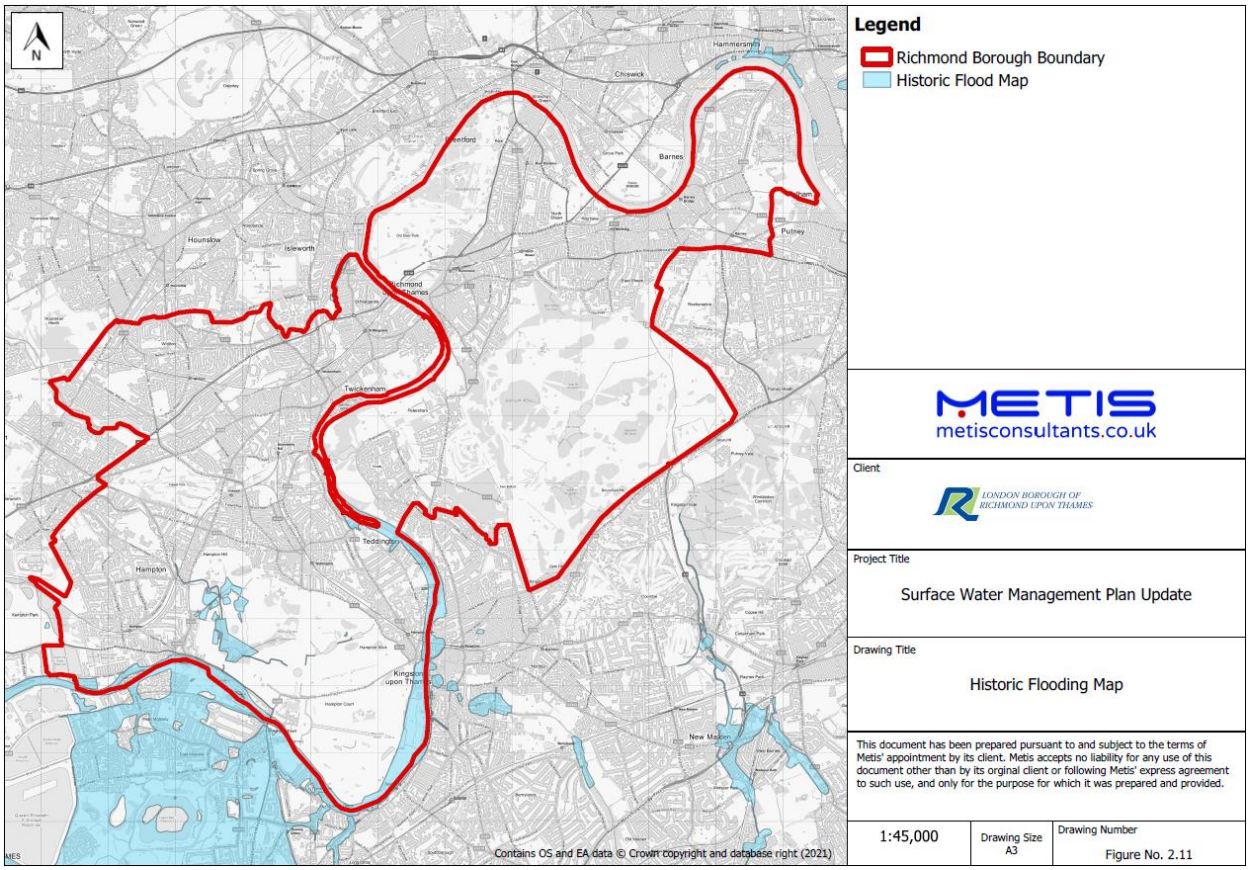

Figure 2-11 Historic Flood Events (EA)

TWUL has provided sewer flooding incident data (*Table 2-2*). Due to sensitivity of the information, it was provided as postcode sectors. Consequently, it is not property specific, and contains flood incidents up to May 2021. In the past, TWUL has gathered flood reports from phone calls and hard copy report forms, but they have recently switched to an online report form. This may result in changes to the rate of reporting. Where a postcode sector crosses the borough boundary the incidents reported are for LB Richmond only. In total, there were 182 recorded sewer flood incidents across the borough, with the largest number occurring in TW3 2, SW15 1, and SW13 9.

Table 2-2 Number of Thames Water Sewer Flood Records across LB Richmond

Postcode Sector	Internal Flooding			External Flooding			Total
	2 in 10 year	1 in 10 year	1 in 20 year	2 in 10 year	1 in 10 year	1 in 20 year	
TW10 5	0	0	0	0	0	0	0
KT2 5	0	0	0	0	0	0	0
KT1 4	0	0	2	0	2	0	4
KT8 9	0	0	0	0	1	0	1
SW13 0	0	0	7	0	0	1	8
SW13 8	0	0	1	0	0	0	1
SW13 9	0	3	7	1	5	1	17
SW14 7	0	0	2	0	0	0	2
SW14 8	0	1	0	0	0	0	1
SW15 1	0	1	20	0	0	4	25
SW15 5	0	0	1	0	0	0	1
SW15 6	0	0	4	0	0	1	5
TW1 1	0	0	5	0	0	0	5
TW1 2	0	0	3	0	0	0	3
TW1 3	0	1	0	0	0	0	1
TW1 4	0	0	2	0	0	5	7
TW10 5	0	0	0	0	0	0	0
TW10 6	0	1	0	0	1	1	3
TW10 7	0	0	0	0	0	0	0
TW11 0	0	0	1	0	0	0	1
TW11 8	0	0	3	0	0	1	4
TW11 9	0	0	1	0	1	0	2
TW12 1	1	2	0	0	8	0	11
TW12 2	0	0	3	0	0	0	3
TW12 3	0	0	0	0	0	3	3
TW13 6	0	0	0	0	0	0	0
TW2 5	0	0	1	0	0	0	1
TW2 6	0	0	1	0	0	0	1
TW2 7	0	0	0	0	0	0	0
TW7 7	0	0	0	0	0	0	0
TW4 5	0	0	0	0	0	0	0
TW3 2	0	0	16	1	0	17	34
TW9 1	0	0	7	0	0	2	9
TW9 2	0	0	5	0	0	0	5
TW9 3	0	0	1	0	0	0	1
TW9 4	0	0	0	0	0	0	0
TOTAL	**1**	**9**	**93**	**2**	**18**	**36**	**155**

3 BASIN BASED APPROACH

3.1 Why this approach

Since the 2011 SWMP which identified seven CDAs in the borough, LB Richmond has worked to improve the understanding of surface water flood risk in some of these areas. As the drainage network and local topography were not integrally considered within the 2011 modelling, the amount of surface water entering a particular area was not fully accounted for. Since 2011, it has been identified that CDA extents sometimes do not correspond to their contributing areas, typically only covering the locations most at risk from surface water flooding.

The new SWMP introduces a new approach to managing flood risk in which the local topography, watercourse and sewer information have been used to better represent hydrological Catchments within larger Basins. The natural Catchments therefore better reflect and cover a larger geographic area than the 2011 CDAs. This approach is in line with national flood risk management and planning policy which have been progressively moving to a Catchment / Basin-based focus in recent years. As many neighbouring boroughs update their SWMPs and / or undertake refined surface water flood risk modelling, they have also used a Catchment / Basin-based approach to define study areas, so consistency is maintained.

The Catchment / Basin-based approach better aligns to the EA's river basin methodology used for the management of fluvial flood risk. Within *Figure 3-1* New Catchments and previous CDAs the new Catchments are depicted alongside the 2011 CDAs, the CDAs being largely focused on non-residential areas such as railway lines. While there were several inconsistencies with the extents of the 2011 CDAs aligning to hydrological Catchments, the new approach reflects the predicted flow paths of rainfall runoff regardless of whether it is over the surface, in watercourses or in the sewer network and mirrors the source-pathway-receptor model for managing flood risk.

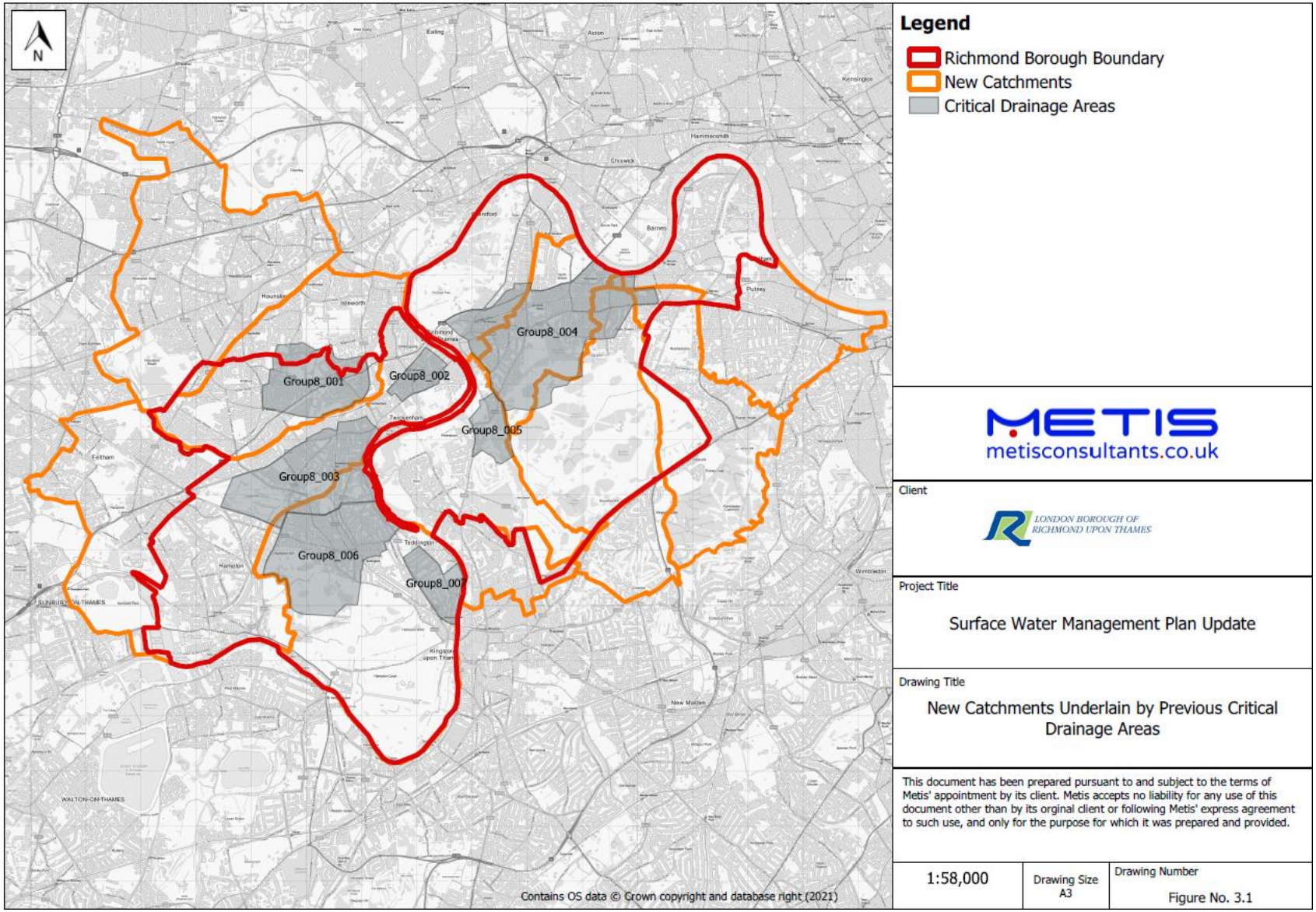

Figure 3-1 New Catchments and previous CDAs

3.2 How the approach was applied

A watershed analysis was carried out to identify the Basins covering LB Richmond by using the local topography and detailed river network. Next, refined hydrological areas within each Basin called 'Catchments' were defined using additional features such as the existing drainage network and key infrastructure. Covering a wider geographical area, Basins reflect the spatial extent that rainfall runoff in that area will cover and contribute to reach its destination. Catchments, however, identify more localised flow paths (above and below ground) across Basins. Key elements used to define the Catchment extents included the following, listed in priority order:

- Detailed river network features such as watercourses
- Surface water and combined sewer network orientation and flow direction
- Flow paths identified from the watershed analysis
- Major railway or London Underground lines
- Road network splits

Under this new approach, six Basins including a total of ten Catchments were defined as per *Figure 3-2*. Several Basins and Catchments cross the borough boundary and are therefore shared with the neighbouring boroughs.

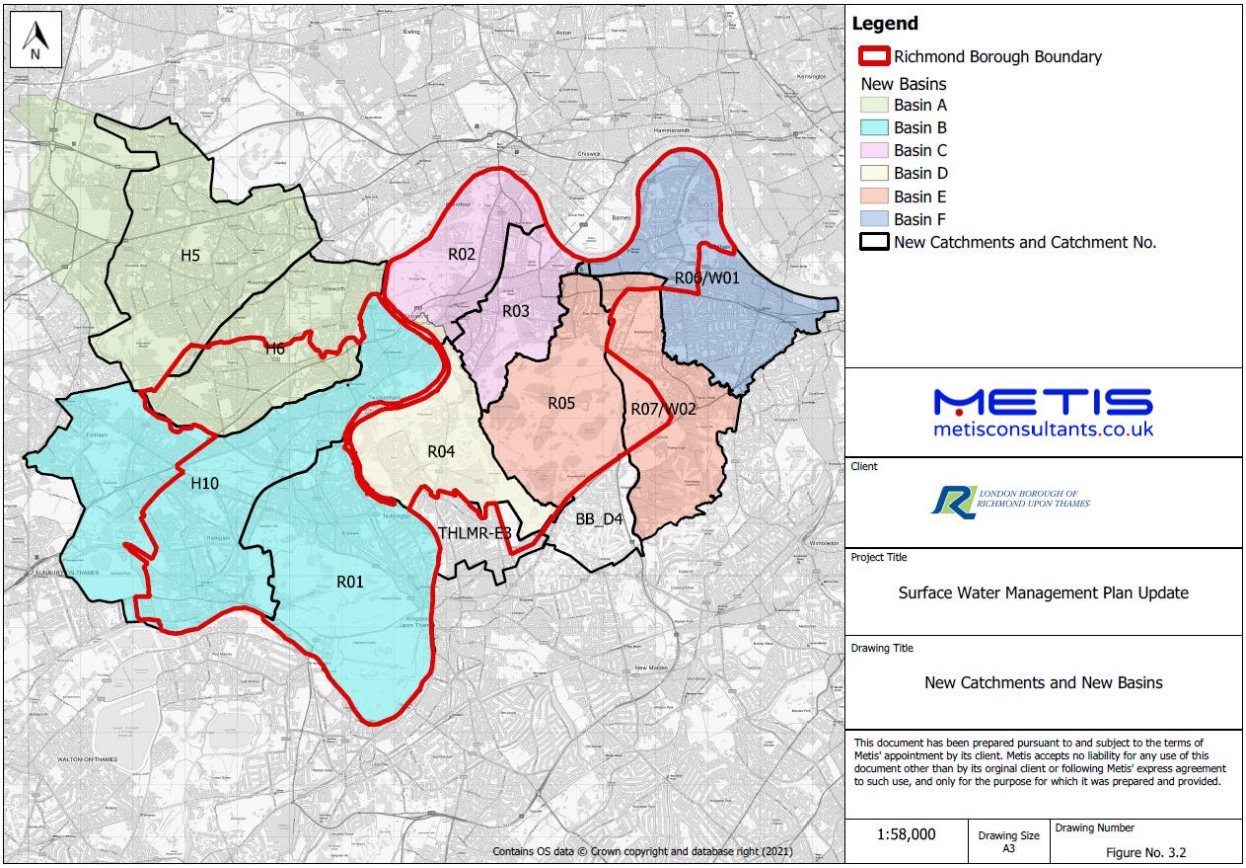

Figure 3-2 New Catchment and Basins

Where the surface water sewer network flows against the general topography, there are slight differences between the Basin and its Catchment boundaries. Due to the key elements of Catchment extent definition listed above, there are areas where Catchment boundaries do not necessarily align with the Basin boundaries. For example, for Catchment North Sheen (R03) in Basin C, Catchment East Sheen (R05) and Putney Heath (R07/W02) in Basin E and Catchment Putney (R06/W01) in Basin F, while the Basin boundaries mainly follow the output of the watershed analysis reflecting the topography, the Catchment boundaries were adjusted due to the locations of surface water sewers, railway lines and major roads to reflect the drainage nature of the area.

Certain Catchments, such as Catchment Petersham (R04) and East Sheen (R05), were trimmed back to align with Kingston's Catchment extents. A very small amount of area in LB Richmond south of Catchment Petersham (R04) is covered by Kingston Catchment THLMR-E3 and BB-D4. This was assessed based on the drainage network and the information received from the relevant cross-boundary Local Authority's LLFA. The northwest corner of the borough is covered in Hounslow's Catchment Hounslow (H5) and Isleworth & North Twickenham (H6) which form Hounslow Basin C (recorded as Basin A in *Table 3.1* below). More information is included in *Section 3.4*. *Table 3-1* provides information on the Basins and Catchments, as defined under the new approach.

Table 3-1 Basins and Catchments

Code	Basin	Catchment No.	Code	Catchment	Cross-boundary Authority
A (Hounslow Basin C)	Hounslow Basin C – River Crane East	1	H5	Hounslow	LB Hounslow
		2	H6	Isleworth & North Twickenham	LB Hounslow
B	Thames River West	3	H10	Hanworth & South Twickenham	LB Hounslow
		4	R01	Hampton	
C	Thames River South – Richmond	5	R02	Kew	
		6	R03	North Sheen	
D	Thames River East	7	R04	Petersham	RB Kingston
E	Beverley Brook	8	R05	East Sheen	RB Kingston
		9	R07/W02	Putney Heath	LBs Wandsworth & Merton
F	Thames River South & Beverley Brook	10	R06/W01	Putney	LB Wandsworth

A high-level validation exercise of the EA's RoFSW datasets was carried out using LB Richmond LLFA's recorded flood incidents (to a road-specific level, not a property-specific level). The RoFSW datasets were then used to quantify the number of properties predicted to be at risk from surface water flooding. At a Basin level, visual checks were carried out by overlaying the RoFSW extents for the 1 in 30-, 100- and 1000-year return periods with LB Richmond's recorded flood information. *Figure 3-3 to Figure 3-8* depict the validation maps for Basins A to F.

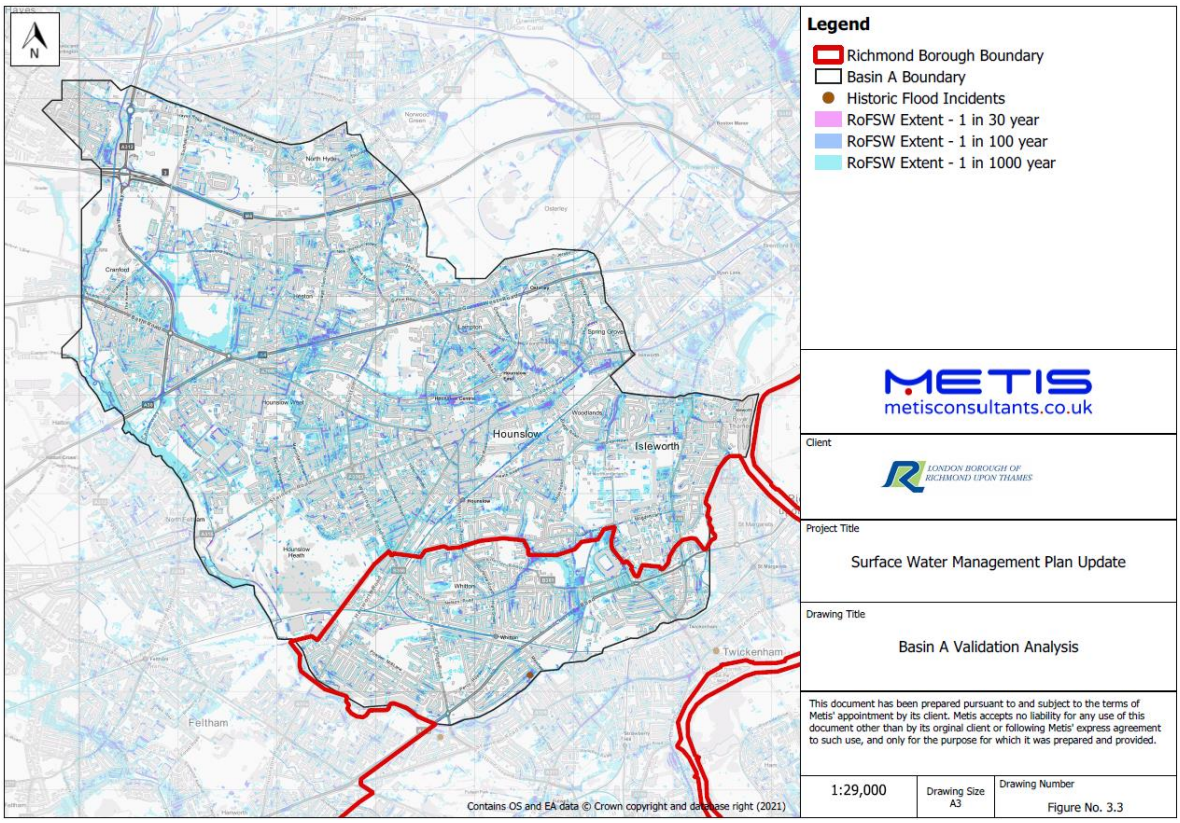

Figure 3-3 Basin A Validation Analysis

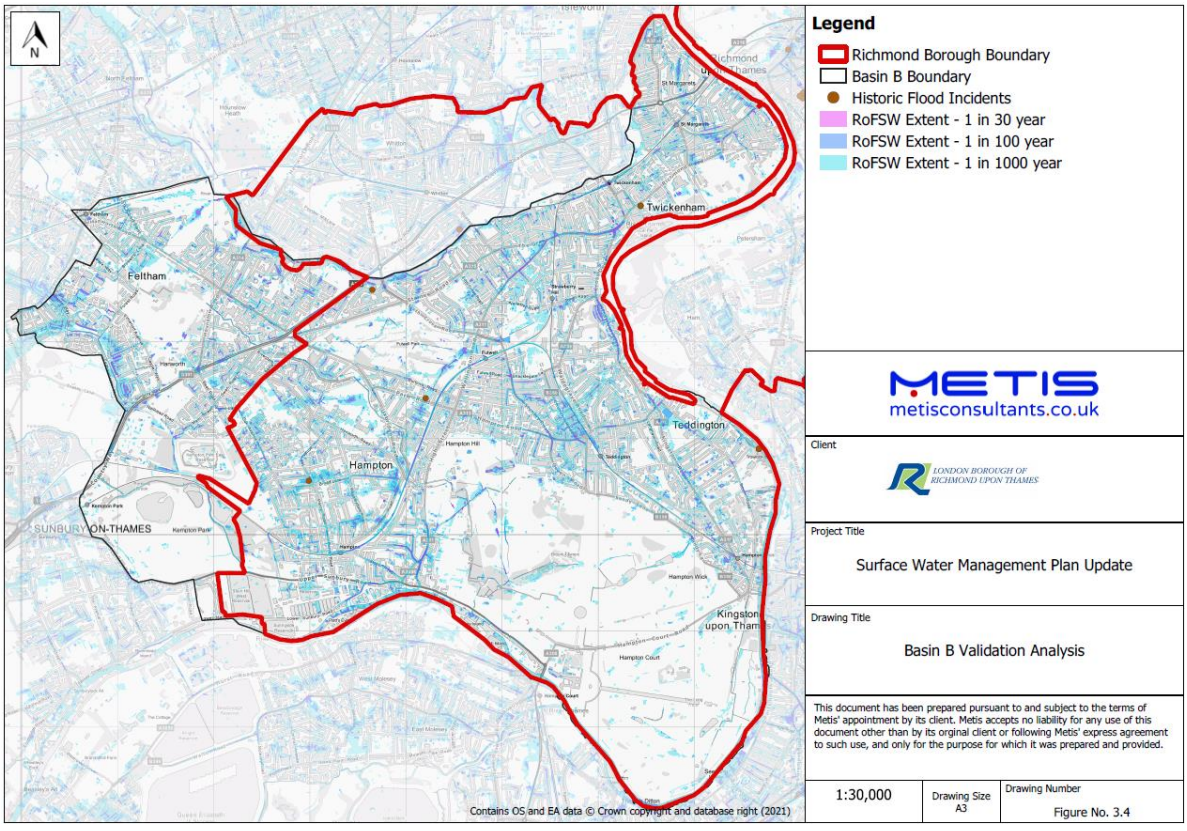

Figure 3-4 Basin B Validation Analysis

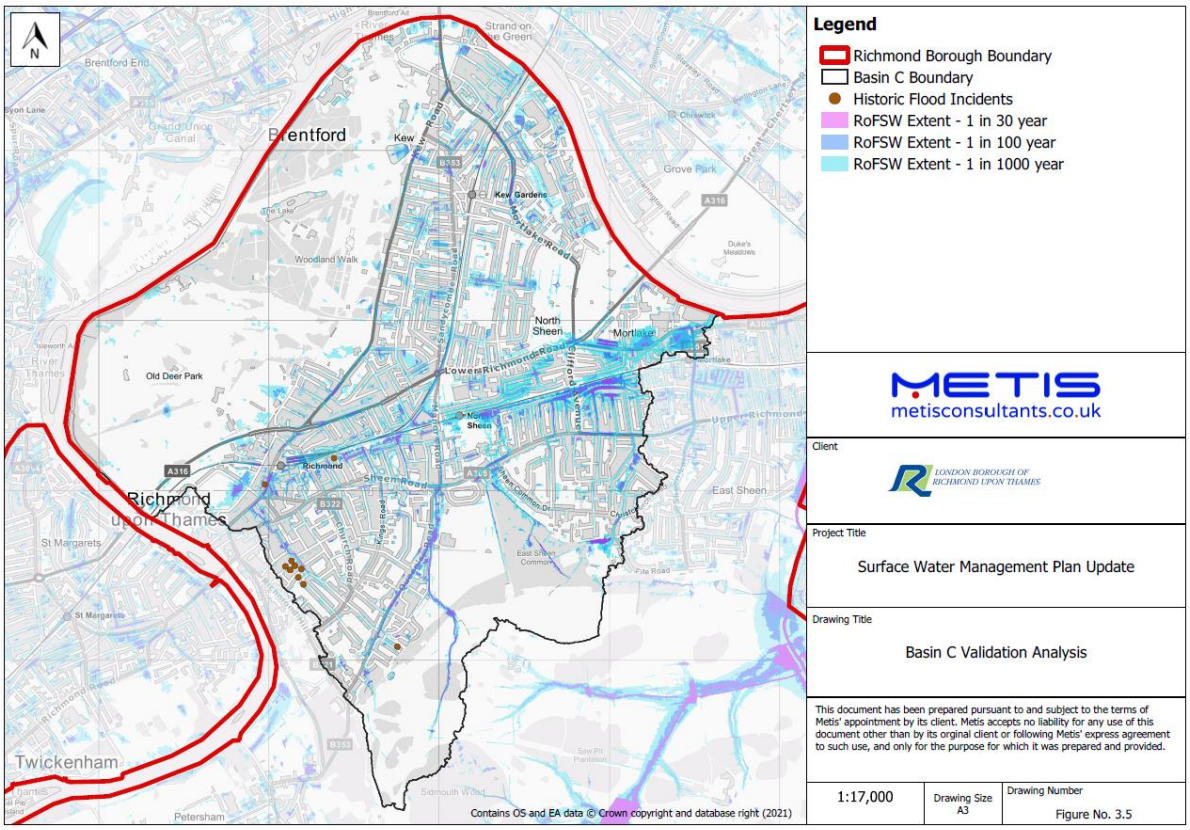

Figure 3-5 Basin C Validation Analysis

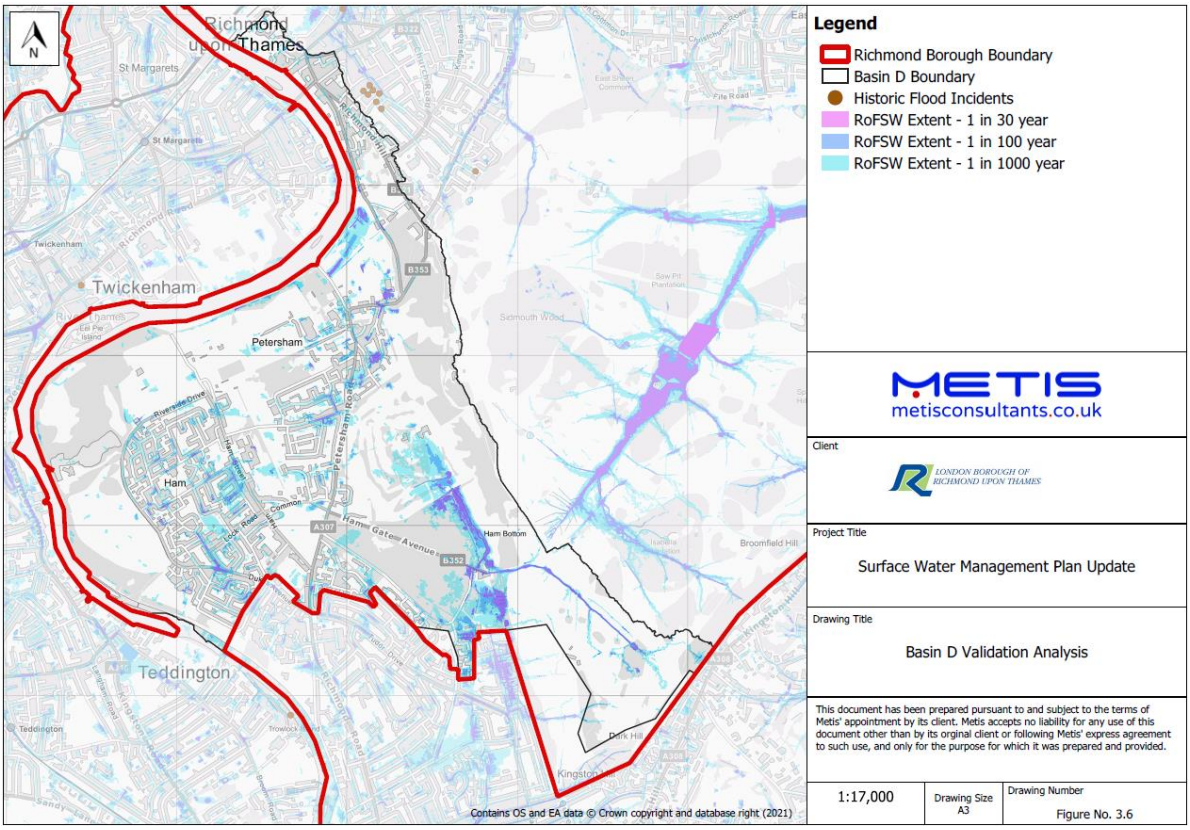

Figure 3-6 Basin D Validation Analysis

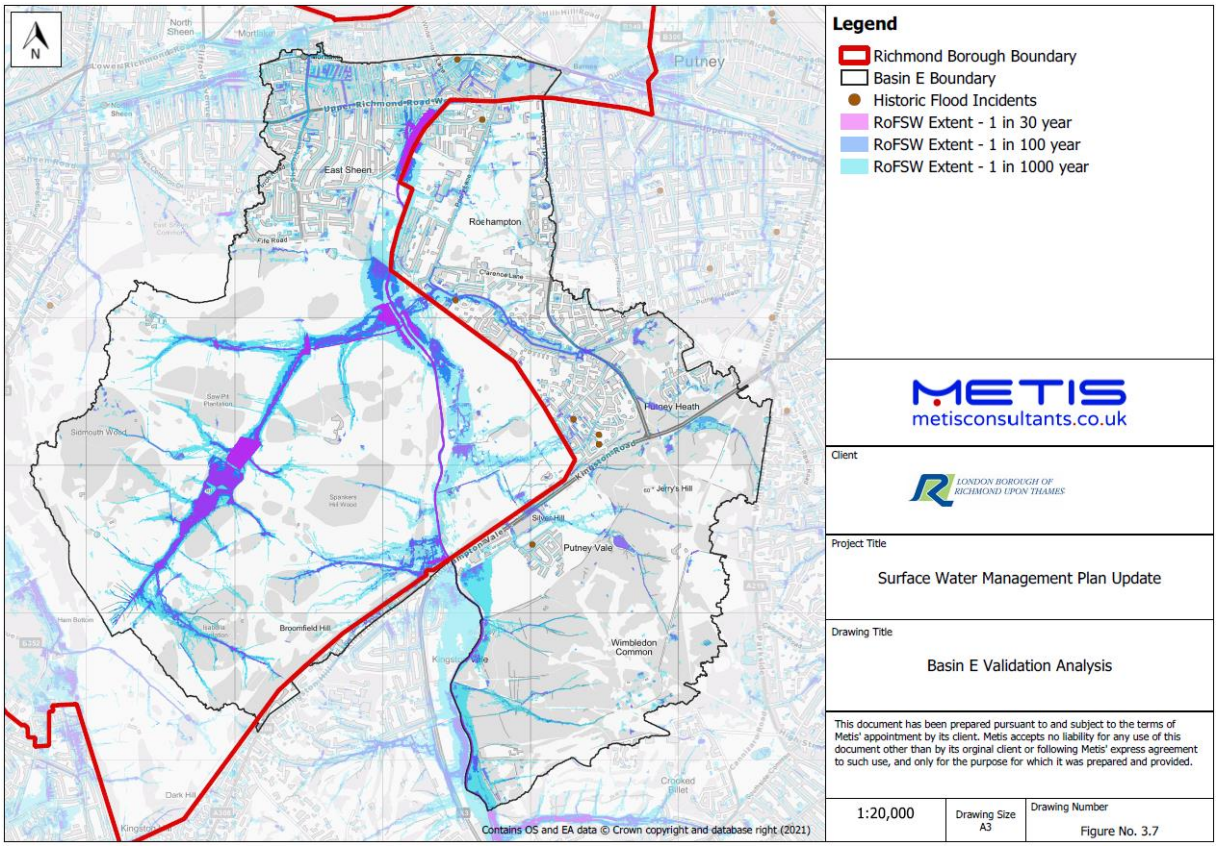

Figure 3-7 Basin E Validation Analysis

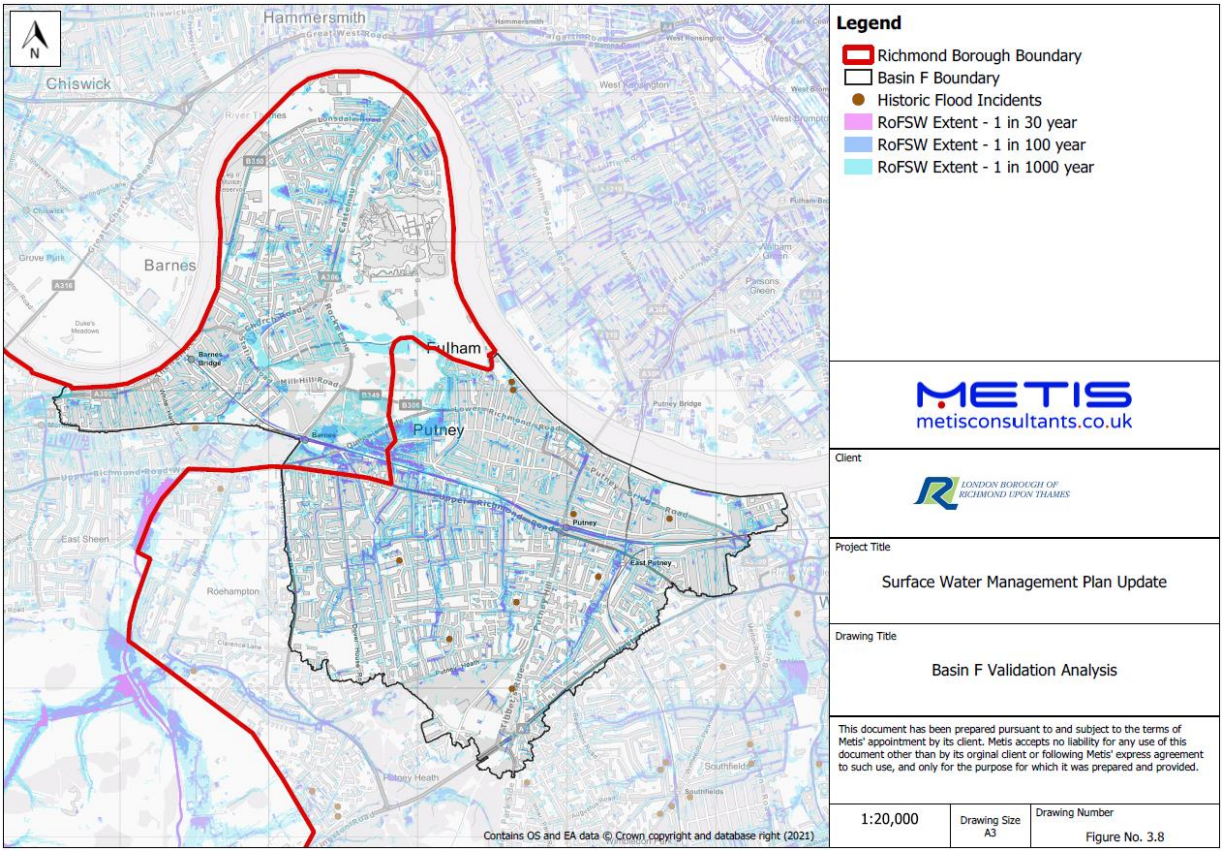

Figure 3-8 Basin F Validation Analysis

Basin A contains one former CDA. The two recorded flood incidents, which were predicted in the 1 in 100-year RoFSW mapping, were not covered by the CDA.

Basin B contains four former CDAs. There are more incidents recorded within the 1 in 100- and 1 in 1000-year return period extents than in the 1 in 30-year return extents. Overall, the flooding extents predicted in the RoFSW mapping appear to be predominantly consistent with the incidents recorded within Basin B. However, only two out of the 14 incidents were in the CDAs.

Basin C contains one former CDA. Similar to Basin B, there are more incidents recorded within the 1 in 100- and 1 in 1000-year return period extents than in the 1 in 30-year return extents. There is one recorded flood incident within this Basin, and it aligns with an area with high RoFSW. However, the flood incident in this Basin is not within the CDA which covers the east half of the Basin.

Basin D is less populated than the above three Basins. It contains one former CDA and has only two recorded incidents. It has also limited flood extents predicted by the RoFSW mapping for the 1 in 30- and 100-year return periods.

Basin E contains a vast amount of green space. EA main river Beverley Brook and its tributaries pass through Basin A. Where the RoFSW mapping predicted the worst flooding is mostly in open space in Richmond Park. There are two recorded incidents north of the Basin in the build-up area. The recorded flood incidents mostly align with the RoFSW mapping. There is one CDA in this catchment, but it does not contain the flood incidents.

There is only one recorded incident and limited RoFSW predicted in the 1 in 30-year return period in Basin F. There is one CDA in Basin F, but it is within LB Wandsworth and does not influence LB Richmond.

Overall, the recorded flood incidents largely correspond well to the RoFSW datasets. Comparing the recorded incidents and RoFSW prediction against the former CDAs also proves that the Catchment / Basin-based approach better defines the likely flow paths. It shows both the areas that are predicted to flood and the areas that contribute runoff to them and is more practical for the management of surface water flood risk.

3.3 Hotspot and Flood Incident Area creation

The definitions of Hotpots and Flood Incident Areas are:

- Hotspots: areas with a minimum of 15 residential properties predicted to be at risk of flooding in the 1 in 100-year surface water flood event (using the EA's Properties at Risk of Flooding data and the RoFSW map extents).
- Flood Incident Areas: areas identified by LB Richmond where there were two or more flood incidents affecting properties. The threshold was chosen as two flood incidents to ensure that a Flood Incident Area was not defined based on any single event.

Following the validation exercise, Hotspots were created to highlight the areas with higher predicted potential of property flood risk. They were reviewed and validated by relevant staff of LB Richmond. Hotspots can be used to inform the focus of potential flood risk mitigation works in the future or can be used to flag up problematic areas ahead of extreme rainfall events. For example, it is worth noting that some of hotspots are located directly adjacent to railway lines as the railway tracks obstructs the

flow of surface water. Increased flood risk-related planning policy strength can also be used to better protect and ensure sustainable development in these Hotspots. Currently, however, stronger policy borough-wide is preferred by LB Richmond's LLFA.

In addition to the SWMP's identified Hotspots, LB Richmond has also highlighted a 'Flood Incident Area' shown within the Catchment portfolios.

3.4 Cross-boundary involvement

As mentioned in *Section 3.2*, many hydrological Catchments overlap across administrative boundaries and the relevant stakeholders (LLFAs) of each neighbouring borough with identified cross-boundary Basins were contacted for their input. Amendments were made following comments from neighbouring LLFAs, and *Sections 3.4.1 to 3.4.3* summarise these.

3.4.1 Hounslow (H5) and Isleworth & North Twickenham (H6)

The northern corner of West Richmond is covered by Hounslow Catchment Hounslow (H5) and Isleworth & North Twickenham (H6). This has been assessed based on the river network, local sewer network and flow paths identified from the watershed analysis. This was discussed with Hounslow's LLFA to confirm that the Catchment extents do not require change.

3.4.2 Hanworth & South Twickenham (H10)

The original Hounslow Catchment Hanworth & South Twickenham (H10) did not cover the St Margarets area. From the Catchment analysis conducted in this SWMP, it is identified that the St Margarets area should be included as part of Catchment H10 as the flow paths (both above and below ground) go from the original H10 area through the St Margarets area before reaching the River Thames.

This change has been discussed and agreed with Hounslow's LLFA and the Catchment boundary has now been amended.

3.4.3 Petersham (R04) and East Sheen (R05)

Catchment Petersham (R04) and East Sheen (R05) join borders with RB Kingston Catchments TLHMR-E3 and BB-D4. As explained in *Section 3.2*, this has been assessed and agreed with RB Kingston's LLFA that no change is required.

4 CATCHMENT R01 – HAMPTON

4.1 Updates since 2011 SWMP

The Catchment includes the southern portion of CDA 3 Strawberry Hill, CDA 6 Teddington and CDA 7 Hampton Wick. A flood risk management study in 2016 looked at each of the CDAs in greater detail. The key results are summarised in *Table 4-1*. There is now secured Environment Agency funding to conduct feasibility work on flood alleviation schemes in this CDA. To date no updated flood risk modelling has been undertaken in the Hampton Catchment but this catchment includes the Strawberry Vale SuDS project which is at concept design stage.

Table 4-1 Catchment R01 Hampton CDA study outcome summary

CDA	Details
3	Strawberry Hill has potential for a runoff management and attenuation scheme in Fulwell Golf Course and small-scale SuDS schemes at local schools. A feasibility study is ongoing in this CDA, looking at potential flood alleviation schemes.
6	There is ongoing work focused upon Teddington to determine the potential for SuDS on Strawberry Vale. In this CDA, PLP measures provided wholly or partially by LB Richmond were suggested.
7	Hampton Wick was proposed for increased maintenance; however, no capital schemes were suggested due to lower overall flood risk in comparison to other CDAs where increased maintenance did occur.

4.2 Catchment extents

The Catchment (see *Figure 4-1)* comprises of a large area of parkland including Bushy Park and Hampton Court which is southwest of heavily urbanised areas in the northeast including Teddington and Hampton Wick. The Kingston Loop Line cuts through Hampton Wick and Teddington Railway Stations to Strawberry Hill Station at the northern outskirts of this Catchment. The topography of this area is generally low lying with the main flow path being in a north-easterly direction to the River Thames through the urbanised areas. However, the Thames surrounds the western, southern, and eastern perimeter of this Catchment and surface water generally flows in all these directions to the closest outlet into the Thames through gravity drainage. Where the Kingston Loop Line cuts through Teddington, the railway acts as a cut-off in the northerly direction for surface water flow from this Catchment.

Other notable features in this Catchment include Hampton Court Palace, Saint Mary's University College and Hampton Court Palace Golf Club. The A308 (Hampton Court Road) cuts southwest of Bushy Park.

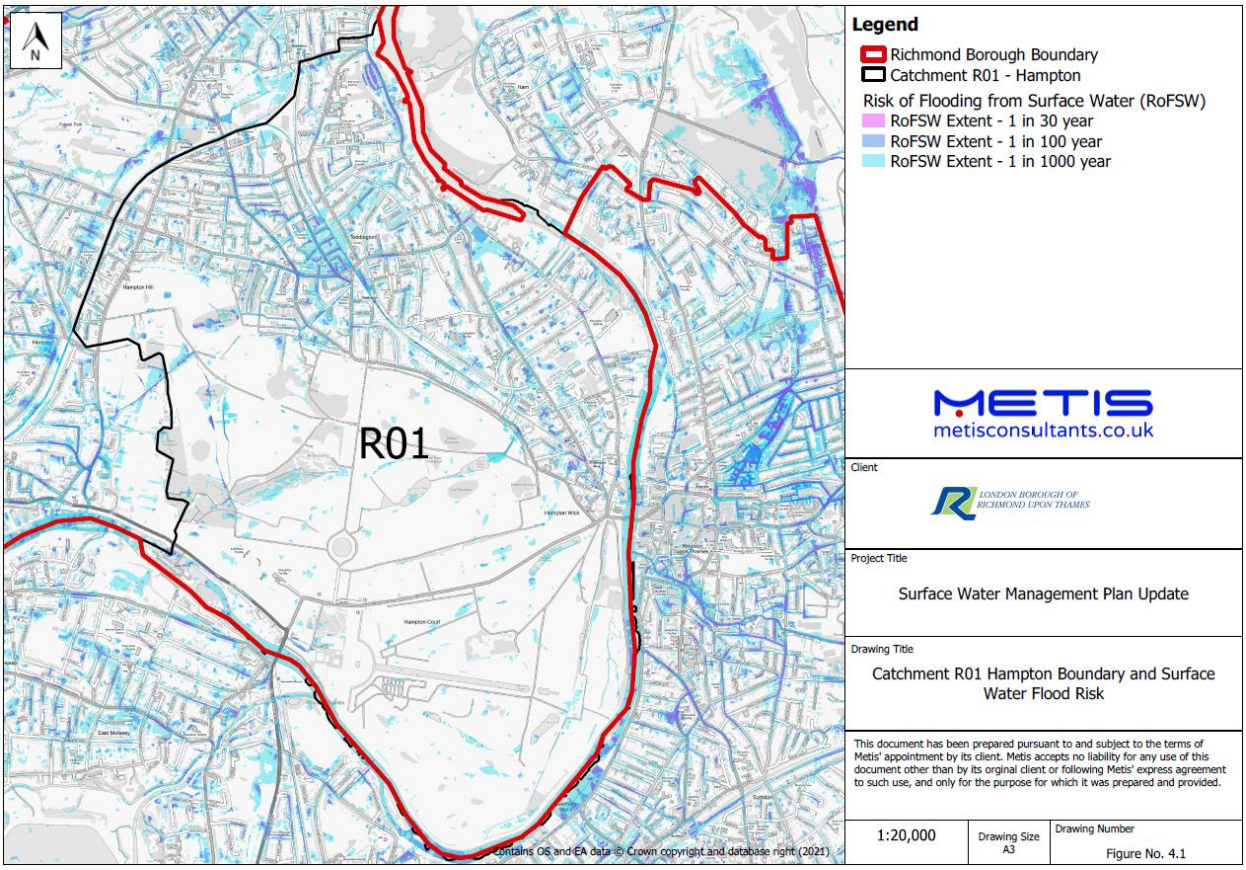

Figure 4-1 Catchment R01 Hampton Boundary and Surface Water Flood Risk

4.3 Properties at risk and Hotspots

Table 4-2 summarises the number of properties predicted to be at risk within this Catchment. Hotspots are shown in *Figure 4-2* and summarised in *Table 4-2.* Richmond has had one historic report of flooding in the Hampton Catchment R01. The incident does not align with the predicted risk areas, along the surface water flow paths to the River Thames along A313 (Hampton Road), A310 (Kingston Road) and Strawberry Vale where Hotspots are mostly located.

Table 4-2 Properties at Risk in Catchment R01 Hampton

Property type	Within 30-year surface water extent	Within 100-year surface water extent	Within 1000-year surface water extent
Residential	67	322	1894
Other	15	100	422
Unclassified	11	53	216

In this Catchment, there are four Hotspots shown in *Figure 2-1*. These have been summarised in *Table 4-3*.

Table 4-3 Hotspots in Catchment R01 Hampton

Hotspot	Location	Flow path or streets affected	Properties predicted to be at risk from surface water flooding from the 1 in 100-year return period
R01_01	Teddington	Stanley Road flow path to Broad Street	33
R01_02	Teddington	Church Road flow path to Broad Street	24
R01_03	Teddington	Broad Road flow path to Park Road roundabout	162
R01_04	Hampton Wick	Vicarage Road flow path along Kingston Road	33

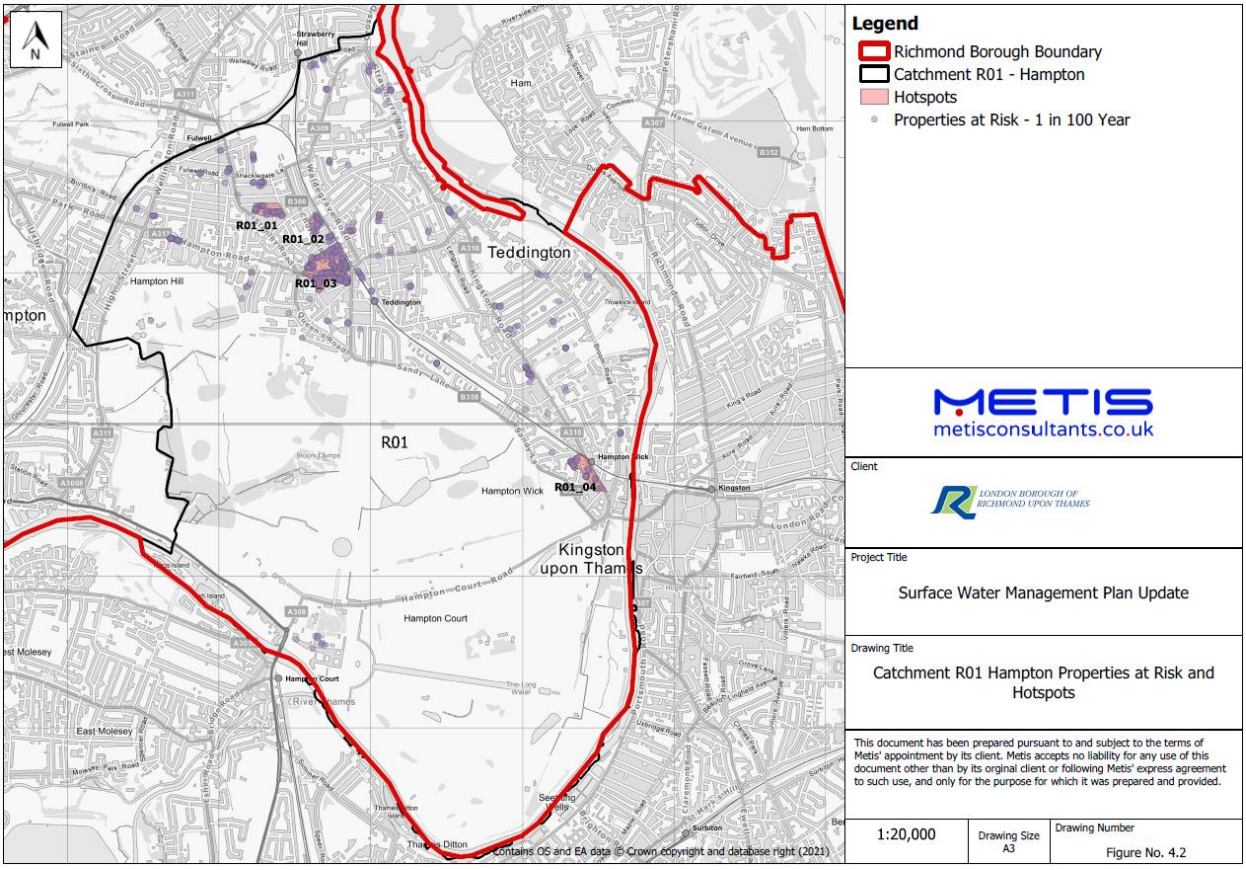

Figure 4-2 Catchment R01 Hampton Properties at Risk and Hotspots

4.4 Historic Flood Incidents and Flood Incident Areas

The only historic flood incident report, in November 2020, is in the north of the Catchment in an urbanised area in Teddington by Trowlock Island. Recorded flood incidents are shown in *Figure 4-3*. There are no Flood Incident Areas in this Catchment. The incident does not align with the predicted risk areas, along the surface water flow path to Trowlock Island and the River Thames.

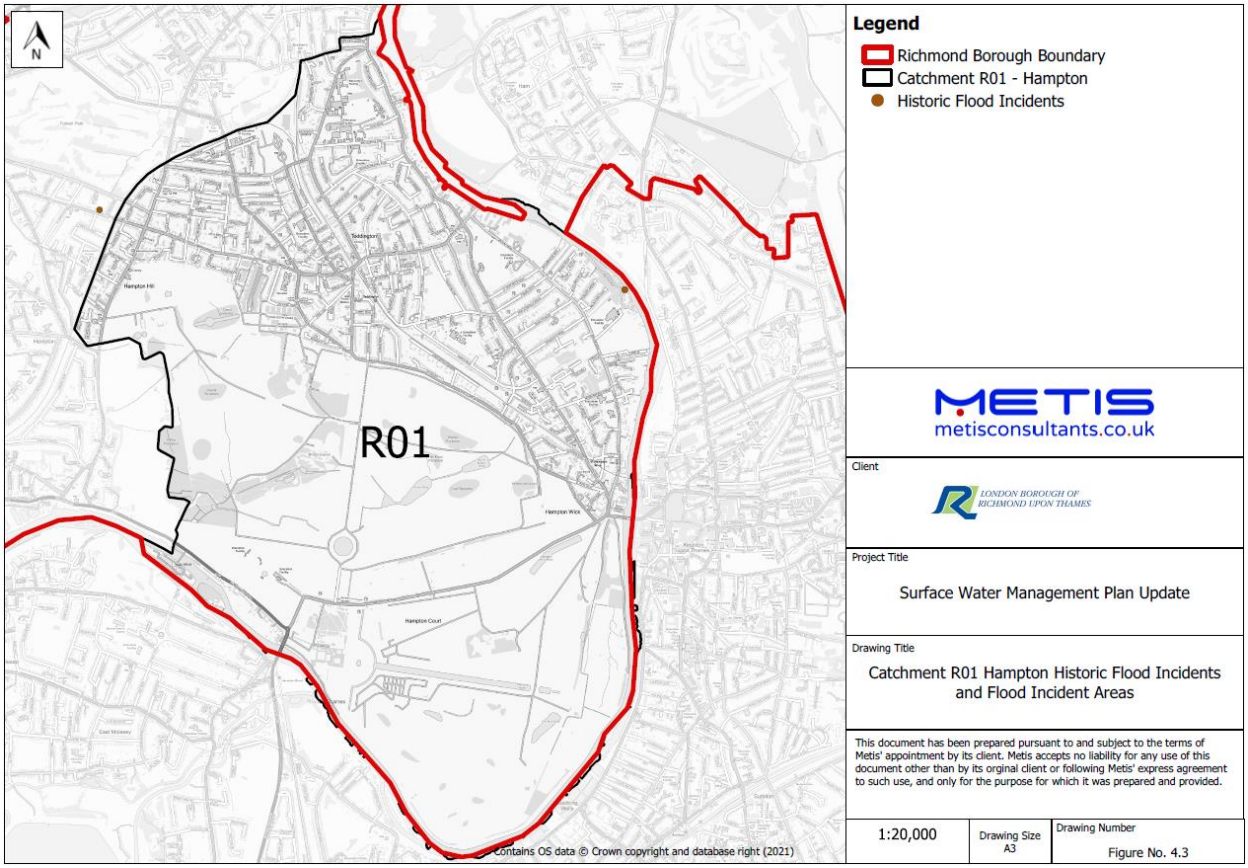

Figure 4-3 Catchment R01 Hampton Historic Flood Incidents and Flood Incident Areas

5 CATCHMENT R02 - KEW

5.1 Updates since 2011 SWMP

Kew Catchment includes the northwest part of CDA 4 Richmond and Mortlake. A flood risk management study completed in 2016 looked at the CDA in greater detail. The key results are summarised in *Table 5-1*. To date no updated flood risk modelling has been undertaken in the Kew Catchment.

Table 5-1 Catchment R02 Kew CDA study outcome summary

CDA	Details
4	Further assessment of businesses in The Quadrant was recommended before a capital scheme could be established.

5.2 Catchment extents

The northwest half of this Catchment (see *Figure 5-1*) is a large area of parkland including Kew Royal Botanical Gardens, Kew Green and Royal Mid-Surrey Golf Club. The southern half of this Catchment is urbanised in Richmond town centre at the southern boundary up to north of Richmond and east of Kew Gardens. The A307 (Kew Road) cuts from north to south of this Catchment and meets the A316 (Twickenham Road) in North Richmond. To the east and south of these roads cuts the District Line through Kew and Richmond Stations. The topography in this area is slightly hilly with the highest point

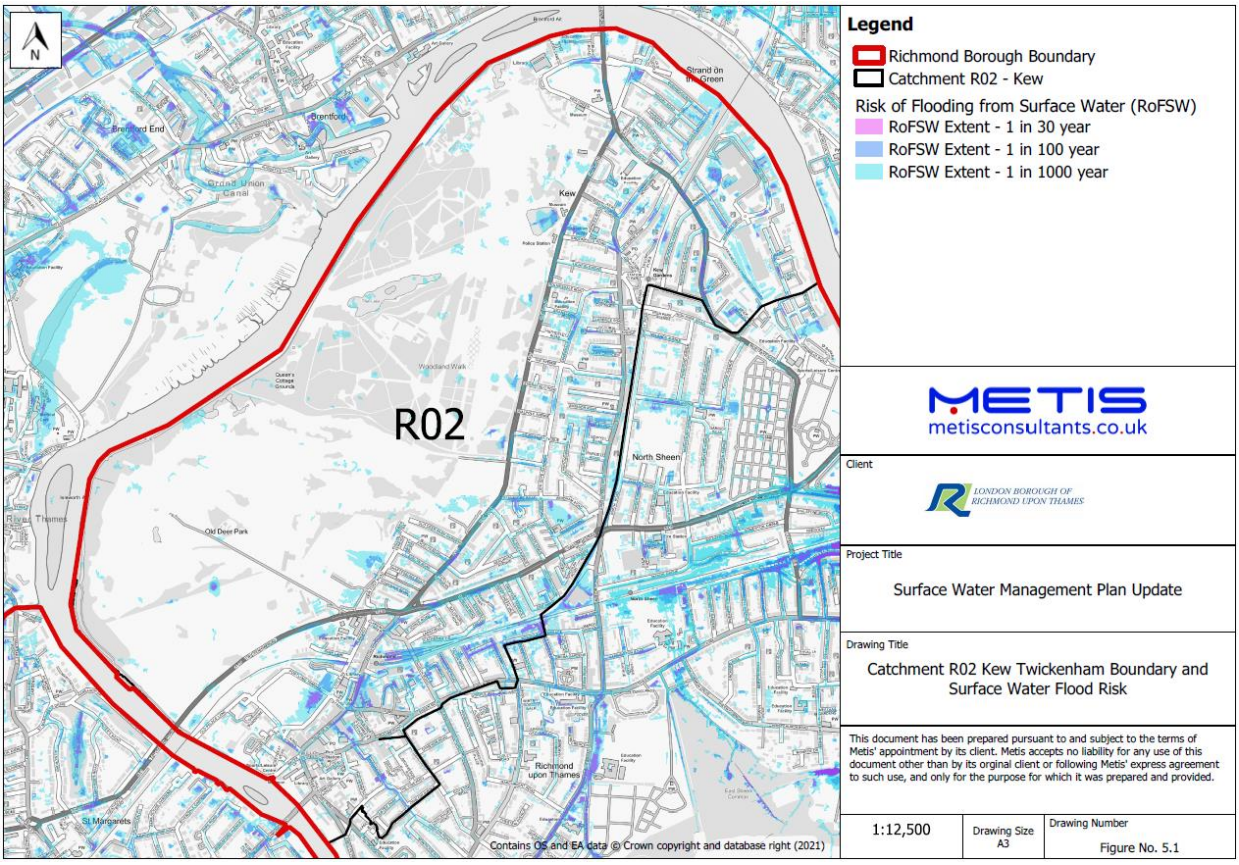

Figure 5-1 Catchment R02 Kew Boundary and Surface Water Flood Risk

at Lion Gate Gardens with the main flow paths conveying north or south from this location to the River Thames along Kew Road. Southbound surface water flow paths meet and head west down Twickenham Road to the River Thames.

5.3 Properties at risk and Hotspots

Table 5-2 summarises the number of properties predicted to be at risk within this Catchment. Richmond has had 13 historic reports of flooding in the Kew Catchment R02. The incidents align with the predicted risk areas, along the surface water flow paths to the River Thames along Halford Road and A307 Kew Road to Richmond Station where Hotspots are mostly located.

Table 5-2 Properties at risk in Catchment R02 Kew

Property type	Within 30-year surface water extent	Within 100-year surface water extent	Within 1000-year surface water extent
Residential	62	226	1212
Other	77	122	422
Unclassified	6	37	151

In this Catchment, there are six Hotspots shown in *Figure 5-2*. These have been summarised in *Table 5-3*.

Table 5-3 Hotspots in Catchment R02 Kew

Hotspot	Location	Flow path or streets affected	Properties predicted to be at risk from surface water flooding from the 1 in 100-year return period
R02_01	Richmond	Along the Paradise Road flow path to Red Lion Street	15
R02_02	Richmond	Along the Kew Road flow path to the A316 junction	99
R02_03	Richmond	Along the Church Road flow path to the District Line	31
R02_04	Richmond	Along the Sheen Park flow path to the District Line	21
R02_05	Richmond	Along the Rosedale Road flow path to Old Deer Park	18
R02_06	North Sheen	Along Dudley Road to Sandycombe Road	15

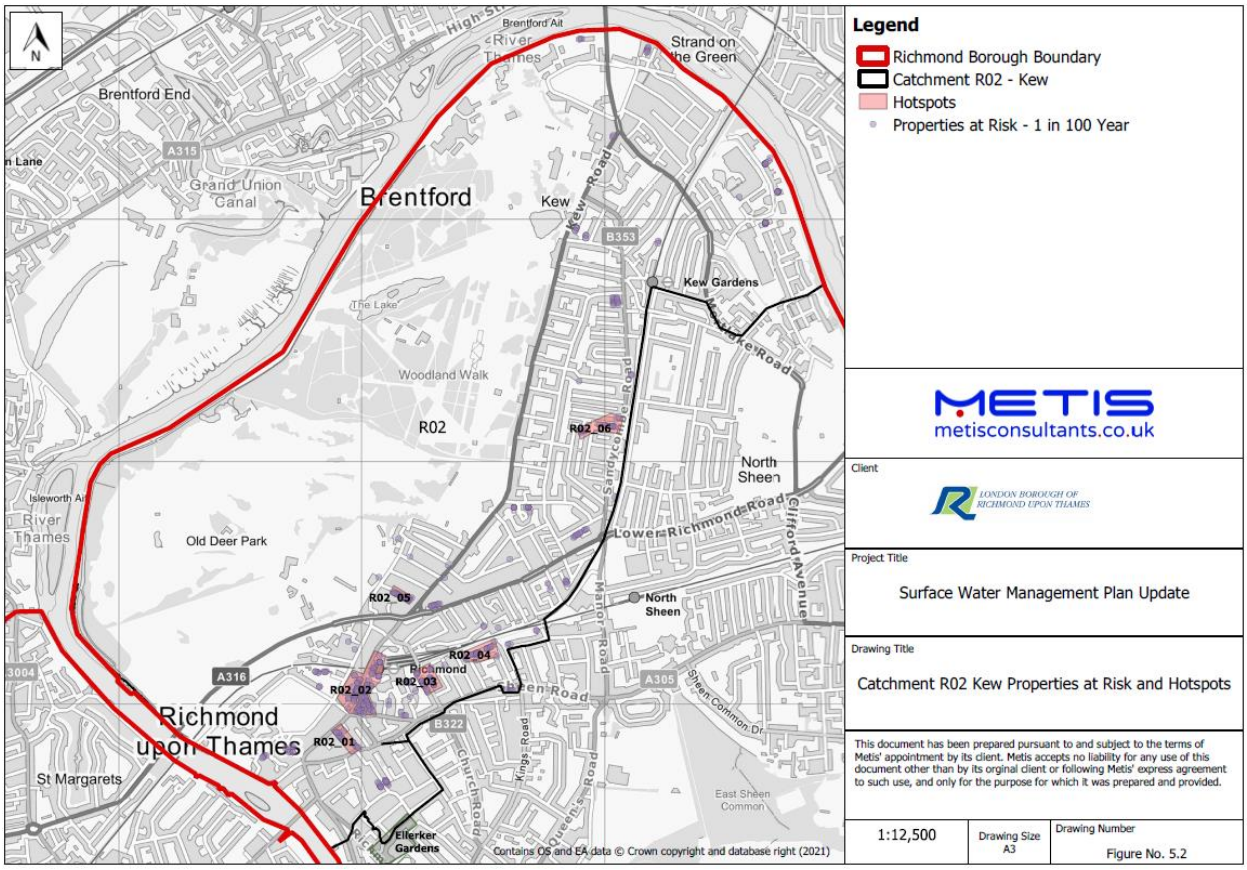

Figure 5-2 Catchment R02 Kew Properties at Risk and Hotspots

5.4 Historic Flood Incidents and Flood Incident Areas

All flood reports have been in the urbanised part of this Catchment. Recorded flood incidents and Flood Incident Areas are shown in *Figure 5-3* and summarised in *Table 5-4*. Most incidents align with the predicted risk areas and Hotspots, along the surface water flow paths on Halford Road, the A307 (Kew Road) and surrounding the railway east of Richmond Station. Historic reports of five properties being flooded in the TW10 area (see *Figure 2-7* for postcode areas) of Richmond town centre at Richmond Hill, Petersham Road, Ellerker Gardens, The Vineyard and Grosvenor Avenue, Montague Road, Lancaster Park, Cambrian Road and Onslow Road in November 2020. The issues on Richmond Hill and Petersham road may have resulted from a TWUL sewer blockage which has now been resolved, however the steep topography in the area may result in fast flowing runoff during times of heavy rainfall which can cause drainage issues. In the TW9 areas of Richmond town centre there were reports of properties flooded on Alton Road in May 2021. Also, in July 2021 in The Quadrant, flooding was reported at a property.

In Kew, Mortlake Road flooding has been identified as causing regular traffic disruption and at Kew Gardens Station. In South Richmond, the Richmond Hill area surface water flooding regularly occurs after heavy rainfall in Ellerker Gardens and Lancaster Park. This is also the case in George Street and Paved Court where there has been flooding to nearby properties.

Table 5-4 Flood Incident Areas in Catchment R02 Kew

Flood Incident Area	Location	Related Hotspots or streets affected	Properties predicted to be at risk from surface water flooding from the 1 in 100-year return period	Recorded flood incidents in this location
Ellerker Gardens	Richmond	Along Ellerker Gardens (overlaps into Catchments R03 North Sheen and R04 Petersham)	0	2

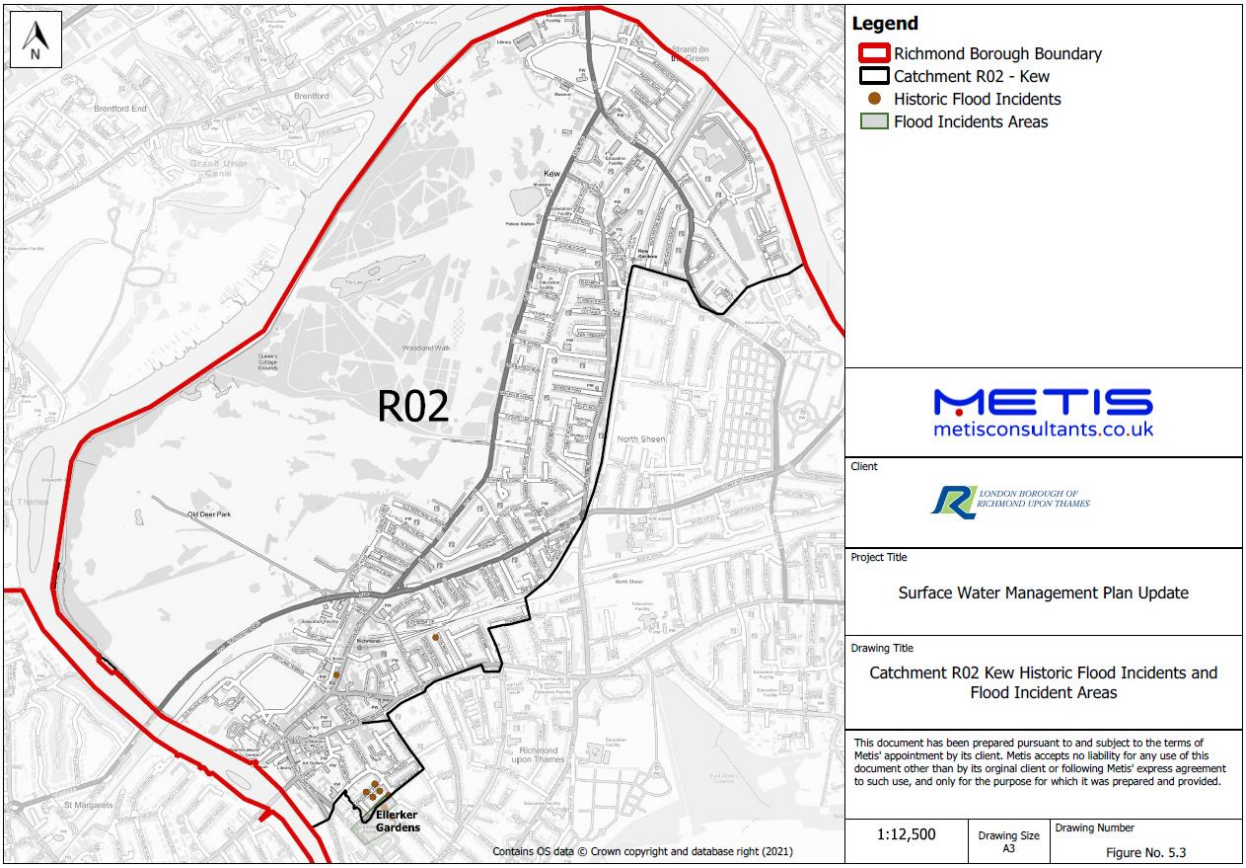

Figure 5-3 Catchment R02 Kew Historic Flood Incidents and Flood Incident Areas

6 CATCHMENT R03 - NORTH SHEEN

6.1 Updates since 2011 SWMP

North Sheen Catchment contains most of CDA 4 Richmond and Mortlake. A flood risk management study completed in 2016 looked at the CDAs in greater detail. However, no schemes were taken forward in this Catchment for further consideration. To date no updated flood risk modelling has been undertaken in the North Sheen Catchment.

6.2 Catchment extents

This Catchment (see Figure 6-1) is mostly urbanised covering North Sheen, Mortlake, and the outskirts of Richmond town centre to the west. Notable features include East Sheen Common and the northern edge of Richmond Park. Key infrastructure includes the A205 (Mortlake Road) which crosses the A316 (Lower Richmond Road) which cuts east to west. The railway cuts through the northern part of this Catchment through North Sheen Station. The topography of this Catchment is generally higher in the west conveying surface water along flow paths in an easterly direction to the River Thames. The flow paths convey north and north-easterly to the Thames from North Sheen.

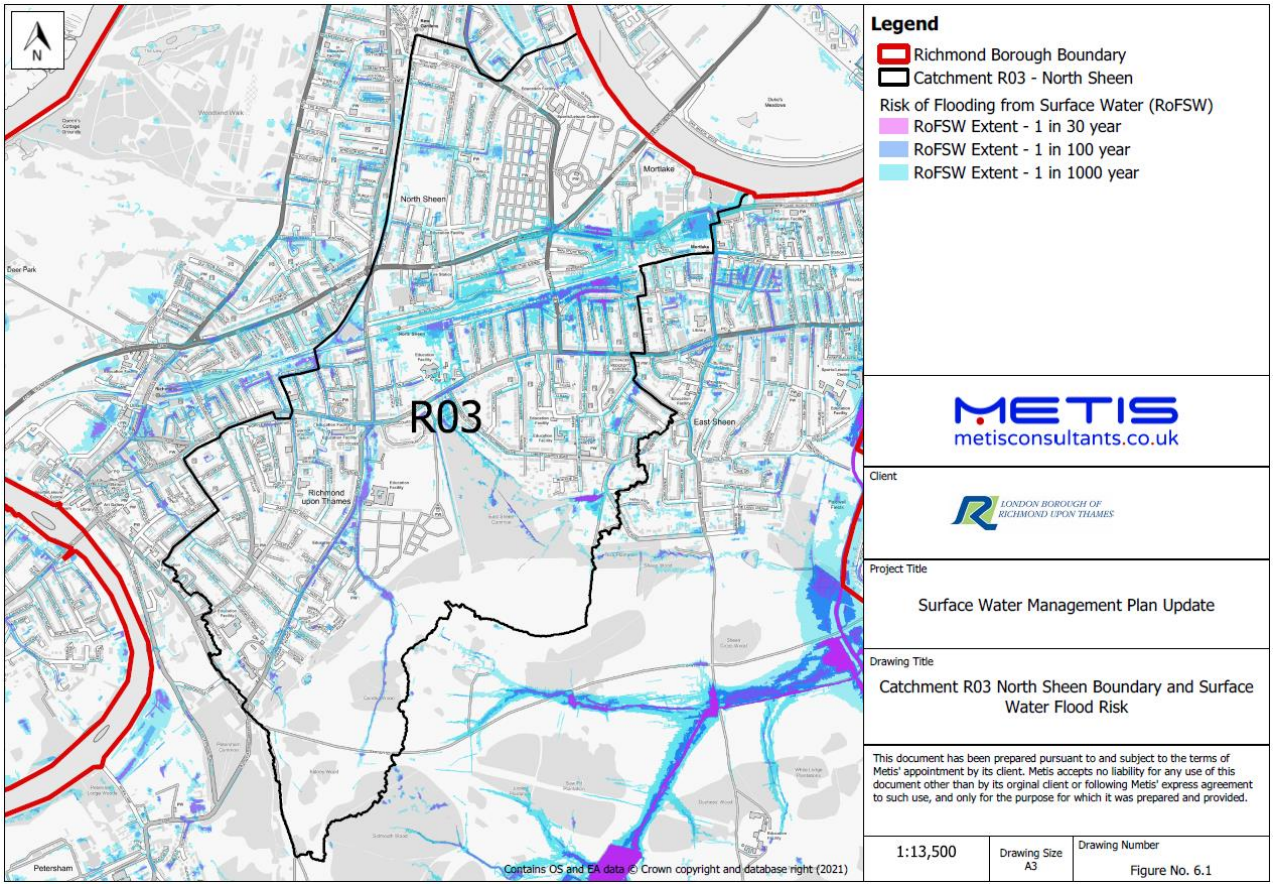

Figure 6-1 Catchment R03 North Sheen Boundary and Surface Water Flood Risk

6.3 Properties at risk and Hotspots

Table 6-1 summarises the number of properties predicted to be at risk within this Catchment. Richmond has had six historic reports of flooding in the North Sheen Catchment R03. The incidents align with the predicted risk areas, along the surface water flow paths to Queen's Road to A305 (Sheen Road) down to the railway where Hotspots are mostly located nearby.

Table 6-1 Properties at risk in Catchment R03 North Sheen

Property type	Within 30-year surface water extent	Within 100-year surface water extent	Within 1000-year surface water extent
Residential	94	304	1369
Other	9	45	180
Unclassified	15	32	121

In this Catchment, there are four Hotspots shown in *Figure 6-2*. These have been summarised in *Table 6-2.*

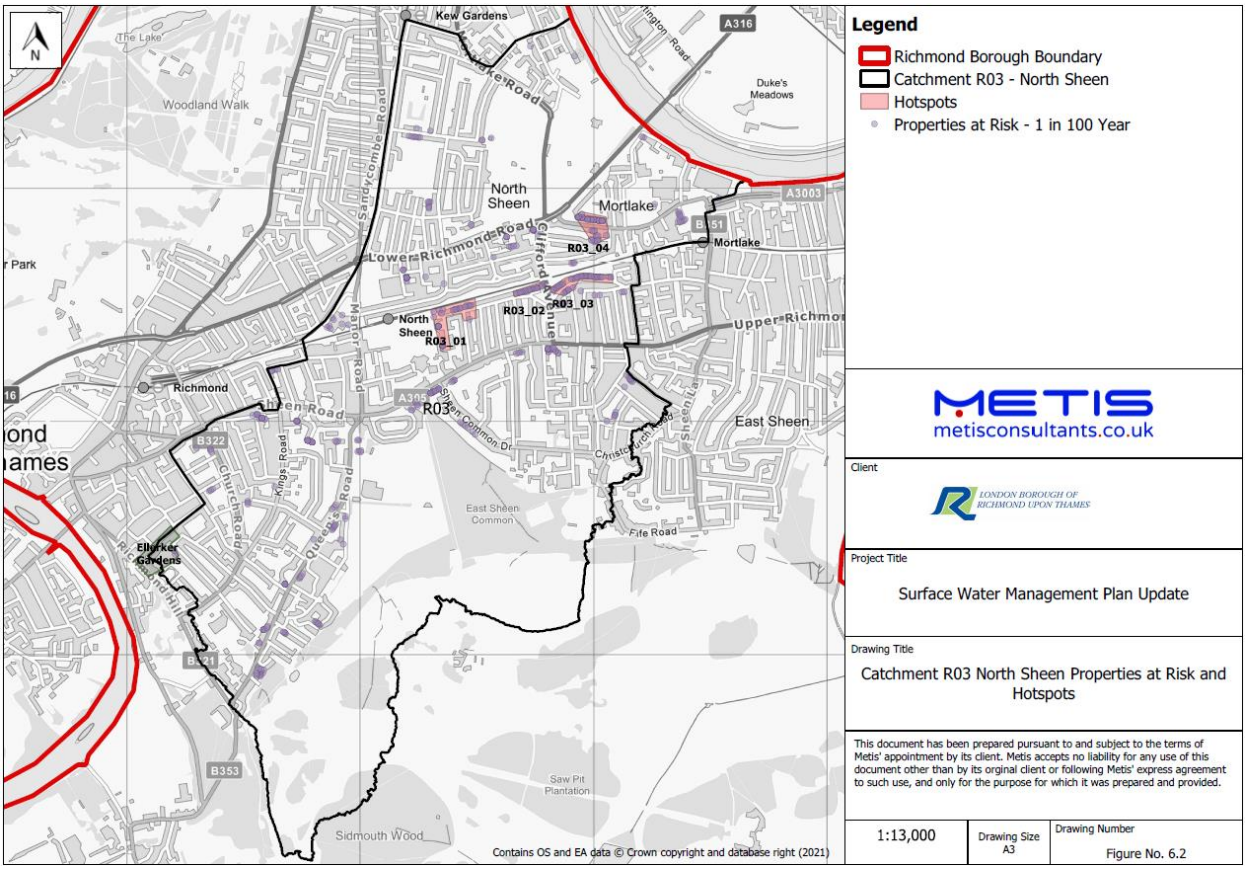

Figure 6-2 R03 Catchment North Sheen Properties at Risk and Hotspots

Table 6-2 Hotspots in Catchment R03 North Sheen

Hotspot	Location	Flow path or streets affected	Properties predicted to be at risk from surface water flooding from the 1 in 100-year return period
R03_01	North Sheen	Along the Sheen Court Road flow path to the railway line near North Sheen Station	34
R03_02	North Sheen	Along the Tangier Road flow path to the A205 (Clifford Avenue)	17
R03_03	North Sheen	Along the St Leonards Road flow path to the A205 (Clifford Avenue)	37
R03_04	North Sheen	Along the A3003 (Lower Richmond Road) flow path to Mortlake High Street	43

6.4 Historic Flood Incidents and Flood Incident Areas

All flood reports have been in the urbanised part of this Catchment. Recorded flood incidents and Flood Incident Areas are shown in *Figure 6-3* and summarised in *Table 6-3*. Most incidents align with the predicted risk areas and Hotspots, along the surface water flow paths to Kew Gardens, along the A316 (Lower Mortlake Road and Lower Richmond Road) to the River Thames and from Richmond Park to Queen's Road. Historic records show that there have been reports of properties flooding in the TW10 area (see *Figure 2-7* for postcode areas) on Montague Road and Cambrian Road in November 2020. In southern Richmond, Queen's Road frequently floods with surface water.

Table 6-3 Flood Incident Areas in Catchment R03 North Sheen

Flood Incident Area	Location	Related Hotspots or streets affected	Properties predicted to be at risk from surface water flooding from the 1 in 100-year return period	Recorded flood incidents in this location
Ellerker Gardens	Richmond	Along Ellerker Gardens (overlaps into Catchments R02 Kew and R04 Petersham)	0	2

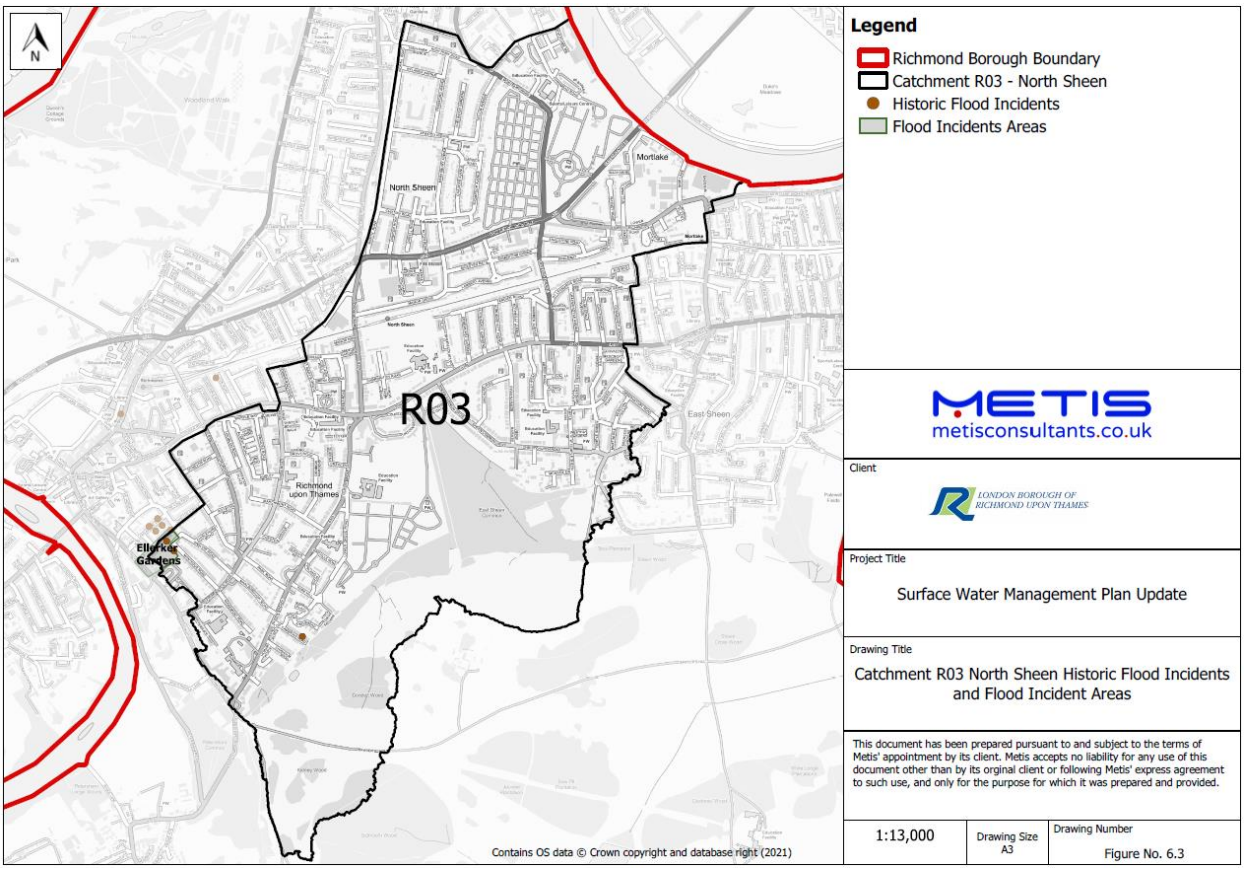

Figure 6-3 Catchment R03 North Sheen Historic Flood Incidents and Flood Incident Areas

7 CATCHMENT R04 - PETERSHAM

7.1 Updates since 2011 SWMP

Petersham Catchment contains CDA 5 Petersham. A flood risk management study completed in 2016 looked at the CDA in greater detail. The key results are summarised in *Table 7-1*. To date no updated flood risk modelling has been undertaken in the Petersham Catchment.

Table 7-1 Catchment R04 Petersham CDA study outcome summary

CDA	Details
5	One option of flood alleviation due to the low flood risk to properties. A swale at Petersham Park entrance was considered and additional evidence of flood risk was needed to prove the scheme to be economically viable.

7.2 Catchment extents

This Catchment (see *Figure 7-1*) contains the urbanised areas of Petersham and Ham on the southeast half of this Catchment. At the western and northern edges of the boundary are nature reserves, National Trust grounds and parks along the southern bank of the River Thames. To the east of this area is Richmond Golf Club and south of this is the Ham Local Woods Nature Reserve. The A307 (Petersham Road) cuts north from Ham, through Petersham, into Richmond. The topography of this Catchment is

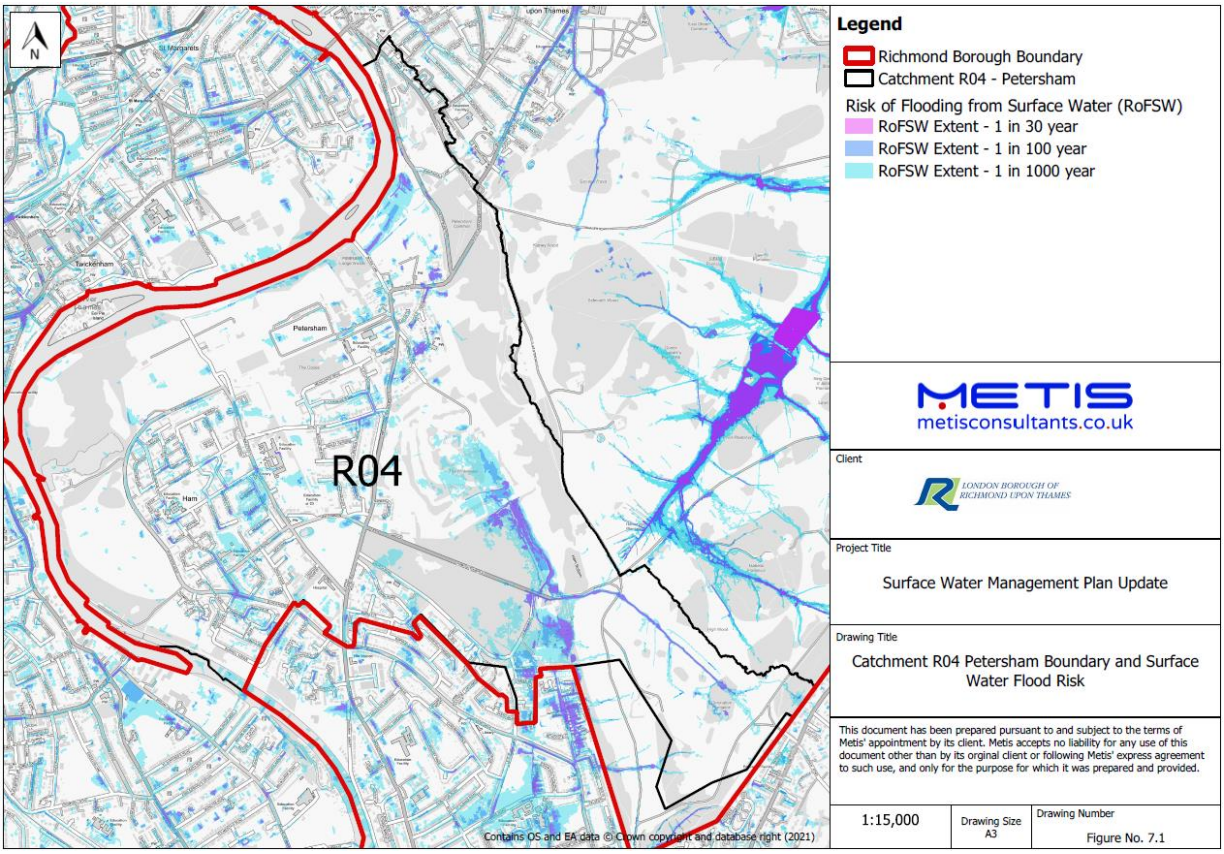

Figure 7-1 Catchment R04 Petersham Boundary and Surface Water Flood Risk

generally low lying with the highest point in Ham and lowest in Petersham with main flow paths heading from south to north along the A307 and Ham Street to the River Thames.

7.3 Properties at risk and Hotspots

Table 7-2 summarises the number of properties predicted to be at risk within this Catchment. Richmond has had 1 historic report of flooding in the Petersham Catchment R04. The incident aligns outside the predicted risk areas, far North of the only Hotspot in this Catchment.

Table 7-2 Properties at risk in Catchment R04 Petersham

Property type	Within 30-year surface water extent	Within 100-year surface water extent	Within 1000-year surface water extent
Residential	9	84	569
Other	3	11	73
Unclassified	5	18	79

In this Catchment, there is one Hotspot shown in *Figure 7-2*. This has been summarised in *Table 7-3.*

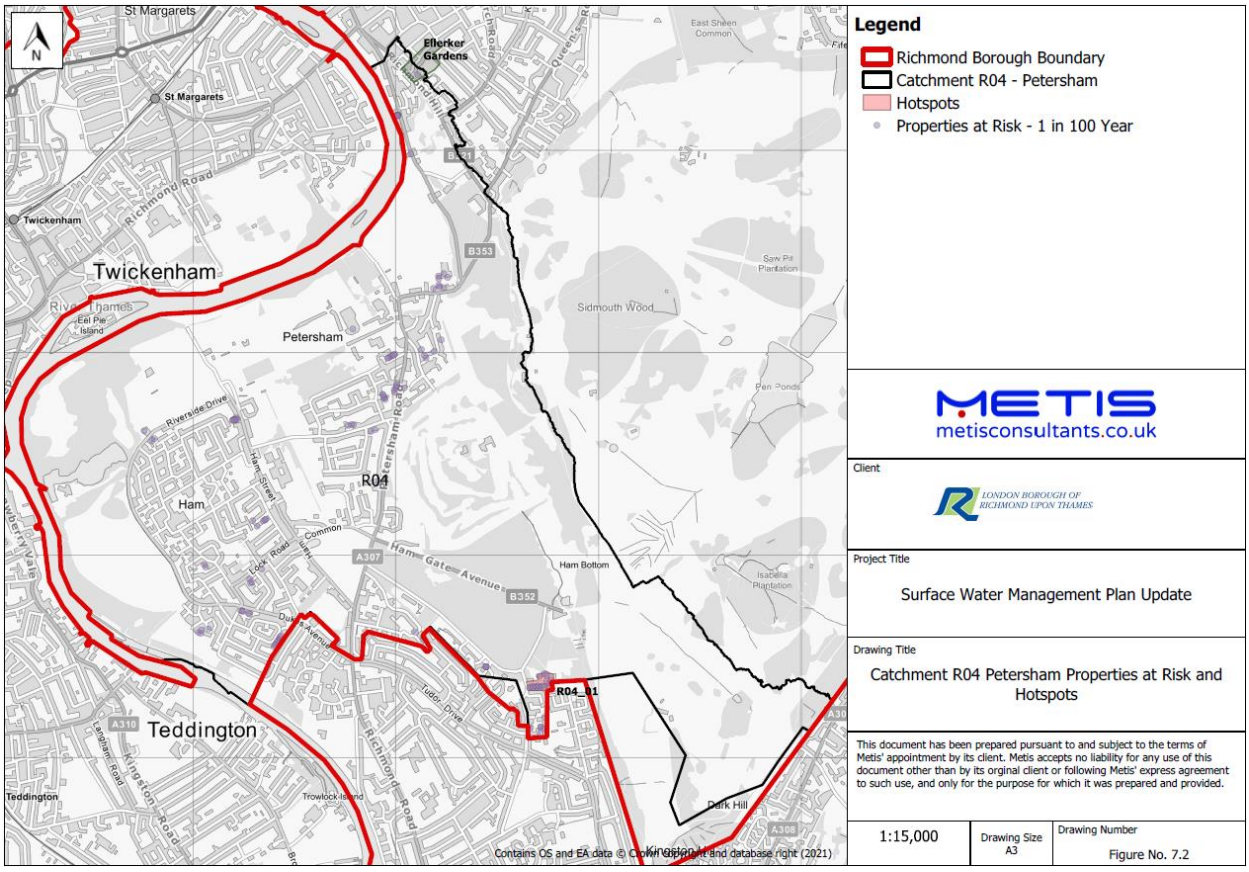

Figure 7-2 Catchment R04 Petersham Properties at Risk and Hotspots

Table 7-3 Hotspots in Catchment R04 Petersham

Hotspot	Location	Flow path or streets affected	Properties predicted to be at risk from surface water flooding from the 1 in 100-year return period
R04_01	Ham	Along the flow path at the end of Ham Ridings	16

7.4 Historic Flood Incidents and Flood Incident Areas

One historic flood incident has been in the urbanised part of this Catchment. Recorded flood incidents are shown in *Figure 7-3*. There are no Flood Incident Areas in this Catchment except the edge of Ellerker Gardens where it has been extended into this catchment due to known areas of ponding and surface water flooding. However, no properties have historically reported flooding within this part of the Flood Incident Area.

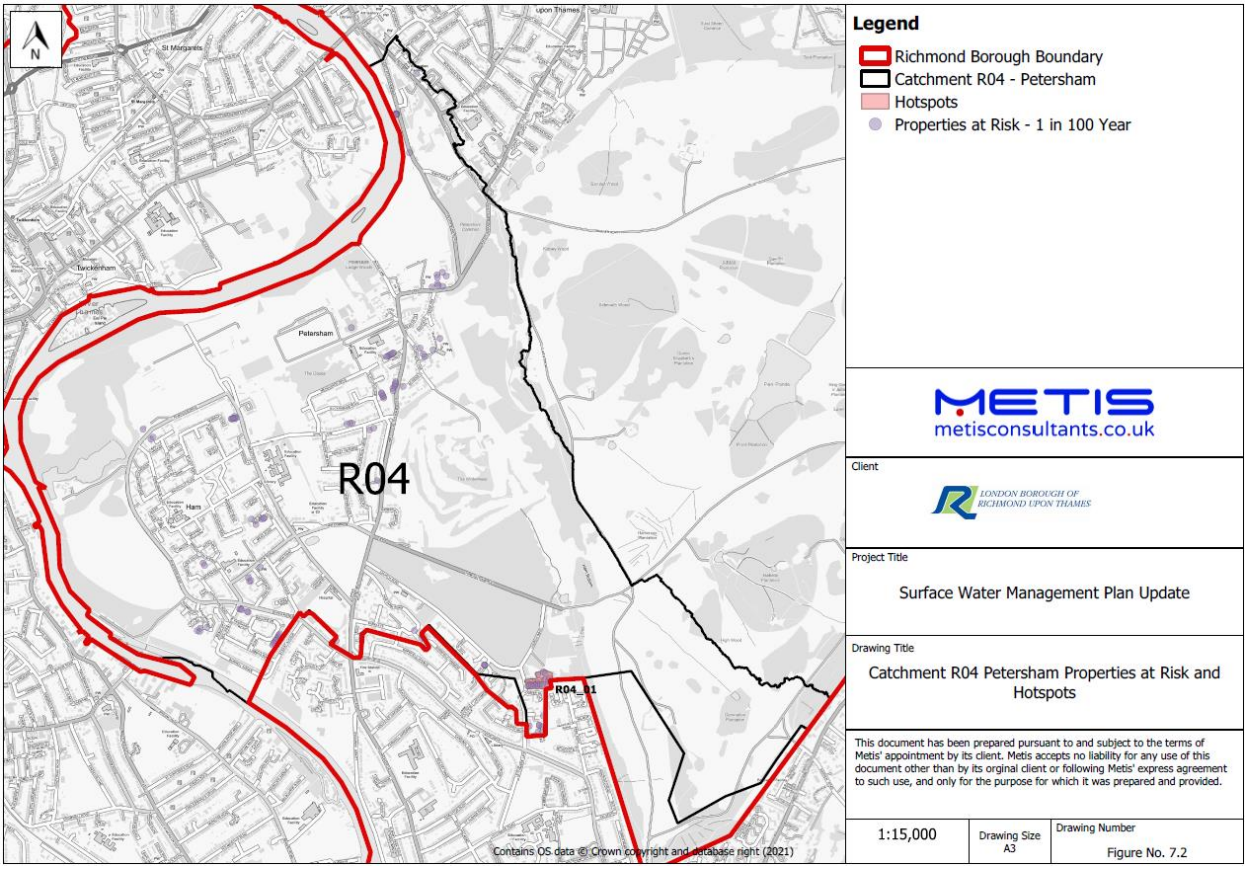

Figure 7-3 Catchment R04 Petersham Historic Flood Incidents and Flood Incident Areas

8 CATCHMENT R05 - EAST SHEEN

8.1 Updates since 2011 SWMP

East Sheen Catchment contains some of CDA 4 Richmond and Mortlake. A flood risk management study completed in 2016 looked at each of the CDAs in greater detail. However, no schemes were taken forward in this Catchment for further consideration. To date no updated flood risk modelling has been undertaken in the East Sheen Catchment but this catchment includes the Beverley Brook flood resilience project.

8.2 Catchment extents

This Catchment (see Figure *8-1*) contains most of Richmond Park from north of the A306 (Kingston Hill) to East Sheen which is the only urbanised area of this Catchment. The western border of this Catchment is along Queens Road up to Sidmouth Wood. Key infrastructure includes Mortlake Station, where the railway cuts through the northern tip of this Catchment east to west, and the A205 (Upper

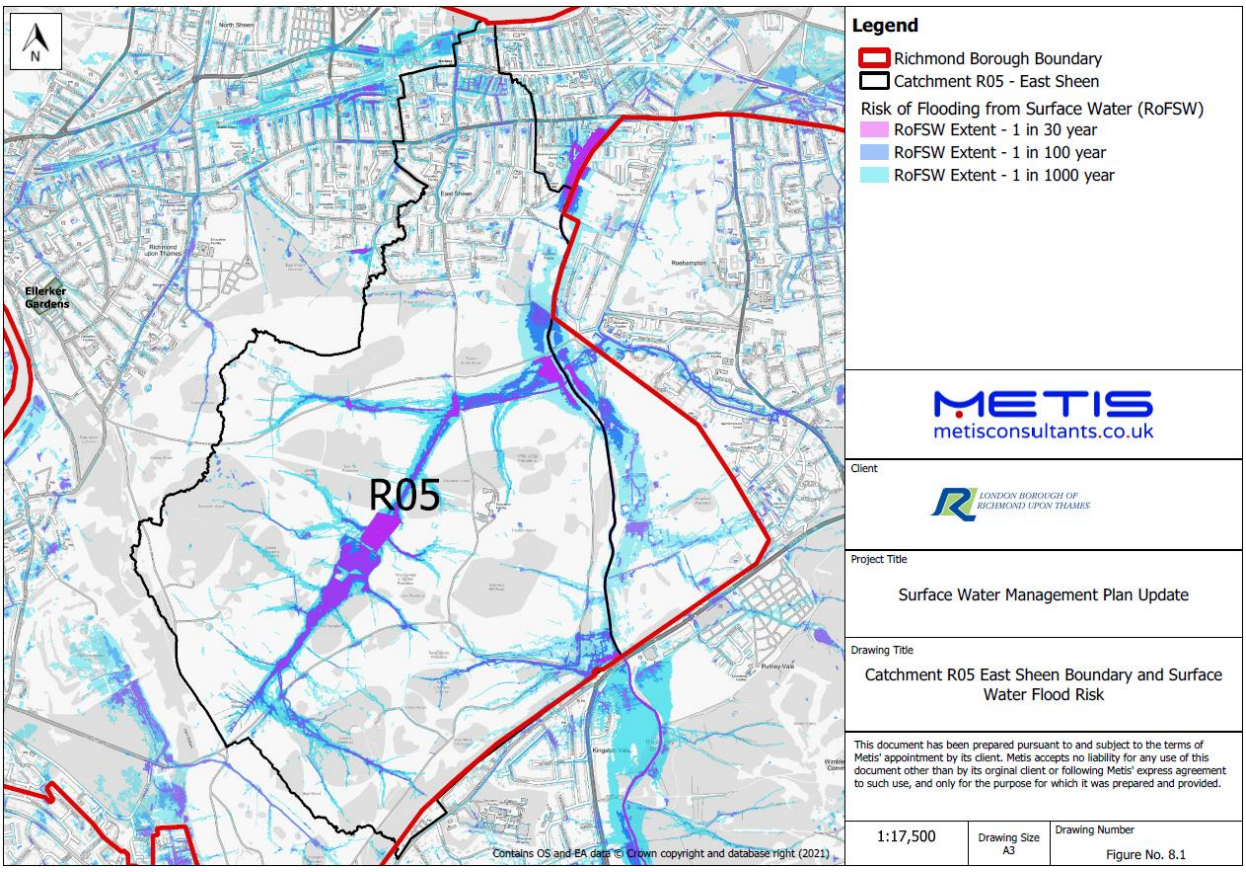

Figure 8-1 Catchment R05 East Sheen Boundary and Surface Water Flood Risk

Richmond Way). The topography of this area is generally higher in the south and lower lying in the north in East Sheen where the flow paths lead from Richmond Park, in a northernly direction, to the A205. The flow paths north of the A205 convey north to the River Thames.

8.3 Properties at risk and Hotspots

Table 8-1 summarises the number of properties predicted to be at risk within this Catchment. Richmond has had no historic reports of flooding in the East Sheen Catchment R05.

Table 8-1 Properties at risk in Catchment R05 East Sheen

Property type	Within 30-year surface water extent	Within 100-year surface water extent	Within 1000-year surface water extent
Residential	37	167	669
Other	28	70	233
Unclassified	8	17	60

In this Catchment, there is one Hotspot shown in *Figure 8-2* and summarised in *Table 8-2*.

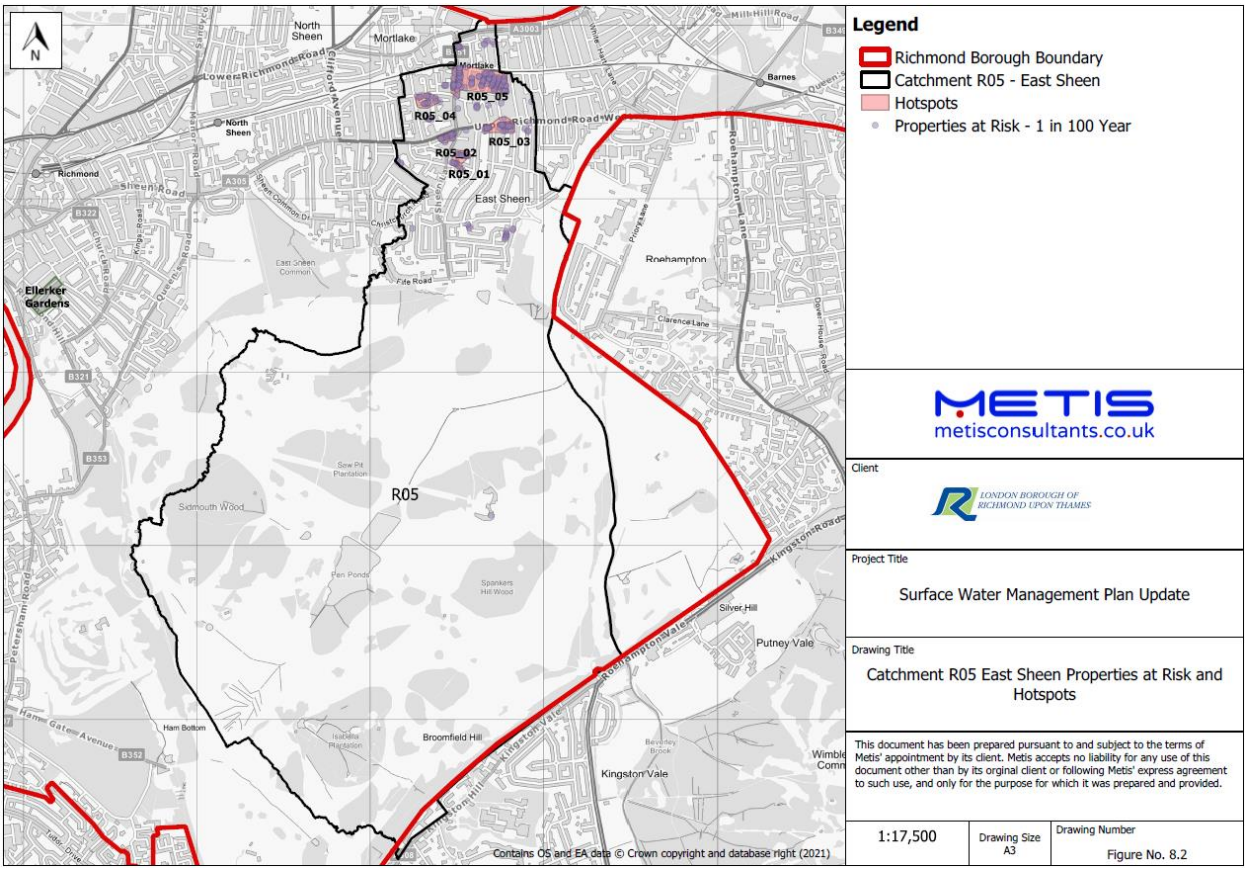

Figure 8-2 Catchment R05 East Sheen Properties at Risk and Hotspots

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Table 8-2 Hotspots in Catchment R05 East Sheen

Hotspot	Location	Flow path or streets affected	Properties predicted to be at risk from surface water flooding from the 1 in 100-year return period
R05_01	East Sheen	Along the flow paths to Richmond Park Road	21
R05_02	East Sheen	Along the flow path to A205 Upper Richmond Road	18
R05_03	East Sheen	Along the flow path along A205 Upper Richmond Road	34
R05_04	East Sheen	Along the flow path along St Leonards Road	18
R05_05	East Sheen	Along the flow path along the railway east, away from Mortlake Station	113

8.4 Historic Flood Incidents and Flood Incident Areas

There are no historic or recent reports of flooding in this Catchment, surface water flood risk is identified in *Figure 8-1*, which shows surface water mostly gathers and flows east of the R05 East Sheen Catchment border. There are no Flood Incident Areas in this Catchment.

9 CATCHMENT R06/W01 - PUTNEY

9.1 Updates since 2011 SWMP

Putney Catchment contains some of CDA 4 Richmond and Mortlake. The flood risk management study completed in 2016 looked at each of the CDAs in greater detail. However, no schemes were taken forward in this Catchment for further consideration. To date no updated flood risk modelling has been undertaken in the Putney Catchment but this catchment includes the Beverley Brook flood resilience project.

9.2 Catchment extents

This Catchment (see *Figure 9-1*) is located across the border of LB Richmond and LB Wandsworth. It is mostly urbanised in the Mortlake, Barnes, and Putney areas with the WWT London Wetland Centre on the east side next to the River Thames. The River Thames is on the northern edge of this Catchment. Other notable features are the Barn Elms Sports Trust grounds and Putney Bridge. The A3 (West Hill), within the south border of this Catchment, and A205 (Upper Richmond Road) cuts across the centre of Putney. The A306 (Castlenau) also cuts in a northernly direction through Barnes. Barnes Bridge, Barnes, Putney and East Putney Stations are in this Catchment along the railway from the west side of the Catchment across to the east. The topography in this Catchment is highest on the furthest extents from the River Thames with the main flow paths conveying from south to north to the A205 (Upper

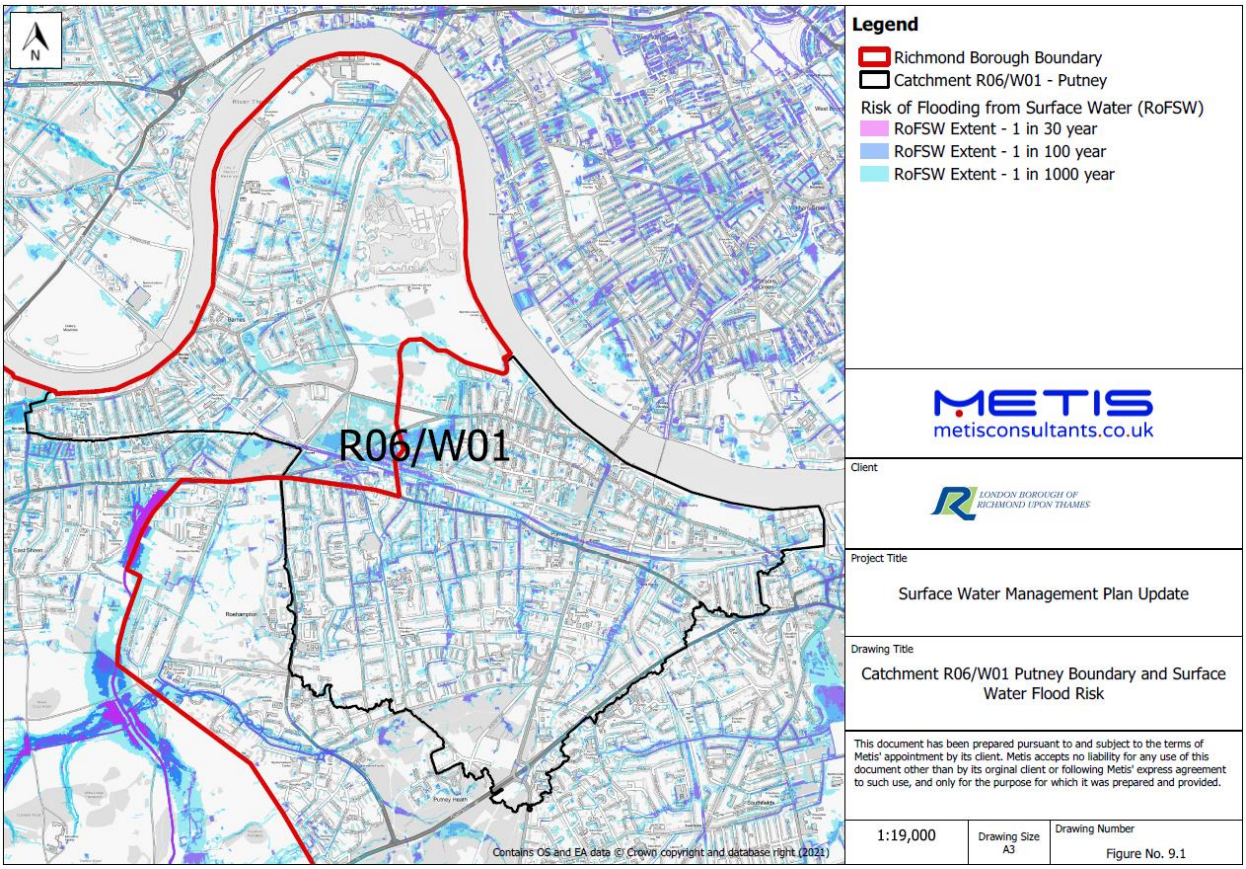

Figure 9-1 Catchment R06/W01 Putney Boundary and Surface Water Flood Risk

Richmond Road). This acts as a break and surface water conveys east from here, then the flow paths convey to the River Thames.

9.3 Properties at risk and Hotspots

Table 9-1 summarises the number of properties predicted to be at risk within this Catchment (Richmond only). Richmond has had no reports of flooding in the Putney Catchment R06/W01.

Table 9-1 Properties at risk in Catchment R06/W01 Putney

Property type	Within 30-year surface water extent	Within 100-year surface water extent	Within 1000-year surface water extent
Residential	88	281	1483
Other	10	40	174
Unclassified	12	30	127

In this Catchment, there are two Hotspots shown in *Figure 9-2*. These have been summarised in

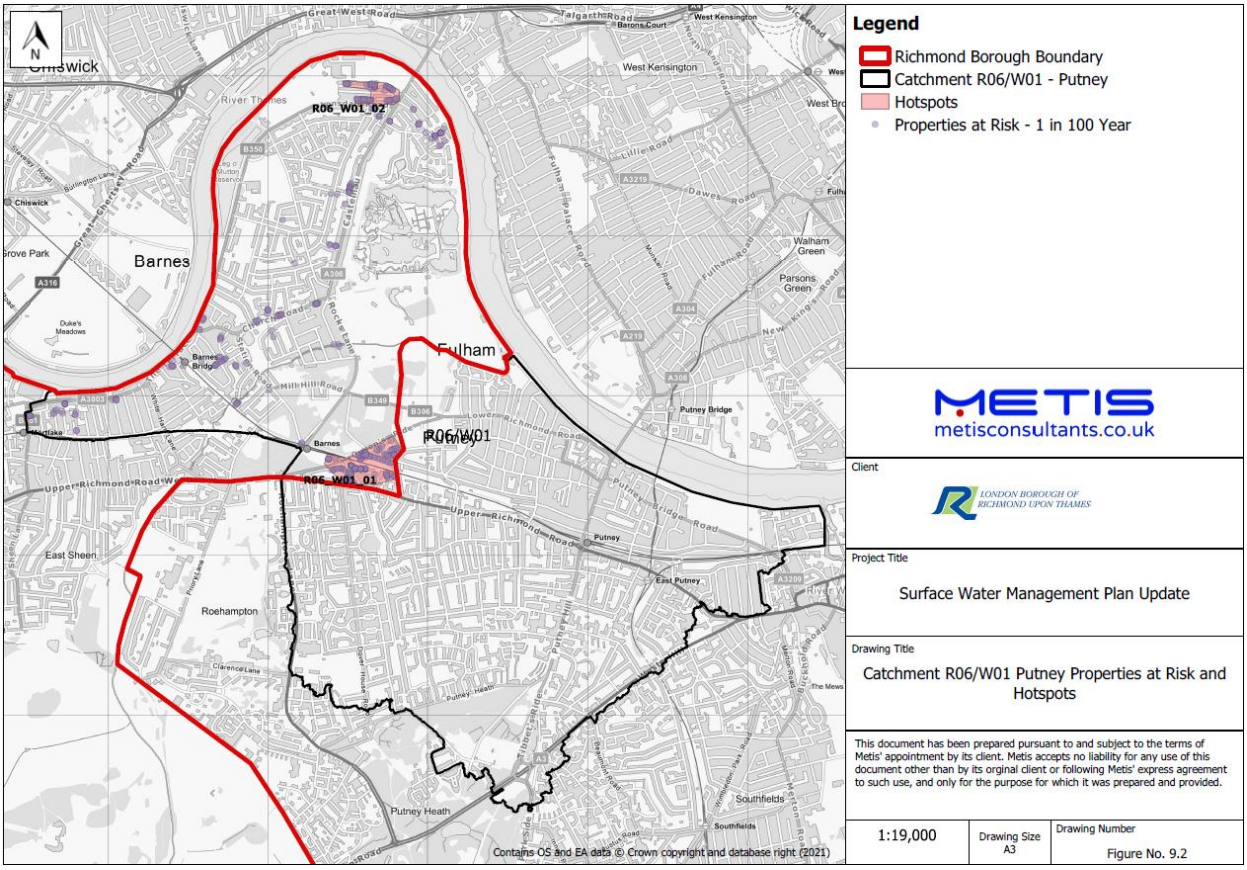

Figure 9-2 Catchment R06/W01 Putney Properties at Risk and Hotspots

Table 9-2.

Table 9-2 Hotspots in Putney Catchment R06/W01

Hotspot	Location	Flow path or streets affected	Properties predicted to be at risk from surface water flooding from the 1 in 100 -ear return period
R06_W01_01	Barnes	Flow paths to the railway line near Barnes Station	134
R06_W01_02	Barnes	Flow paths to Hammersmith Bridge and the River Thames	53

9.4 Historic Flood Incidents and Flood Incident Areas

There are no historic or recent reports of flooding in this Catchment, surface water flood risk is identified in *Figure 9-1*, which shows surface water mostly gathers and flows east of the LB Wandsworth border to Putney. There are no Flood Incident Areas in this Catchment.

10 CATCHMENT R07/W02 - PUTNEY HEATH

10.1 Updates since 2011 SWMP

Putney Heath Catchment contains some of CDA 4 Richmond and Mortlake. The flood risk management study completed in 2016 looked at each of the CDAs in greater detail. However, no schemes were taken forward in this Catchment for further consideration. To date no updated flood risk modelling has been undertaken in the Putney Heath Catchment but this catchment includes the Beverley Brook flood resilience project.

10.2 Catchment extents

This Catchment (see *Figure 10-1*) contains the eastern edge of Richmond Park and the northern part of Wimbledon Common. This Catchment also includes urbanised areas such as East Sheen, Putney Vale, Putney Heath and Roehampton. Notable features include the University of Roehampton and Richmond Park Golf Course. The A3 (Kingston Road) cuts northwest through the centre of this Catchment and the A306 (Roehampton Lane) leads north from this along the east of this Catchment up to the A205 (Upper Richmond Road). The Beverley Brook also runs north along the western edge of this Catchment. The general topography is highest on the eastern edge and lower on the western edge with most surface water running along flow paths to Beverley Brook, mostly along the A306. From the A205, the flow path conveys north to the River Thames.

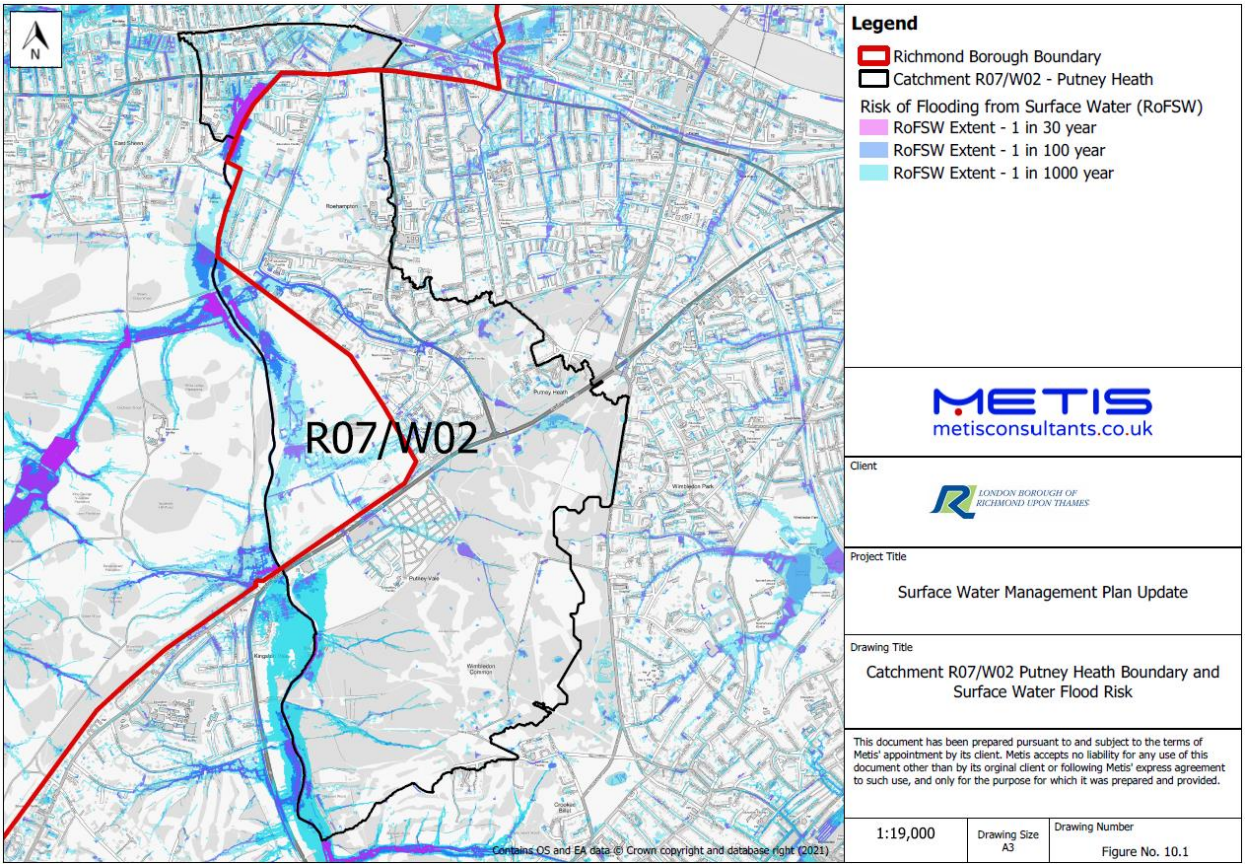

Figure 10-1 Catchment R07/W02 Putney Heath Boundary and Surface Water Flood Risk

10.3 Properties at risk and Hotspots

Table 10-1 summarises the number of properties predicted to be at risk within this Catchment (Richmond only). Richmond has had 1 historic report of flooding in the Putney Heath Catchment R07/W02. The incident aligns with the predicted risk areas, along the surface water flow paths on Eleanor Grove to White Hart Lane to A205 (Upper Richmond Road west) where a Hotspot is located.

Table 10-1 Properties at risk in Catchment R07/W02 Putney Heath

Property type	Within 30-year surface water extent	Within 100-year surface water extent	Within 1000-year surface water extent
Residential	9	50	466
Other	1	2	21
Unclassified	2	7	31

In this Catchment, there is one Hotspot shown in *Figure 10-2*. This has been summarised in *Table* 10-2.

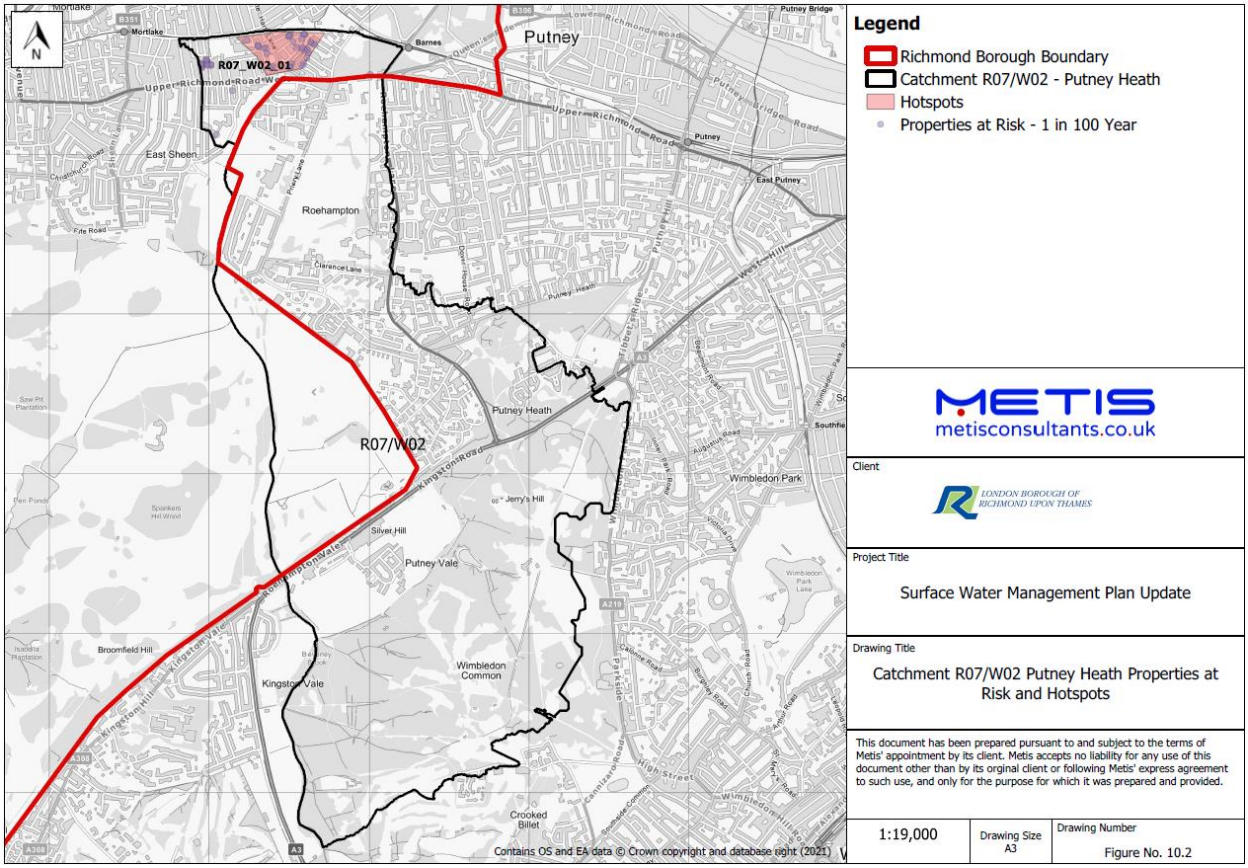

Figure 10-2 Catchment R07/W02 Putney Heath Properties at Risk and Hotspots

Table 10-2 Hotspots in Catchment R07/W02 Putney Heath

Hotspot	Location	Flow path or streets affected	Properties predicted to be at risk from surface water flooding from the 1 in 100-year return period
R07_W02_01	Barnes	Flow paths along White Hart Lane to the A205 (Upper Richmond Road)	35

10.4 Historic Flood Incidents and Flood Incident Areas

There is one historic report of flood incidents in this Catchment (in the LB Richmond boundary) which is a recent report in July 2021 on Eleanor Grove. The flood report was in the urbanised part of this Catchment. There are no identified Flood Incident Areas in this Catchment. The incident aligns with the predicted risk areas and Hotspots, along the flow paths to Beverley Brook (*Figure 10-3*).

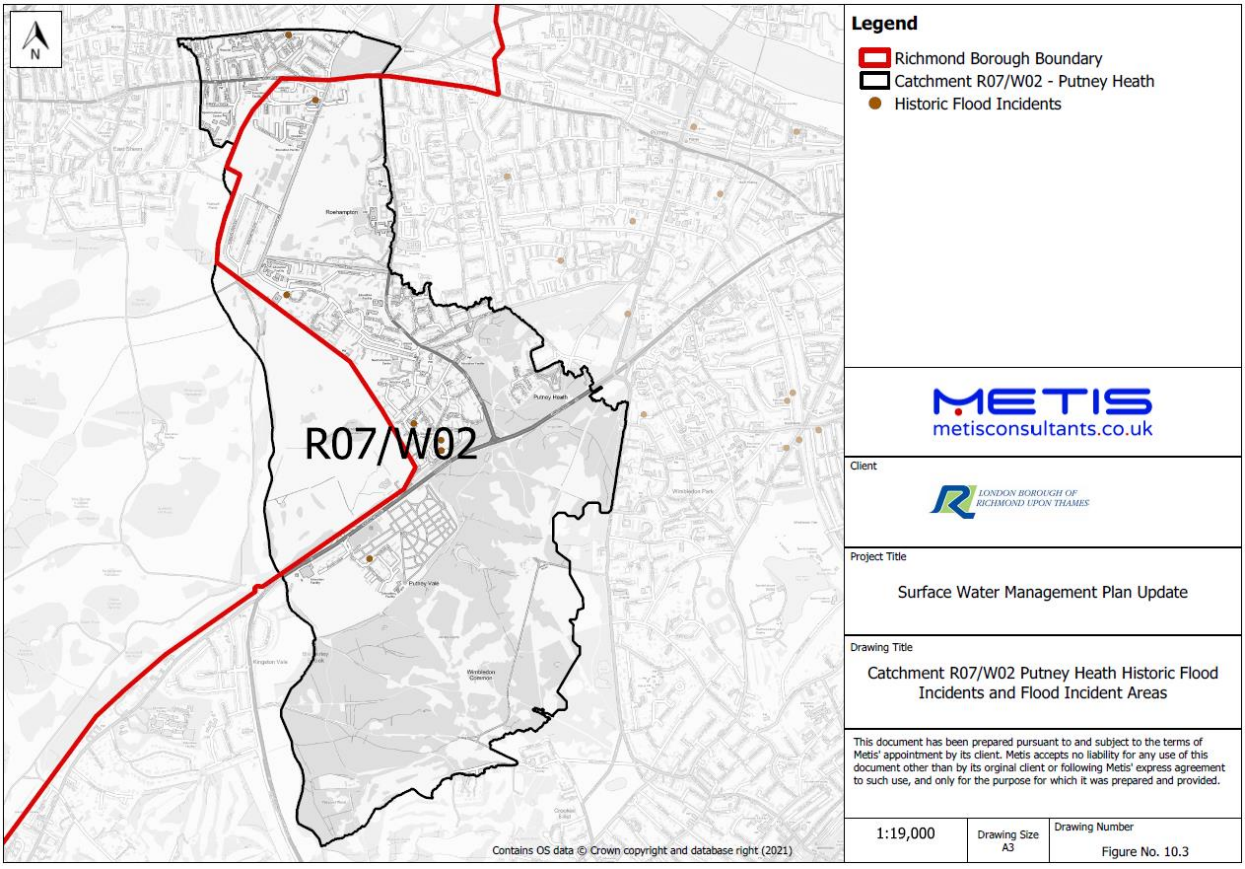

Figure 10-3 Catchment R07/W02 Putney Heath Historic Flood Incidents and Flood Incident Areas

11 CATCHMENT H6 - ISLEWORTH & NORTH TWICKENHAM

11.1 Updates since 2011 SWMP

Although this Catchment contains CDA 1 Twickenham, no former CDAs have been identified within the LB Hounslow boundary. A flood risk management study completed in 2016 looked at each of the CDAs in greater detail. However, no schemes were taken forward in this Catchment for consideration as validation of flooding history is needed and Palmerston Road and the A316 (Chertsey Road) were suggested for increased maintenance. To date no updated flood risk modelling has been undertaken in the Isleworth and North Twickenham Catchment but this catchment includes the Marlow Crescent SuDS project currently ongoing. This is at concept design stage.

11.2 Catchment extents

This Catchment (see *Figure 11-1*) is mostly urbanised and includes Mogden Wastewater Treatment Works, Whitton Railway Station, and Twickenham Stadium. The River Crane surrounds the south of this Catchment, with the Duke of Northumberland River crossing this Catchment from South to North through the Mogden Wastewater Treatment Works. Whitton, Hanworth, Woodlands, North

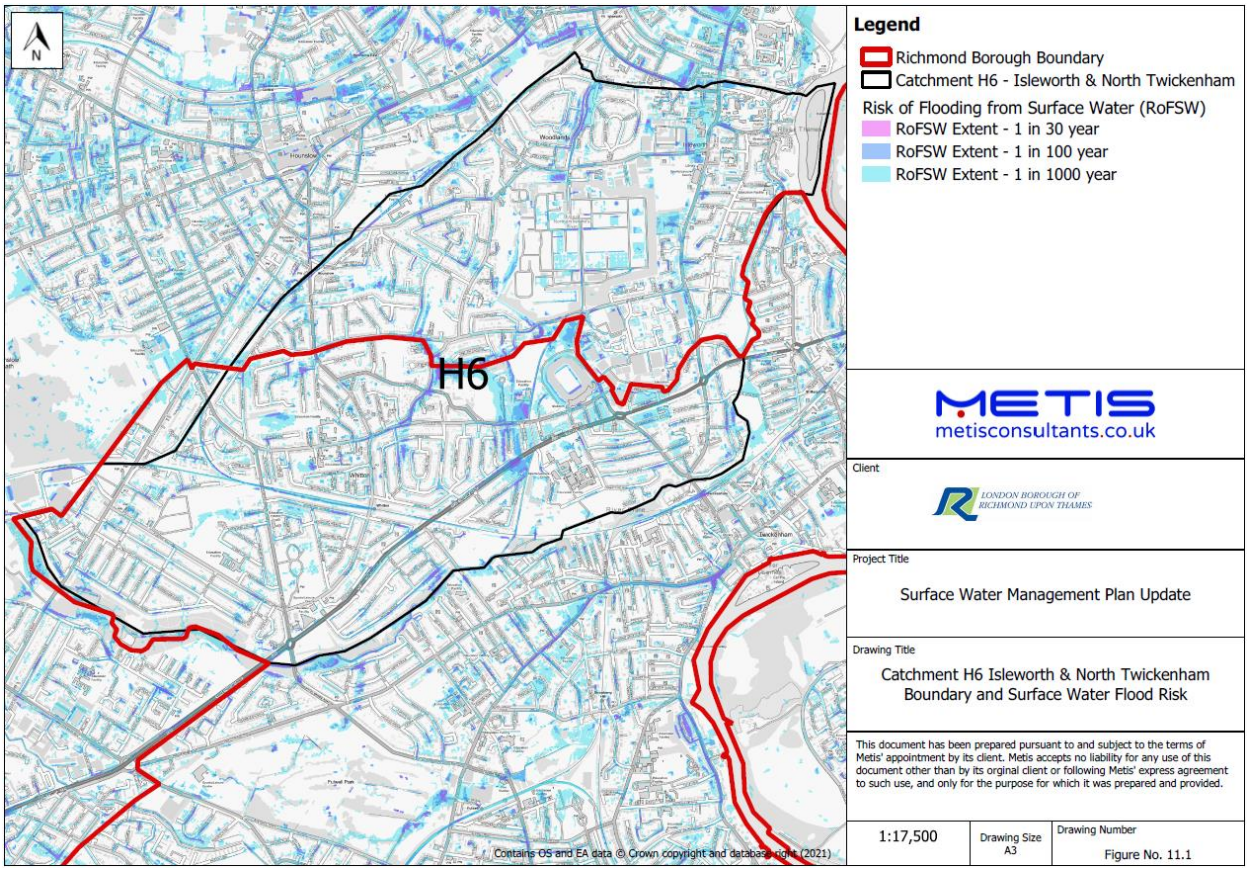

Figure 11-1 Catchment H6 Isleworth & North Twickenham Boundary and Surface Water Flood Risk

Twickenham and Isleworth are also located in this Catchment. Key infrastructure includes the railway

line running through Whitton from west to east through the southern half of the Catchment. The topography of this Catchment is generally highest in the west and lowest in the east to the River Thames. Surface water flood risk mapped by the RoFSW extents seems to follow the River Crane along the southern edge of the Catchment boundary, the Duke of Northumberland's River just below the LB Hounslow administrative boundary, and along Twickenham Road from the north-west.

11.3 Properties at risk and Hotspots

Table 11-1 summarises the number of properties predicted to be at risk within this Catchment (Richmond only). Richmond has had one historic report of flooding in the Isleworth and North Twickenham Catchment H6.

Table 11-1 Properties at risk in Catchment H6 Isleworth & North Twickenham

Property type	Within 30-year surface water extent	Within 100-year surface water extent	Within 1000-year surface water extent
Residential	27	169	1114
Other	4	16	80
Unclassified	1	19	81

In this Catchment, there are two Hotspots shown in *Figure 11-2*. This has been summarised in *Table 11-2*.

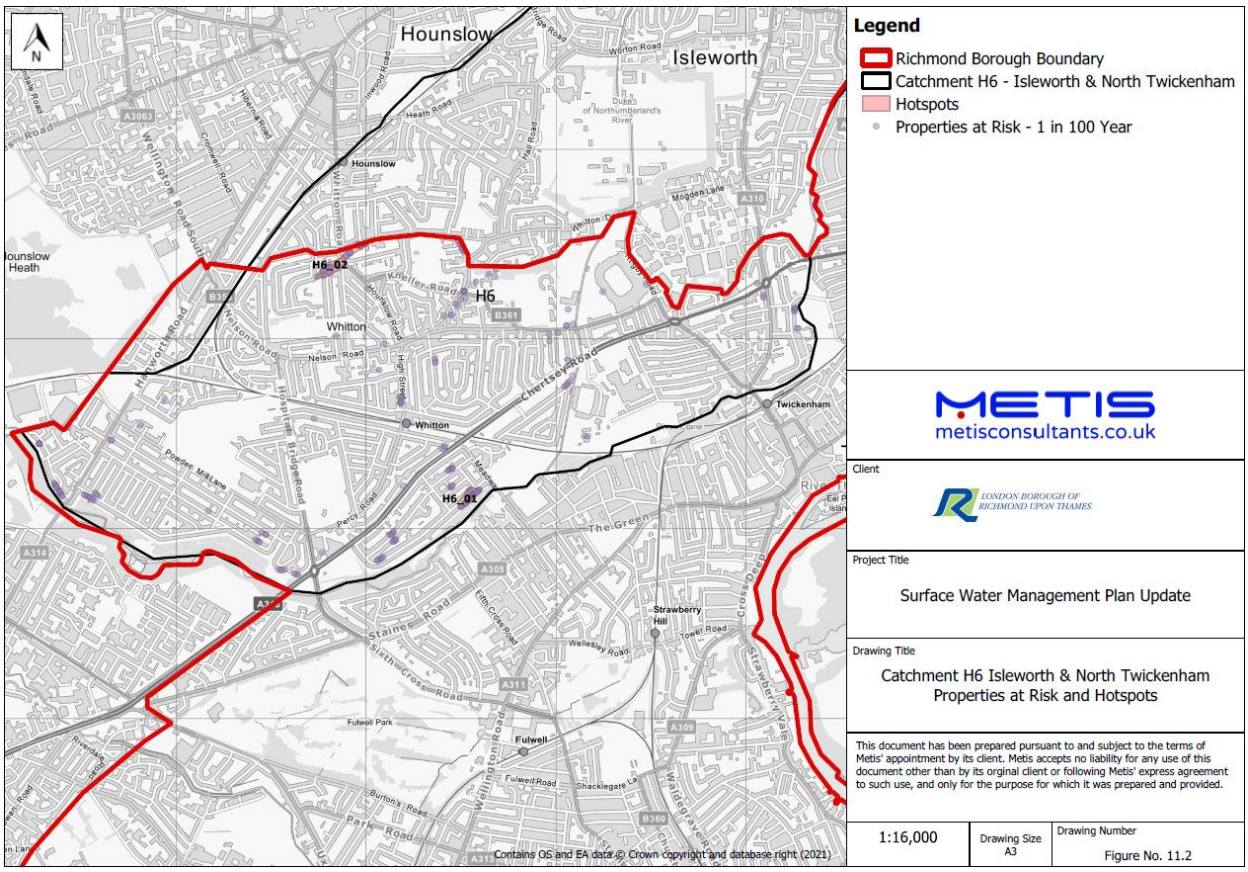

Figure 11-2 Catchment H6 Isleworth & North Twickenham Properties at Risk and Hotspots

Table 11-2 Hotspots in Catchment H6 Isleworth & North Twickenham

Hotspot	Location	Flow path or streets affected	Properties predicted to be at risk from surface water flooding from the 1 in 100-year return period
H6_01	Whitton	On the flow path along Lincoln Avenue to the River Crane	26
H6_02	Whitton	Along the flow path from Rydal Gardens and Whitton Dene to Whitton Road	27

11.4 Historic Flood Incidents and Flood Incident Areas

One historic flood incident from the LLFA is recorded within this Catchment. It was a report of sewer flooding from July 2021 in the TW2 area (see *Figure 2-7* for postal codes) at Lincoln Avenue where a property flooded. The flood report was in the urbanised area of this Catchment. Recorded flood incidents are shown in *Figure 11-3*. There are no Flood Incident Areas in this Catchment.

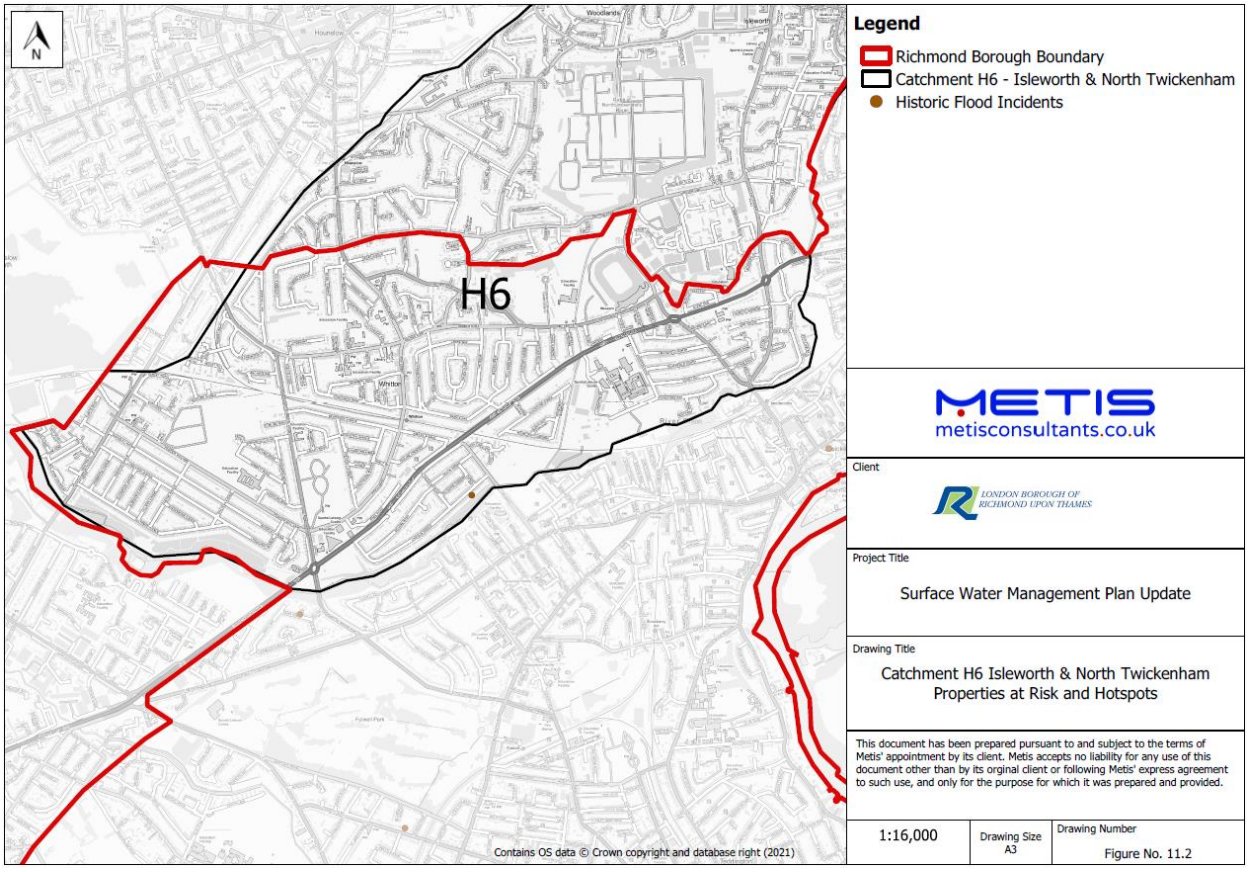

Figure 11-3 Catchment H6 Isleworth & North Twickenham Historic Flood Incidents and Flood Incident Areas

12 CATCHMENT H10 - HANWORTH & SOUTH TWICKENHAM

12.1 Updates since 2011 SWMP

This Catchment contains CDA 2 St Margarets and most of CDA 3 Strawberry Hill. A flood risk management study completed in 2016 looked at each of the CDAs in greater detail. However, no schemes were taken forward in this Catchment for further consideration. There is now secured Environment Agency funding to conduct feasibility work on flood alleviation schemes in this CDA. Increased gully maintenance was recommended at Amyand Park, Arlington Road and Beaconsfield Road after the high number of flood reports from the summer 2007 flood event. In CDA 3 Strawberry Hill, there was potential for a run-off management and attenuation scheme in Fulwell Golf Course and small-scale SuDS schemes at local schools. However, potential SuDS schemes in Fulwell Golf Course were reviewed as part of a SuDS development project but no feasible options were identified due to the large number of tree protection orders in place at the golf club. In the Hounslow side of this Catchment, there are no former CDAs. The Feltham flood modelling project extents are spread across this Catchment and further into LB Hounslow. To date no updated flood risk modelling has been undertaken in the Hanworth and South Twickenham Catchment.

12.2 Catchment extents

This large Catchment consists of mostly urbanised areas including Hampton, Fulwell, Twickenham and St Margarets with parks throughout including Kempton Park, Fulwell Park and Marble Hill Park. The Longford River runs through the middle of this Catchment from northwest to southeast, being partly culverted where Feltham joins Hanworth. An unnamed drain which is also partly culverted and runs northeast of the Catchment to join the River Thames in Richmond. To the southwest, the Lower Feltham Brook joins the Portlane Brook. This Catchment also includes the Staines Reservoir Aqueduct, and the River Thames having influences around Sunbury-on-Thames. This Catchment is bounded by the River Crane on its eastern side and the River Thames on its south and north-east borders. Key infrastructure includes the Railway Stations running through Hampton, Fulwell, Strawberry Hill, Twickenham, and St Margarets Stations. The A305 (Staines Road) and the A311 (Wellington Road) cut north-east to Twickenham. The topography of this Catchment is generally highest in the centre with flow paths conveying south or northeast to the River Thames. Surface water flood risk in the Catchment can be seen in *Figure 12-1.*

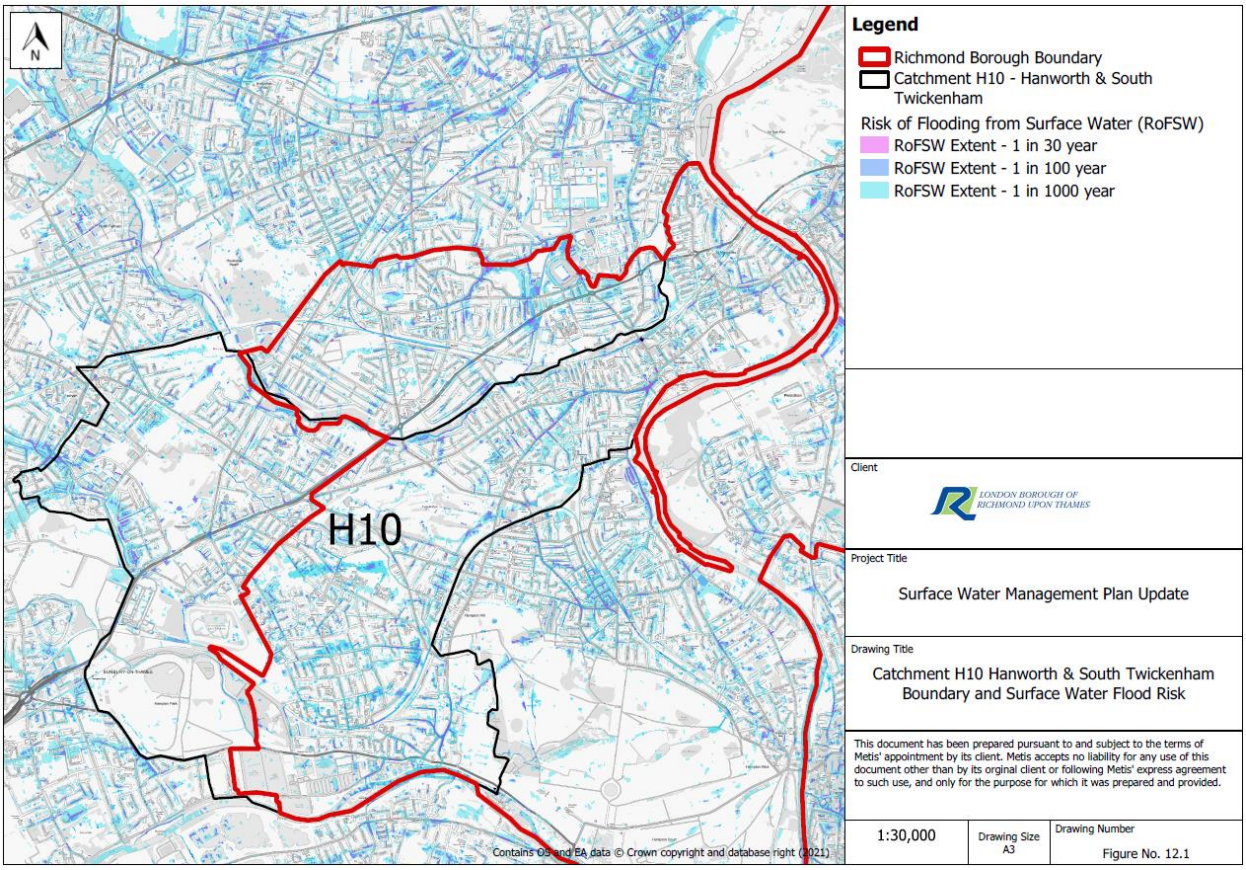

Figure 12-1 Catchment H10 Hanworth & South Twickenham Boundary and Surface Water Flood Risk

12.3 Properties at risk and Hotspots

Table 12-1 summarises the number of properties predicted to be at risk within this Catchment (Richmond only). Richmond has had 5 historic reports of flooding in the Hanworth and South Twickenham Catchment H10. The incidents align with the predicted risk areas, along the surface water flow paths on The Avenue, the A313 (Park Road), River Way (next to the River Crane) and Church Lane where Hotspots are located.

Table 12-1 Properties at Risk in Catchment H10 Hanworth & South Twickenham

Property type	Within 30-year surface water extent	Within 100-year surface water extent	Within 1000-year surface water extent
Residential	90	459	2988
Other	25	130	589
Unclassified	8	43	272

In this Catchment, there are six Hotspots shown in *Figure 12-2*. This has been summarised in Table 12-2.

Table 12-2 Hotspots in Catchment H10 Hanworth & South Twickenham

Hotspot	Location	Flow path or streets affected	Properties predicted to be at risk from surface water flooding from the 1 in 100-year return period
H10_01	Twickenham	On the flow path along Cross Deep to the A305 (York Street)	59
H10_02	Twickenham	On the flow path along Amyand Park Road to Victoria Road.	16
H10_03	St Margarets	On the flow path along St Margarets Road to the River Thames	62
H10_04	Twickenham	On the flow path along St Margarets Road to the River Thames via Railshead Road	32
H10_05	Fulwell	On the flow path along Fulwell Park Avenue to the River Crane	37
H10_06	Hampton	On the flow path along Priory Road to Wensleydale Road	22

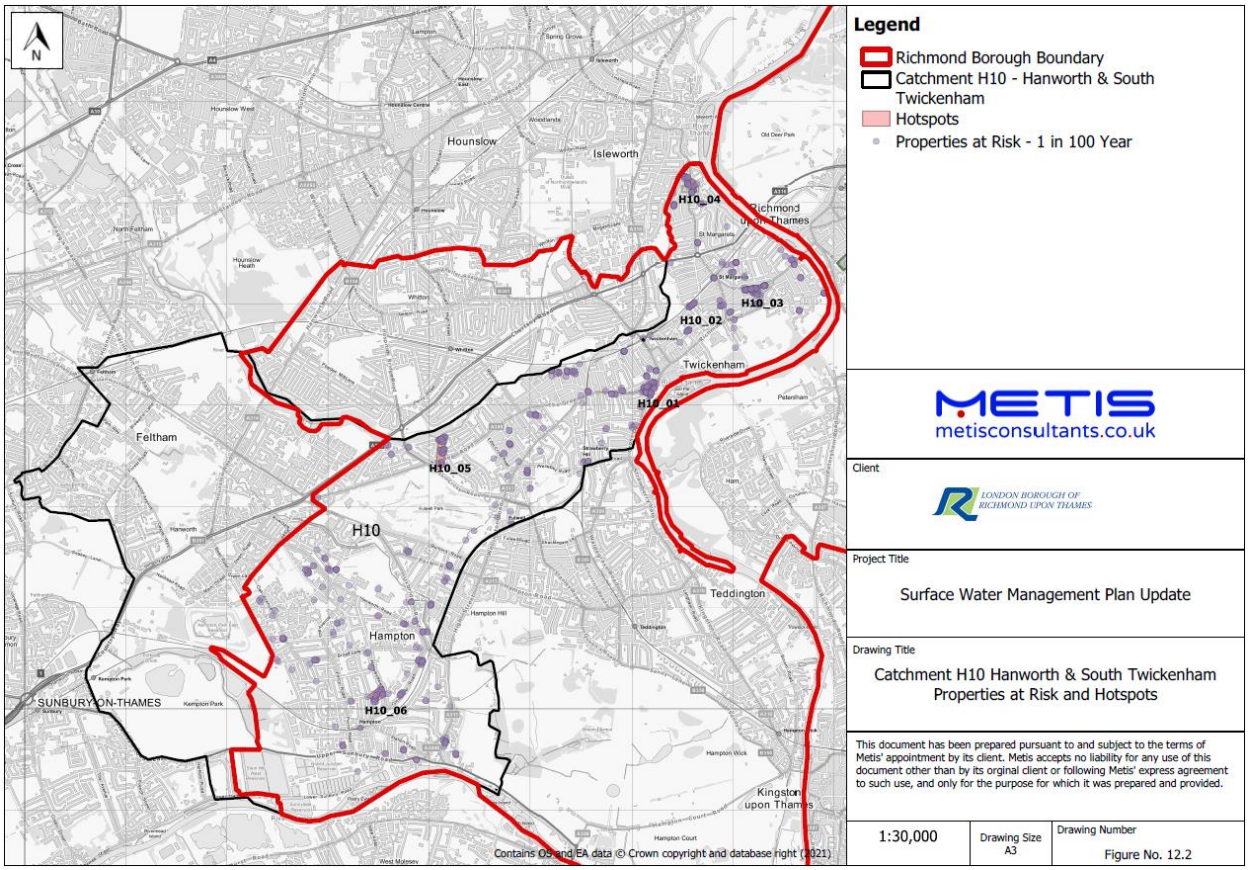

Figure 12-2 Catchment H10 Hanworth & South Twickenham Properties at Risk and Hotspots

12.4 Historic Flood Incidents and Flood Incident Areas

Historic surface water flood incidents for Hounslow are located close to both banks of the Longford River, with most concentrated along the surface water flow paths within TW1 3 (see *Figure 2-7* for postal codes) to the eastern bank of the Portlane Brook. Within Richmond, postcode area TW12 has had 11 reported sewer flood incidents reported on both banks of the Longford River. More recent reports include properties flooding in in the TW1 area of York Street in February 2021. In June 2021, at Park Road in the TW12 area property flooding was also reported. All flood reports have been in the urbanised areas of this Catchment. Recorded flood incidents are shown in *Figure 12-3*. There are no Flood Incident Areas in this Catchment. Most incidents align with the predicted risk areas and Hotspots, along the flow paths to the River Crane in the north of this Catchment, to the River Thames in the east of this Catchment and to the railway line and Fulwell Golf Course in the south of this Catchment. Further regular flood incidents have been reported at Twickenham Riverside on Park Road at the junction with Willoughby Road. In St Margarets and North Twickenham, Ailsa Road was reported as regularly flooding up to the outer walls of properties. In Hampton North, infrastructure and notable features have been reported as regularly flooding including Hampton Square, The Avenue, Courtlands Avenue, and the Green Link nature trail.

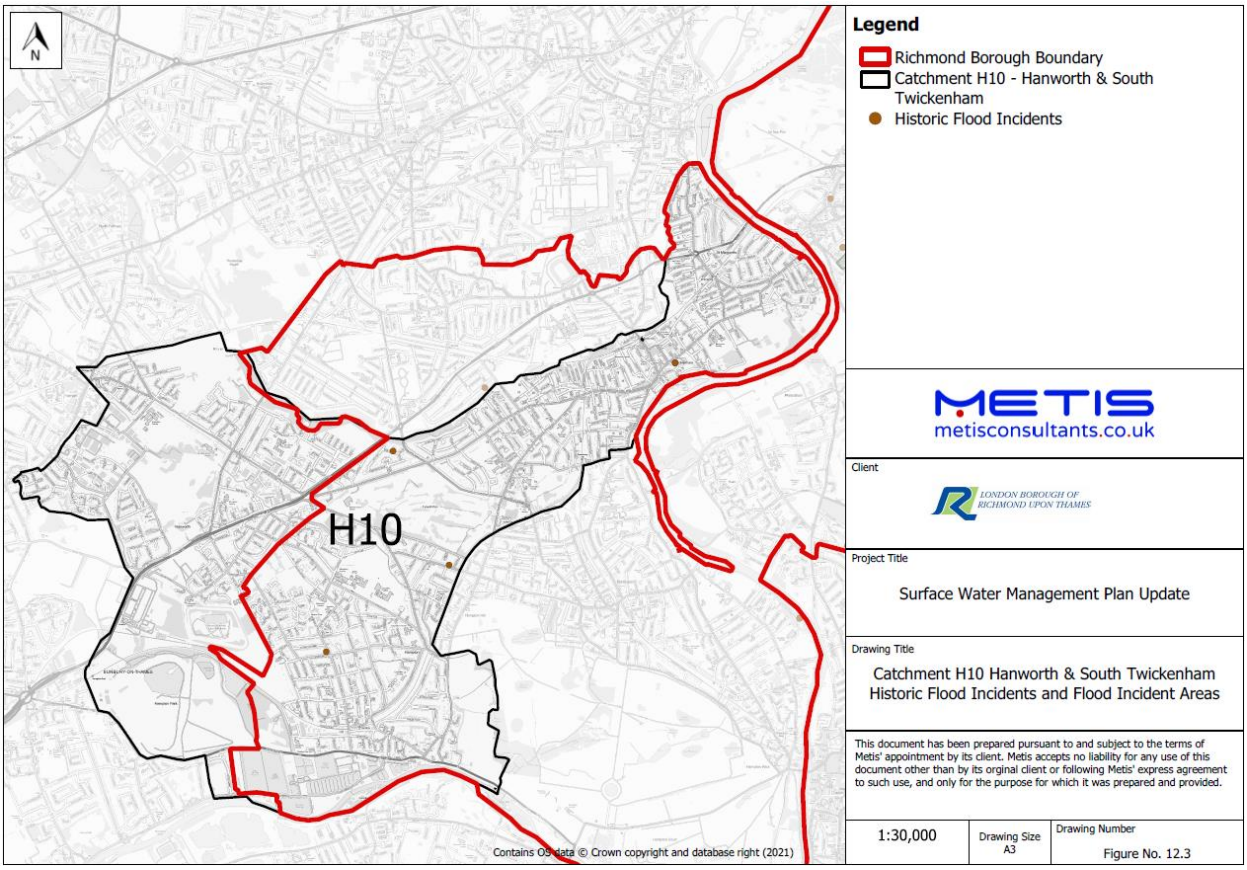

Figure 12-3 Catchment H10 Hanworth & South Twickenham Historic Flood Incidents and Flood Incident Areas

13 CATCHMENT H5 - HOUNSLOW WEST

13.1 Updates since 2011 SWMP

This Catchment contains no CDAs in LB Richmond. Catchment H5 encompasses the following former CDAs in LB Hounslow:

- Group1_026 – (between Whitton Road and Heath Road, Hounslow),
- Group1_036 – (Section of Great West Road (A4) between Osterley and Lampton)
- Group1_038 – (Railway cutting to Hounslow West Station)
- Group1_039 – (Properties near the intersection of Bridge Road and Pears Road; Hounslow Town Primary School and High Street)

To date no updated flood risk modelling has been undertaken in the Hounslow West Catchment.

13.2 Catchment extents

This Catchment is a mostly urbanised area including Hounslow, Hounslow West, Lampton, Heston and North Hyde. Hounslow Heath is on the LB Richmond administrative border and key infrastructure includes the A314 (Hanworth Road). The topography is generally highest at the LB Richmond border with flow paths conveying to the railway then heading west to the Rive Crane through Hounslow Heath. Catchment extents and surface water flood risk can be seen in *Figure 13-1.*

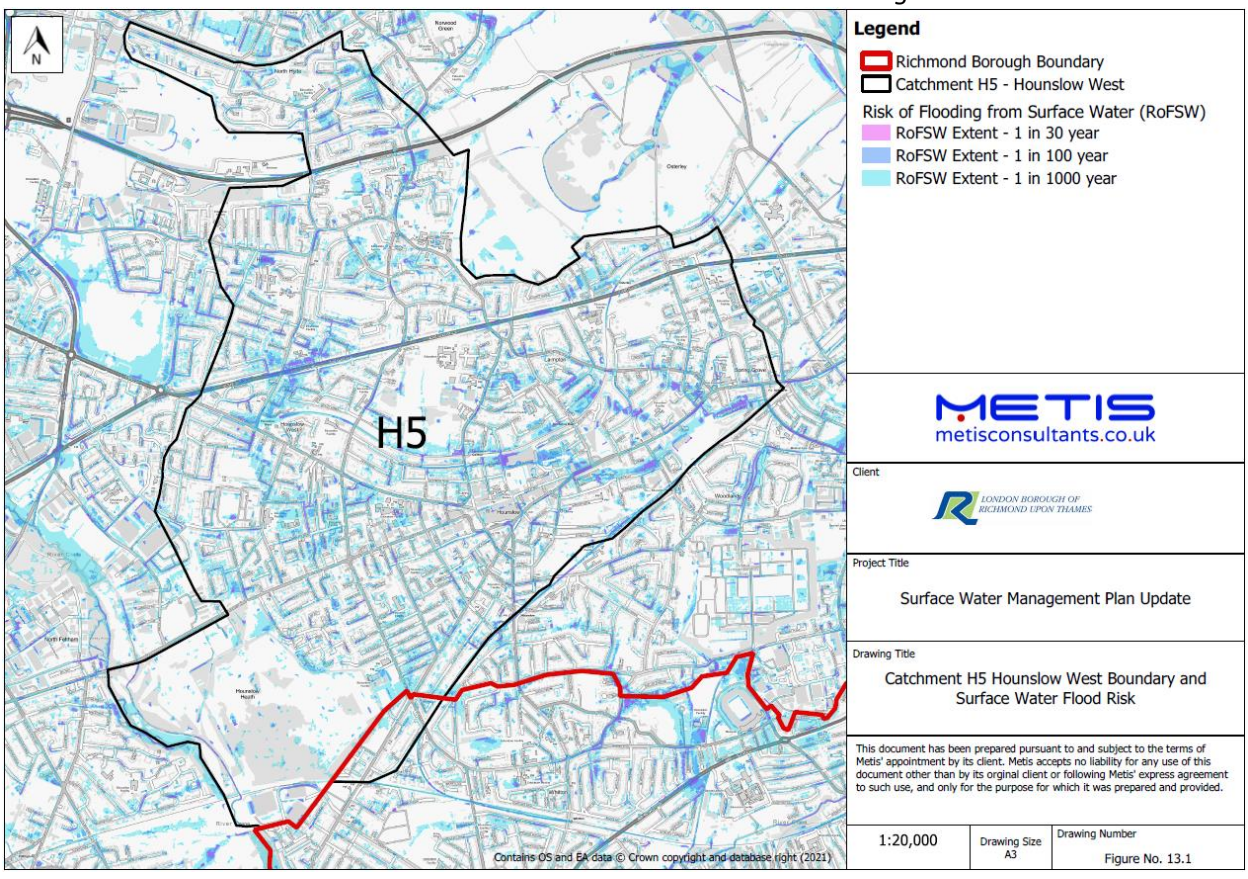

Figure 13-1 Catchment H5 Hounslow West Boundary and Surface Water Flood Risk

13.3 Properties at risk and Hotspots

There are no Hotspots in this Catchment. *Table 13-1* summarises the number of properties predicted to be at risk within this Catchment (LB Richmond only).

Table 13-1 Properties at risk in Catchment H5 Hounslow West

Property type	Within 30-year surface water extent	Within 100-year surface water extent	Within 1000-year surface water extent
Residential	0	0	56
Other	0	0	4
Unclassified	0	0	3

13.4 Historic Flood Incidents and Flood Incident Areas

There are no Flood Incident Areas in this Catchment and no reported flood incidents within the LB Richmond part of this Catchment.

14 CATCHMENT BB-D4 - COOMBE

14.1 Updates since 2011 SWMP

This Catchment contains no CDAs in LB Richmond or in RB Kingston. To date no updated flood risk modelling has been undertaken in the Coombe Catchment. This catchment has been included in the SWMP because it has a slight overlap with LB Richmond and has influence on the fluvial flood risk due to the Beverley Brook flowing through it.

14.2 Catchment extents

This Catchment is a partially urbanised area including Kingston Vale on the southern side of Richmond Park. A large area of this Catchment contains Coombe Hill Golf Club and key infrastructure includes the A3 Robin Hood Way (Kingston Bypass) and the A308 (Kingston Hill). The topography is generally highest in the west of the Catchment and lowest in the east with flow paths conveying to Beverley Brook along the east side of this Catchment. Catchment extents and surface water flood risk can be seen in Figure 14-1.

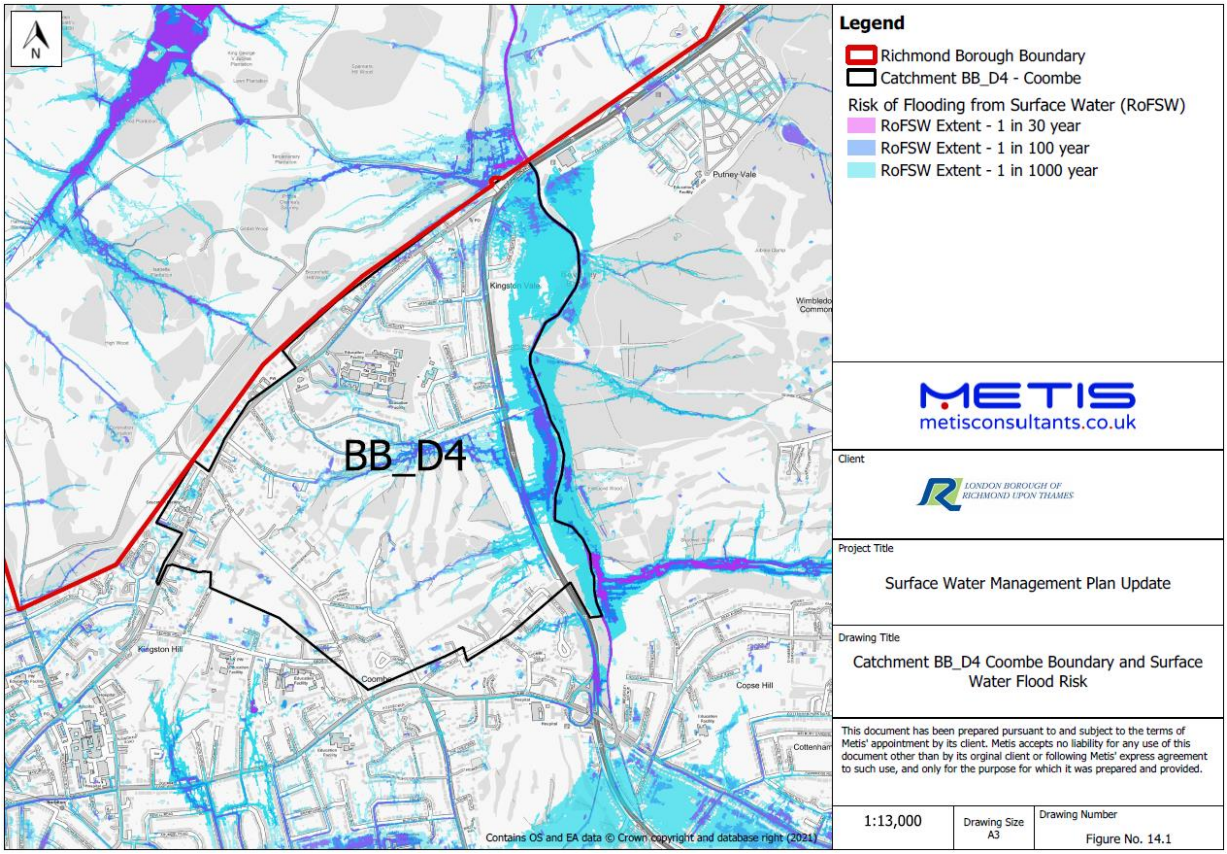

Figure 14-1 Catchment BB-D4 Coombe Boundary and Surface Water Flood Risk

14.3 Properties at risk and Hotspots

There are no Hotspots in this Catchment. *Table 14-1* summarises the number of properties predicted to be at risk within this Catchment (LB Richmond only).

Table 14-1 Properties at risk in Catchment BB-D4 Coombe

Property type	Within 30-year surface water extent	Within 100-year surface water extent	Within 1000-year surface water extent
Residential	0	0	0
Other	0	0	0
Unclassified	0	0	0

14.4 Historic Flood Incidents and Flood Incident Areas

There are no Flood Incident Areas in this Catchment and no reported flood incidents within the LB Richmond part of this Catchment.

15 CATCHMENT THLMR-E3 – TUDOR DRIVE

15.1 Updates since 2011 SWMP

This Catchment contains no CDAs in LB Richmond or in RB Kingston. To date no updated flood risk modelling has been undertaken in the Tudor Drive Catchment.

15.2 Catchment extents

This Catchment is a mostly urbanised area including Ham on the southern side of Richmond Park. Notable features in this Catchment are Latchmere Recreation Ground and the southern corner of Richmond Park and key infrastructure includes the A307 (Richmond Road). The topography is generally highest in the east of the Catchment and lowest in the west with flow paths conveying to the River Thames from Richmond Park along the east side of this Catchment. Catchment extents and surface water flood risk can be seen in *Figure 15-1.*

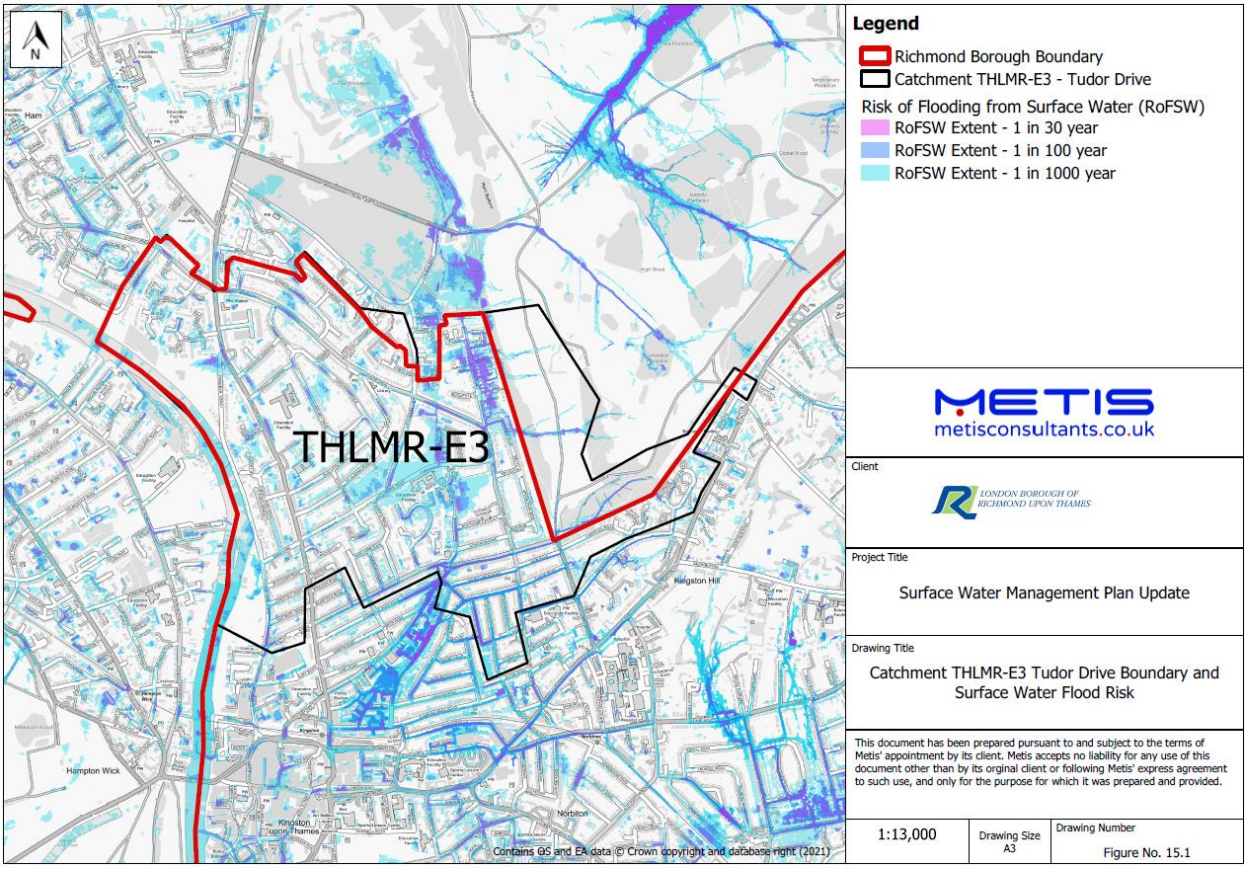

Figure 15-1 Catchment THLMR-E3 Tudor Drive Boundary and Surface Water Flood Risk

15.3 Properties at risk and Hotspots

There are no Hotspots in this Catchment. *Table 15-1* summarises the number of properties predicted to be at risk within this Catchment (LB Richmond only).

Table 15-1 Properties at risk in Catchment THLMR-E3 Tudor Drive

Property type	Within 30-year surface water extent	Within 100-year surface water extent	Within 1000-year surface water extent
Residential	0	0	3
Other	0	0	0
Unclassified	0	0	0

15.4 Historic Flood Incidents and Flood Incident Areas

There are no Flood Incident Areas in this Catchment and no reported flood incidents within the LB Richmond part of this Catchment.

16 BOROUGH-WIDE OPTIONS

16.1 Mitigation options

Potential options to mitigate the risk of flooding from surface water have been identified at a high-level throughout Richmond. These options have been categorised into three types following the source-pathway-receptor method. **Source** options include swales, detention basins, or wetlands which could be used to attenuate small or large volumes of surface water upstream of Catchments. **Pathway** options include improving maintenance regimes, managing overland flow through preferential flow paths, or de-culverting watercourses to provide flood mitigation along flood corridors. **Receptor** options include planning policies to influence development and social change, education and awareness, to propose mitigation through the end user's experience.

An opportunity assessment (OA) has been carried out using the 'red, amber, green' (RAG) method in which red (R) represents that the measure is not deemed applicable due to its perceived ineffectiveness in providing sufficient flood mitigation, amber (A) shows that intermediate flood mitigation can be expected from the measure, and green (G) indicates good, estimated benefits in terms of flood damages avoided. *Table 16-1* lists the different types of mitigation options assessed.

Users of this SWMP should note that the mitigation options are all initial, high level and generic proposed ideas which have been identified from desktop assessments only. No site-specific feasibility or economic viability work has been undertaken. The reason for this is to enable a prioritised list of potential mitigation options which can be assessed for the most relevant Catchments in line with the LLFA's available resources. Further feasibility and viability work may show that mitigation options initially thought to be viable may not be possible. This could be due to site constraints (such as available space or the presence of existing below ground utilities), or the availability of funding. Possible constraints and risks for each mitigation option are shown in *Table 16-1.*

Table 16-1 Measures used when proposing mitigation options

	Measure	OA	Description	Constraints / risks
Source	Blue / green roof		Generic measure which could be integrated into new developments or retrofitted into older buildings	Can only be implemented on developments with flat roofs. May cause structural / loading issues on some buildings
	Soakaway		Specific measure which could be implemented in geologically suitable areas	Not suitable for areas with impermeable geology or constrained sites where they cannot be sited more than 5m away from buildings
	Swales		Specific measure which could be introduced in open areas within key areas of interest to channel water to storage features or temporarily hold surface water	Not suitable for constrained sites or where there is existing underground infrastructure / utilities
	Permeable paving		Generic measure, could be introduced across most car parks and in new developments	Not suitable where there is existing underground infrastructure / utilities

	Measure	OA	Description	Constraints / risks
	Rainwater harvesting			Some developments may not have a requirement for recycled water. Rainwater harvesting tanks may cause structural / loading issues on some buildings
	Detention basin / dry pond		Specific measure which could be introduced across most open areas within key areas of interest	Not suitable for constrained sites or where there is existing underground infrastructure / utilities
	Pond			
	Wetland			
	Rain garden		Specific measure, most suitable to open spaces or on wide footways	Not suitable for constrained sites or where there is existing underground infrastructure / utilities
Pathway	Increase capacity in drainage system / watercourse		Existing drainage or watercourse channel storage capacity increased to accommodate additional surface water and prevent peak flooding	Increasing capacity in one part of the drainage system / watercourse may not be feasible if downstream parts do not have sufficient capacity to accommodate the additional surface water
	Separation of foul and surface water sewers		Sewer system almost completely separated	Is only beneficial for areas where the drainage system is combined
	Diversion of drainage system / watercourse		Watercourse channels diverted through areas that could intermittently flood as an exceedance measure	Not suitable for constrained or heavily urbanised areas
	Improved maintenance regimes		Drainage network being properly maintained removes the incidence of blockages and consequent flooding	N/A
	Managing overland flow - online storage		Storage areas created for temporary storage in open spaces with slow release back into the surface water sewer network at a restricted rate	Not suitable for constrained or heavily urbanised areas
	Managing overland flow - preferential flow paths		Flows diverted to open areas such as parks or roadside swales with possible kerb raising	Not suitable for constrained or heavily urbanised areas
	Land management practices		Management of runoff rates and volumes from upstream Catchments	Only applicable to rural areas
	De-culverting watercourse(s)		Watercourses returned to a more natural state to prevent flooding upstream of culverts	Not suitable for constrained or heavily urbanised areas
Receptor	Improved weather warning		Warning time provided to residents ahead of flooding	In instances of flash flooding, it is unlikely that sufficient warning time would be able to be provided to residents

	Measure	OA	Description	Constraints / risks
	Planning policies to influence development		Generic measure which could be applied to all Catchments to reduce flooding from new developments	N/A
	Temporary / demountable flood defences		Specific measure which could be installed in areas of significant risk of flooding with adequate warning	In instances of flash flooding, it is unlikely that there would be sufficient time to install flood defences
	Social change, education and awareness		Generic measures, focusing on community engagement and the need for property level protection	N/A
	Improved resilience and resistance measures		Educating the local community of the need and how to protect themselves using commercial and residential property level measures	N/A

A more detailed review of the existing drainage system and a feasibility study should be undertaken if the 'Increase Capacity in Drainage System / Watercourse' option is proposed. It is suggested that asset owners are engaged to consider existing maintenance regimes and potential constraints of upgrading drainage infrastructure. *Section 16.4* includes a proposed stakeholder engagement plan. It should also be noted that green roofs do not typically store high volumes of water. Blue roofs with higher attenuation capacity should be considered instead of green roofs where large volumes of water can be stored.

16.2 Options in high-risk areas

The options proposed are initial attempts to identify potential opportunities to reduce surface water flood risk across the borough. Using the number of benefitting properties, each proposed option was assessed and given a risk level (low, medium or high). If the number of properties at risk in the 1 in 100-year return period were up to and including 30 a 'Low' risk was assigned. If the number of properties at risk in the same return period were between 31 to 50 inclusive a 'Medium' risk was assigned, and if it was 51 or beyond a 'High' risk was assigned. This document has identified seven Hotspots from a total of 31 with a 'High' risk rating. *Appendix B* – High Level Option Assessment contains the options assessment for each Hotspot alongside its risk rating. Proposed mitigation options for the seven Hotspots with a 'High' risk rating (the shortlisted high risk Hotspots) are shown in *Table 16-2*. It is recommended that for future feasibility studies for these Hotspots, an economic appraisal approach is used to assess, then score, the high risk proposed options (please refer to the recommendations in *Section 17)*.

Table 16-2 Shortlisted high-risk Hotspots

Hotspot ID	Type	Number of properties at risk	Option Description
R01_03 (Refer to *Section 4* and *Figure 4-2*)	Source	162	Permeable paving in car parks. Rain gardens or planters implemented in footways. Residents encouraged to use rainwater harvesting. Retrofit flat roofs with green/blue roofs.
R06_W01_01 (Refer to *Section 9* and *Figure 9-2*)	Combination of source and pathway	134	Permeable paving in car parks. Planters or raingardens in footways. Encourage residents and business owners to use rainwater harvesting. Separation of foul and surface water sewers could also be implemented. Retrofit flat roofs with green/blue roofs.
R05_05 (Refer to *Section 8* and *Figure 8-2*)	Source	113	Rain gardens or swales in open areas. Rain gardens or planters in footways. Permeable paving in car parks. Encourage residents to use rainwater harvesting. Retrofit flat roofs with green/blue roofs.
R02_02 (Refer to *Section 5* and *Figure 5-2*)	Combination of source and pathway	98	Rain gardens, swales, wetlands, detention basins, ponds, or management of overland flow (online storage and preferential flow paths) in open areas. Rain gardens and planters in footways. Permeable paving in car parks. Encourage residents to use rainwater harvesting. Retrofit flat roofs with green/blue roofs.
H10_03 (Refer to *Section 12* and *Figure 12-2)*	Source	62	Permeable paving in car parks. Rain gardens or swales in open areas. Planters or raingardens in footways. Encourage residents to use rainwater harvesting. Retrofit flat roofs with green/blue roofs.
H10_01 (Refer to *Section 12* and *Figure 12-2)*	Source	59	Permeable paving in car parks. Planters or raingardens in footways. Encourage residents and business owners to use rainwater harvesting. Retrofit flat roofs with green/blue roofs.
R06_W01_02 (Refer to *Section 9* and *Figure 9-2*)	Source	53	Rain gardens or swales in open areas. Encourage residents to use rainwater harvesting. Retrofit flat roofs with green/blue roofs.

It should be noted that five of the shortlisted Hotspots lie within CDAs (Hotspots R01_03, R05_05, R02_02, H10_03, H10_01). Hotspot R01_03 lies within the Teddington CDA and Hotspot H10_01 lies within the Strawberry Hill CDA, both of which have received Grant in Aid funding from the EA. Hotspot R06_W01_01 lies within the extent of the Beverley Brook flood resilience project, which has also received Grant in Aid funding from the EA. For these Hotspots, alternative sources of funding should be sought if the mitigation options are prioritised for further detailed investigation, design and construction. If no new mitigation options are feasible for a Hotspot currently being investigated through CDA studies (or the Beverley Brook flood resilience project), then LB Richmond will explore mitigation options for the Hotspot with the next highest number of properties at risk, as shown in *Appendix B* – High Level Option Assessment (this may be a Hotspot with a 'Medium' risk rating).

It is recommended that a consistent prioritisation mechanism is used at the initial assessment stage to ensure that focus is given to the options with the most potential benefits. The methods used within this document to identify possible options reflect the range of benefits offered by SuDS features and the potential to include them into future collaborative projects.

16.3 Action Plan

The purpose of the Action Plan is to define activities required by the LLFA to meet its requirements set out by the FWMA 2010. The Action Plan sets out the tasks and priority for managing surface water across the borough through the following timeframes: short term (1-2 years), medium term (2-5 years) and long term (5-10 years). These tasks provide a structure for implementing the potential preferred options identified. The parties responsible for implementing actions and key partners are included within the Action Plan. Most of the actions within the plan align with the measures for LB Richmond in the Thames River Basin District FRMP. These measures are currently out for public consultation and are subject to change.

The types of actions proposed are categorised as follows:

- **Communication / Partnerships** – actions used internally or externally to communicate risk or create / improve flood risk related partnerships.
- **Financial / Resourcing** – actions used to internally or externally secure funding to support works or additional resources to deliver actions.
- **Flood and Water Management Act / Flood Risk Regulations** – actions which are aligned to legislative duties or powers under the FWMA 2010 or FRR 2009.
- **Flooding Mitigation** – actions relating to maintenance or capital works done to mitigate flood risk.
- **Investigation / Feasibility / Design** – actions which include or enable further investigation / feasibility studies / design of mitigation options to occur.
- **Policy** – actions which improve planning or development control activities.

A summary of the Action Plan is provided in *Table 16-3*. Actions with a 'High' priority ranking are displayed within this summary. The full Action Plan is included within *Appendix C* – Action Plan. A RAG progress tracker is displayed within the Action Plan. Green actions are those which LB Richmond have already implemented and they will continue to implement these / strengthen their approach. Amber actions are those which LB Richmond are planning to carry out, and should be actioned if possible. Red actions are those which are not currently in progress. The SWMP Action Plan should be reviewed and updated regularly (approximately every two or three years) to capture updates such as investigatory works being carried out or changes occurring which may influence the surface water flood risk within LB Richmond.

Table 16-3 Action Plan Summary

ID	Action	Key Focuses	Alignment to existing FRMP measure(s) (2020)	Priority Ranking	Time-frame	Action Type	Responsibility	
							Lead RMA	Primary Support
1	Co-operation between Authorities in exercising functions under the Flood and Water Management Act and all relevant legislation	- Attendance at key strategic meetings to share best practices and manage common challenges. - Engage with RMAs through cross-borough boundary projects to work collaboratively to achieve local flood risk objectives.	- Continue to hold quarterly flood group meetings in Richmond. - Work together with the Environment Agency to understand the fluvial and tidal interactions and the operation of the Thames Barrier in Richmond. - Work together with Thames Water to understand the interaction between the sewer system and fluvial/tidal flooding in Richmond.	High	Short	Flood and Water Management Act	LB Richmond LLFA	EA, TWUL, neighbouring Local Authorities, and TfL
2	Investigate repeat or significant flood incidents which have occurred in Hotspots and Flood Incident Areas to determine the potential cause(s) and recommendations for future actions	- Determine process and timescale for conducting Section 19 investigations. - Undertake projects to identify potential solutions	- Identify key 'at risk' communities, develop resources in Richmond.	High	Short	Investigation / Feasibility / Design	LB Richmond LLFA	EA, TWUL, and neighbouring Local Authorities

ID	Action	Key Focuses	Alignment to existing FRMP measure(s) (2020)	Priority Ranking	Time-frame	Action Type	Responsibility	
							Lead RMA	Primary Support
		to flooding problem (where resources permit) and, where viable, deliver schemes.						
3*	Carry out an economic appraisal for each proposed mitigation option for the shortlisted high risk Hotspots, and revise the ranking given to reflect its economic viability	- The economic appraisal should include a cost benefit analysis of the scheme over its lifetime. - A programme should be produced outlining how and when viable schemes could be taken forward.	- Publish and begin implementing a programme of flood alleviation schemes which mitigate local flood risks, utilising a catchment-based approach in Richmond. - Investigate increasing the surface water pipe diameter in St Margarets Road to reduce flooding in Richmond.	High	Short	Investigation / Feasibility / Design	LB Richmond LLFA	
8	Record incidents in a timely and consistent manner at the exact location of flooding	- Further advertise use of the LLFA's online reporting system and regularly review submitted information. - Liaise with Thames Water where flooding reports are / may	- This action does not directly link to the FRMP measures, however, it is relevant to other LB Richmond priorities.	High	Short	Flood and Water Management Act	LB Richmond LLFA	TWUL

ID	Action	Key Focuses	Alignment to existing FRMP measure(s) (2020)	Priority Ranking	Time-frame	Action Type	Responsibility	
							Lead RMA	Primary Support
		be associated with sewer infrastructure and ensure residents are reporting such via Thames Water's online reporting function too.						
9	Conduct maintenance of the drainage system such as ensuring gullies and drains are regularly maintained to allow the drainage network to operate at capacity in Hotspots	- Review existing maintenance schedules and incorporate SWMP findings wherever possible e.g. maintenance works could be carried out in order of risk ranking for Hotspots and Flood Incident Areas.	- This action does not directly link to the FRMP measures, however it is relevant to other LB Richmond priorities.	High	Short	Flood and Water Management Act	LB Richmond Highways	LB Richmond Highways, TWUL, and TfL
10†	Investigate the capacity of the surface water sewer system within Hotspot and Flood Incident Areas and investigate options for increasing sewer capacity	- Investigations should be carried out in order of risk ranking for Hotspots and Flood Incident Areas.	- Investigate increasing the surface water pipe diameter in St Margarets Road to reduce flooding in Richmond.	High	Short	Investigation / Feasibility / Design	TWUL	LB Richmond LLFA
11	Ensure all new developments, particularly in Hotspots and Flood Incident Areas, contribute to measures to reduce	- Engage with Richmond's Planning Team to incorporate extra requirements for	- Work with Local Planning Authority colleagues to implement strengthened policy and guidance in Richmond.	High	Short	Policy	LB Richmond Planning	LB Richmond LLFA

ID	Action	Key Focuses	Alignment to existing FRMP measure(s) (2020)	Priority Ranking	Time-frame	Action Type	Responsibility	
							Lead RMA	Primary Support
	surface water flood risk in the Catchment through the incorporation of rainwater harvesting and green blue infrastructure	planning applications within Hotspots and Flood Incident Areas.						
12	Seek opportunities within all relevant local or regional strategic plans to integrate surface water flood risk reduction measures	- Engage with Richmond's Planning Team to incorporate flood risk reduction measures within local or regional strategic plans.	- Work with Local Planning Authority colleagues to implement strengthened policy and guidance in Richmond.	High	Medium	Policy	LB Richmond Planning	EA, TWUL, neighbouring Local Authorities, Greater London Authority, and TfL
13	Introduce SuDS retrofitting policies and incentives which seek to enhance or replace conventional drainage systems in favour of green roofs, rainwater harvesting and reuse, or other above ground green blue attenuation features on new developments	- Engage with Richmond's Planning Team to incorporate extra requirements for planning applications.	- Work with Local Planning Authority colleagues to implement strengthened policy and guidance in Richmond.	High	Short	Policy	LB Richmond Planning	LB Richmond LLFA
15‡	Investigate resilience of key transport infrastructure across the borough including the strategic highway network, railway lines and public transport assets	- Develop and keep up to date a list of all critical infrastructure and work with relevant departments and RMAs to ensure the resilience of this	- This action does not directly link to the FRMP measures, however it is relevant to other council priorities.	High	Short	Investigation / Feasibility / Design	LB Richmond LLFA	LB Richmond Transport, TfL and Network Rail

ID	Action	Key Focuses	Alignment to existing FRMP measure(s) (2020)	Priority Ranking	Time-frame	Action Type	Responsibility	
							Lead RMA	Primary Support
		infrastructure against flood risk now and in the future.						

*Completion of action is dependent on successful application for funding

†TWUL should be collaborated with and informed of any capacity issues identified by LB Richmond LLFA

‡LB Richmond investigates resilience of its own assets

16.4 Stakeholder engagement plan

A borough-wide stakeholder engagement plan has been created to help the LB Richmond increase awareness of the SWMP and the opportunities for future collaborative working to help mitigate flood risk in the borough. The plan explains how different partners can use the updated SWMP to enable effective and enhance ongoing collaborative working with the LB Richmond in the future.

16.4.1 Stakeholder mapping

Stakeholders' interest was mapped against their power to influence the direction of future initiatives and decision-making to identify the stakeholders who should be engaged. Stakeholders which have high levels of interest and influence should be targeted for collaboration as they would be valuable to further investigations. Stakeholders who would be more affected by policy changes but are perceived to have less influence in decision-making should be consulted. Care should be taken to ensure this category of stakeholder has a voice to reduce the risk that their issues might be overlooked even if they are likely to be substantially affected by the outcomes.

Lobbying and campaigning type organisations such as local charities should be involved to provide valuable input in terms of knowledge and funding. Academic or research focused organisations linked to water policy might be informed such as the BGS, or NGOs. These stakeholders might be called upon to provide expert input as and when necessary. Table 16-4 Stakeholder strategy*Table 16-4* shows the engagement strategy and actions for different combinations of interest and influence.

Table 16-4 Stakeholder strategy

Interest	Influence	Strategy	Actions
High	High	Collaborate	• Stakeholder panels • Steering groups • Facilitated meetings
High	Low	Consult	• Surveys • Meetings • Interviews
Low	High	Involve	• Workshops • Forums • Focus groups
Low	Low	Inform	• Briefings • Electronic documents • Exhibitions

Stakeholder engagement should be dynamic. It is therefore recommended to engage the stakeholders identified at the SWMP level for specific actions within the Action Plan in contributing to the identification and segmentation of future stakeholder groups. The stakeholder analysis may then provide both a management tool and a rationale as to why certain stakeholder groups are invited to participate in certain stages of the process and others not. *Figure 16-1* illustrates the engagement strategy for each stakeholder identified for the purposes of the SWMP. Each stakeholder was given a score between 1 and 5 based on their level of interest and level of influence. The combination of these two scores was used to plot the stakeholders' position on the

map in *Figure 16-1.* A score of 4 - 5 indicated high interest or influence, and a score of 1 - 2 indicated low interest or influence. The strategy for stakeholders with high interest and high influence is to collaborate, for high interest and low influence is to consult, for low interest and high influence is to involve, and for low interest and low influence is to inform.

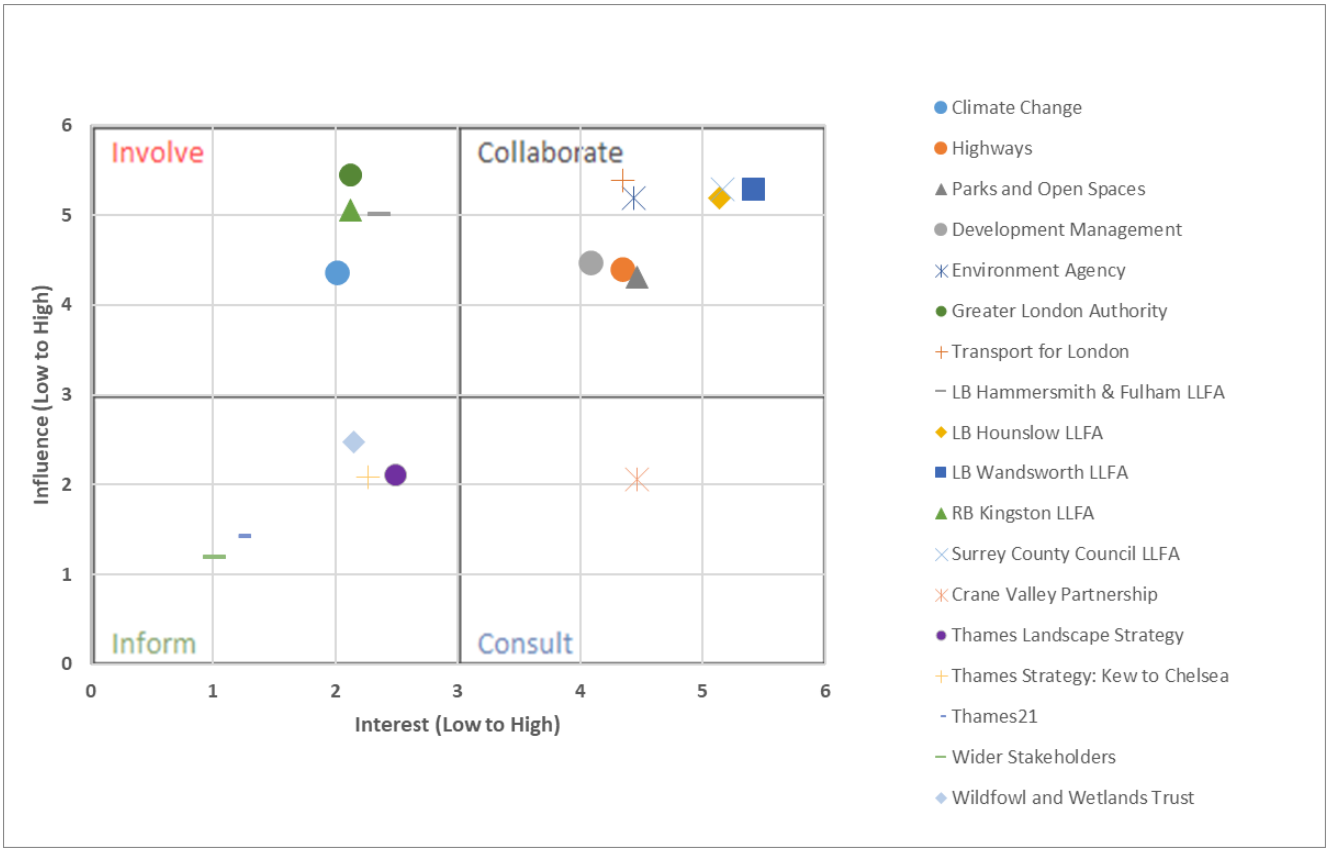

Figure 16-1 Stakeholder map

16.4.2 Stakeholder groups and engagement

LB Richmond

Several teams within the LB Richmond were identified for potential future collaboration. In seeking opportunities within all relevant local or regional strategic plans to integrate surface water flood risk reduction measures (Action Plan ID 12, *Appendix C* – Action Plan), the Highways, Parks and Open Spaces, and Development Management internal teams should continue to be engaged collaboratively. Engagement with other teams within the LB Richmond occurs via Internal Flood Group meetings, where flooding issues are discussed.

The Highways, Parks and Open Spaces, and Transport and Strategy teams will be essential in helping the LB Richmond LLFA in designing and building financially viable schemes which provide multiple benefits (Action Plan ID 7, *Appendix C* – Action Plan). In addition to these teams, the Climate Change Group within the Communications team should also be contacted when identifying potential

funding contributors and securing funding for scheme options to increase potential for delivery (Action Plan ID 6, *Appendix C* – Action Plan), maximising multiple benefits where possible.

The Transport and Strategy team should investigate the resilience of key transport infrastructure across the borough including the strategic highway network, railway lines and public transport assets (Action Plan ID 16, *Appendix C* – Action Plan). The results of such investigations should be clearly communicated to the LLFA. It is also key that the LLFA continues to communicate with the Highways team regarding the maintenance of drainage systems to ensure gullies and drains are regularly maintained to allow the drainage network to operate at capacity in Hotspots (Action Plan ID 9, *Appendix C* – Action Plan).

Key Organisations

These act as focal points for discussion and consultation throughout the development of schemes. Key Organisations identified include the EA, GLA, TfL and TWUL. These organisations are currently engaged through existing partnerships such as the London Drainage Engineer's Group and the South West London Strategic Flood Group, and on flooding and drainage issues as they occur. Inclusion of this group through meetings/workshops offers a more participatory process. The EA, TWUL, and TfL should continue to be engaged for the following, as per the Action Plan:

- Co-operation between authorities in exercising functions under the Flood and Water Management Act and all relevant legislation (Action Plan ID 1, *Appendix C* – Action Plan); and
- Undertake detailed flood risk modelling if required to better assess the benefits of the options with the highest priority ranking (Action Plan ID 4, *Appendix C* – Action Plan); and
- Identifying potential funding contributors and securing funding for scheme options to enable delivery (Action Plan ID 6, *Appendix C* – Action Plan).

It is highly recommended that the EA, TWUL, and GLA are engaged to integrate surface water flood risk reduction measures in relevant local or regional plans (Action Plan ID 12, *Appendix C* – Action Plan). They should also be involved in order to successfully design and build financially viable flood alleviation schemes providing multiple benefits (Action Plan ID 7, *Appendix C* – Action Plan). LB Richmond are currently working with the EA and TWUL on the Beverley Brook project, along with numerous other stakeholders (internal LB Richmond teams, existing partnerships, local community groups and wider stakeholders).

Continued engagement with TfL is critical in ensuring gullies and drains are regularly maintained to allow the drainage network to operate at capacity in Hotspots (Action Plan ID 9, *Appendix C* – Action Plan). Investigating the resilience of key transport infrastructure across the borough including the strategic highway network, railway lines and public transport assets (Action Plan ID 16, *Appendix C* – Action Plan) from a surface water flood risk viewpoint, should be carried out with support from the LB Richmond LLFA. TfL should be engaged regarding opportunities to integrate surface water flood risk reduction measures (Action Plan ID 12, *Appendix C* – Action Plan) within existing or future strategic development or mitigation plans.

Cross-boundary Local Authorities

Through the creation of the SWMP, other LLFAs were contacted for their input on key deliverables. Keeping them engaged is essential in helping drive future flood risk management both within Richmond and at wider surface water basin / catchment level. The Local Authorities identified as part of this group are the LB Hammersmith & Fulham, LB Hounslow, LB Wandsworth, RB Kingston and Surrey CC LLFAs. Co-operation between Authorities in exercising functions under the FWMA 2010 and all relevant legislation (Action Plan ID 1, *Appendix C* – Action Plan) and seek opportunities within all relevant local or regional strategic plans to integrate surface water flood risk reduction measures (Action Plan ID 12, *Appendix C* – Action Plan) are expected to be continued from these LLFAs through the London Drainage Engineer's Group, the South West London Strategic Flood Group and the Thames Regional Flood and Coastal Committee.

Other Organisations

Many individuals and organisations are likely to be affected by the decisions made by the LB Richmond LLFA. For the Crane Valley Partnership, Beverley Brook Catchment Partnership, Richmond Housing Partnership, Richmond Biodiversity Partnership and the South East Rivers Trust, information should be shared and discussions held. As it may be impractical to involve these remaining stakeholders within one of the other groups outlined above, a group of 'Wider stakeholders' has also been identified for members of the public, friends / volunteer groups, allotment societies, sports groups, and the like. Friends of Barnes Common, the Thames Landscape Strategy, Thames Strategy: Kew to Chelsea, Thames21, the Wildfowl and Wetlands Trust and other wider stakeholders should be kept informed about relevant projects.

Beverley Brook Flood Resilience Project

The LB Richmond have secured funding to deliver flood resilience through innovative actions in the Beverley Brook river catchment over a six year period (2021-2026). A number of stakeholders are currently being engaged as part of this project which include Key Organisations, LB Richmond internal teams and Other Organisations. Key Organisations include the EA and TWUL, and LB Richmond internal teams include Development Management, Parks and Open Spaces, Climate Change Group, Highways, Education, Communications, Facilities Management and Adults/Health. There are a variety of Other Organisations involved which range from local partnerships and organisations to wider stakeholders. Local partnerships and organisations include the Beverley Brook Catchment Partnership, Richmond Housing Partnership, Richmond Biodiversity Partnership, the South East Rivers Trust and Royal Parks. Wider stakeholders include local community groups, allotment societies, local schools, local businesses, sports clubs, property owners and local councillors.

17 RECOMMENDATIONS

This document has shortlisted seven Hotspots with a 'High' risk rating. It is recommended that, subject to securing funding, standalone feasibility studies are carried out for the Catchments containing the shortlisted Hotspots, in order of risk ranking. Recommended tasks for these studies are as follows:

1. Use the outputs of this new SWMP (prioritised Catchment and Hotspot information) to create sub-Catchments (where necessary for individual Hotspots to enable inclusion of the contributing and benefitting areas).
2. Gather further information about significant recorded flood incidents and validate against predicted surface water flood risks extents.
3. Identify potential benefactors and constraints.
4. Conduct locally-specific long-list and short-listing exercises to identify potential mitigation options.
5. Determine the feasibility of each potential mitigation option using a multi-criteria decision matrix.
6. Conduct an economic appraisal for the options identified for each Catchment through cost benefit analysis. This should include identification of flood and non-flood risk related benefits, flood damage calculations, and consideration of whole life costs. This should also define the benefitting area and identify the volume of surface water that could be stored in a 1 in 30-year surface water flood event for each option.
7. Use the results of the economic appraisal to revise the current risk rating for each Catchment. The options with the highest refined rating which are shown to be feasible could then be prioritised for further detailed investigation.
8. Options which are prioritised for further detailed investigation should undergo detailed modelling and a business case should be prepared and submitted to determine potential for continuation through detailed design to construction.

Other Hotspots could progress through a similar set of tasks. This should be determined by LB Richmond's LLFA according to any increased information about local flood risks or improved collaborative mitigation scheme potential, where resources permit.

Additional recommendations identified through this SWMP update include:

- The LB Richmond LLFA should continue to work with neighbouring boroughs, building on engagement made during this SWMP update, where catchments overlap political boundaries to manage the flood risks holistically.
- Ensure that flood incidents are recorded consistently and accurately and conduct investigations of repeat or significant flood incidents which have occurred in Hotspots and Flood Incident Areas.
- Conduct regular maintenance of gullies and drains, prioritising those within Hotspots or Flood Incident Areas.
- Liaise with Richmond's Planning team to ensure that new developments incorporate rainwater harvesting and green blue infrastructure, particularly within Hotspots or Flood Incident Areas.
- Liaise with Richmond's Climate Change Group (within the Communications team) and contribute to projects which help to reduce the impacts of climate change, reduce carbon emissions and work to becoming carbon neutral, in line with Richmond's Climate Emergency Strategy.

- Investigate resilience of key transport infrastructure across the borough including the strategic highway network, railway lines and public transport assets.

In addition to the above bullet points it is recommended that this document is updated when significant work in reducing flood risk is completed and / or when significant improvements in the knowledge and understanding of local flood risk are identified. As a minimum, this should be every ten years. This may result in changes to the number of Hotspots with 'High' risk ratings. The action plan should be reviewed every two or three years to remove actions that have been completed, check that other actions are still relevant and add new ones if required.

18 CONCLUSION

Since 2011, the LB Richmond has an increased understanding of surface water flood risk in the borough which has therefore resulted in this update to the 2011 SWMP. The 2011 SWMP identified a number of CDAs across the borough as areas at increased risk of surface water flooding. Some of these CDAs have undergone investigation of potential flood mitigation options in order to further the understanding of flood risk in those areas.

This new SWMP reflects this Catchment-based approach, replacing the CDAs with Basins and Catchments which cover larger areas and represent the local watershed. The Basins and Catchments have been defined using topography and local drainage networks (watercourses and sewer systems). This accounts for contributing areas consistently and more accurately than the 2011 SWMP did, aligned with national planning policy and the EA's fluvial flood risk management Catchment-based approach. The updated approach allows for increased potential in collaborative working with neighbouring boroughs, with local/ national organisations and/ or other authorities all being potential stakeholders. EA national flood mapping data has been used to identify the number of properties predicted to be at risk in a 1 in 100-year return period surface water event. The total number of properties at this level of surface water risk is 2,853 across the whole borough.

To better represent the areas most at risk of surface water flooding, Hotspots and Flood Incident Areas have been defined within each Catchment. There are 12 Catchments in total, 31 Hotspots and 1 Flood Incident Area. Potential options to mitigate the risk of flooding from surface water have been identified at a high-level for the seven Hotspots throughout the borough which are most at risk (R01_03, R06_W01_01, R05_05, R02_02, H10_03, H10_01, and R06_W01_02). These options have been identified using the source-pathway-receptor method. The options proposed are initial attempts to identify potential opportunities to reduce local flood risks as sustainably as possible, and mostly involve installing a mixture of SuDS such as rainwater harvesting, rain gardens, swales, blue/green roofs, and permeable paving. Using the number of properties at risk, each Hotspot was assessed and given a risk rating. The methods used within this document to assess possible options reflect the complexity of benefits offered by SuDS features and the simplicity of how SuDS can be incorporated into future collaborative projects.

It is recommended that each option undergoes an economic appraisal to revise the risk rating given at this stage through a cost benefit analysis, starting with the options for the Hotspots most at risk. The economic appraisal exercise should define the benefitting area and identify the volume of surface water that could be stored in a 1 in 30-year surface water flood event for each option. The options with the highest rating could then be prioritised for further detailed investigation, subject to LB Richmond's LLFA securing sufficient resources. Options with the most potential benefits are more likely to qualify for and attract grant funding to enable further investigation work at detailed design stage. Options within Hotspots with a lower risk rating should not be discounted as these may become more viable through collaborative working with stakeholders leading on other, non-flood risk schemes which can deliver multiple benefits. This, along with the Action Plan, gives the LB Richmond a high-level initial programme of potential local flood risk mitigation schemes.

19 APPENDICES

19.1 Appendix A - Methodology for properties at risk of surface water flooding

The EA Properties at Risk of Flooding dataset (2014) contains information about every property identified as being at risk from surface water flooding. Each property has a wetted perimeter percentage for three rainfall events, namely the 1 in 30-, 1 in 100- and 1 in 1000-year events for a range of minimum flood depths (see *Figure A-1* below). To be deemed at risk in this SWMP, properties at ground or basement level identified in the EA dataset must have had a minimum flood depth of 150 mm and a minimum wetted perimeter of 20%. 150 mm is the typical height of a doorstep which is why it was chosen as flood depth threshold. The chances that a given property would have been flooded internally if the flood depth in the area was above 150 mm are typically high as doorsteps are entry paths for flood water. A wetted perimeter of 20% was selected to filter out the properties which are only marginally within the flood extent, making their likelihood of encountering flooding low. Only basement and ground floor properties were included in the count.

os_class	floorarea	floorlevel	P100_NoDT	P100_D150	P100_D200	P100_D300	P100_D600	P100_D900
Dwelling	261.28	pG	0.478	0.464	0.445	0.391	0	0

Figure A-1. Example of the EA's RoFSW output for a 1 in 100-year event

19.2 Appendix B – High Level Option Assessment

Please refer to the relevant PDF

19.3 Appendix C – Action Plan

Please refer to the relevant PDF