URS

London Borough of Camden SFRA

Strategic Flood Risk Assessment

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ACRONYM	DEFINITION
AEP	Annual Exceedance Probability
ASTGWF	Areas Susceptible to Groundwater Flooding
BGS	British Geological Survey
CDA	Critical Drainage Area
CFMP	Catchment Flood Management Plan
CLG	(Department for) Communities and Local Government
CoLC	The City of London Corporation
C&RT	The Canal and River Trust
Defra	Department for Environment, Flood and Rural Affairs
DPD	Development Plan Document
DTM	Digital Terrain Model
EA	Environment Agency
IDB	Internal Drainage Board
LBC	London Borough of Camden
FCERM	Flood and Coastal Erosion Risk Management
FRA	Flood Risk Assessment
FWMA	Flood and Water Management Act
GIS	Geographical Information System
LDF	Local Development Framework
LiDAR	Light Detection and Ranging
LFRZ	Local Flood Risk Zone
LLFA	Lead Local Flood Authority
LPA	Local Planning Authority
LRF	Local Resilience Forum
MAFP	Multi-Agency Flood Plan
NPPF	National Planning Policy Framework
PAB	Project Advisory Board
SA	Sustainability Appraisal

SAB	SuDS Approval Body
SFRA	Strategic Flood Risk Assessment
SPD	Supplementary Planning Document
SPZ	Source Protection Zone
SuDS	Sustainable Drainage Systems
TfL	Transport for London
TWUL	Thames Water Utilities Ltd
uFMfSW	Updated Flood Map for Surface Water

GLOSSARY	DEFINITION
Annual exceedance probability (AEP)	Annual exceedance probability (AEP) of occurrence in any one year, expressed as a percentage. For example, a 1 in 200 annual exceedance probability event has a 0.5% AEP of occurring in any year.
Aquifer	A source of groundwater comprising water bearing rock, sand or gravel capable of yielding significant quantities of water.
Attenuation	In the context of this report - the storing of water to reduce peak discharge of water.
Catchment Flood Management Plan	A high-level planning strategy through which the Environment Agency works with their key decision makers within a river catchment to identify and agree policies to secure the long-term sustainable management of flood risk.
Climate Change (CC)	Long term variations in global temperature and weather patterns caused by natural and human actions. For fluvial events a 20% increase in river flow is applied and for rainfall events, a 30% increase. These climate change values are based upon information within the NPPF and Planning Practice Guidance.
Critical Drainage Area	A discrete geographic area (usually a hydrological catchment) where multiple and interlinked sources of flood risk (surface water, groundwater, sewer, main river and/or tidal) cause flooding in one or more Local Flood Risk Zones during severe weather thereby affecting people, property or local infrastructure
Culvert	A channel or pipe that carries water below the level of the ground.
DG5 Register	A water-company held register of properties which have experienced sewer flooding due to hydraulic overload, or properties which are 'at risk' of sewer flooding more frequently than once in 20 years.
Exception Test	The exception test should be applied following the application of the sequential test. Conditions need to be met before the exception test can be applied.
Flood Defence	Infrastructure used to protect an area against floods as floodwalls and embankments; they are designed to a specific standard of protection (design standard).
Flood Resilience	Measures that minimise water ingress and promotes fast drying and easy cleaning, to prevent any permanent damage.
Flood Resistant	Measures to prevent flood water entering a building or damaging its fabric. This has the same meaning as flood proof.
Flood Risk	The level of flood risk is the product of the frequency or likelihood of the flood events and their consequences (such as loss, damage, harm, distress and disruption).
Flood Risk Area	An area determined as having a significant risk of flooding in accordance with guidance published by Defra and WAG.
Flood Zone	Flood Zones show the probability of flooding, ignoring the presence of existing defences
Freeboard	Height of flood defence crest level (or building level) above designed water level
Functional Floodplain	Land where water has to flow or be stored in times of flood.

Lead Local Flood Authority (LLFA)	As defined by the Flood and Water Management Act, in relation to an area in England, this means the unitary authority or where there is no unitary authority, the county council for the area, in this case LBC.
Local Flood Risk Zone (LFRZ)	Local Flood Risk Zones are defined as discrete areas of flooding that do not exceed the national criteria for a 'Flood Risk Area' but still affect houses, businesses or infrastructure. A LFRZ is defined as the actual spatial extent of predicted flooding in a single location.
Local Planning Authority (LPA)	Body that is responsible for controlling planning and development through the planning system.
Main River	Watercourse defined on a 'Main River Map' designated by Defra. The Environment Agency has permissive powers to carry out flood defence works, maintenance and operational activities for Main Rivers only.
Mitigation measure	An element of development design which may be used to manage flood risk or avoid an increase in flood risk elsewhere.
Residual Flood Risk	The remaining flood risk after risk reduction measures have been taken into account.
Return Period	The average time period between rainfall or flood events with the same intensity and effect.
Risk	Risk is a factor of the probability or likelihood of an event occurring multiplied by consequence: Risk = Probability x Consequence. It is also referred to in this report in a more general sense.
Sequential Test	Aims to steer vulnerable development to areas of lowest flood risk.
Source Protection Zone (SPZ)	Defined areas in which certain types of development are restricted to ensure that groundwater sources remain free from contaminants.
Sustainable drainage systems (SuDS)	Methods of management practices and control structures that are designed to drain surface water in a more sustainable manner than some conventional techniques.
Topographic survey	A survey of ground levels.
Watercourse	All rivers, streams, drainage ditches (i.e. ditches with outfalls and capacity to convey flow), drains, cuts, culverts and dykes that carry water.

1 INTRODUCTION AND USER GUIDE

1.1 Introduction

1.1.1 The National Planning Policy Framework (NPPF)[1] and associated Planning Practice Guidance for Flood Risk and Coastal Change[2] emphasise the active role Local Planning Authorities (LPAs) such as the London Borough of Camden (LBC) should take to ensure that flood risk is understood and managed effectively and sustainably throughout all stages of the planning process.

1.1.2 LBC is distinctive in its lack of main rivers and resultant location entirely within Fluvial Flood Zone 1, where all areas have a less that 1 in 1000 annual probability of flooding from fluvial sources, as classified by the Environment Agency. However whilst the risk of flooding from fluvial sources is negligible within LBC, there is a risk of flooding from other sources such as surface water, groundwater, sewers and artificial sources such as reservoirs and canals.

1.1.3 The NPPF outlines that Local Plans should be supported by a Strategic Flood Risk Assessment (SFRA) and LPAs should use the findings to inform strategic land use planning. Figure 1.1 overleaf, reproduced from the Planning Practice Guidance, illustrates how flood risk should be taken into account in the preparation of the Local Plan for LBC.

1.1.4 The purpose of the SFRA is to collate and present the most up to date flood risk information for use by LBC to inform the preparation of robust planning documents as part of the Camden Local Plan and prudent decision-making by Development Management officers on a day-to-day basis.

1.1.5 As stated in the LBC Local Development Scheme[3], the Local Plan is currently made up of the following adopted documents:

- Camden Core Strategy (adopted 2010);
- Camden Development Policies (adopted 2010);
- Site Allocations (adopted 2013);
- Statement of Community Involvement (2011);
- a range of supplementary guidance documents.

1.1.6 In order to achieve this, the SFRA will inform the application of the Sequential and Exception Tests in the allocation of future development sites, as required by the NPPF, taking into account all sources of flooding.

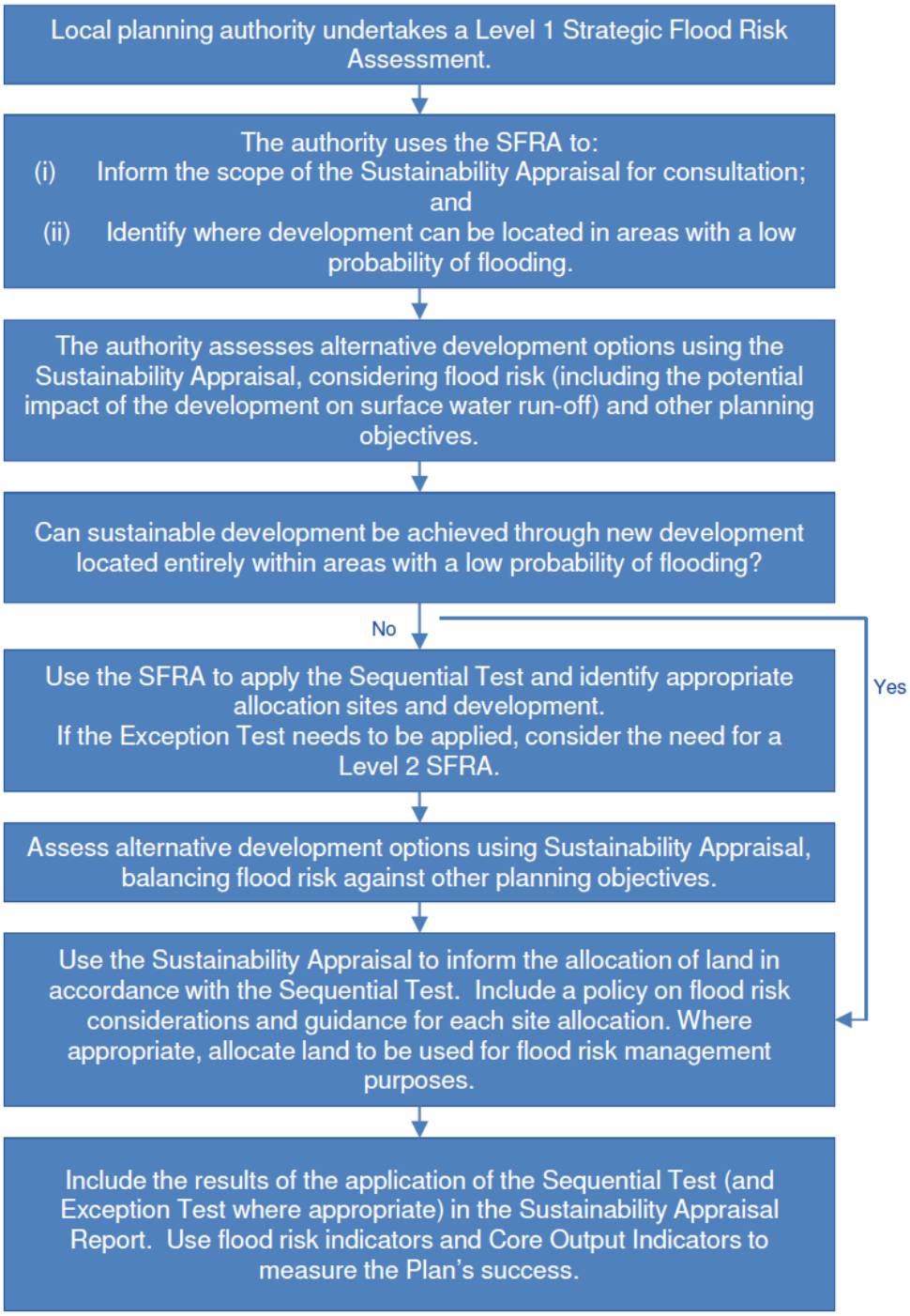


Figure 1.1- Taking flood risk into account in the preparation of a Local Plan (Planning Practice Guidance for Flood Risk and Coastal Change, p6)

1.2 User Guide

1.2.1 It is anticipated that the SFRA will have a number of end users, with slightly different requirements. This Section describes how to use the SFRA and how to navigate the report and mapping deliverables.

1.2.2 The LBC SFRA report is set out as follows:

- Section 2: Policy and Local Context
- Section 3: SFRA Methodology
- Section 4: Strategic Assessment of Flood Risk
- Section 5: Guidance on the application of the Sequential and Exception Tests
- Section 6: Guidance for preparing Site Specific FRAs
- Section 7: Sustainable Drainage Systems
- Section 8: Policy Options
- Appendix A: Data Register
- Appendix B: Flood Risk Mapping

Strategic Planning and Policy

1.2.3 The chief purpose of the SFRA for LBC, in accordance with the NPPF, is to provide a strategic overview of flood risk within the borough to enable effective risk-based strategic planning for the future through the preparation of the Local Plan.

1.2.4 The information presented in Section 4 should be used by LBC to inform their knowledge of flooding and flood risk from all sources, throughout the borough.

1.2.5 As part of the SFRA, a number of policy options have been developed for the borough and are presented in Section 8. These should be taken forward to inform the application of the Sequential Test and Exception Test during the process of allocating development within the borough.

1.3 Applying the Sequential Test

1.3.1 The NPPF sets strict tests to protect people and property from flooding which all LPAs are expected to follow. The aim of the Sequential Test under the NPPF is to steer new development to areas with the lowest probability of flooding. Section 4 provides the data required to undertake the Sequential Test and Section 5 provides specific guidance on applying both the Sequential and, where appropriate, Exception Tests.

1.4 Emergency Planning

1.4.1 LBC is a Category 1 Responder under the Civil Contingencies Act 2004[4] and therefore has a responsibility, along with other organisations, for developing emergency plans to help reduce, control or ease the effects of an emergency.

1.4.2 The complex nature of flooding and the consequences that arise require a comprehensive and often sustained response from a wide range of organisations, and as such LBC has prepared a Multi-Agency Flood Plan (MAFP) to allow all responding parties to work together in a coordinated response to severe flooding.

1.4.3 The SFRA deliverables should be used by the LBC Emergency Planning team as a useful resource providing up to date information about flood risk. The SFRA should be reviewed by the team so that, where appropriate, the findings are incorporated into their understanding of flood risk and future revisions of the MAFP.

1.5 Preparing Site Specific FRAs

1.5.1 For those preparing site specific Flood Risk Assessments (FRAs) for individual development sites, the strategic review provided by the SFRA provides a useful starting point.

- Section 4 provides an overview of the key issues within the borough in relation to flood risk.
- Section 5 provides guidance on the application of the Sequential Test for sites that have not been tested by the LPA, as well as details on when the Exception Test is required and how to apply it.
- Section 6 provides specific guidance for preparing site specific FRAs in accordance with the checklist presented in the Planning Practice Guidance. Recommendations are provided for potential mitigation and resilience measures that may need to be addressed.

1.6 Assessing Planning Applications

1.6.1 Planning and development officers who are reviewing FRAs as part of the planning application process should consult Section 4 of the SFRA to provide the background for flood risk in the area relating to the planning application. Section 6 can also be used by those assessing applications as a checklist for issues that need to be addressed as part of site specific FRAs.

2 POLICY AND LOCAL CONTEXT

2.1 National Policy

The Flood Risk Regulations (December 2009)

2.1.1 The Flood Risk Regulations[5] came into force on the 10th December 2009 and sets out duties for the Environment Agency and LLFAs in the preparation of a range of reports and mapping outputs.

2.1.2 The Flood Risk Regulations (2009) transpose the EU Floods Directive (2007/60/EC)[6] into UK Law. One of the main impacts on LLFAs in England and Wales is that they are required to complete Preliminary Flood Risk Assessments (PFRAs). Where Flood Risk Areas were defined within the PFRA it is required that Flood Risk maps showing the extents and hazards of flooding are produced alongside the Flood Risk Management Plans. The LBC is a LLFA and is responsible for preparing the following:

- A PFRA report for flooding from sources other than from the sea, main rivers and reservoirs, which was completed in 2011;
- Determining whether there is a significant flood risk in the LLFA area in line with the Environment Agency's guidance[7] and identify the part of the area, if any, where this risk exists (for sources other than that from sea, main rivers and reservoirs); and
- Where a Flood Risk Area is identified there is a requirement to prepare flood hazard and flood risk maps for these areas for publication by the Environment Agency. In addition, for these areas, a Flood Risk Management Plan must be prepared for publication by the Environment Agency by 22nd December 2015.

The Flood and Water Management Act (2010)

2.1.3 Following the devastating national floods of 2007, one of the recommendations from Sir Michael Pitt's review[8] was that *"the role of local authorities should be enhanced so that they take on responsibility for leading the co-ordination of flood risk management in their areas".*

2.1.4 The Flood and Water Management Act (FWMA) (2010)[9] brings in new roles and responsibilities for local authorities. In particular, the Act defines the role of the LLFA, which includes Unitary Authorities or County Councils. LLFAs are encouraged to bring together relevant bodies and stakeholders to effectively manage local flood risk, which may include County, City and District/Borough Councils, Internal Drainage Boards (IDBs), highways authorities, water companies and the Environment Agency.

2.1.5 The new responsibilities the Act assigns to LLFAs include:

- Coordinated management of flooding from surface water, ground water and ordinary watercourses;
- Development, maintenance and implementation of a Flood Risk Management Strategy;
- Investigation and recording of local flood events;
- Establishment and maintenance of a Flood Risk Asset Register; and,
- Ordinary watercourse regulation.

2.1.6 The Act gives LLFAs the role of Sustainable Drainage Systems (SuDS) Approval Body (SAB) where the LLFA is responsible for adopting and maintaining SuDS. This means that planning applications which have drainage implications will need to be approved by the SAB before work can commence.

Draft National Standards for Sustainable Drainage Systems (SuDS) – Designing, constructing, operating and maintaining drainage for surface runoff (2011)

2.1.7 Schedule 3 (Sustainable Drainage) of the Flood and Water Management Act 2010 contains new regulations which have implications on the design, approval and adoption of sustainable drainage. The Draft National Standards for SuDS[10] were published for consultation[i] in December 2011. The Draft Standards have been developed in order to define a standardised approach to management of surface water runoff from the design stage all the way through to maintenance of such schemes, in accordance with Schedule 3 to the Flood and Water Management Act 2010. Further to the consultation, the Government plans to implement the sustainable drainage provisions i.e. publish the National Standards for SuDS and associated guidance with a proposed commencement of the statutory instruments by the end of 2014. At the time of writing this SFRA, the final National Standards are yet to be published.

2.1.8 Once finalised, the Government will ensure that the National Standards (currently in draft) for SuDS are consistent with the Building Regulations and Code for Sustainable Homes.

[i] The consultation on the Implementation of the Sustainable Drainage Systems provisions in Schedule 3 – Flood and Water Management Act 2010 closed on 13th March 2012.

2.1.9 Future developments will have to comply with the National Standards (currently in draft) with a requirement for the submission of a separate drainage application to the LLFA who also act as the SAB. It is the intention that where SuDS serve more than a single property[ii] and are designed to new national standards, the LLFA will adopt the approved drainage system provided that three conditions are met:

- The drainage system is constructed in pursuance of approval;
- The drainage system is constructed and functions in accordance with approval; and
- The drainage system is a sustainable drainage system.

2.1.10 The Summary of Consultation Responses[11] (2012) indicated that the majority of respondents to the consultation exercise carried out for the Draft National Standards for SuDS document thought that the definition of 'single property' with regards to adoption of SuDS was either unclear or incorrect. Defra will therefore look to clarify this definition when the final National Standards are published.

2.1.11 The Draft National Standards define SuDS for adoption as those parts of a drainage system that are not vested in a sewerage undertaker pursuant to an agreement under section 104 of the Water Industry Act 1991[12]. A developer can therefore request that the SAB adopts drainage systems which serve more than one property and cannot be adopted by the sewerage undertaker. It should also be noted that the draft proposal still requires the Highways Authorities to adopt drainage associated with publically maintained roads.

2.1.12 The Flood and Water Management Act 2010 amends Section 106[13] of the Water Industry Act 1991 by introducing a new Section 106A which removes the automatic right to connect to a surface water sewer. Connection will depend on the drainage system being approved to meet new National Standards for SUDS and only approved SuDS systems will have the right to do so.

2.1.13 The principal strategy for the management of surface water runoff is contained within the Draft National Standards for SuDS and follows existing legislation (such as Building Regulations Part H3[14]).

[ii] Defined in the Summary of Consultation Responses to the Draft National Standard for SuDS as: *"a drainage system or any part of a drainage system is to be treated as designed only to provide drainage for a single property if it is designed to provide drainage for any buildings or other structures that, following completion of the construction work, will be owned, managed or controlled by a single person or two or more persons together".*

National Planning Policy Framework (2012)

2.1.14 The NPPF was published on 27th March 2012 together with accompanying Technical Guidance[15]. The NPPF revoked most of the previous Planning Policy Statements (PPS) and Planning Policy Guidance, including *PPS25: Development and Flood Risk Practice Guide*[16]. However, NPPF did not revoke the PPS25 Practice Guide. This was revoked on the 6th March 2014 along with the NPPF Technical Guidance, when it was replaced by the Planning Practice Guidance *Flood Risk and Coastal Change*.

2.1.15 The NPPF consists of a framework within which councils and local people can produce local and neighbourhood plans that reflect the needs and priorities of their communities.

2.1.16 The overall approach to flood risk is broadly summarised in NPPF Paragraph 103:

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

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

2.2 Additional Guidance and Strategy Documents

National Flood and Coastal Erosion Risk Management (FCERM) Strategy

2.2.1 In accordance with the FWMA, the Environment Agency has developed a National Strategy for Flood and Coastal Erosion Risk Management (FCERM) in England[17]. This strategy provides a framework for the work of all flood and coastal erosion risk management authorities.

2.2.2 The National FCERM Strategy sets out the long-term objectives for managing flood and coastal erosion risks and the measures proposed to achieve them. It sets the context for, and informs the production of, local flood risk management strategies by LLFAs, which will in turn provide the framework to deliver local improvements needed to help communities manage local flood risk. It also aims to achieve effective risk management by LLFAs encouraging information sharing and cooperation between people, communities, business and the public sector to work together to:

- secure a clear understanding of the risks of flooding and coastal erosion, nationally and locally, so that investment in risk management can be prioritised more effectively;
- set out clear and consistent plans for risk management so that communities and businesses can make informed decisions about the management of the remaining risks;
- encourage innovative management of risks taking account of the needs of communities and the environment;
- ensure that emergency responses to flood incidents are effective and that communities are able to respond properly to flood warnings; and,
- ensure informed decisions are made on land use planning.

2.2.3 The Environment Agency's 'Adapting to Climate Change: Advice for Flood and Coastal Erosion Risk Management Authorities'[18] guidance is a supporting note for the National FCERM Strategy. It provides the UK Climate Projections (UKCP09) climate change factors for river flood flows and extreme rainfall for each river basin district, and provides advice on applying climate change projections in the FCERM. It is essential that investment projects for flood and coastal erosion management measures consider designing for adaptation to a changing climate where appropriate.

Catchment Flood Management Plan (CFMP)

2.2.4 A CFMP is a high-level strategic planning document that provides an overview of the main sources of flood risk and how these can be managed in a sustainable framework for the next 50 to 100 years. The Environment Agency engages stakeholders within the catchment to produce policies in terms of sustainable flood management solutions whilst also considering local land use changes and effects of climate change. CFMPs are due to be replaced by Flood Risk Management Plans (FRMPs) in 2015.

2.2.5 The CFMPs are used to inform and support planning policies, statutory land use plans and implementation of the Water Framework Directive, so that future development in the catchment is sustainable in terms of flood risk. Awareness of the role of CFMPs among land-use planners is in its infancy at the time of this report.

2.2.6 The approach that the Environment Agency would like to see taken to flood risk management within the Study Area is outlined in the Thames CFMP (2009)[19]. The CFMP aims to identify flood risk management policies for the catchment and sets out the preferred plan for sustainable flood risk management in the Thames region over the next 50 to 100 years.

2.2.7 The policies listed below are used to identify the appropriate approach to flood risk management across all CFMPs, and will continue to be used in the FRMPs:

- Policy 1 – No active intervention (including Flood Warning and Maintenance). Continue to monitor and advise.
- Policy 2 – Reduce existing flood risk management actions (accepting that flood risk will increase over time).
- Policy 3 – Continue with existing or alternative actions to manage flood risk at current levels.
- Policy 4 – Take further action to sustain the current level of flood risk into the future (responding to the potential increases in risk from urban development, land use change and climate change).
- Policy 5 – Take further action to reduce flood risk.
- Policy 6 – Take action with others to store water or manage runoff in locations that provide overall flood risk reduction or environmental benefits, locally or elsewhere in the catchment.

2.2.8 The preferred policy for the LBC in the CFMP is Policy 4 - Take further action to sustain the current level of flood risk into the future.

2.3 Regional Policy

The London Plan (2011)

2.3.1 The London Plan (2011)[20] is the overall strategic plan for London and delivers an integrated framework for the development of London over the next 20 – 25 years. The plan provides details with regard to the requirement of new development to demonstrate a reduction in surface water runoff.

2.3.2 The Sustainable Design and Construction – Draft Supplementary Planning Guidance (SPG) (2013)[21] sets out a number of 'Mayor's Priorities' relating to surface water flooding and sustainable drainage, which support the London Plan. These priorities state that developers should aim to achieve greenfield runoff, design schemes following the SuDS hierarchy set out in the London Plan and incorporate surface water attenuation measures.

2.3.3 *"The London Plan Policy 5.13 Sustainable Drainage states that:*

'Development should aim to achieve greenfield run-off rates and ensure that surface water run-off is managed as close to its source as possible in line with the following drainage hierarchy:

- *store rainwater for later use;*
- *use infiltration techniques, such as porous surfaces in non-clay areas;*
- *attenuate rainwater in ponds or open water features for gradual release to a watercourse;*
- *attenuate rainwater by storing in tanks or sealed water features for gradual release to a watercourse;*
- *discharge rainwater direct to a watercourse;*
- *discharge rainwater to a surface water drain;*
- *discharge rainwater to the combined sewer."*

2.3.4 The use of Sustainable Drainage Systems should be promoted for development unless there are practical reasons for not doing so. Such reasons may include the local ground conditions or density of development. In such cases, the developer should seek to manage as much runoff as possible on site and explore sustainable methods of managing the remainder as close as possible to the site.

2.3.5 *"The Mayor will encourage multi-agency collaboration (GLA Group, Environment Agency, Thames Water) to identify sustainable solutions to strategic surface water and combined sewer drainage flooding/overflows."*

The Mayor's Water Strategy (2011)

2.3.6 The Mayor's Water Strategy[22] outlines the Mayor's aim to *"adopt a more creative approach to managing flood risk from rainfall in London. Taking opportunities to slow the progress of water from 'rain to drain' and using rainwater for non-potable uses to reduce demand for treated mains water."*

2.3.7 The surface water runoff and sustainable drainage requirements of the London Plan are reiterated in Policy 2 respectively of the Mayor's Water Strategy

2.4 Local Policy

Camden Local Development Scheme (2013)

2.4.1 The Camden Local Development Scheme (LDS)[23] was revised and published in October 2013 and provides information on the documents that (in conjunction with national planning policy and the Mayor's London Plan[24]) the Council intends to produce to form its planning policy framework. It sets out the timetable and programme for their production.

Camden Core Strategy (2010)[25]

2.4.2 The core strategy was adopted in 2010 and defines and presents a plan for the future of the borough. Strategies within the document that are relevant to flood risk are listed below.

CS13 Water and surface water flooding

2.4.3 *We will make Camden a water efficient borough and minimise the potential for surface water flooding by:*

- *g) protecting our existing drinking water and foul water infrastructure;*
- *h) making sure development incorporates efficient water and foul water infrastructure;*
- *i) requiring development to avoid harm to the water environment, water quality or drainage systems and prevents or mitigates local surface water and downstream flooding, especially in areas up-hill from, and in, areas known to be at risk from surface water flooding such as South and West Hampstead, Gospel Oak and King's Cross.*

Camden Development Policies (2010)

2.4.4 The Camden Development Policies present detailed planning criteria that are used to determine planning applications in the borough. Policies relevant to flood risk in the document are listed below.

DP23 Water

2.4.5 *The Council will require developments to reduce their water consumption, the pressure on the combined sewer network and the risk of flooding by:*

- *a) incorporating water efficient features and equipment and capturing, retaining and re-using surface water and grey water on-site;*
- *b) limiting the amount and rate of run-off and waste water entering the combined storm water and sewer network through the methods outlined in part a) and other sustainable urban drainage methods to reduce the risk of flooding;*
- *c) reducing the pressure placed on the combined storm water and sewer network from foul water and surface water run-off and ensuring developments in the areas identified by the North London Strategic Flood Risk Assessment and shown on Map 2 as being at risk of surface water flooding are designed to cope with the potential flooding;*

- *d) ensuring that developments are assessed for upstream and downstream groundwater flood risks in areas where historic underground streams are known to have been present; and*
- *e) encouraging the provision of attractive and efficient water features.*

DP27 Basements and lightwells

2.4.6 *In determining proposals for basement and other underground development, the Council will require an assessment of the scheme's impact on drainage, flooding, groundwater conditions and structural stability, where appropriate. The Council will only permit basement and other underground development that does not result in flooding or ground instability. We will require developers to demonstrate by methodologies appropriate to the site that schemes:*

- *a) maintain the structural stability of the building and neighbouring properties;*
- *b) avoid adversely affecting drainage and run-off or causing other damage to the water environment;*
- *c) avoid cumulative impacts upon structural stability or the water environment in the local area;*

Camden Planning Guidance

2.4.7 Camden Planning Guidance (CPG) 4: Basements and Lightwells provides additional information on LBC planning policies included in the LDF and covers two key areas relating to basement dwellings;

1. *basement impact assessments, principal impacts of basements, planning and design considerations; and*
2. *how basement dwellings maybe affected in streets at risk from flooding.*

2.4.8 The guidance is relevant to new basement developments and extensions requiring planning permission. It provides further detailed explanation and guidance on the stages required to deliver a Basement Impact Assessment, the aim of which is to ensure no nearby properties, or the water environment are adversely impacted as a result of development, or that adverse impacts can be mitigated. The guidance states that all basement development should undergo the first screening stage of Basement Impact Assessments in order to identify any potential risks from such development.

2.5 Study Area Overview

2.5.1 This Section provides a description of the study area and the local planning policy context.

2.6 Location

2.6.1 The LBC is located within Greater London, to the north of the River Thames. LBC is bordered by the administrative areas of the City of Westminster, the City of London and the London Boroughs of Brent, Barnet, Haringey and Islington.

2.6.2 LBC encompasses the areas of Holborn, King's Cross, Bloomsbury, Belsize Park, Chalk Farm, Kentish Town, Highgate and Hampstead. Hampstead Heath is a large green space covering over 300 hectares and is located in the north of the borough.

2.7 Topography

2.7.1 Appendix B: Figure 1 shows the topography of the study area. The north of the borough lies at a maximum elevation of approximately 130m AOD. The borough slopes down towards the south and south-east, with elevations in the south-east of the borough as low as approximately 10-15m AOD.

2.8 Waterbodies

Historic rivers

2.8.1 Historically the sources of the Rivers Fleet, Tyburn, Kilburn and Brent were located in the area of Hampstead Heath[26]. In the present day no main rivers are located in the London Borough of Camden following the incorporation of the reaches located within Camden into the Thames Water Utilities Ltd (TWUL) sewer network and therefore the borough is located entirely in Flood Zone 1. The absence of main rivers has been confirmed by a review of the Detailed River Network provided by the Environment Agency to inform this SFRA. The headwaters of the River Brent, located approximately 2km to the north-west of Camden remains an open watercourse.

2.8.2 The two sources of the River Fleet feed two chains of ponds on Hampstead Heath: the Hampstead Ponds and the Highgate Ponds. The two branches of the River Fleet historically flowed through Gospel Oak and Kentish Town before converging north of Camden Town. The River subsequently flowed past King's Cross, along King's Road, Farringdon Street and then into the River Thames[26].

2.8.3 The River Fleet became entirely enclosed in the 19th Century and is now fully incorporated into the TWUL sewer network[27], eventually out-falling into the River Thames under Blackfriars Bridge. In the 1870s the Fleet Storm Relief Sewer was built to increase the ability of the sewer network to cope during high flow events. TWUL network plans, provided to inform this SFRA, indicate that the Fleet Storm Relief Sewer begins in proximity to Kentish Town railway station before running roughly parallel to the Fleet Trunk Sewer past Camden Town and St Pancras railway stations, southwards along Grays Inn Road, Hatton Garden and subsequently outfalls into the River Thames.

2.8.4 The Hampstead Ponds, located along the original path of one branch of the River Fleet, connect to the sewer network downstream of Hampstead Number 1 Pond and the Highgate Ponds connect to the sewer network downstream of Highgate Number 1 Pond. Both discharges into the sewer network are limited, restricted by the capacity of the outfall pipe from the two pond chains. The River Kilburn originated at Whitestone Pond in the north-west of Hampstead Heath. The watercourse flowed through Kilburn and into Hyde Park. Here the river formed the Serpentine, and subsequently flowed through Knightsbridge, Sloane Square and into the River Thames. The River Kilburn was culverted in the 19th Century and incorporated into the TWUL sewer network as the Ranelagh Sewer, which discharges into the River Thames at Battersea Park[28].

2.8.5 The River Tyburn originally flowed from two sources to the south of Hampstead Heath; Hampstead Heath and Shepherd's Well, before converging at the Woronzow Road. The river subsequently flowed through Regent's Park and under Buckingham Palace, before splitting and entering the River Thames at two points. The River Tyburn has been incorporated into the TWUL sewer network as the King's Scholar's Main Sewer, outfalling into the River Thames at Pimlico near Vauxhall Bridge.

2.8.6 The Environment Agency Detailed River Network indicates that a small watercourse originates in West Heath in the north-west of the borough, flowing approximately north-west into the Leg of Mutton Pond, and subsequently westward into the London Borough of Brent. The watercourse is culverted at the west of Golders Hill Park and subsequently open in sections until it connects to the River Brent approximately 2.5km to the west of LBC.

2.8.7 Outside of Hampstead Heath, significant water bodies within LBC include three ponds located within Waterlow Park in the north-west of the Borough and the Regent's Canal.

Canals

2.8.8 Regent's Canal enters LBC in the east of the borough, to the north of King's Cross railway station, and flows through Camden Town and towards Regents Park to the west of the borough. Regent's Canal is maintained by the Canal and River Trust. A number of lock gates are located along the section of Regent's Canal running through Camden.

2.9 Geology

2.9.1 The underlying geology can influence the presence and nature of groundwater in an area, and therefore the potential flood risk from groundwater. The geology can also impact on the potential for infiltration based drainage systems. The geology information has been obtained from British Geological Survey and Environment Agency data. Appendix B Figures 4a and 4b show the underlying geology within LBC.

2.9.2 The bedrock geology of LBC comprises primarily of London Clay Formation, with the exception of Claygate Member and Bagshot Formation which underlie the higher ground in the north of the borough on Hampstead Heath.

2.9.3 The majority of the borough is shown to be free of superficial deposits. Lynch Hill Gravel Formation, Hackney Gravel Formation and Langley Silt are located in the southern section of the borough, south of Euston Station. Very small isolated sections of Stanmore Gravel are located in the very north of the borough on Hampstead Heath.

2.10 Hydrogeology

Aquifer Type

2.10.1 Aquifers are defined as layers of permeable rock or unconsolidated material (sand, gravel, silt etc.) capable of storing and transporting large quantities of water. The understanding of the behaviour and location of aquifers is important as they can provide an indication of the potential for groundwater flooding.

2.10.2 In the Environment Agency aquifer type dataset, the River Terrace Deposits, which comprise a number of superficial geological formations in the south of the borough close to the River Thames, are classified as a secondary aquifer. According to Environment Agency definitions, a secondary aquifer is defined as a permeable layer capable of supporting water supplies at a local rather than strategic scale and in some cases forming an important source of base flow to rivers.

2.10.3 In addition to the secondary aquifer in the south, towards the north of the borough, underlying the Hampstead Heath area, there is a secondary aquifer comprised of the Bagshot Formation geological deposits.

2.10.4 The London Clay Formation is a non-aquifer or unproductive strata – these are rocks with low permeability that have negligible significance for water supply or river base flow.

2.10.5 The Inner Zone of a Groundwater Source Protection Zone (GSPZ) is located within the south-west of Primrose Hill park. An Outer Protection Zone covers a section of South Hampstead from Prince Albert Road to Swiss Cottage. The aim of GSPZs is to identify particular areas where there are likely to be certain risks posed to quality and/or quantity of groundwater abstracted[29], should particular activities occur in the area. The presence of a GSPZ is not primarily of consideration in relation to flood risk, though should be taken into consideration when considering the environmental impact of a development.

Bedrock Permeability

2.10.6 Bedrock permeability can provide information relevant to surface water infiltration capacity. Further information on the suitability of infiltration SuDS techniques is provided in Section 7. The Environment Agency bedrock permeability datasets shows that the Bagshot Formation is classified as bedrock deposits that are likely to be free draining. The Claygate Member and London Clay Formation are classified as bedrock whose permeability is spatially variable, but likely to permit moderate infiltration.

3 SFRA METHODOLOGY

3.1 Overview

3.1.1 Under Section 10 of the NPPF, the risk of flooding from all sources must be considered as part of a SFRA, including flooding from rivers, land, groundwater, sewers and artificial sources (flooding from the sea is not relevant to the study area). The methodology for the appraisal of flood risk from all sources is outlined below. A description of the datasets used to assess the risk of flooding from each source is provided, further details of which are included within the data register in Appendix A.

3.2 Data Collection and Methodology

3.2.1 Table 3.1 outlines the stakeholders contacted during the development of this SFRA.

Table 3.1: SFRA Stakeholder Organisations and Roles

Stakeholder Organisation	Role with respect to the LBC SFRA
LBC	As a LPA LBC has a responsibility to consider flood risk in their strategic land use planning and the development of their Local Plan. The NPPF requires LPAs to undertake a SFRA and to use their findings, and those of other studies, to inform strategic land use planning including the application of the Sequential Test which seeks to steer development towards areas of lowest flood risk prior to consideration of areas of greater risk. LBC is also required to consider flood risk when assessing applications for development. During the preparation of the SFRA, records held by the Council of flood incidents across the borough were used to help inform the flood risk within Camden. The SFRA should be used by the LBC Emergency Planning team so that the findings where appropriate are incorporated into their understanding of flood risk and the preparation of their Multi-Agency Flood Plans (MAFP).
Environment Agency	The Environment Agency has a role to provide technical advice to LPAs and developers on how best to avoid, manage and reduce the adverse impacts of flooding. Part of this role involves advising on the preparation of spatial plans and sustainability appraisals as well as the evidence base documents underlying such documents, including SFRAs. The Environment Agency undertakes systematic modelling and mapping of fluvial flood risk associated with all Main Rivers in the study area, as well as mapping of surface water flood risk, and will supply available datasets for use within the SFRA. The Environment Agency will perform a technical review role of the draft project deliverables.
The City of London Corporation	The City of London Corporation (CoLC) maintains Hampstead Heath, including the Hampstead Heath ponds, ensuring that they are safe. CoLC was consulted in order to confirm the maintenance and management of the Hampstead Heath Ponds, to obtain information of the Hampstead Heath Ponds Project currently being developed with the aim to ensure the safety of the pond dams and to confirm the rate of discharge from the ponds to the local TWUL sewer network.

Stakeholder Organisation	Role with respect to the LBC SFRA
Thames Water Utilities Ltd	Thames Water is responsible for surface water drainage from development via adopted sewers and for maintaining public sewers into which much of the highway drainage connects. In relation to the SFRA, the main role that Thames Water plays is providing data regarding past sewer flooding.
Network Rail	Network Rail was consulted to provide details of any known historic and recent flood risks across their infrastructure routes in the borough, areas that are susceptible to flooding, flood mitigation measures that have already been put in place and maintenance regimes. At the time of writing this SFRA, no data had been provided by Network Rail.
British Geological Survey	The British Geological Survey holds a number of datasets that will inform the SFRA, including superficial and bedrock geology and suitability of infiltration SuDS.
Transport for London (TfL)	Transport for London (TfL) is responsible for the running and management of the London Overground, London Underground and sections of the London road network. TfL was consulted to provide details of any known historic and recent flood risks across their infrastructure routes in the borough, areas that are susceptible to flooding, flood mitigation measures that have already been put in place and maintenance regimes. At the time of writing this SFRA, no data had been provided by TfL.
Canal and River Trust	The Canal and River Trust (C&RT) maintains over 2,000 miles of canals and rivers in the UK, including Regent's Canal which runs through LBC. The C&RT provided details of the assets within LBC which they control and confirmed the absence of any overtopping events in the borough.

Flooding from Rivers

3.2.2 All main rivers historically located within LBC are now culverted and incorporated into the TWUL sewer network. The flood risk from these 'lost rivers' is discussed within Section 4.4. The original sources of the River Fleet feed the Hampstead Heath Ponds. The flood risk from the Hampstead Heath Ponds is discussed in Section 4.5.

Historic Flooding

3.2.3 The Environment Agency's Historic Flood Map shows that no flooding has occurred within LBC from fluvial or tidal sources.

Flooding from Surface Water

3.2.4 Overland flow and surface water flooding typically arise following periods of intense rainfall, often of short duration, that is unable to soak into the ground or enter drainage systems. It can run quickly off land and result in localised flooding.

Updated Flood Map for Surface Water

3.2.5 The Environment Agency has undertaken modelling of surface water flood risk at a national scale and produced mapping identifying those areas at risk of surface water flooding during three annual exceedance probability events: 1 in 30 year (3.33% AEP), 1 in 100 year (1% AEP and 1 in 1,000 year (0.1% AEP). The latest version of the mapping is referred to as the updated Flood Map for Surface Water (uFMfSW) and the extents have been made available to LBC as GIS layers.

3.2.6 The uFMfSW provides all relevant stakeholders, such as the Environment Agency, LBC (as the LLFA) and the public access to information on surface water flood risk which is consistent across England and Wales[30]. The modelling will help the Environment Agency take a strategic overview of flooding, and assist LBC (as the LLFA) in their duties relating to management of surface water flood risk. For the purposes of this SFRA, the mapping allows an improved understanding of areas within the LBC administrative area which may have a surface water flood risk.

3.2.7 The modelling represents a significant improvement on previous mapping, namely the Flood Map for Surface Water (FMfSW) (2010) and the Areas Susceptible to Surface Water Flooding (AStSWF) (2009), for example:

- Increased model resolution to 2m grid;
- Representation of buildings and flow routes along roads and manual editing of the model for structural features such as flyovers;
- Use of a range of storm scenarios; and
- Incorporation of appropriate local mapping, knowledge and flood incident records.

3.2.8 However, it should be noted that this national mapping has the following limitations:

- Use of a single drainage rate for all urban areas;
- It does not show the susceptibility of individual properties to surface water flooding;
- The mapping has significant limitations for use in flat catchments;
- No explicit modelling of the interaction between the surface water network, the sewer systems and watercourses;
- In a number of areas, modelling has not been validated due to a lack of surface water flood records;

- As with all models, the uFMfSW is affected by a lack of, or inaccuracies, in available data.

3.2.9 Local surface water modelling carried out for the Highgate and West Camden areas on behalf LBC has been incorporated into the uFMfSW data.

Climate Change

3.2.10 The uFMfSW does not include a specific scenario to determine the impact of climate change on the risk of surface water flooding. However a range of three annual exceedance probability events have been undertaken, 3.3%, 1% and 0.1% and therefore it is considered appropriate to use the 0.1% AEP event as a substitute dataset to provide an indication of the implications of climate change.

Historic Flooding

3.2.11 Appendix B Figure 3i – 3v presents this mapping for the LBC study area in combination with historical surface water flooding data recorded by LBC. It should be noted that where streets are shown to have experienced flooding during the 1975 and 2002 flood events, this mapping is relatively coarse in scale and does not allow a distinction between, for example, an entire street flooding, or an isolated section of road flooding as a result of a blocked gully.

Flooding from Groundwater

3.2.12 Groundwater flooding usually occurs in low lying areas underlain by permeable rock and aquifers that allow groundwater to rise to the surface through the permeable subsoil following long periods of wet weather. Low lying areas may be more susceptible to groundwater flooding because the water table is usually at a much shallower depth and groundwater paths tend to travel from high to low ground.

3.2.13 Table 3.2 details the datasets that were supplied to the project team by the Environment Agency and the British Geological Survey (BGS) regarding the underlying geology, the presence of groundwater and the risk of groundwater flooding.

Table 3.2: Geology and Groundwater Flood Risk Datasets

Source	Dataset Title	Figure No.
1	Superficial geology (British Geological Survey)	Appendix B Figure 4a
2	Bedrock geology (British Geological Survey)	Appendix B Figure 4b
3	Aquifer Type (Environment Agency)	-
4	Bedrock Permeability	-
5	Groundwater Vulnerability Classification (Environment Agency)	-
6	SuDS drainage potential – depths to water table (BGS)	-
7	SuDS drainage potential – infiltration constraints summary (BGS)	Appendix B Figure 4c
8	SuDS drainage potential – drainage summary (BGS)	Appendix B Figure 4d
9	Increased Potential for Elevated Groundwater (LBC SWMP)	Appendix B Figure 4e

3.2.14 In order to provide a strategic assessment of the risk of groundwater flooding in LBC, the following two stage assessment was undertaken using the data sources in Table 3.2.

3.2.15 The initial stage included a review of the GIS layers of the BGS superficial geology (Source 1) and bedrock geology (Source 2), the EA aquifer type (Source 3), bedrock permeability (Source 4) and groundwater vulnerability (Source 5).

3.2.16 The next stage was to use the GIS layer produced by the BGS showing a data set of infiltration SuDS mapping, the GIS layers used were the depth to water table (Source 6), the infiltration constraints summary (Source 7) (identifying areas with very significant potential for one or more geohazards) and the drainage summary (Source 8) (identifying areas with very significant constraints, areas probably suitable for infiltration SuDS and areas potentially suitable for infiltration SuDS).

3.2.17 The risk of flooding from groundwater is detailed in Section 4.3.

Flooding from Sewers

3.2.18 During heavy rainfall, flooding from the sewer system may occur if:

1. *The rainfall event exceeds the capacity of the sewer system/drainage system:*

3.2.19 Sewer systems are typically designed and constructed to accommodate rainfall events with a 3.3% AEP (1 in 30 years) or less. Therefore, rainfall events with a return period of frequency greater than 3.3% AEP would be expected to result in surcharging of some of the sewer system. While TWUL are concerned about the frequency of extreme rainfall events, it is not economically viable to build sewers that could cope with every extreme rainfall event.

2. The system becomes blocked by debris or sediment:

3.2.20 Over time there is potential that road gullies and drains become blocked from fallen leaves, build-up of sediment and debris (e.g. litter).

3. The system surcharges due to high water levels in receiving watercourses:

3.2.21 Where the local area is served by 'combined' sewers i.e. containing both foul and storm water, if rainfall entering the sewer exceeds the capacity of the combined sewer and storm overflows are blocked by high water levels in receiving watercourses, surcharging and surface flooding may again occur but in this instance floodwaters will contain untreated sewage.

Historic Flooding

3.2.22 TWUL has provided an extract from their DG5 Flood Register for the study area. Due to data protection requirements this data has not been provided at individual property level; rather the register comprises the number of properties within 4 digit postcode areas that have experienced flooding either internally or externally within the last 10 years.

3.2.23 Appendix B: Figure 5a shows that 8 properties have been affected by internal sewer flooding in the past 10 years in two separate areas in South Hampstead and north-west of Primrose Hill. In Hampstead, including an area in Hampstead Heath, 4 properties have been affected by internal sewer flooding. A small number of properties (1-2 properties) have experienced internal flooding in three separate areas in Camden Town, West Hampstead and Kilburn.

3.2.24 Appendix B: Figure 5b shows that external flooding is concentrated in the west of the borough in the South Hampstead and Kilburn areas. An area of South Hampstead has 18 recorded incidents of external sewer flooding, with adjacent areas experiencing between 1 and 4 recorded external flooding incidents in the past 10 years. One external flooding incident has also been recorded in the Hampstead area.

Flooding from Reservoirs, Canals and Other Artificial Sources

3.2.25 The failure of a reservoir has the potential to cause catastrophic damage due to the sudden release of large volumes of water. The Planning Practice Guidance encourages LPAs to identify any impounded reservoirs and evaluate how they might modify the existing flood risk in the event of a flood in the catchment it is located within, and / or whether emergency draw-down of the reservoir will add to the extent of flooding.

3.2.26 Table 3.3 provides a summary of the artificial sources of flooding in the study area that have been identified from a review of the Ordnance Survey (OS) 1:10,000 scale mapping. Water bodies over 1500m^2 in area have been identified in Table 3.3. A number of smaller ponds, pools and other water bodies are present within the borough, though have not been included due to their limited potential to impact on local flood risk.

3.2.27 The Environment Agency's Risk of Flooding from Reservoirs Mapping[31] identifies areas that could be flooded if a large[32] reservoir were to fail and release the water it holds. There are three water bodies designated as 'large' within LBC; Hampstead Pond Number 1 and Highgate Ponds Number 2 and 3.

3.2.28 Reservoirs in the UK have an extremely good safety record. The Environment Agency is the regulatory authority for the Reservoirs Act 1975 in England and Wales. All large reservoirs must be inspected and supervised by reservoir panel engineers on an annual basis.

3.2.29 The Maiden Lane Reservoir in Islington is a covered service water reservoir owned by TWUL which could also pose a risk to Camden residents if there was a breach. The LBC Local Flood Risk Management Strategy[33] states that TWUL declared that there is a low risk of the Maiden Lane Reservoir failing. TWUL is able to rapidly empty the reservoir should there be a requirement to do so.

3.2.30 During consultation with the CoLC it was confirmed that there are three designated reservoirs on Hampstead Heath, which are routinely inspected as required by the Reservoirs Act 1975. Previous inspection identified that there was a substantial risk of failure of the ponds and there was therefore a need for works to be carried out on the Hampstead Heath Ponds. This has led to the City of London Corporation Hampstead Heath Ponds Project. The risk from reservoir flooding is discussed in Section 4.5.

3.2.31 The CoLC were consulted during the writing of this SFRA in order to confirm its current maintenance and management practices for the Hampstead Heath Ponds. The existing risk of flooding from the Hampstead Heath Ponds was assessed as part of the Hampstead Heath Ponds Quantitative Risk Assessment[34] and Hampstead Heath Ponds Project Assessment of Design Flood[35] reports. A summary is provided in Section 4.5.

3.2.32 LBC is responsible for working with members of the Local Resilience Forum (LRF) to develop emergency plans for reservoir flooding.

Table 3.3: Artificial Sources / Water bodies

Area	Water body	Approximate Area (m^2)
Hampstead Heath	Wood Pond	6,920
Hampstead Heath	Thousand Pound Pond	4,085
Hampstead Heath (Highgate Pond Chain)	Stock Pond	4,383
Hampstead Heath (Highgate Pond Chain)	Kenwood Ladies' Bathing Pond	6,810
Hampstead Heath (Highgate Pond Chain)	Bird Sanctuary Pond	6,504
Hampstead Heath (Highgate Pond Chain)	Model Boating Pond	16,134
Hampstead Heath (Highgate Pond Chain)	Highgate Men's Bathing Pond	18,229
Hampstead Heath (Highgate Pond Chain)	Highgate No. 1 Pond	13,613
Hampstead Heath	Leg of Mutton Pond	2,470
Hampstead Heath	Whitestone Pond	1,852
Hampstead Heath (Hampstead Pond Chain)	Vale of Health Pond	8,548
Hampstead Heath (Hampstead Pond Chain)	Viaduct Pond	2,452
Hampstead Heath (Hampstead Pond Chain)	Mixed Bathing Pond (No. 3)	6,864
Hampstead Heath (Hampstead Pond Chain)	Hampstead No. 2 Pond	10,845
Hampstead Heath (Hampstead Pond Chain)	Hampstead No. 1 Pond	15,074
Waterlow Park	Waterlow Park Lakes	2,638 and 2,459

Area	Water body	Approximate Area (m^2)
King's Cross / Camden Town	Regent's Canal	N/A

Historic Flooding

3.2.33 The C&RT have confirmed that no flooding incidents associated with the Regent's Canal have been recorded within LBC.

3.2.34 The dams on the Hampstead Heath Ponds experienced damage following the 1975 extreme rainfall event. In addition, in 2010 Stock Pond was overtopped during a rainfall event[36]. Further detail is provided in Section 4.5.

3.3 Summary

3.3.1 This Section has provided a description of the datasets that have been supplied for use as part of the SFRA. The following Section uses these datasets to provide an assessment of the flood risk within the borough.

4 STRATEGIC ASSESSMENT OF FLOOD RISK WITHIN LONDON BOROUGH OF CAMDEN

4.1 Flooding from Rivers

4.1.1 As stated in Section 3.2.2 all main rivers historically located within LBC are now culverted and incorporated into the TWUL sewer network and therefore there is no fluvial flood risk within LBC.

4.1.2 The flood risk from these 'lost rivers' is discussed within Section 4.4. The original sources of the River Fleet feed the Hampstead Heath Ponds. The flood risk from the Hampstead Heath Ponds is discussed in Section 4.5.

4.2 Flooding from Surface Water

4.2.1 The LBC Surface Water Management Plan (SWMP) identified a number of Critical Drainage Areas (CDAs) within LBC (Appendix B: Figure 6), which are defined in the SWMP as:

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

4.2.2 Therefore a specific area within a CDA is not necessarily at higher risk from surface water than an area outside of a CDA. However the location of an area within a CDA indicates that it is within a catchment area which contributes to a flooding hotspot. Within CDAs, surface water management should be a particular focus of new developments.

4.2.3 The majority of the borough is located within a CDA identified in the SWMP (See Appendix B Figure 6), with the exception of a narrow strip of land along the northern boundary of the borough, the western section of Hampstead Heath including the Hampstead Pond chain and an area around Royal Free Hospital. Any development in areas of previously undeveloped land in LBC is likely to have a negative impact on surface water flood risk in LBC by reducing the potential for infiltration of runoff, unless appropriate surface water management is incorporated into the development to reduce the runoff from the site post-development.

4.2.4 The SWMP also identifies a number of Local Flood Risk Zones (LFRZ), which are included in Appendix B Figure 6, and are defined in the SWMP as:

4.2.5 *"discrete areas of flooding that do not exceed the national criteria for a 'Flood Risk Area' but still affect houses, businesses or infrastructure. A LFRZ is defined as the actual spatial extent of predicted flooding in a single location."*

4.2.6 The uFMfSW is the most recent and up-to-date surface water modelling available for LBC and is presented in Appendix B Figure 3. The mapping shows that for the model scenarios (3.33% AEP, 1% AEP and 0.1% AEP) the surface water flood extent broadly follows the natural topography of the borough, as expected. Potential flooding also follows man-made features such as roads and rail lines. Such flow routing is most prominent during the 3.33% AEP event, which represents the least extreme rainfall event of those modelled. For the more extreme modelling scenarios, increased ponding in areas of properties can be identified. Whilst potential flooding is identified throughout the borough, concentrations of ponding occur in the Camden Town and Dartmouth Park areas, as well as in West and South Hampstead.

4.2.7 Historic flood records indicate that LBC, particularly to the north of Euston Road, is prone to surface water flooding. Two large surface water flooding events have occurred in LBC in 1975 and 2002 causing widespread damage, as described below.

4.2.8 A large storm event occurred in north London on 14th August 1975, and has been identified as the most extreme rainfall event ever recorded in London[37], with approximately 170.8mm of precipitation recorded by the Hampstead Scientific Society in a 2 to 3 hour period.

4.2.9 Numerous roads and houses in the area were severely flooded, with the local sewer network overloaded leading to surcharging. One member of the public lost their life as a result of flood waters and over 250 people were re-housed either temporarily or permananently[37]. The following areas were identified as being affected by flooding during the August 1975 rainfall event:

- Gospel Oak
- West Hampstead
- Kilburn
- Primrose Hill
- Oak Village
- Hampstead Garden Suburb
- Hornsey
- Golders Green
- Willesden
- Cricklewood
- Kentish Town.

4.2.10 In 1994 a Flood Relief Sewer was constructed by TWUL; the North West Storm Relief Sewer. The sewer runs from the western end of Fawley Road in West Hampstead south-eastward roughly parallel to Fairhazel Road, before turning approximately south-west along Belsize Road and Oxford Road. The Storm Relief Sewer was designed to accommodate a 1 in 10 year storm event[38] (10% AEP).

4.2.11 Severe surface water flooding was also experienced in Camden on 7th August 2002. Appendix B: Figure 3 shows the location of roads affected by surface water flooding during this event. As with the 1975 flooding records, this mapping is relatively course and should be used to indicate roads where flooding was experienced and not to identify the exact extent of flood waters during the rainfall event. The Report of the Floods Scrutiny Panel for the 2002 floods[38] found that Hampstead Heath experienced 60mm of rain in under an hour resulting in flooding primarily in West and South Hampstead and Kentish Town, with flooding on a number of other roads.

4.2.12 As with the 1975 rainfall event, the sewer system capacity was exceeded resulting in surcharging of the sewer system in a number of locations[38]. The flooding caused damage to housing, public services and private businesses. Following the flood event, TWUL provided evidence confirming that the sewer system had reached maximum capacity reducing the ability of the sewer network to drain surface water. Evidence suggests that during extreme rainfall events, the TWUL sewer network reaches capacity very quickly resulting in surcharging of sewers. Due to the magnitude of the rainfall event, the North West Storm Relief Sewer also reached capacity and therefore flooding was experienced along roads in proximity to the sewer.

4.2.13 TWUL, upon consultation, provided details of a flood alleviation scheme at Sumatra Road, West Hampstead, delivered after the 2002 flood event. A sewer was constructed at Sumatra Road, designed to intercept and divert flow towards a storage tank which provides approximately 1700m^3 of storage during extreme rainfall events. Whilst the scheme will help to reduce the local flood risk, there is still potentially still a flood risk during an extreme rainfall event.

4.3 Flooding from Groundwater

Geology

4.3.1 In Source 1 (see Table 3.2), there are superficial deposits in the southern part of the Camden BC area comprising River Terrace Deposits (see Appendix B: Figure 4a). The named formations are the Lynch Hill Gravel Formation (Sand & Gravel (S&G)), Hackney Gravel Formation (S&G) and Langley Silt (Silt). In Source 2, the bedrock geology in the borough is underlain by Bagshot Formation (Sand), Claygate Member (Sand, Silt and Clay) and London Clay Formation (Silt and Clay) in different parts of the area (see Appendix B: Figure 4b). The majority of the area is underlain by London Clay Formation, although there is Bagshot Formation and Claygate Member underlying the higher ground in the north of the borough on Hampstead Heath.

Flooding from Groundwater

4.3.2 In Source 6 (see Table 3.2), the areas underlain by bedrock within the borough are expected to have depths to the water table of either >5m throughout the year or <3m for part of the year. The deepest water tables are expected to occur on Bagshot Formation, such as on Hampstead Heath. In the areas with superficial deposits, the expected depths to the water table is either between 3 and 5m for part of year or <3m for part of the year. In Source 7, the infiltration constraints map shows very significant potential for one or more geohazards in the area lying along the northern edge of the River Terrace Deposits (in the south of the borough) (see Figure 2 – elevated groundwater levels map). In this area, a factor which may be influencing this risk is that the River Terrace Deposits may be quite thin (i.e. limited storage) and the underlying bedrock is a relatively impermeable London Clay Formation (i.e. the water cannot drain away).

4.3.3 Appendix A Figure 4e shows a dataset from the LBC SWMP described as ‘Increased Potential for Elevated Groundwater’. This dataset was derived from four individual data sources (BGS Groundwater Flood Susceptibility maps; Environment Agency Thames Estuary 2100 groundwater hazard maps; Defra Groundwater emergence maps; and JBA Consulting Groundwater flood maps) and identifies areas where there is increased potential for groundwater levels to rise within 2m of the ground surface following periods of higher than average recharge. Permeable superficial deposits with increased potential for elevated groundwater only cover a small area towards the south of the borough.

4.3.4 It can be noted that a number of groundwater flooding incidents have been recorded outside the areas of Increased Potential for Elevated Groundwater. Groundwater flooding is often relatively small scale and site-specific, whereas the mapping shown in Appendix A Figure 4e (and also the SuDS suitability mapping in Appendix A Figure 4d) are produced from regional mapping and therefore should be used as a guide only. Therefore there is a potential for groundwater flooding outside the areas identified as having an Increased Potential for Elevated Groundwater.

4.3.5 As detailed in the Camden Geological, Hydrogeological and Hydrological Study[39] within Camden groundwater can be encountered within River Terrace Deposits, isolated perched water bodies within sandy layers of the London Clay and a more significant water table within the Bagshot Beds. Perched groundwater is typically isolated above the primary aquifer, where the two are separated by an impermeable layer, such as the London Clay present underneath Camden. The perched water tables are identified to be a slope stability, rather than flood risk, issue within Camden and should be assessed as such in any Basement Impact Assessment. The Study details that: *"Low permeability clay layers within the Bagshot Formation may lead to perched water tables which can affect slope stability."*

4.4 Flooding from Sewers

4.4.1 The majority of LBC is served by a combined surface and foul water sewer system. The TWUL sewer systems are now typically designed and constructed to accommodate rainfall events with a 3.3% AEP or less. Therefore, rainfall events with a return period of frequency greater than 3.3% AEP would be expected to result in surcharging of some of the sewer system. However the North London SFRA[27] identified the sewer network within Camden as being particularly old, with some sections of sewer potentially designed to only convey storms up to the 10% AEP event.

4.4.2 Historic 'lost rivers' within LBC, such as the River Fleet, were culverted and incorporated into the local sewer network in the 19th Century. The River Fleet was incorporated into the sewer network as the Fleet Trunk Sewer, with the Fleet Storm Relief Sewer built in the 1870s to increase the ability of the sewer network to cope during extreme rainfall events. The Fleet Storm Relief Sewer runs through Kentish Town railway station before running roughly parallel to the Fleet Trunk Sewer past Camden Town and St Pancras railway stations, southwards along Grays Inn Road, Hatton Garden and subsequently outfalls into the River Thames. The River Kilburn has been incorporated into the TWUL sewer network as the Ranelagh Sewer and the River Tyburn as the King's Scholar's Trunk Sewer. Further detail on the lost rivers of Camden is provided in Section 2.8.

4.4.3 The River Fleet would historically have drained a large proportion of LBC and the Fleet Trunk Sewer broadly still follows the natural topography of the borough, running approximately south-east from Hampstead Heath towards the River Thames. Therefore rain falling within the former River Fleet's broad catchment area is likely to flow into the combined sewer network.

4.4.4 The combined sewer network is designed to outfall into the River Thames during intense rainfall events when the sewer network reaches capacity. However there is evidence that during the 1975 and 2002 extreme rainfall events surcharging of the local sewer network occurred as its capacity was exceeded[38] [39]. This is potentially due to the inability of the combined sewer network to discharge to the River Thames at a high enough rate to convey surface water present during particularly extreme rainfall events.

4.4.5 TWUL DG5 flood records (Appendix B: Figure 5a) show that internal sewer flooding of properties is concentrated in the north of the borough. One or more flood incidents have occurred in the areas of Camden Town, West Hampstead and Kilburn, with 8 flooding incidents in the past 10 years in both South Hampstead and north-west of Primrose Hill.

4.4.6 Appendix B: Figure 5b shows that external flooding is further concentrated in the west of the borough in the South Hampstead and Kilburn areas. One or more properties have experience external sewer flooding in the past 10 years in Hampstead and South and West Hampstead with 18 flooding incidents recorded in one area of South Hampstead.

4.5 Flooding from Reservoirs, Canals and other Artificial Sources

Reservoirs and other ponds

4.5.1 There are about 30 ponds located within Hampstead Heath[40], three of which are classified as 'large raised reservoirs' under the Reservoirs Act 1975. Following routine inspection by a Supervising Panel Engineer, CoCL was advised that works were required to ensure that the flood risk from the ponds is minimised. As a result of this the Hampstead Heath Ponds Project was initiated in 2012 by CoCL, who have managed Hampstead Heath for 25 years. It is important to note that the Project is currently in progress and a number of reports are in draft form. A planning application for the Project is currently programmed for July 2014[41]. If approved, and once completed, the potential flood risk from failure of one or more of the Hampstead Heath ponds is expected to be reduced significantly as a result of the completion of the Hampstead Heath Ponds Project. Should this occur it is recommended that this SFRA be revised to reflect the change in flood risk from this source.

4.5.2 As discussed in Section 2.8 the Hampstead Ponds connect to the sewer network downstream of Hampstead Number 1 Pond and the Highgate Ponds connect to the sewer network downstream of Highgate Number 1 Pond.

4.5.3 Table 4.1 shows the flow rates from the ponds into the local sewer network, provided by CoLC. The discharge rates are based on a peak water level within the Highgate and Hampstead No. 1 Ponds, as indicated within Table 2.1. The rates are provided for the Probable Maximum Flood event which is an industry standard design flood event for reservoir safety studies[42] and is estimated to be a 1 in 400,000 year event, Appendix B: Figure 2 shows the location of the Hampstead Heath Ponds.

Table 4.1: Hampstead Heath Ponds outfall pipe flow rates

Pond	Overflow pipe diameter, mm	Probable Maximum Flood peak discharge (existing scenario), m^3/s
Highgate No. 1 Pond	457	0.60 (at peak level of 64.12m)
Hampstead No. 1 Pond	300	0.25 (at peak level of 71.1m)

4.5.4 The Hampstead Heath Ponds Project: Assessment of Design Flood report[35] developed an estimate of the Probable Maximum Flood (PMF) (estimated as a 1 in 400,000 year event), as well as 1 in 100 year, 1000 year and 10,000 year storm events and provides an indication of the likelihood of overtopping of each pond within the study area. Ponds within the Highgate and Hampstead chains were included within the study, with the exception of Wood Pond and Thousand Pounds Pond within the Highgate chain in Kenwood Park which are owned by English Heritage. Ponds within the Golders Hill Park and Heath Extension chain were excluded from the study.

4.5.5 The report provides a summary of the current standard of protection of each pond assessed in the study. The summary is replicated below in Table 4.2.

Table 4.2: Current Standard of Protection of Highgate and Hampstead Chain Ponds. Source: Atkins (2013), Hampstead Heath Ponds Project: Assessment of Design Flood

Pond	Current Standard of Protection (Rainfall event where overtopping occurs)
Highgate Chain	
Stock	1 in 5 year
Ladies Bathing	1 in 20 year
Bird Sanctuary	1 in 20 year
Model Boating	1 in 20 year for auxiliary spillway 1 in 50 year for main embankment
Men's Bathing	1 in 50 year
Highgate No. 1	1 in 100 year
Hampstead Chain	
Vale of Heath	1 in 1,000 year
Viaduct	1 in 1,000 year
Mixed Bathing	1 in 100 year
Hampstead No. 2	1 in 100 year
Hampstead No. 1	1 in 10,000 year

4.5.6 Maximum dam overtopping depths, representing the depths of water flowing over the embankments of the ponds, were calculated for a range of design flood events. Maximum water depths over the embankments ranged from 0.12m to 0.62m during the PMF, with velocities ranging from 2.34m^3/s to 5.42m^3/s. Maximum dam overtopping depths ranged from 0m to 0.43m and 0.06m to 0.46m for the 1 in 1,000 year and 1 in 10,000 year events respectively. Predicted flood extents during the PMF are shown in Figure 5-2 in the Hampstead Heath Ponds Project: Assessment of Design Flood report. The flood extent mapping has informed both the Design Flood Report and Quantitative Risk Assessment Report; however the full mapping is currently not available in the public domain and therefore is not presented in this SFRA. The Environment Agency Risk of Flooding from Reservoirs mapping[31] (discussed below) should be consulted for a consideration of risk in the event of a reservoir failure. The Assessment of Design Flood report indicated that the pond embankments require reinforcement to prevent erosion during overtopping events which could lead to a breach of one or more of the ponds.

4.5.7 The Hampstead Heath Ponds Quantitative Risk Assessment Interim Report[34] should be consulted for a more detailed assessment of the probability of failure of the Hampstead Heath Ponds.

4.5.8 Consultation with CoLC confirmed that inspection of the ponds is carried out as required under the Reservoirs Act 1975 for the three ponds designated as 'large' reservoirs, as well as for the smaller ponds owned by CoLC. Routine inspection and maintenance is carried out as and when required, and during large rainfall events. CoLC has developed its own on-site Emergency Response Plan to be implemented in the event of flooding on Hampstead Heath.

4.5.9 It is important to note that a routine inspection by a Supervising Panel Engineer has identified a significant risk associated with overtopping and potential failure of one or more of the ponds on Hampstead Heath. In response, the City of London Corporation has initiated the Hampstead Heath Ponds Project, with the aim of reducing this risk.

Environment Agency Risk of Flooding from Reservoirs Mapping

4.5.10 The Environment Agency's Risk of Flooding from Reservoirs Mapping[31] identifies areas that could be flooded if a large[iii] reservoir were to fail and release the water it holds. The mapping shows that in the unlikely event of Hampstead Pond No. 1 failing, water would initially flow southwards towards Hampstead Heath Rail and Overground Station and then eastwards as far as Gospel Oak Rail and Overground Station. Flood depths could potentially reach between 0.3m and 2m, with isolated areas where depths could potentially reach over 2m, with flood velocities exceeding 2m/s.

4.5.11 In the event that Highgate Ponds No. 2 or 3 failed, flood waters would flow south-east from Hampstead Heath and reach as far east as York Rise in Dartmouth Park. Flood water would also flow southwards towards the rail line west of Kentish Town and then along the rail line as far as just north of St Pancras rail station. Flood depths would be predominantly between 0.3m and 2m and flood velocities between 0.5m/s and 2m/s, with isolated areas of velocities above 2m/s. In the event that Highgate Pond No. 3 failed, flood waters would flow further south nearly as far south as Pentonville Road.

4.5.12 The Maiden Lane Reservoir in Islington is a covered service water reservoir owned by TWUL which could pose a risk to Camden residents if there was a breach. Environment Agency mapping indicates that flood waters resulting from the unlikely failure of the Maiden Lane reservoir would be similar to those as a result of failure of the Highgate Ponds No.2 and 3, though flood waters would not extend southwards beyond Kentish Town Rail and Overground Station. Flood waters would also flow across an area along and around Burghley Road.

[iii] A large reservoir is one that holds over 25,000 cubic metres of water, equivalent to approximately 10 Olympic sized swimming pools.

Hampstead Heath Ponds Project

4.5.13 As outlined in Section 4.5.1 works are required to the Hampstead Heath Ponds in order to ensure that they are safe. The primary aim of the Hampstead Heath Ponds Project, developed by CoLC, is to reduce the likelihood of overtopping of the ponds during extreme rainfall events, thereby reducing the risk of downstream bank erosion and subsequent breaching of one or more ponds.

4.5.14 The Hampstead Heath Ponds Project Preferred Solution Report[43] provides details of the preferred solutions and should be consulted for further detail on the proposed works. A single option each has been selected for the Highgate and Hampstead Pond Chains, from two preferred options for each pond chain presented in the Hampstead Heath Ponds Project Preferred Options Report[44]. Restoration of the dam crests is proposed for Stock Pond, Kenwood Ladies Bathing Pond and Bird Sanctuary Pond. Raising of the existing dams is proposed for the Model Boating Pond (raising by 2.5), Men's Bathing Pond (raising by 1.0m) and Highgate Pond No. 1 (raising by 1.25m). New open grass spillways are proposed for all ponds with the exception of the Bird Sanctuary Pond, where relocation of the overflow pipe will occur.

4.5.15 The preferred solution for the Hampstead Pond Chain is for restoration of the dam crests at the Vale of Heath Pond, Viaduct Pond and Hampstead No. 2 Pond. New open grass spillways are proposed for the Vale of Heath Pond, Viaduct Pond and Catchpit area, the latter of which will also include the building of a new flood storage dam up to 5.6m high. A new box culvert overflow will be constructed for the Hampstead No. 1 and 2 Ponds.

Regent's Canal

4.5.16 The Canal and River Trust (C&RT) was consulted during the writing of this SFRA and confirmed that there are no recorded incidents of overtopping or breaches of the Regent's Canal in or within 500m of LBC. The C&RT has documented standards for asset inspection and management, outlining requirements and responsibilities for asset inspection. Such procedures ensure the appropriate management of all C&RT assets.

4.5.17 The water level within Regent's Canal is controlled by a series of lock gates, and the risk of flooding as a result of overtopping or breaching of the canal is low.

4.6 Consideration of Climate Change

4.6.1 The Environment Agency was consulted during the writing of this SFRA in order to confirm the approach towards the assessment of future climate change impacts on flood risk within LBC. The Environment Agency has released guidance on how to allow for climate change in the future[45], with the relevant information outlined below:

Table 4.3: Climate change allowance for calculation of future peak rainfall intensity. (Extract from Table 2 of Environment Agency guidance note: 'Climate change allowance for planners'.)

Parameter	1990 to 2025	2025 to 2055	2055 to 2085	2085 to 2115
Peak rainfall intensity	+5%	+10%	+20%	+30%

4.6.2 The Environment Agency confirmed that the impacts of climate change have not currently been taken into account within the uFMfSW.

5 GUIDANCE ON THE APPLICATION OF THE SEQUENTIAL AND EXCEPTION TESTS

5.1 Overview

5.1.1 As described in Section 2, the NPPF and Planning Practice Guidance for Flood Risk and Coastal Change set strict tests to protect people and property from flooding which LBC, as a Local Planning Authority (LPA), must adhere to during the preparation of their Local Plan.

5.1.2 The emphasis of the NPPF is to steer new development away from areas at risk of flooding using the Sequential Test. Where development cannot be avoided in areas identified to be at risk of flooding, guidance is provided regarding the types of development that are appropriate, based on the vulnerability classification and criteria are set for when the Exception Test may be required before development can be permitted.

5.1.3 Guidance on the application of the Sequential and Exception Test is largely focused on flood risk from fluvial sources, as outlined in Figure 5.1 below, an extract from the Planning Practice Guidance for Flood Risk and Coastal Change.

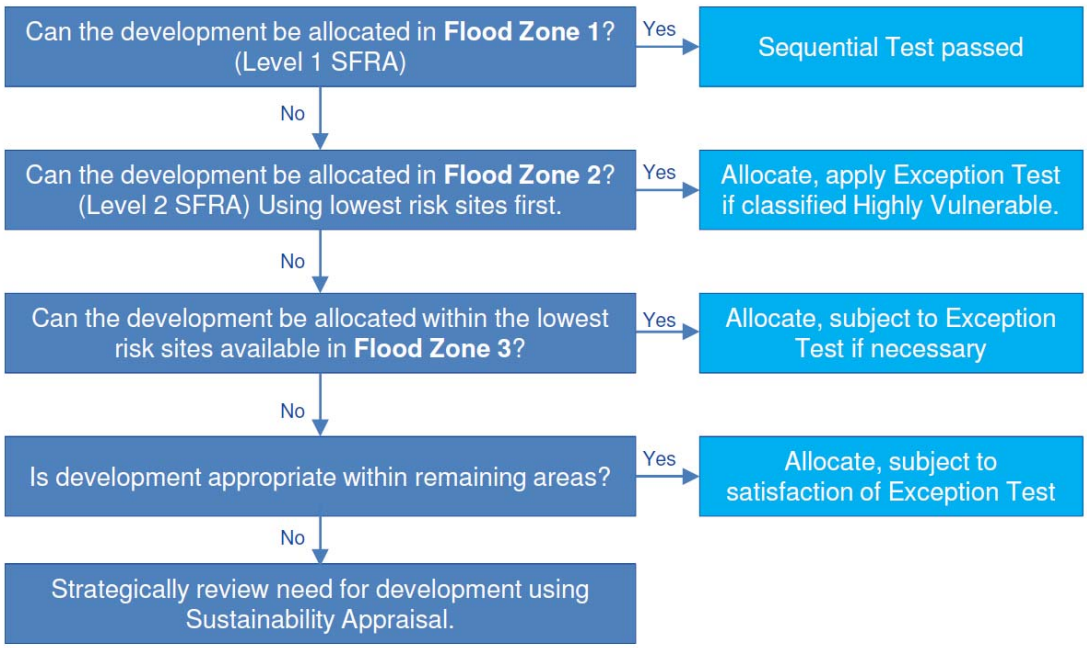


Figure 5.1: Application of Sequential Test for Local Plan preparation (Diagram 2 from Planning Practice Guidance – Flood Risk and Coastal Change

5.1.4 Despite the focus on fluvial flood risk the Planning Practice Guidance for Flood Risk and Coastal Change makes it clear that developments in Flood Zone 1 should consider and where appropriate be steered away from other sources of flooding such as surface and ground water.

5.1.5 The application of the sequential approach aims to manage the risk from flooding by avoidance. This will help avoid the promotion of sites that are inappropriate on flood risk grounds. The subsequent application of the Exception Test will ensure that new developments in flood risk areas will only occur where flood risk is clearly outweighed by other sustainability drivers.

5.2 Fluvial Flood Zones

5.2.1 As no main rivers are located within LBC the entire borough is located within Flood Zone 1. The Sequential Test must therefore consider flood risk from other sources.

Development Vulnerability

5.2.2 The NPPF provides guidance on the suitability of a development based on its vulnerability and location within a flood risk area. Flood risk vulnerability classifications, as defined in the Planning Policy Guidance, are presented in Table 5.1.

Table 5.1: Flood Risk Vulnerability Classification (Planning Practice Guidance, 2014)

Vulnerability Classification	Development Uses
Essential Infrastructure	Essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk. Essential utility infrastructure which has to be located in a flood risk area for operational reasons, including electricity generating power stations and grid and primary substations; and water treatment works that need to remain operational in times of flood. Wind turbines.
Highly Vulnerable	Police stations, ambulance stations and fire stations and command centres and telecommunications installations required to be operational during flooding. Emergency dispersal points. Basement dwellings. Caravans, mobile homes and park homes intended for permanent residential use. Installations requiring hazardous substances consent. (Where there is a demonstrable need to locate such installations for bulk storage of materials with port or other similar facilities, or such installations with energy infrastructure or carbon capture and storage installations, that require coastal or water-side locations, or need to be located in other high flood risk areas, in these instances the facilities should be classified as “essential infrastructure”).

Vulnerability Classification	Development Uses
More Vulnerable	Hospitals. Residential institutions such as residential care homes, children's homes, social services homes, prisons and hostels. Buildings used for dwelling houses, student halls of residence, drinking establishments, nightclubs and hotels. Non–residential uses for health services, nurseries and educational establishments. Landfill and sites used for waste management facilities for hazardous waste. Sites used for holiday or short-let caravans and camping, subject to a specific warning and evacuation plan.
Less Vulnerable	Police, ambulance and fire stations which are not required to be operational during flooding. Buildings used for shops, financial, professional and other services, restaurants and cafes, hot food takeaways, offices, general industry, storage and distribution, non–residential institutions not included in "more vulnerable", and assembly and leisure. Land and buildings used for agriculture and forestry. Waste treatment (except landfill and hazardous waste facilities). Minerals working and processing (except for sand and gravel working). Water treatment works which do not need to remain operational during times of flood. Sewage treatment works (if adequate measures to control pollution and manage sewage during flooding events are in place).
Water-Compatible Development	Flood control infrastructure. Water transmission infrastructure and pumping stations. Sewage transmission infrastructure and pumping stations. Sand and gravel working. Docks, marinas and wharves. Navigation facilities. MOD defence installations. Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location. Water-based recreation (excluding sleeping accommodation). Lifeguard and coastguard stations. Amenity open space, nature conservation and biodiversity, outdoor sports and recreation and essential facilities such as changing rooms. Essential ancillary sleeping or residential accommodation for staff required by uses in this category, subject to a specific warning and evacuation plan.

5.2.3 The NPPF indicates suitability of a development based on its vulnerability and location within a fluvial flood zone (see Table 5.2).

Table 5.2. Planning Practice Guidance, Table 3 Flood Risk Vulnerability and Flood Zone 'Compatibility'

Flood Risk Vulnerability Classification		Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone	1	✓	✓	✓	✓	✓
	2	✓	✓	Exception Test Required	✓	✓
	3A	Exception Test Required	✓	✗	Exception Test Required	✓
	3B	Exception Test Required	✓	✗	✗	✗

✓ – Development is appropriate ✗ – Development should not be permitted

5.2.4 However the vulnerability classification of types of development is still relevant when considering flood risk from other sources. For example a basement dwelling will still be more vulnerable to surface water flooding than an office development.

5.2.5 Indeed, the NPPF acknowledges that some areas will be at risk of flooding from flood sources other than fluvial or tidal systems. All sources of flooding must be considered when looking to locate new development. The other sources of flooding requiring consideration when situating new development allocations include:

- Surface Water;
- Groundwater;
- Sewers; and
- Artificial Sources.

5.2.6 LBC should consider utilising the Environment Agency's uFMfSW which provides banding of Low, Medium and High surface water flood risk within Camden. The Low, Medium and High bands of surface water flood risk may be substituted in place of Flood Zones 1, 2 and 3,in Table 5.2, above.

5.2.7 Where a 'More Vulnerable' development is proposed in an area with a potential flood risk, suitable mitigation measures, such as raising of finished floor levels and access levels and introducing thresholds to buildings, should be utilised in order to mitigate risks to property and people.

5.2.8 LB Camden should consider restricting development of 'Highly Vulnerable' development in 'High' surface water flood risk areas where a specific flood risk has been identified. For example new basement dwellings should be discouraged in such areas. Essential infrastructure associated with proposed developments may be discouraged from being placed on the ground flood in high risk areas.

5.2.9 LB Camden should consider requiring a FRA for More Vulnerable development in High surface water flood risk areas, and for Highly Vulnerable development in Medium surface water flood risk areas.

5.3 Recommended stages for LPA application of the Sequential Test

5.3.1 The flood risk within Camden has been identified on a strategic basis in Section 4, with a number of areas identified as being within broad areas of higher risk of flooding. The deliverables from the LB Camden SWMP provide Local Flood Risk Zones (LFRZ) where discrete flooding is possible, affecting houses, business or infrastructure. In addition to the LFRZs, the uFMfSW also identified areas of potential surface water ponding in South Hampstead, Dartmouth Park and Camden Town. The uFMfSW extent mapping should be utilised to identify areas of Low (within the flood extent during a 1 in 1000 year rainfall event), Medium (within the flood extent during a 1 in 100 year rainfall event and High (within the flood extent during a 1 in 30 year rainfall event) surface water flood risk, as defined by the Environment Agency. The flood risk banding developed by the Environment Agency should be utilised to initially allocate development in Camden towards areas of lower flood risk i.e. following a sequential approach to location of development.

5.3.2 Hazard Mapping created by the Environment Agency as part of the uFMfSW (Appendix B, Figure 3vi-x) indicates the hazard to people following a methodology presented by Defra in its R&D report on Flood Risks to People[46]. Hazard is defined as a factor of depth and velocity of flow. Hazard categories are as Low, Moderate, Significant and Extreme. Even for the 1 in 1000 year rainfall event, areas of Extreme Hazard within Camden are limited.

5.4 Exception Test

5.4.1 The purpose of the Exception Test is to ensure that development is only permitted in medium and high flood risk areas, dependant on their vulnerability to flooding and where flood risk is clearly outweighed by other sustainability factors and where the development will be safe during its lifetime, considering climate change.

5.4.2 In the absence of fluvial flood zones in Camden, available information on flood risk from all sources should be consulted to determine the risk to a site or area. Information discussed in this SFRA includes the uFMfSW, Environment Agency Risk of Flooding from Reservoirs Mapping and historic flood records. If available information indicates that the flood risk to a site is not low i.e., there is a potential flood risk to the site dependent on the vulnerability, then the Exception Test should be applied.

5.4.3 For the Exception Test to be passed:

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

5.4.4 Both elements of the test will have to be passed for development to be allocated or permitted.

5.4.5 In order to satisfy part (a) of the Exception Test, the objectives of the Sustainability Appraisal (SA) can be used to assess each potential development site. The LBC SA[47] includes a series of Sustainability Objectives which allow quantification of the sustainable performance of a potential development sites. The criteria could provide a consistency in the sustainability analysis of sites. When determining planning applications, LBC should ensure flood risk is not increased elsewhere and should only consider development in areas at risk of flooding to be appropriate where, informed by a site-specific FRA, following the Sequential Test, and if required the Exception Test, it can be demonstrated that:

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

5.4.6 There are a number of ways a new development can be made safe:

- Avoiding flood risk by not developing in areas at risk from floods;

- Substituting higher vulnerability land uses for lower vulnerability uses in higher flood risk locations and locating higher vulnerability uses in areas of lower risk on a strategic scale, or on a site basis;
- Providing adequate flood risk management infrastructure which will be maintained for the lifetime of the development; and
- Mitigating the potential impacts of flooding through design and resilient construction..

Applying the Sequential Test to proposed developments not included in London Borough of Camden's Allocated Sites

5.4.7 As illustrated in Figure 5.2, the flood risk Sequential Test can be considered adequately demonstrated if (1) the Sequential Test has already been carried out for the site for the same development type at the Local Plan level for allocated sites AND (2) the development vulnerability is appropriate to the flood risk, as determined by LBC.

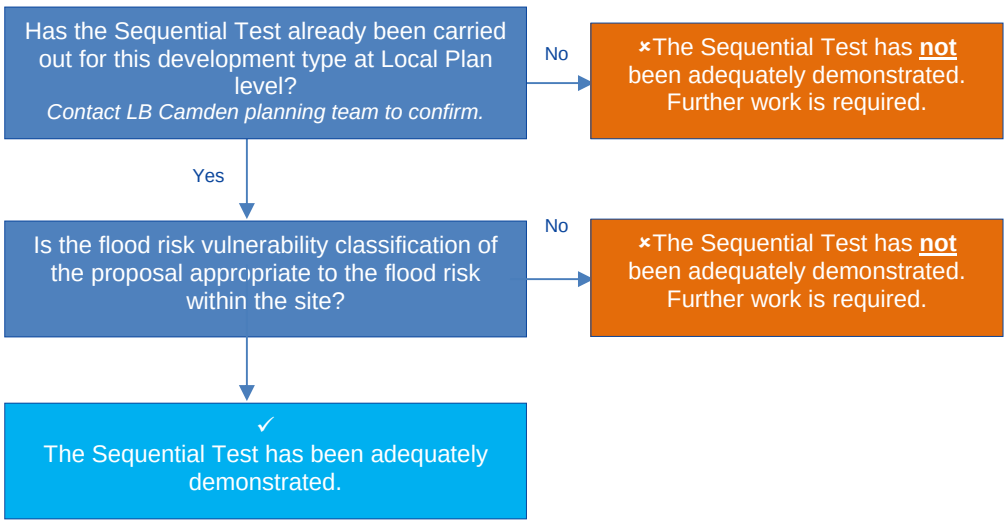


Figure 5.2: Determining when the Sequential Test is required

5.4.8 If the answer to either of these two criteria is 'no', then it is necessary to undertake a Sequential Test for the site. The Environment Agency publication 'Demonstrating the flood risk Sequential Test for Planning Applications ' sets out the procedure as follows:

- Identify the geographical area of search over which the test is to be applied; for example the borough area, or a specific catchment if this is appropriate and justification is provided;

- Identify the source of 'reasonably available' alternative sites; usually drawn from evidence base / background documents produced to inform the Local Plan;
- State the method used for comparing flood risk between sites; for example the Environment Agency updated Flood Map for Surface Water, the SFRA mapping, site specific FRAs if appropriate, other mapping of flood sources;
- Apply the Sequential Test; systematically consider each of the available sites, indicate whether the flood risk is higher or lower than the application site, state whether the alternative option being considered is allocated in the Local Plan, identify the capacity of each alternative site, and detail any constraints to the delivery of the alternative site(s).
- Conclude whether there are any reasonably available sites in areas with a lower probability of flooding that would be appropriate to the type of development or land use proposed.
- Where necessary, apply the Exception Test.
- Apply the Sequential approach (See Section 5.3) to locating development within the site.

5.4.9 Windfall sites are defined in the NPPF as: *'Sites which have not been specifically identified as available in the Local Plan process'* and therefore will not have undergone the Sequential Test at Local Plan level, as detailed in Section 5.4.7. The procedure set out above (See Section 5.3) would therefore be required.

6 GUIDANCE FOR PREPARING SITE SPECIFIC FRAS

6.1 When is a Flood Risk Assessment required?

6.1.1 The Environment Agency provides flood risk standing advice for applicants and agents on their website: https://www.gov.uk/planning-applications-assessing-flood-risk. This includes information on when a FRA is required and advice on the contents of FRAs for various development types in Flood Zone 1, Flood Zone 2 and Flood Zone 3. As LBC is located entirely within Flood Zone 1, advice relating to Flood Zone 2 and 3 is not relevant.

6.1.2 The NPPF states that a site specific FRA is required in the following circumstances:

- Proposals for new development (including minor development and change of use) in Flood Zones 2 and 3.
- Proposals for new development (including minor development and change of use) in an area within Flood Zone 1 which has critical drainage problems (as notified to the LPA by the Environment Agency).
- Proposals of 1 hectare or greater in Flood Zone 1.
- Where proposed development or a change of use to a more vulnerable class may be subject to other sources of flooding.

6.1.3 It should be noted that LBC is located entirely within Flood Zone 1 and therefore no proposals located within Flood Zone 2 and 3 will be brought forward for development.

6.1.4 The Environment Agency Guidance Note for FRAs in Flood Zone 1[48] (https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/311502/LIT_9193.pdf) should be consulted for advice on the approach and content of a FRA.

6.2 Scope of a site-specific FRA

6.2.1 The Planning Practice Guidance states that site-specific FRAs should always be proportionate to the degree of flood risk and make optimum use of readily available information, for example the mapping presented within this SFRA.

6.2.2 Table 6.1 is based on the checklist for site specific FRAs provided in the Planning Practice Guidance. Where appropriate, references have been added to determine where the information can be found to support each required item.

Table 6.1: Site-Specific Flood Risk Assessment Checklist (Planning Practice Guidance)

1. Development description and location	
1a. What type of development is proposed (e.g., new development, an extension to existing development, a change of use etc.) and where will it be located?	☐
1b. What is its flood risk vulnerability classification? **Refer to Section 5.2 Table 5.1.**	☐
1c. Is the proposed development consistent with the Local Plan for the area? LBC is currently carrying out a review of the LBC Core Strategy and Development Policies and are due to publish its Draft Local Plan in late 2014. The existing Core Strategy and Development Policies should be referred to on the LBC website: http://www.camden.gov.uk/ccm/navigation/environment/planning-and-built-environment/planning-policy/ and seek advice from LBC if necessary	☐
1d. What evidence can be provided that the Sequential Test and where necessary the Exception Test has/have been applied in the selection of this site for this development type? Consult LBC to determine if the site has been included in the Sequential Test. If not, refer to Section 5.3 for guidance on undertaking the Sequential Test for individual development sites and to determine whether the Exception Test is required.	☐
1e. Will your proposal increase overall the number of occupants and/or users of the building/land, or the nature or times of occupation or use, such that it may affect the degree of flood risk to these people? This is particularly relevant to minor developments (alterations & extensions) & changes of use.	☐
2. Definition of the flood hazard	
2a. What sources of flooding could affect the site? Refer to Section 4	☐
2b. For each identified source under 2a above, can you describe how flooding would occur, with reference to any historic records where these are available? Refer to Section 4	☐
2c. What are the existing surface water drainage arrangements for the site? Undertake a site survey to determine specific details. Where appropriate an asset location survey can be provided by Thames Water http://www.thameswater-propertysearches.co.uk/.	☐
3. Probability	
3a. Which flood zone is the site within? In the case of LBC, the borough is entirely within Flood Zone 1 as defined by the Flood Map for Planning (Rivers and Sea) on the Environment Agency's website http://maps.environment-agency.gov.uk/wiyby. Therefore Section 3a of this checklist does not apply.	☐
3b. Does the SFRA show the same or a different flood zone compared with the Environment Agency's flood map? Both this SFRA and the Flood Map for Planning (Rivers and Sea) on the Environment Agency's website http://maps.environment-agency.gov.uk/wiyby indicate that the borough is entirely within Flood Zone 1. If different you should seek advice from the local planning authority and, if necessary, the Environment Agency enquiries@environment-agency.gov.uk.	☐

3c. What is the probability of the site flooding, taking account of the maps of flood risk from rivers and the sea and from surface water, on the Environment Agency's website, and the SFRA, and of any further flood risk information for the site? Refer to mapping in Section 4.2 and Appendices B, as well as the Flood Map for Planning (Rivers and Sea) and the Flood Risk from Surface Water mapping on the Environment Agency's website http://maps.environment-agency.gov.uk/wiyby. In the case of LBC the Flood Map for Planning (Rivers and the Sea) is not applicable due to LBC's location entirely within Flood Zone 1.	☐
3d. If known, what (approximately) are the existing rates and volumes of surface water run-off generated by the site?	☐
4. Climate change	
How is flood risk at the site likely to be affected by climate change? No main rivers are located within LBC and therefore there is no flood risk from fluvial sources. Refer to Section 4.6 for a description of how climate change will impact other sources of flooding.	☐
5. Detailed development proposals	
Where appropriate, are you able to demonstrate how land uses most sensitive to flood damage have been placed in areas within the site that are at least risk of flooding (including providing details of the development layout)? Refer to Section 6.3 regarding the use of the sequential approach within development sites.	☐
6. Flood risk management measures	
How will the site/building be protected from flooding, including the potential impacts of climate change, over the development's lifetime? Refer to Section 6.4 for details regarding finished floor levels, basement dwellings, flood resilient design, car parking considerations, and provision of safe access / egress.	☐
7. Off-site impacts	
7a. How will you ensure that your proposed development and the measures to protect your site from flooding will not increase flood risk elsewhere? Refer to Section 6.11 regarding off-site impacts including flood routing and Section 7.	☐
7b. How will you prevent run-off from the completed development causing an impact elsewhere? Refer to Section 7 regarding surface water management. Refer to Section 7.3 regarding the use of specific types of SuDS throughout the borough.	☐
7c. Are there any opportunities offered by the development to reduce flood risk elsewhere? Refer to Section 7 regarding surface water management. Refer to Section 7.3 regarding the use of specific types of SuDS throughout the borough.	☐
8. Residual risks	
8a. What flood-related risks will remain after you have implemented the measures to protect the site from flooding?	☐
8b. How, and by whom, will these risks be managed over the lifetime of the development? (E.g., flood warning and evacuation procedures). Refer to Section 6.9 for details regarding flood warning and flood evacuation plans.	☐

6.3 Sequential Approach within Development Sites

6.3.1 Flood risk should be considered at an early stage in deciding the layout and design of a site to provide an opportunity to reduce flood risk within the development. Most large development proposals include a variety of land uses of varying vulnerability to flooding. The sequential approach should be applied within development sites to locate the most vulnerable elements of a development in the lowest risk areas e.g. residential developments should be restricted to areas at lower probability of flooding whereas parking, open space or proposed landscaped areas can be placed on lower ground with a higher probability of flooding.

6.3.2 Should development pressure create a need to develop more vulnerable land uses within the site in higher flood risk areas appropriate mitigation measures should be incorporated that are proportionate to the flood risk and would not increase the risk of flooding to surrounding areas.

6.3.3 Structures such as (bus, bike) shelters, park benches and refuse bins (and associated storage areas) located in areas with a high flood risk should be flood resilient and be firmly attached to the ground.

6.4 Flood Risk Management Measures

Finished Floor Levels

6.4.1 There is no set guidance for the setting of finished floor levels of development in relation to flood risk other than from fluvial sources, where the Environment Agency requires a minimum freeboard of 300mm above the 1% AEP plus climate change peak fluvial flood level for More Vulnerable development such as housing.

In the absence of national guidance on finished floor levels, LBC should consider requiring a freeboard for proposed developments in areas of surface water flood risk. Appendix B Figure 6 shows the majority of Camden has been identified as being within a Critical Drainage Area (CDA) "*A discrete geographic area (usually a hydrological catchment) where multiple and interlinked sources of flood risk (surface water, groundwater, sewer, main river and/or tidal) cause flooding in one or more Local Flood Risk Zones during severe weather thereby affecting people, property or local infrastructure.*"

6.4.2 The Environment Agency's updated Flood Map for Surface Water details flood extents and depths during three rainfall events, and is available online at http://watermaps.environment-agency.gov.uk/wiyby.

Basement Dwellings

6.4.3 LBC guidance CPG4[49] covers basements and lightwells and supports the policies in the Local Development Framework (LDF). There are two aspects relating to basement dwellings covered by the guidance;

1. *basement impact assessments, principal impacts of basements, planning and design considerations; and*
2. *how basement dwellings may be affected in streets at risk from flooding.*

6.4.4 The issue of basements built within the borough has received a lot of recent press coverage. The issue which a groundwater specialist needs to consider is how the basements will affect groundwater flow in the local area. Factors which will influence this are the geological setting, thickness of the strata, the depths to the water table and permeability/confining nature of the layers. The creation of a barrier in the sub-surface may cause an obstruction to groundwater flow, with can lead to a rise in the water table on the upstream side and a fall in the water table on the downstream side. An example of what may happen to groundwater flows when a single basement is constructed is shown in the diagrams below.

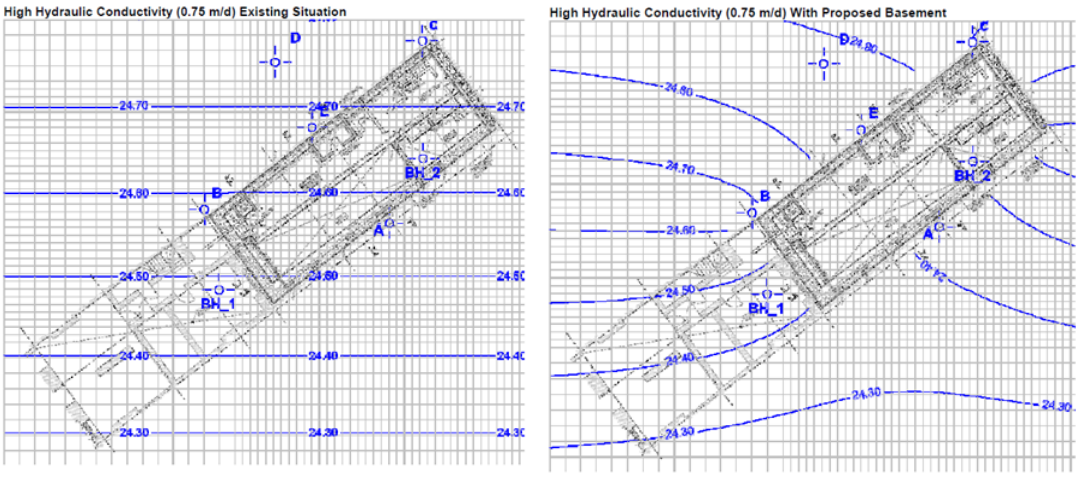


Figure 6.1: Groundwater flows around basements – pre and post-development

6.4.5 Moreover, if a basement development is close to a well or a spring feeding a surface water feature, the effect of groundwater taking a new flow pathway may result in reduced flow to the well or spring. Alternatively, a dormant spring may be reactivated or new spring activated, causing groundwater to take a different flow path. A larger basement will have a larger impact on the groundwater flow regime. A Basement Impact Assessment should assess the likely damming effect of the development and assess the likely rise in groundwater levels. The impact should not be considered in isolation. An example of predicted groundwater rise is provided below.

6.4.6 The pre-development conditions (Figure 6.1, left hand drawing) show groundwater movement in a southerly direction (at right angles to the blue groundwater contours). With the basement constructed (Figure 6.1, right hand drawing) – it is predicted that groundwater levels would rise by 0.2m on the north west side of the structure, and correspondingly lower to the south east. As part of the assessment carried out for basement development it will be important to identify any potential receptors which may be affected by the change in water level. Locally within the LBC area, the main receptors are likely to be existing basements, various abstraction sources from the River Terrace Deposits and groundwater-fed water features. A basement search radius of 500m around a development is advisable to inform a basement impact assessment.

6.4.7 In terms of groundwater flooding basement impact assessments should consider the following:

- Quantitative assessment of groundwater level rise; and
- Design the basement and selecting construction method to minimise the impact on groundwater flow.

6.4.8 This is relevant to both groundwater within River Terrace Deposits, and within perched water within sand pockets within London Clay and Bagshot Beds.

6.4.9 The other issue which may affect basement dwellings is in streets which are affected by surface water flooding. Basement dwellings are classified in the NPPF as Highly Vulnerable development and therefore should be discouraged within areas at risk of surface water or groundwater flooding. LBC Core Strategy Camden Development Policy 27 – Basements and lightwells (see Section 2.4.6) outlines requirements for basement development when it is proposed. Adverse impacts on drainage and runoff must be avoided.

6.4.10 Where basement dwellings are constructed, access must be situated 300mm above the design flood level, and waterproof construction techniques should be employed to avoid seepage during flood events. Similar problems can also occur where excessive surface water ponding occurs close to the sides of buildings, leading to significant infiltration. Surface water flow paths should be assessed to ensure that this does not occur, and to inform the strategic location of SuDS and techniques to route flows around the edge of buildings.

6.4.11 LBC should consider restricting the placement of sleeping accommodation below the external street level in areas of 'High' surface water flood risk in order to reduce the risk of water ingress into bedrooms during extreme rainfall events. For dwelling and non-dwelling basements, single storey accommodation and multi-storey buildings with ground floor sleeping accommodation in areas of flood risk from sources other than fluvial external, access should be located above the predicted flood level. For example, should the uFMfSW indicate that a proposed development is in an area of medium or high flood risk, the level of external access should be of primary consideration. It should be noted that the uFMfSW should not be used on a site-specific basis due to the limitations of the modelling, but instead should be used as a guide for potential risk.

Flood Resistant and Resilient Design

6.4.12 In order to mitigate any potential flood damage, there are a range of flood resilient construction techniques that can be implemented in new developments. The Department for Communities and Local Government (CLG) has published a document 'Improving the Flood Performance of New Buildings, Flood Resilient Construction'[50], the aim of which is to provide guidance to developers and designers on how to improve the resilience of new properties in low or residual flood risk areas, through the use of suitable materials and construction details. Figure 6.2 provides a summary of different design strategies depending on the depth of floodwater that could be experienced.

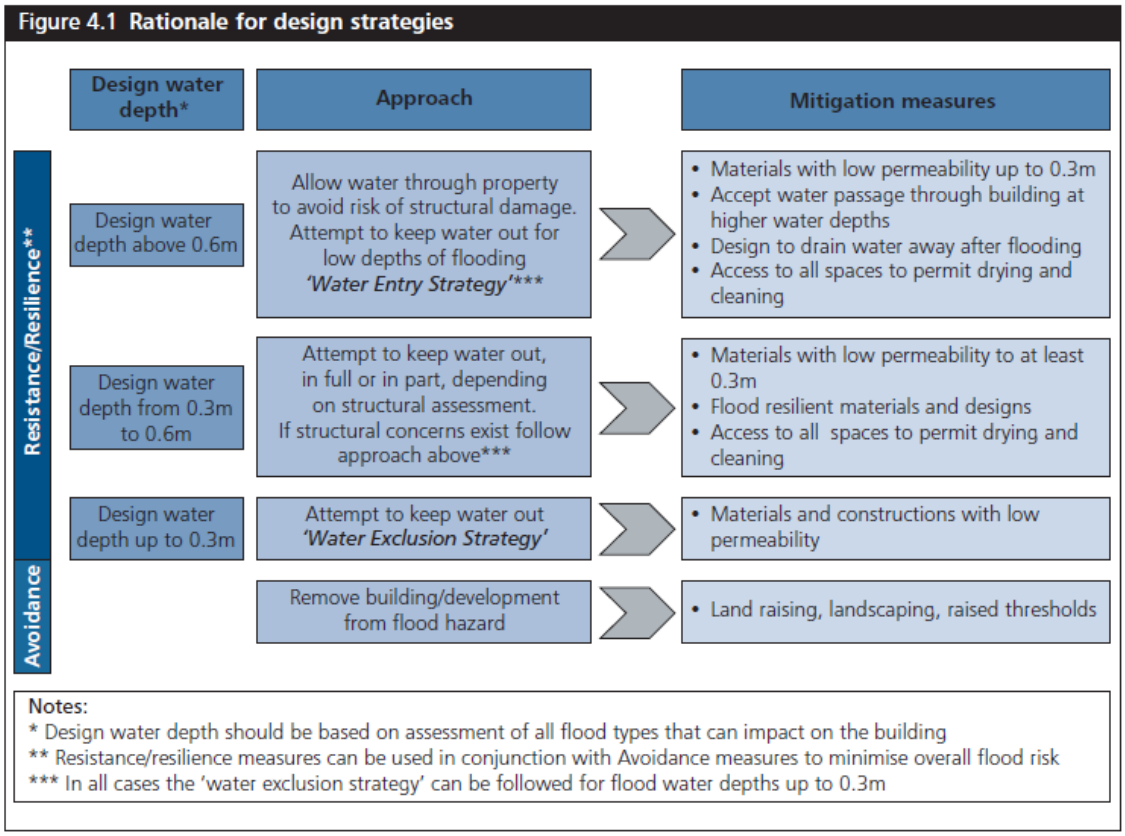


Figure 6.2: Flood Resilient Design Strategies, Improving Flood Performance, CLG 2007

6.4.13 A number of design strategies are detailed including the Water Exclusion Strategy and Water Entry Strategy. Resistance measures are aimed at preventing water ingress into a building (Water Exclusion Strategy); they are designed to minimise the impact of floodwaters directly affecting buildings and to give occupants more time to relocate ground floor contents. These measures will probably only be effective for short duration, low depth flooding, i.e. less than 0.3m.

6.4.14 For flood depths greater than 0.6m, it is likely that structural damage could occur in traditional masonry construction due to excessive water pressures. In these circumstances, the strategy should be to allow water into the building, i.e. the Water Entry Strategy.

6.4.15 Due to the absence of fluvial flood risk, and the nature of surface water flood risk and the likely flood depths, the Water Exclusion Strategy is most appropriate within LBC for the majority of cases. In areas within the flood extent in the event of a reservoir breach, flood depths may potentially exceed 0.6m and therefore the Water Entry Strategy may be most appropriate. It is recommended that Environment Agency Risk of Flooding from Reservoirs Mapping be consulted for detailed information on potential flood water depths in the event of such a breach.

6.4.16 The principle behind the Water Entry Strategy is not only to allow water through the property to avoid the risk of structural damage, but also to implement careful design in order to minimise damage and allow rapid re-occupancy of the building. The NPPF considers these measures to be appropriate for both changes of use and for Less Vulnerable uses where temporary disruption is acceptable and suitable flood warning is received.

6.4.17 Materials will be used which allow the passage of water whilst retaining their structural integrity and they should also have good drying and cleaning properties. Alternatively sacrificial materials can be included for internal and external finishes; for example the use of gypsum plasterboard which can be removed and replaced following a flood event. Flood resilient fittings should be used to at least 0.1m above the design flood level. Resilience measures are either an integral part of the building fabric or are features inside a building that will limit the damage caused by floodwaters.

6.4.18 Further specific advice regarding suitable materials and construction techniques for floors, walls, doors and windows and fittings can be found in 'Improving the Flood Performance of New Buildings, Flood Resilient Construction' (CLG, 2007).

6.5 Property Level Resilience Measures

6.5.1 Following the intense rainfall events of 1975 and 2002, parts of LBC suffered notable flooding associated with surface water and the local drainage network. Current climate change predictions suggest that intense rainfall events are likely to become more frequent, thereby putting a greater strain on the local drainage network and increasing the potential for surface water flooding. It is not possible for the drainage network to be upgraded to accommodate extreme rainfall events and consequently there remains a risk that sewer and surface water flooding can occur. To mitigate the effects of flooding from these extreme events the homeowner or developer can install permanent or temporary flood proofing measures.

Figure 6.3: Examples of property level flood barriers, air bricks, non-return valves (Floodguards)

6.5.2 Temporary flood barriers (Figure 6.3) are moveable flood defences that can be fitted to doorways or windows. On a smaller scale, temporary clip-on covers for airbricks and air vents can also be fitted to prevent water entry.

6.5.3 Permanent flood barriers can also be created, which may comprise built up doorsteps, rendered brick walls and toughened glass barriers. There are methods for ensuring that such measures are sympathetic to the surroundings.

6.5.4 In order to provide protection from the risk of sewer flooding, non-return valves can be installed to prevent water entering the property from drains and sewers. Further information can be found in the CIRIA publication 'Low cost options for preventing flooding from sewers'[51].

6.6 Car Parks

6.6.1 Where car parks are specified as areas for the temporary storage of floodwaters, flood depths should not exceed 300mm given that vehicles may be moved by water of greater depths. Where greater depths are expected, car parks should be designed to prevent the vehicles from floating out of the car park. Signs should be in place to notify drivers of the susceptibility of flooding and flood warning should be available to provide sufficient time for car owners to move their vehicles if necessary.

6.7 Structures

6.7.1 Structures such as (bus, bike) shelters, park benches and refuse bins (and associated storage areas) located in areas with a high flood risk should be flood resilient and be firmly attached to the ground.

6.8 Safe Access and Egress

6.8.1 Safe access and egress is required to enable the evacuation of people from the development, provide the emergency services with access to the development during times of flood and enable flood defence authorities to carry out any necessary duties during periods of flood.

6.8.2 A safe access/egress route should allow occupants to safely enter and exit the buildings and be able to reach land outside the flooded area using public rights of way without the intervention of emergency services or others during design flood conditions, including climate change allowances.

6.8.3 For developments located in areas at flood risk the Environment Agency consider 'safe' access/egress to be in accordance with 'FRA Guidance for new Developments FD 2320' (Defra and EA 2005). The requirements for safe access and egress from new developments are as follows in order of preference:

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

6.9 Flood Warning and Evacuation Plans

6.9.1 Flood warning and emergency procedures tend to form part of higher level emergency management plans for the wider area including information such as repair procedures, evacuation routes, refuge areas, flood warning dissemination and responsibilities.

6.9.2 No Environment Agency Flood Alerts or Warnings would be issued in LBC due to the absence of watercourses within the borough. Met Office Severe Weather Warnings provide warning to communities of extreme weather events, including rainfall events, and can be viewed at http://www.metoffice.gov.uk/public/weather/warnings/?regionName=uk.

6.10 Emergency Plan

6.10.1 LBC has developed a Multi-Agency Flood Plan (MAFP) to allow all responding parties to work together on an agreed coordinated response to severe flooding within the borough. Where necessary the LBC Multi Agency Flood Plan should be reviewed in the light of information generated by this SFRA and updated where appropriate. This will ensure that emergency plans are appropriate to the conditions expected during a flood event and that the local authority and emergency services are fully aware of the likely conditions and how this may affect their ability to safeguard the local population.

6.10.2 When submitting FRAs for developments within flood risk areas, developers should make reference to local flood warning and emergency procedures to demonstrate their development will not impact on the ability of the local authority and the emergency services to safeguard the current population. The flood hazard in a particular area must be viewed in the context of the potential evacuation and rescue routes to and from that area and discussed as part of a site-specific FRA.

6.11 Flood Routing

6.11.1 Potential overland flow paths should be determined and appropriate solutions proposed to minimise the impact of the development, for example by configuring road and building layouts to preserve existing flow paths and improve flood routing, whilst ensuring that flows are not diverted towards other properties elsewhere.

6.11.2 Careful consideration should be given to the use of fences and landscaping walls so as to prevent causing obstruction to flow routes and increasing the risk of flooding to the site or neighbouring areas.

7 SUSTAINABLE DRAINAGE SYSTEMS

7.1.1 When designing buildings, flood risk management policies require that the developments are 'safe', do not increase flood risk elsewhere and where possible reduce flood risk overall.

7.1.2 It is strongly recommended that suitable surface water mitigation measures are incorporated into any development plans in order to reduce and manage surface water flood risk to, and posed by the proposed development. This should ideally be achieved by incorporating SuDS.

7.1.3 SuDS are typically softer engineering solutions inspired by natural drainage processes such as ponds and swales which manage water as close to its source as possible. Wherever possible, a SuDS technique should seek to contribute to each of the three goals identified below with the preferred system contributing significantly to each objective. Where possible SuDS solutions for a site should seek to:

1. *Reduce flood risk (to the site and neighbouring areas);*
2. *Reduce pollution; and,*
3. *Provide landscape and wildlife benefits.*

7.1.4 These goals can be achieved by utilising a management plan incorporating a chain of techniques, as outlined in the Interim Code of Practice for Sustainable Drainage Systems[52], where each component adds to the performance of the whole system:

Prevention	Good site design and upkeep to prevent runoff and pollution (e.g. limited paved areas, regular pavement sweeping).
Source Control	Runoff control at/near to source (e.g. rainwater harvesting, green roofs, pervious pavements).
Site Control	Water management from a multitude of catchments (e.g. route water from roofs, impermeable paved areas to one infiltration/holding site).
Regional Control	Integrate runoff management systems from a number of sites (e.g. into a detention pond).

7.1.5 The application of SuDS is not limited to a single technique per site. Often a successful SuDS solution will utilise a combination of techniques, providing flood risk, pollution and landscape/wildlife benefits. In addition, SuDS can be employed on a strategic scale, for example with a number of sites contributing to large scale jointly funded and managed SuDS. It should be noted, each development site must offset its own increase in runoff and attenuation cannot be "traded" between developments.

7.1.6 SuDS techniques can be used to reduce the rate and volume and improve the water quality of surface water discharges from sites to the receiving environment (i.e. natural watercourse or public sewer etc.), which is of particular importance for mineral sites. Various SuDS techniques are available and operate on two main principles:

- Infiltration
- Attenuation

7.1.7 All systems generally fall into one of these two categories, or a combination of the two.

7.1.8 SuDS designs should aim to reduce runoff by integrating storm water controls throughout the site in small, discrete units. Through effective control of runoff at source, the need for large flow attenuation and flow control structures should be minimised.

7.1.9 As part of any SuDS scheme, consideration should be given to the long-term maintenance of the SuDS to ensure that it remains functional for the lifetime of the development.

7.1.10 Table 7.1 has been reproduced from the SuDS Manual, CIRIA C679[53] and outlines typical SuDS options and details their typical components.

Table 7.1: Typical SuDS Components

Component Description	Example
Filter Strips	Wide, gently sloping areas of grass or other dense vegetation that treat runoff from adjacent impermeable areas.
Swales	Swales are broad, shallow channels covered by grass or other suitable vegetation. They are designed to convey and/or store runoff, and can infiltrate the water into the ground (if ground conditions allow).
Infiltration Basins	Infiltration basins are depressions in the surface that are designed to store runoff and infiltrate the water to the ground. They may also be landscaped to provide aesthetic and amenity value.
Wetland Ponds	Wetland ponds are basins that can remove pollutants present within surface water. They provide runoff attenuation and wildlife benefits.
Extended Detention Basins	Extended detention basins are normally dry, though they may have small permanent pools at the inlet and outlet. They are designed to detain a certain volume of runoff as well as providing water quality treatment.
Constructed Wetlands	Constructed wetlands are ponds with shallow areas and wetland vegetation to improve pollutant removal and enhance wildlife habitat.
Filter Drains and Perforated Pipes	Filter drains are trenches that are filled with permeable material. Surface water from the edge of paved areas flows into the trenches, is filtered and conveyed to other parts of the site. A slotted or perforated pipe may be built into the base of the trench to collect

Component Description	Example
	and convey the water.
Infiltration Devices	Infiltration devices temporarily store runoff from a development and allow it to percolate into the ground.
Pervious Surfaces	Pervious surfaces allow rainwater to infiltrate through the surface into an underlying storage layer, where water is stored before infiltration to the ground, reuse, or release to surface water.
Green Roofs	Green roofs are systems which cover a building's roof with vegetation. They are laid over a drainage layer, with other layers providing protection, waterproofing and insulation. It is noted that the use of brown/green roofs should be for betterment purposes and not to be counted towards the provision of on-site storage for surface water. This is because the hydraulic performance during extreme events is similar to a standard roof (CIRIA C697).
Rainwater Harvesting	Storage and use of rainwater for non-potable uses within a building, e.g. toilet flushing. It is noted that storage in these types of systems is not usually considered to count towards the provision of on-site storage for surface water balancing because, given the sporadic nature of the use of harvested water, it cannot be guaranteed that the tanks are available to provide sufficient attenuation for the storm event.

SuDS Approval Body (SAB)

7.1.11 Under the FWMA, LBC is designated as the SuDS Approval Body (SAB) for any new drainage system, and therefore must approve, adopt and maintain any new SuDS within the area.

7.1.12 The SAB will have responsibility for the approval of proposed drainage systems in new developments and redevelopments, subject to exemptions and thresholds, and approval must be granted before the developer can commence construction.

7.1.13 In order to be approved, proposed drainage systems will have to meet new national standards for sustainable drainage. Where planning permission is required, applications for drainage approval and planning permission may need to be lodged jointly with the planning authority but LBC, as the SAB, will determine the drainage application. Regulations will set a timeframe for the decision so as not to hold up the planning process.

7.1.14 The SAB will also be responsible for adopting and maintaining SuDS which serve more than one property, where they have been approved. Highways authorities will be responsible for maintaining SuDS in public roads, to National Standards.

7.1.15 The SAB must arrange for SuDS on private property, whether they are adopted or not, to be designated under Schedule 1 to the FWMA as features that affect flood risk. The SAB will also be required to arrange for all approved SuDS to be included on the register of structures and features (as a separate category).

7.1.16 The National Standards will set out the criteria by which the form of drainage appropriate to any particular site or development can be determined, as well as requirements for the design, construction, operation and maintenance of SuDS. Local authorities are represented on the Project Advisory Board for the development of these National Standards.

7.1.17 The FWMA, in response to Sir Michael Pitt's Review, also makes the right to connect surface water drainage from new development to the public sewerage system conditional on the surface water drainage system being approved by the SAB.

7.1.18 Defra has worked closely with key stakeholders and technical experts including the Environment Agency, Local Authorities, developers and water companies to develop National Standards. The National Standards will apply to construction work (domestic and commercial new developments and redevelopments) and will allow flexibility for local conditions.

7.1.19 The requirements for SuDS in England is yet to be implemented and in the interim period, the ongoing requirement is to continue to seek advice from the Environment Agency regarding the design of SuDS and the management of surface water runoff from development sites.

7.2 The SuDS hierarchy

7.2.1 The National Standards for sustainable drainage systems[54] states that *"the following destinations must be considered for surface runoff in order of preference":*

1. *Discharge into the ground*
2. *Discharge to a surface water body*
3. *Discharge to a surface water sewer*
4. *Discharge to a combined sewer*

7.2.2 In addition to these standards, as outlined in Section 2.3, The London Plan Policy 5.13 provides further detail for Sustainable Drainage, following the principles of the National Standards:

7.2.3 *"Development should aim to achieve greenfield run-off rates and ensure that surface water run-off is managed as close to its source as possible in line with the following drainage hierarchy:*

- *store rainwater for later use;*
- *use infiltration techniques, such as porous surfaces in non-clay areas;*
- *attenuate rainwater in ponds or open water features for gradual release to a watercourse;*
- *attenuate rainwater by storing in tanks or sealed water features for gradual release to a watercourse;*
- *discharge rainwater direct to a watercourse;*
- *discharge rainwater to a surface water drain;*
- *discharge rainwater to the combined sewer."*

7.3 Feasibility of the SUDs Hierarchy in Camden

Discharge into the ground

7.3.1 SuDS suitability – In Source 8 (see Table 3.2), the southern part of borough is likely to suffer very significant constraints associated with infiltration SuDS, in particular in the area along the northern edge of the River Terrace Deposits. The area with the least constraints i.e. suitable for free-draining infiltration SuDS, is the area in the north of borough underlain by the Bagshot Formation. In between these two areas, there lies an area which is classed as either probably suitable for infiltration SuDS (where depth to water table is >5m through the year) or potentially suitable for infiltration SuDS (where depth to water table is <3m for part of year). In this central part of the borough, local confirmation would be required of depth to the water table before design of SuDS is considered.

7.3.2 Overall, it is areas in the southern part of borough which are likely to have the biggest constraints on the use of infiltration SuDS, and in particular in those areas where the depth to the water table <3m below the ground surface occur. In the northern part of the borough, the use of infiltration SuDS will generally be suitable on the free-draining Bagshot Formation. In the central parts of borough, some areas may have potential for infiltration SuDS, although the design will be influenced by local ground conditions.

Discharge to a surface water body

7.3.3 Section 3.2 provides details of surface water bodies located within LBC over 1500m^2 in surface area. OS MasterMap was utilised in order to identify all inland water bodies

7.3.4 All surface water bodies above 1500m^2 in surface area are located within Hampstead Heath and Waterlow Park, with the exception of the Regent's Canal. Therefore there is limited potential for new development within LBC to discharge to a surface water body. No watercourses, except for those located within Hampstead Heath, exist within the borough. The surface water bodies above 1500m^2 in area are located close to the Allocated Sites included in this SFRA.

Discharge to a surface water sewer

7.3.5 A desktop study was carried out to identify the location of LBC Highways drains and TWUL surface water assets in order to ascertain the potential for new development to discharge surface water runoff to a surface water sewer. Although a limited number of surface water sewers are located with LBC, all subsequently connect to a combined sewer and therefore any connection to a surface water sewer will still add flow to the combined sewer network. The NPPF states that new development must not increase surface water runoff rates post-development, and the London Plan states that all new development should aim to achieve greenfield runoff rates where practicable. Opportunities for surface water attenuation and water re-use, such as through use of water butts, should be considered as part of any new development.

8 POLICY OPTIONS

8.1 Overview

8.1.1 This section provides options for LBC to consider as part of the development of the LBC Local Plan.

8.2 Policy Aims within Flood Zone 1

8.2.1 The entirety of LBC is located within Flood Zone 1, which comprises land outside the extent of fluvial flooding in a 0.1% AEP event. As set out in the NPPF all types of development are considered appropriate within Flood Zone 1. Proposals for new development greater than 1 hectare in Flood Zone 1 will require a site specific FRA to ensure that surface water generated by the site is managed in a sustainable manner and does not increase the burden on existing infrastructure and/or flood risk to neighbouring property. Due to the majority of the borough being located within a Critical Drainage Area as defined by the LBC SWMP, all opportunities should be taken during development to reduce existing runoff rates post-development. Policy 5.13 of the London Plan[55] states that all development should aim to achieve greenfield runoff rates, and where this is not possible, runoff rates post-development should not exceed those pre-development, as per the NPPF. The SWMP Critical Drainage Areas and Local Flood Risk Zones, and the Environment Agency's uFMfSW dataset should be used as a starting point to indicate broad areas with a potential for surface water flood risk in the borough. In the absence of fluvial flood risk within the borough, a clear focus for new development should be a reduction in surface water runoff rates post-development, wherever practicable.

8.3 Policy Options

Spatial Planning

1. *Sites should be allocated in accordance with the Sequential Test to reduce the flood risk and ensure that the vulnerability classification of the proposed development is appropriate to the flood risk. In the absence of fluvial flood risk within the borough, available information, such as the Environment Agency's uFMfSW and Flood Risk from Reservoirs should be utilised to direct development towards areas of lowest flood risk.*
2. *Basement dwellings and other 'Highly Vulnerable' development should be discouraged in areas where a high surface water flood risk has been identified.*
3. *LBC should consider requiring a FRA to accompany any planning application for 'Highly Vulnerable' development in an area of Medium surface water flood risk, and for 'More Vulnerable' development in an area of High surface water flood risk as defined by the uFMfSW.*

4. *LBC should consider the cumulative impact of new development on flood risk.*

Flood Risk Management

1. *FRAs are required for proposals of 1 hectare or greater in Flood Zone 1 and for new development (including minor development and change of use) in an area of Flood Zone 1 which has critical drainage problems. The majority of the borough is located within a CDA as defined by the LB Camden SWMP and therefore LB Camden should consider requiring FRAs for all development located within Local Flood Risk Zones as defined by the SWMP, which show discrete areas of flooding.*
2. *For proposed developments located within a CDA, as indicated by Appendix B, Figure 6, LBC should consider setting as a requirement a minimum reduction in surface water runoff rates post-development of 50%. The intention of such a requirement would be to reduce surface water runoff and also reduce the strain on the combined sewer network.*
3. *Where changes of use result in an increase in the vulnerability classification of a development, applicants should be required to provide an assessment of flood risk to accompany their planning application. This should demonstrate how the flood risks to the development will be managed so that it remains safe through its lifetime including provision of safe access and egress.*
4. *Flood Risk to development should be assessed for all sources of flooding.*
5. *Surface water flooding should be investigated in detail as part of site specific FRAs for future developments and early liaison with LBC is recommended for appropriate management techniques.*
6. *Groundwater flooding should be investigated in more detail as part of site specific FRAs for developments located in areas of the borough where a potential for groundwater flooding exists.*
7. *When re-developing existing buildings in areas at risk from flooding, the use of flood resilient measures should be promoted at the individual property level.*
8. *The screening stage of a Basement Impact Assessment should be applied to all basement developments to identify any potential risks in relation to the water environment or local properties. Should any risks be identified, appropriate assessment of these risks should be carried out.*
9. *A Basement Impact Assessment should demonstrate that the impacts of the proposed development are acceptable, or that appropriate mitigation measures will be adopted.*

Sustainable Drainage Systems & Surface Water Management

1. *Sustainable Drainage Systems (SuDS) should be included in new developments unless it is demonstrably not possible to manage surface water using these techniques. Section 7.3 should be consulted in the first instance for guidance on the potential for SuDS techniques.*
2. *NPPF requires the use of SuDS as an opportunity for managing flood risk, improving water quality and increasing amenity and biodiversity.*
3. *FRAs are required for proposals of 1 hectare or greater in Flood Zone 1 and for new development (including minor development and change of use) in an area of Flood Zone 1 which has critical drainage problems.*
4. *Policy 5.13 of the London Plan states that development should aim to achieve greenfield runoff rates, and where this is not possible, runoff rates post-development should not exceed those pre-development, as per the NPPF. In addition, an allowance should be made for climate change.*
5. *For proposed developments located within a CDA, as indicated by Appendix B, Figure 6, LBC should consider setting as a requirement a minimum reduction in surface water runoff rates post-development of 50%. The intention of such a requirement would be to reduce surface water runoff and also reduce the strain on the combined sewer network.*
6. *Potential overland flow paths should be considered to ensure that buildings do not obstruct flows.*
7. *Where basements are proposed the risk of surface water flooding should be considered, with possible mitigation options including raised thresholds and inclusion of storage for surface water in such developments.*
8. *Opportunities should be sought to reduce the risk of flooding from the sewer network through consultation with TWUL to determine key areas for maintenance and flood alleviation schemes.*
9. *At the site specific FRA level, the suitability of SuDS should be investigated for each development. Section 7.3 indicates that the southern section of the borough is likely to suffer significant constraints associated with infiltration SuDS, with such techniques likely to be least constrained in the north of the borough where it is underlain by the Bagshot Formation (Appendix B: Figure 4b).*
10. *The vulnerability and importance of local ecological resources, such as water quality and biodiversity, should be considered when determining the suitability of SuDS.*

Residual Risk & Emergency Planning

1. *Where development within flood risk areas is absolutely necessary, flood proof construction methods should be employed to reduce the impact of flooding.*
2. *Where development is within flood risk areas, emergency planning strategies should be put in place in order to direct people to safety during times of flooding.*

APPENDIX A: DATA SOURCES

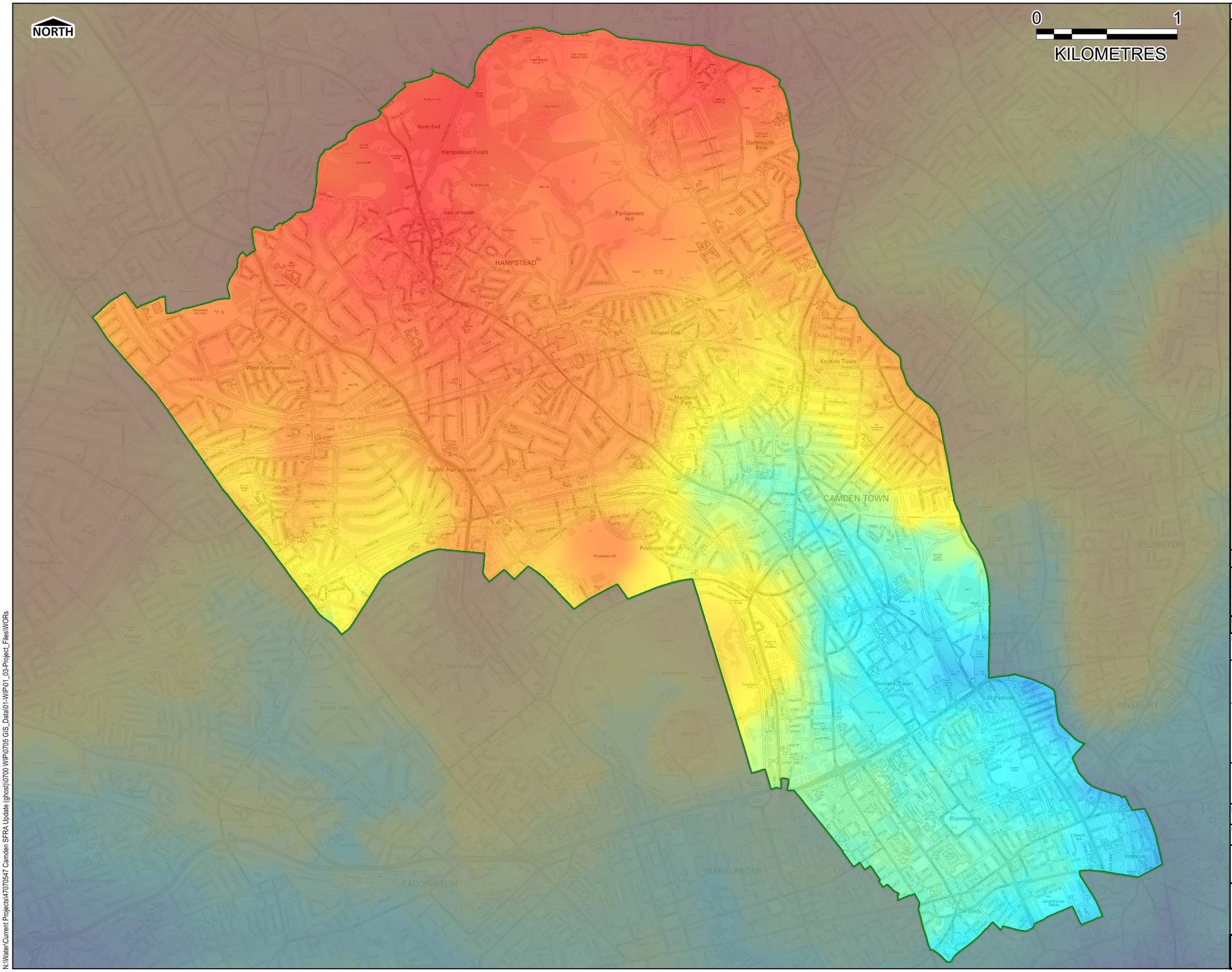
Dataset Description	Source	Format	Benefits / Limitations
Fluvial			
Environment Agency Flood Zones	Environment Agency Geostore	GIS Layer	Confirmation that LBC is located entirely within Flood Zone 1.
Detailed River Network (DRN)	Environment Agency Geostore	GIS Layer	Identification of the river network including Ordinary Watercourses and Regent's Canal.
Historic Flood Map	Environment Agency Geostore	GIS Layer	Confirmation that no fluvial historic events have been recorded in LBC.
Surface water			
'Updated Flood Map for Surface Water' dataset	LBC (Camden LLFA)	GIS Layer	Provides an indication of the broad areas likely to be at risk of surface water flooding, i.e. areas where surface water would be expected to flow or pond. This dataset does not show the susceptibility of individual properties to surface water flooding.
Surface Water management Plan and associated GIS deliverable	LBC	GIS Layer	GIS layer identifying Critical Drainage Areas: A discrete geographic area (usually a hydrological catchment) where multiple and interlinked sources of flood risk (surface water, groundwater, sewer, main river and/or tidal) cause flooding in one or more Local Flood Risk Zones during severe weather thereby affecting people, property or local infrastructure. CDAs indicate areas where surface water management should be a key focus of any future development.
Local surface water modelling outputs for Highgate and West Hampstead	WSP	GIS Layer	GIS outputs from detailed local pluvial modelling within Highgate and West Hampstead areas within LBC.
Records of flooding from all sources	LBC	GIS Layer	Identifies locations within the borough which are vulnerable to flooding.
Groundwater			
Underlying Geology	LBC	GIS Layer	Illustrates bedrock and superficial geology across the Borough.

Dataset Description	Source	Format	Benefits / Limitations
'Areas Susceptible to Groundwater Flooding' dataset	Environment Agency Geostore	GIS Layer	A strategic scale map showing groundwater flood areas on a 1km square grid. It was developed specifically by the Environment Agency for use by Lead Local Flood Authorities (LLFAs) for use in Preliminary Flood Risk Assessment (PFRA) as required under the Flood Risk Regulations. The data should not be interpreted as identifying areas where groundwater is actually likely to flow or pond, thus causing flooding, but may be of use to LLFAs in identifying where, for example, further studies may be useful.
Groundwater vulnerability zone	Environment Agency Geostore	GIS Layer	Broadly shows extents of aquifers in the Borough. Where aquifers are highly vulnerable, they often have a more permeable covering and, together with dry valley and watercourse networks, potential groundwater flooding areas can be identified.
Aquifer Designation Map for bedrock and superficial deposits	Environment Agency Geostore	GIS Layer	A polygon shapefile that shows aquifer designations for bedrock aquifers. The designations identify the potential of the geological strata to provide water that can be abstracted and have been defined through the assessment of the underlying geology.
Increased Potential for Elevated Groundwater dataset	LBC	GIS Layer	This dataset was derived from four individual data sources (BGS Groundwater Flood Susceptibility maps; Environment Agency Thames Estuary 2100 groundwater hazard maps; DEFRA Groundwater emergence maps; and JBA. Groundwater flood maps) and identifies areas where there is increased potential for groundwater levels to rise within 2 m of ground surface following periods of higher than average recharge.
Infiltration for SuDS	British Geological Survey	GIS Layer	Dataset produced by the BGS of relevance to professionals who make decisions on SuDS design, construction and approval. The maps will help: (1) make preliminary decisions on the suitability of the subsurface for infiltration SuDS; (2) make preliminary decisions on the type of infiltration SuDS that will likely be appropriate; (3) assess SuDS planning applications to determine whether the necessary factors have been considered; and (4) determine whether infiltration SuDS could be appropriate where a non-infiltrating SuDS technique has been proposed.
EA Groundwater Flood Calls	Environment Agency	MS Excel Spreadsheet	Records of calls to the Environment Agency regarding suspected groundwater flooding.
Sewer			

Dataset Description	Source	Format	Benefits / Limitations
Sewer flooding records	Thames Water	MS Word Doc	Indicates post code areas that may be prone to flooding as have experienced flooding in the last 10 years due to hydraulic incapacity. However, given that TWUL target these areas for maintenance and improvements, areas that experienced flooding in the past may no longer be at greatest risk of flooding.
TWUL asset information	Thames Water	GIS Layer	GIS layer of all TWUL assets including surface and foul water and combined sewers. Layer provides confirmation of the route of the sewers which have incorporated the 'lost rivers' of Camden.
Flow rates from Hampstead Heath Ponds to local sewer network	City of London Corporation	MS Word Doc	Confirmation of the sizes of the outlet pipes from the Hampstead and Highgate Pond Chains within Hampstead Heath, and the flow rates from the ponds into the local sewer network.
Planning			
OS Mapping of LBC administrative area (1:10K Streetview, 1:50K, OS MasterMap)	LBC	GIS Layer	Provides background mapping to other GIS layers. Designed for use at 1:50K and 1:10K scales.
GIS layer of administrative boundary	LBC	GIS Layer	Defines the administrative area of the Borough for mapping purposes.
GIS layer of post code boundaries	LBC	GIS Layer	Delineates post code boundaries for the Borough. Enables mapping of TWUL datasets which are provided by post code sector.
GIS layer of development sites.	LBC	GIS Layer	Layer of LBC Allocated Sites.
LBC highways assets	LBC	GIS Layer	Identifies highways gullies maintained by LBC
Emergency Planning			
Borough-wide Emergency Flood Plan	LBC	PDF document	Details LBC's co-ordinated response to a flood event.
National Receptor Database (NRD)	Environment Agency Geostore	GIS Layer	Spatial dataset which contains a number of layers categorised into the themes of Buildings, Transport, Utilities, Land Use, Agriculture, Heritage, Environment and Miscellaneous. Each information theme contains a number of relevant data layers.
Canal			

Dataset Description	Source	Format	Benefits / Limitations
Asset Inspection Procedures Manual	Canal and River Trust	PDF document	Detailed information on the inspection and management of Canal and River Trust assets to ensure their continued safety.
Canal and River Trust asset information	Canal and River Trust	GIS layer	Detailed information in GIS format of all Canal and River Trust asset data within LBC.
Reservoirs			
Management of the Hampstead Heath Ponds	City of London Corporation	PDF document	Details of current management of the Hampstead Heath Ponds by CoLC which may have an impact on flood risk.
Hampstead Heath Ponds Project information	City of London Corporation	PDF document	A number of documents have been published by City of London Corporation detailing the existing flood risk at the Hampstead Heath Ponds and the proposed works to ensure the safety of the ponds in the future.

APPENDIX B: BOROUGH MAPPING



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LEGEND

London Borough Camden Boundary

Topography (mAOD)

- -2 to 12
- 12 to 25
- 25 to 39
- 39 to 53
- 53 to 80
- 80 to 121
- 121 to 135

Revision Details	By / Check	Check Date	Suffix

Purpose of Issue: FINAL

Client: Camden

Project Title: LONDON BOROUGH OF CAMDEN STRATEGIC FLOOD RISK ASSESSMENT

Drawing Title: LB Camden Topography

Drawn	Checked	Approved	Date
CB	JS	MT	03/07/2014

URS Internal Project No.	Scale at A3
47070547	1:40,000

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FIGURE 1	Rev 1

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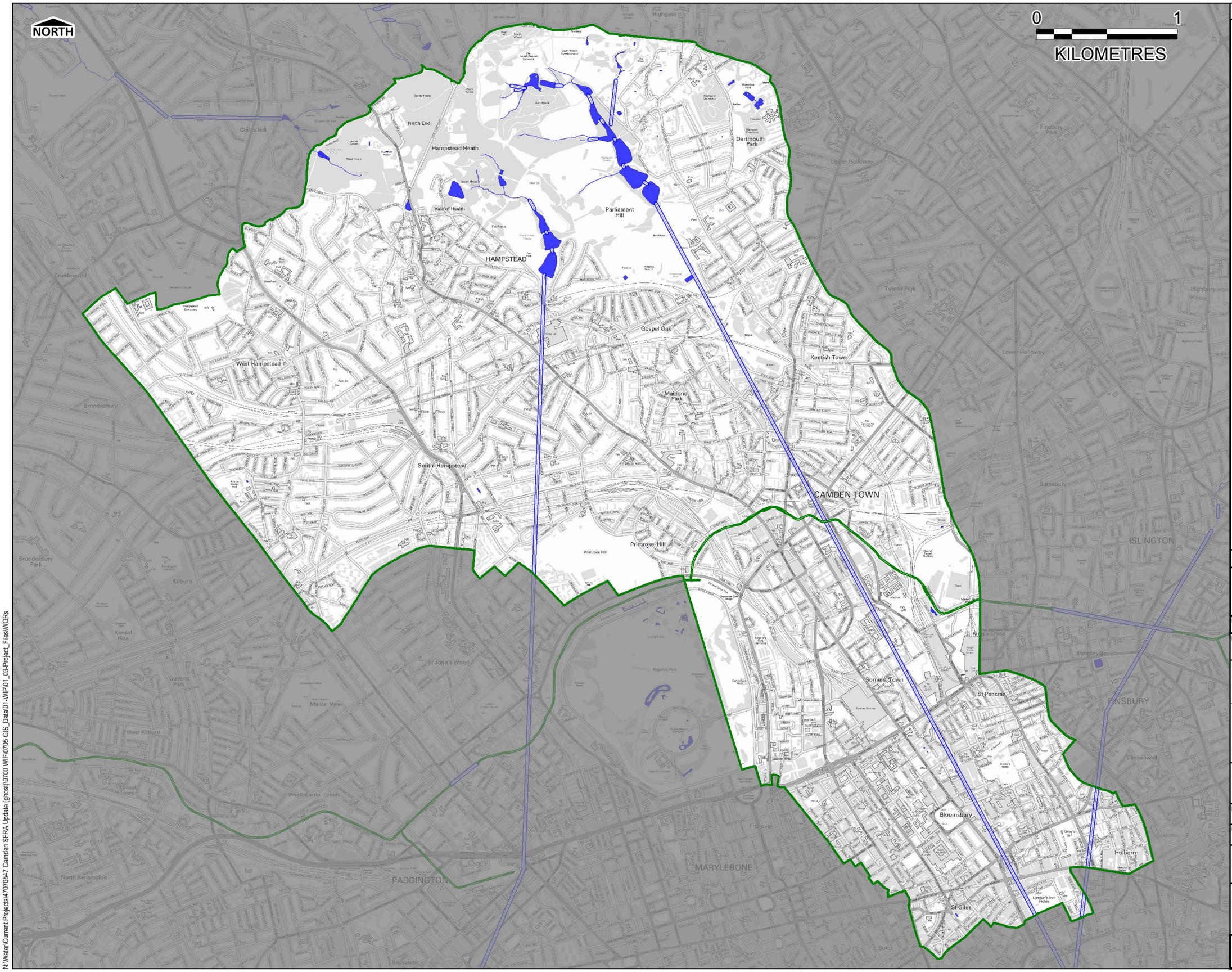

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LEGEND

- London Borough Camden Boundary
- Inland Waters
- Open Watercourse
- Culverted Watercourse
- Canal

Revision Details	By / Check	Check Date	Suffix

Purpose of Issue: FINAL

Client: Camden

Project Title: LONDON BOROUGH OF CAMDEN STRATEGIC FLOOD RISK ASSESSMENT

Drawing Title: LB Camden Surface Waterbodies

Drawn	Checked	Approved	Date
CB	JS	MT	03/07/2014

URS Internal Project No.	Scale at A3
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Drawing Number: **FIGURE 2** Rev: **Rev 1**

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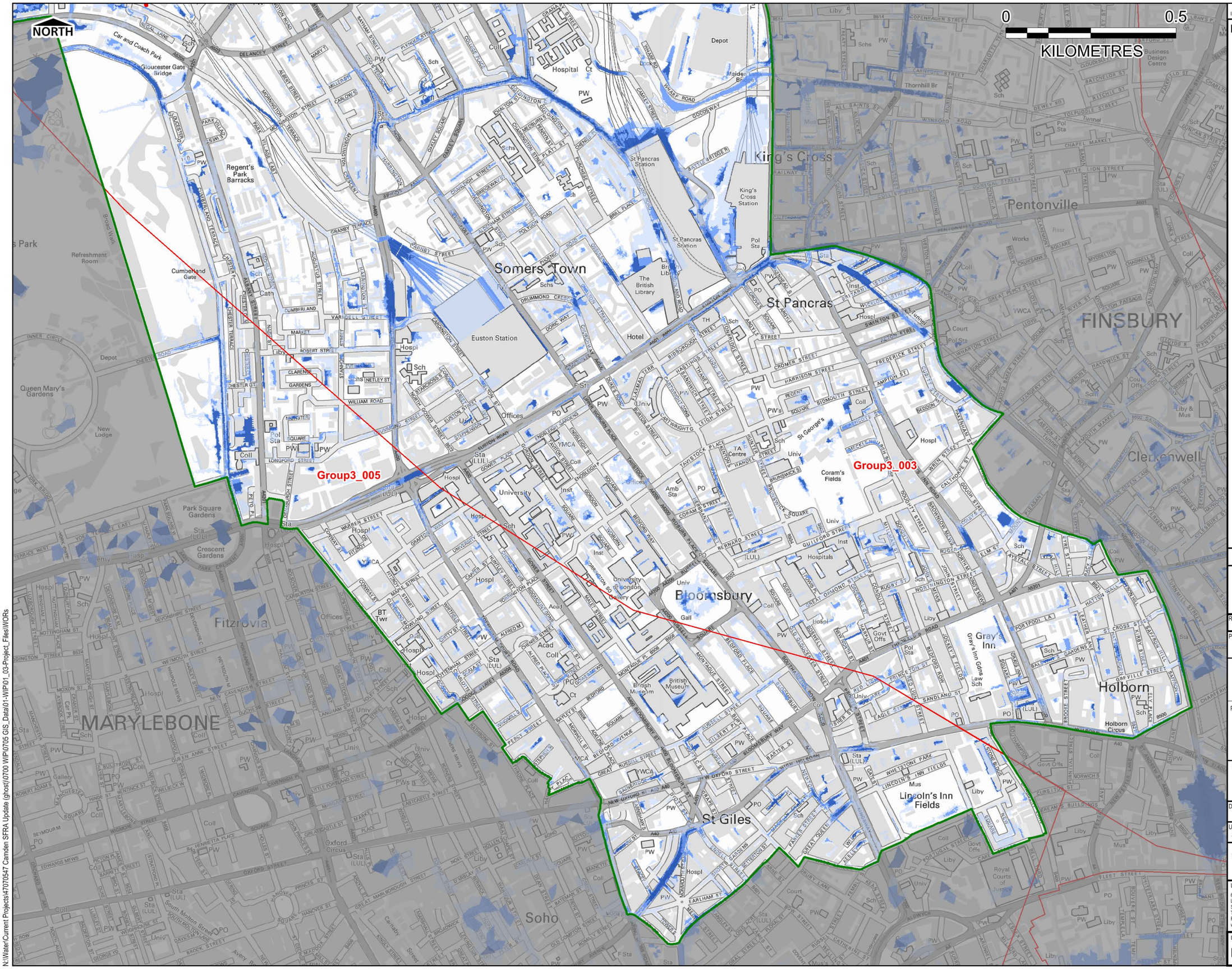

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LEGEND

- London Borough Camden Boundary
- Critical Drainage Area

Risk of Flooding from Surface Water

- High (1 in 30 year)
- Medium (1 in 100 year)
- Low (1 in 1000 year)
- Very Low (<1 in 1000 year)

Revision Details	By / Check	Check Date	Suffix

Purpose of Issue: FINAL

Client: Camden

Project Title: LONDON BOROUGH OF CAMDEN STRATEGIC FLOOD RISK ASSESSMENT

Drawing Title: Updated Flood Maps for Surface Water Flooding (uFMfSW)

Drawn	Checked	Approved	Date
CB	JS	MT	03/07/2014

URS Internal Project No.	Scale at A3
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FIGURE 3 i	Rev 1

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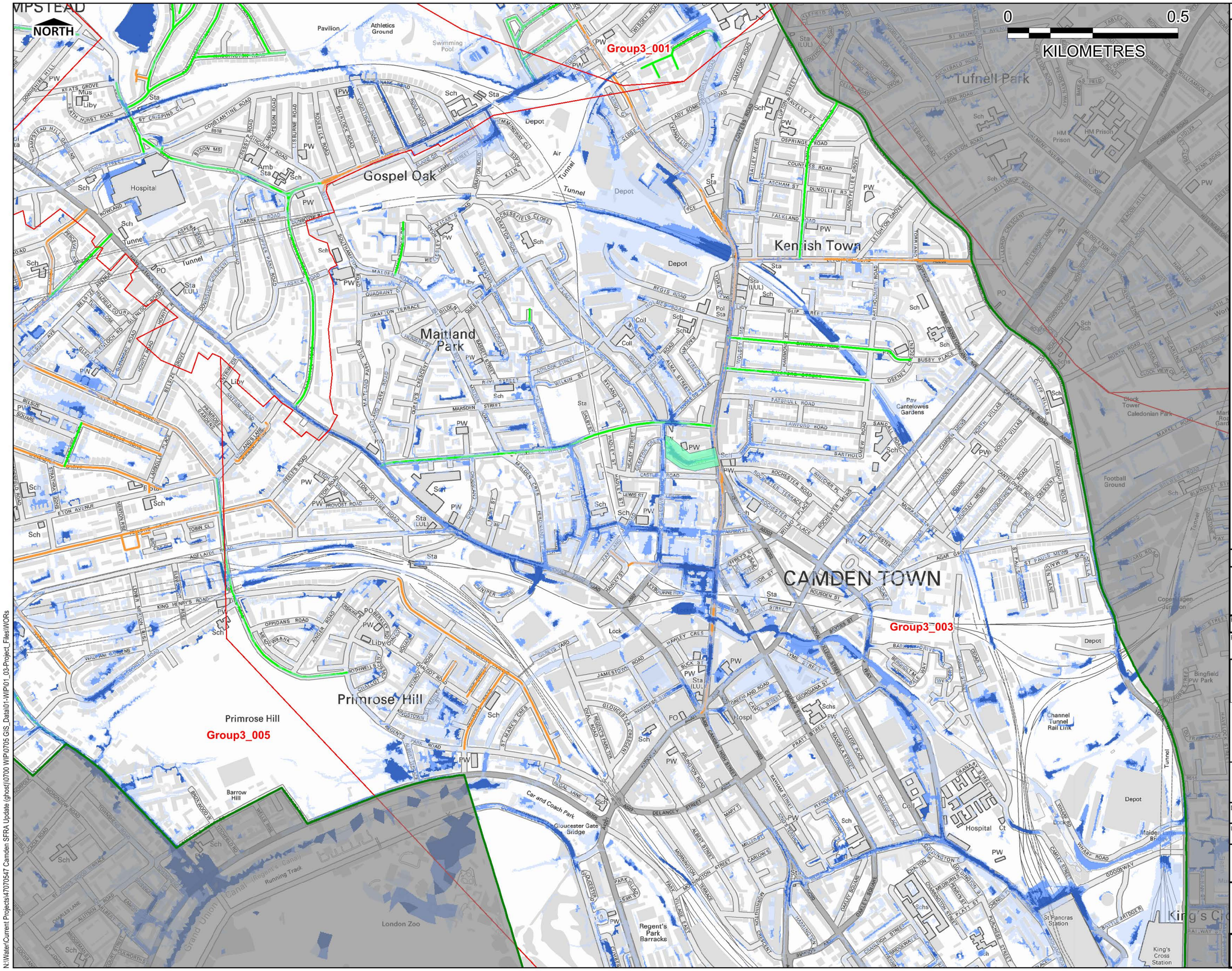

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LEGEND

- London Borough Camden Boundary
- Critical Drainage Area
- Flooded Streets (2002)
- Flooded Streets (1975)

LBC Historic SW Flooding Records
No. Properties affected

- 1
- 2

Risk of Flooding from Surface Water

- High (1 in 30 year)
- Medium (1 in 100 year)
- Low (1 in 1000 year)
- Very Low (<1 in 1000 year)

Revision Details	By	Check	Check Date	Suffix

Purpose of Issue: FINAL

Client: Camden

Project Title: LONDON BOROUGH OF CAMDEN STRATEGIC FLOOD RISK ASSESSMENT

Drawing Title: Updated Flood Maps for Surface Water Flooding (uFMfSW)

Drawn	Checked	Approved	Date
CB	JS	MT	03/07/2014

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Drawing Number: FIGURE 3 ii

Rev: Rev 1

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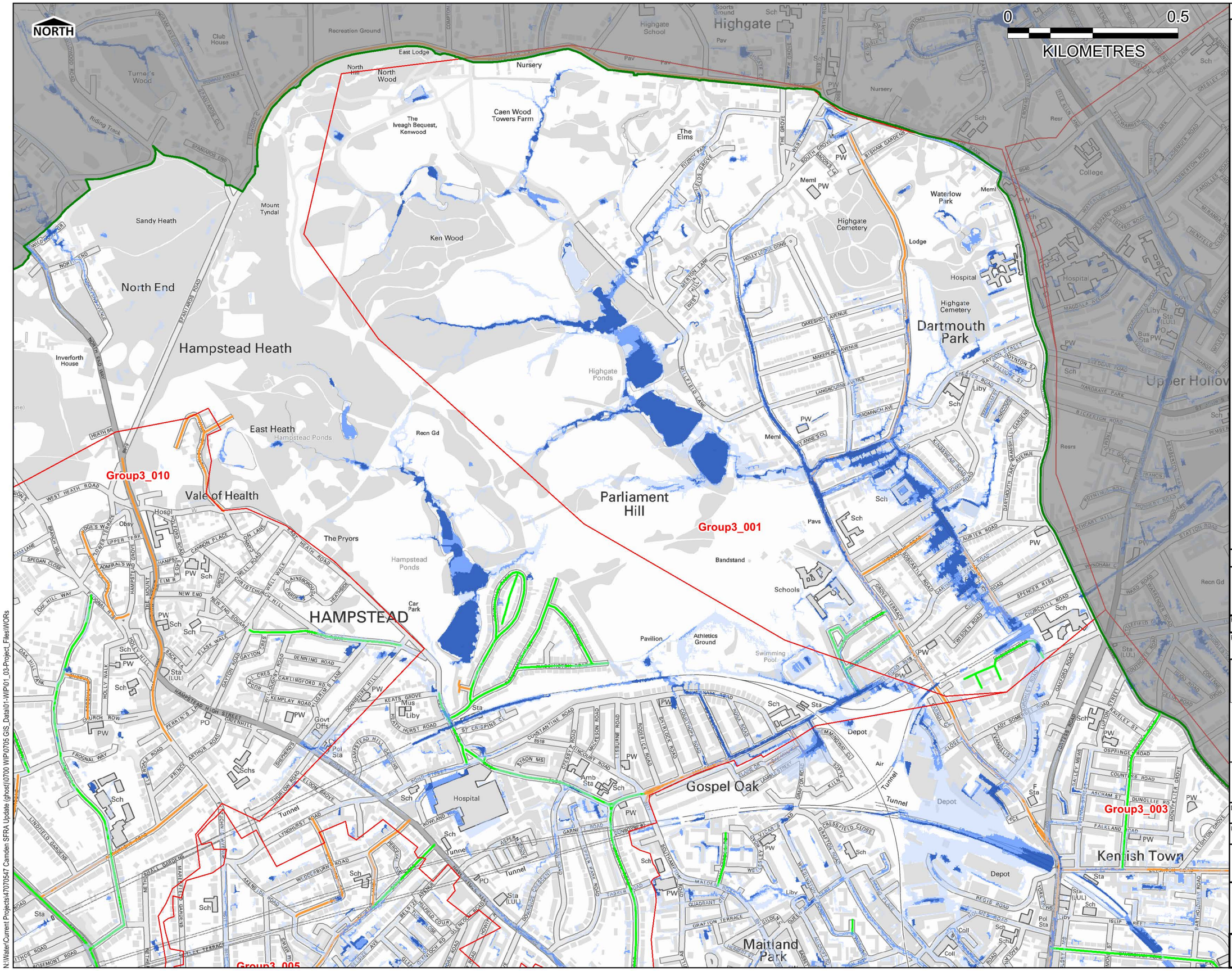

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LEGEND

- London Borough Camden Boundary
- Critical Drainage Area
- Flooded Streets (2002)
- Flooded Streets (1975)

Risk of Flooding from Surface Water

- High (1 in 30 year)
- Medium (1 in 100 year)
- Low (1 in 1000 year)
- Very Low (<1 in 1000 year)

Revision Details	By	Check	Date	Suffix

Purpose of Issue: FINAL

Client: Camden

Project Title: LONDON BOROUGH OF CAMDEN STRATEGIC FLOOD RISK ASSESSMENT

Drawing Title: Updated Flood Maps for Surface Water Flooding (uFMfSW)

Drawn	Checked	Approved	Date
CB	JS	MT	03/07/2014

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FIGURE 3 iii	Rev 1

NORTH

Group3_001

Group3_010

Group3_005

HAMPSTEAD

Hampstead Heath

North End

Childs Hill

West Hampstead

Brondesbury

Vale of Health

East Heath

Hampstead Ponds

Westfield

Basing Hill Park

Childs Hill Park

Golders Hill Park

Sandy Heath

Ken Wood

Mount Tyndal

Leg of Mutton Pond

West Heath

The Hill Garden

Inverforth House

The Pryors

Recreation Ground

Hampstead Cemetery

Depot

Hospital

0 0.5 KILOMETRES

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LEGEND

- London Borough Camden Boundary
- Critical Drainage Area
- Flooded Streets (2002)
- Flooded Streets (1975)

LBC Historic SW Flooding Record
No. Properties affected
- 1
- 2

Risk of Flooding from Surface Water
- High (1 in 30 year)
- Medium (1 in 100 year)
- Low (1 in 1000 year)
- Very Low (<1 in 1000 year)

Revision Details	By / Check	Check Date	Suffix

Purpose of Issue: FINAL

Client: Camden

Project Title: LONDON BOROUGH OF CAMDEN STRATEGIC FLOOD RISK ASSESSMENT

Drawing Title: Updated Flood Maps for Surface Water Flooding (uFMfSW)

Drawn	Checked	Approved	Date
CB	JS	MT	03/07/2014

URS Internal Project No.: 47070547

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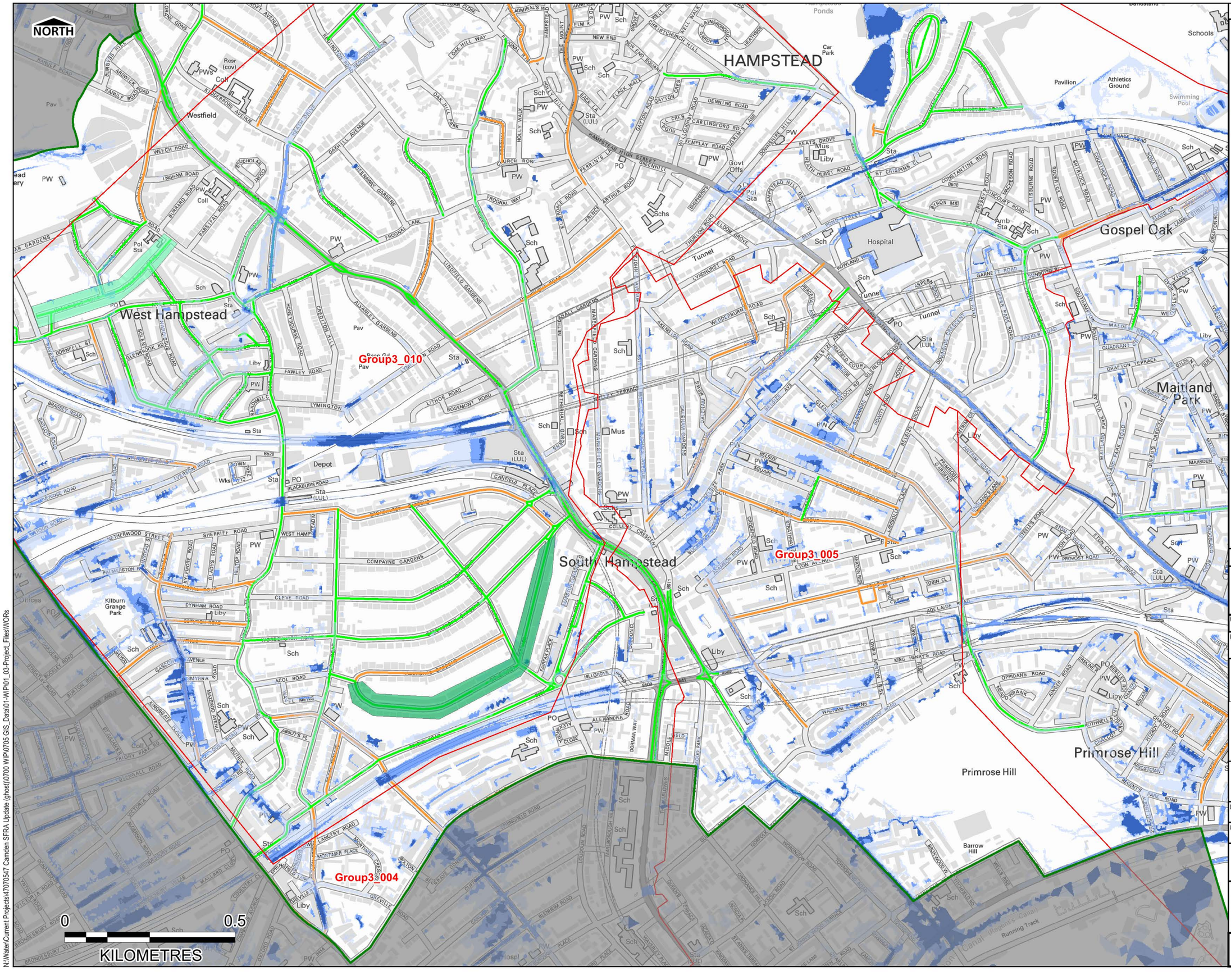
Drawing Number: FIGURE 3 iv

Rev: Rev 1



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LEGEND

- London Borough Camden Boundary
- Critical Drainage Area
- Flooded Streets (2002)
- Flooded Streets (1975)

LBC Historic SW Flooding Record
No. Properties affected

- 1
- 2

Risk of Flooding from Surface Water

- High (1 in 30 year)
- Medium (1 in 100 year)
- Low (1 in 1000 year)
- Very Low (<1 in 1000 year)

Revision Details	By	Check	Date	Suffix

Purpose of Issue: FINAL

Client: Camden

Project Title: LONDON BOROUGH OF CAMDEN STRATEGIC FLOOD RISK ASSESSMENT

Drawing Title: Updated Flood Maps for Surface Water Flooding (uFMfSW)

Drawn	Checked	Approved	Date
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Drawing Number: FIGURE 3 v

Rev: Rev 1

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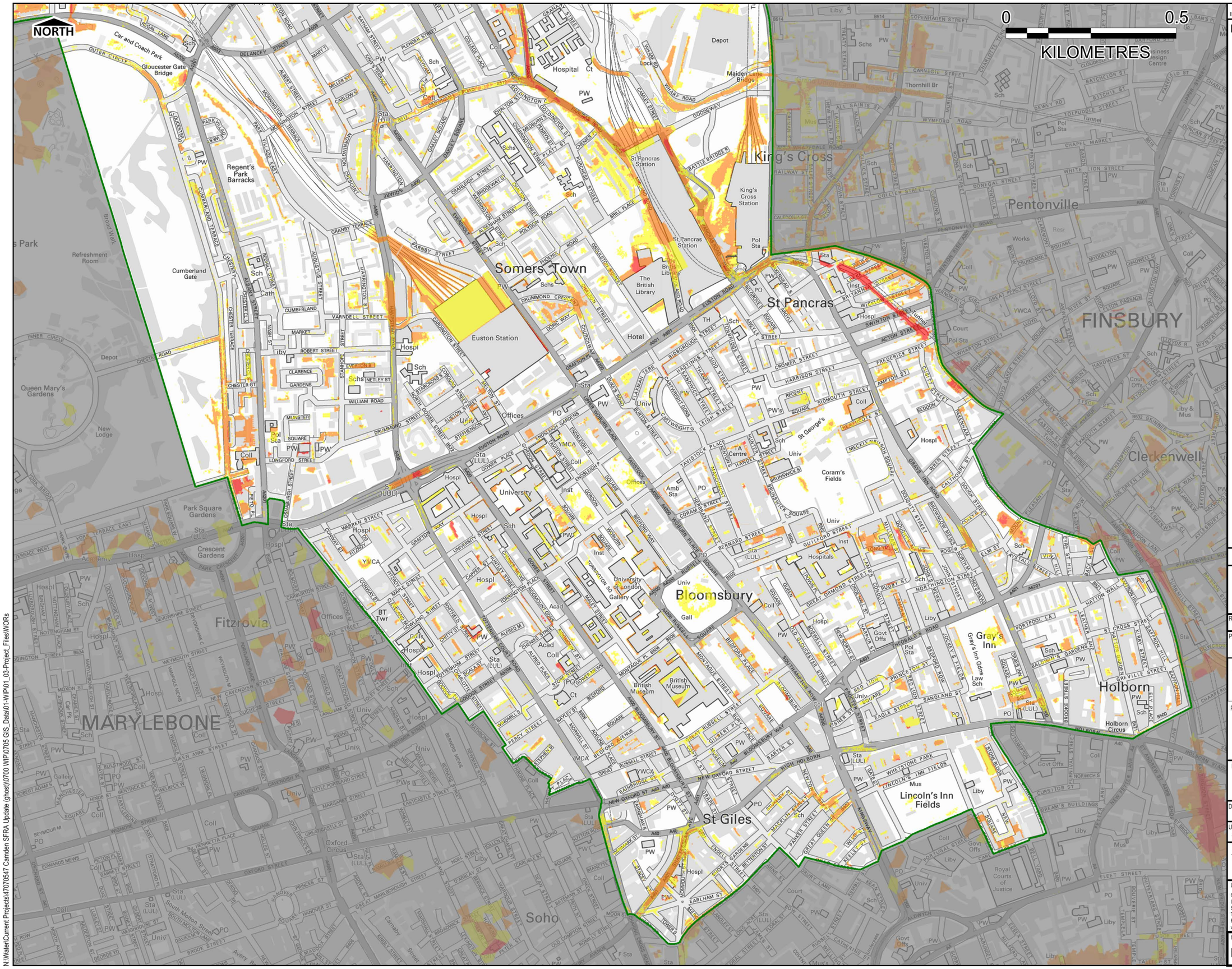

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LEGEND

- London Borough Camden Boundary

Flood Hazard (m)

- >2.5 Extreme (Danger for all)
- 1.25 - 2.5 Significant (Danger for most)
- 0.75 - 1.25 Moderate (Danger for some)
- <0.75 Low (Caution)

Revision Details	By / Check	Check Date	Suffix

Purpose of Issue: FINAL

Client: Camden

Project Title: LONDON BOROUGH OF CAMDEN STRATEGIC FLOOD RISK ASSESSMENT

Drawing Title: **Hazard: 1 in 1000 Year Flood Event**

Drawn	Checked	Approved	Date
CB	EY	MT	02/07/2014

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Drawing Number: **FIGURE 3 vi**

Rev: **Rev 1**

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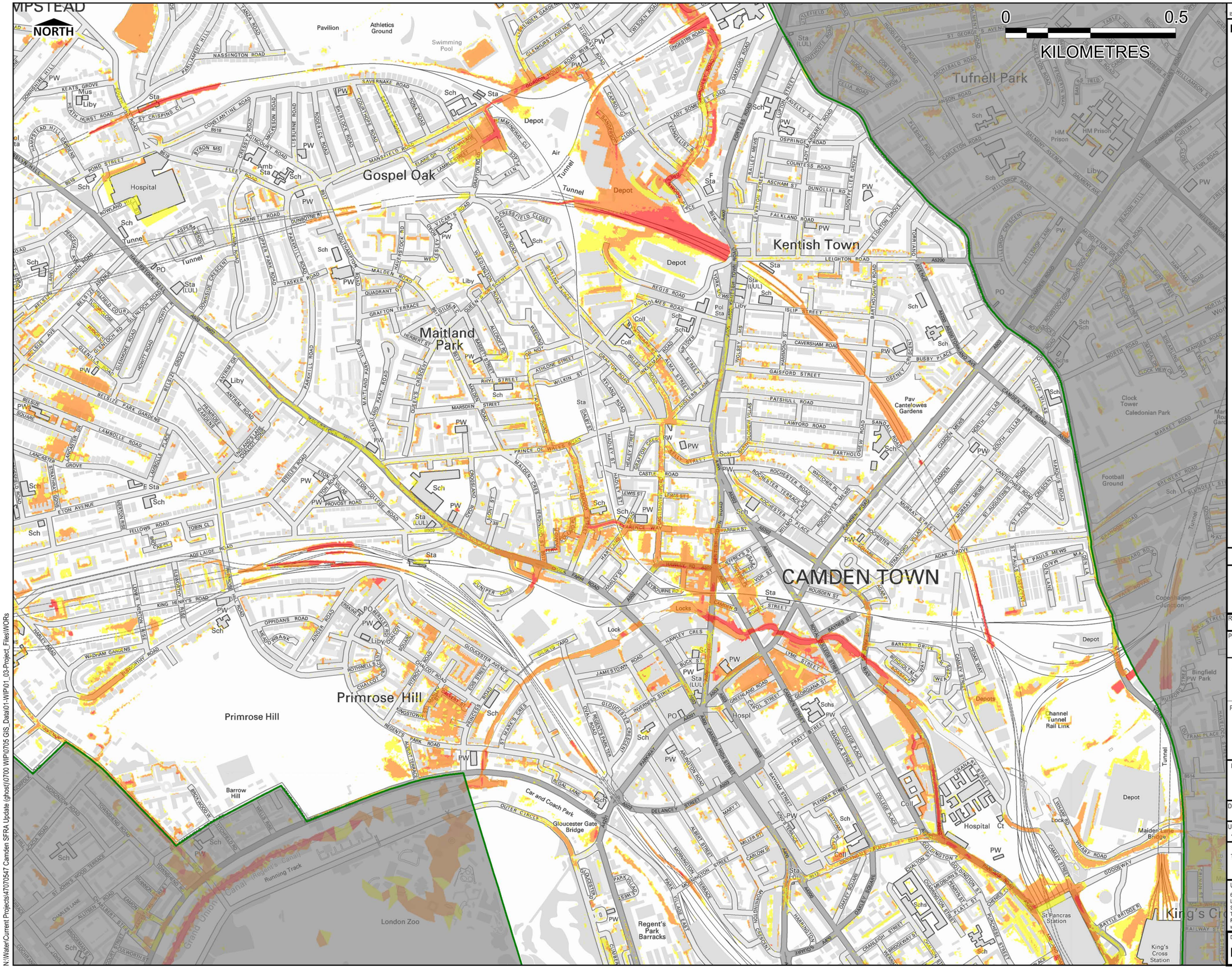

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LEGEND

- London Borough Camden Boundary

Flood Hazard (m)

- >2.5 Extreme (Danger for all)
- 1.25 - 2.5 Significant (Danger for most)
- 0.75 - 1.25 Moderate (Danger for some)
- <0.75 Low (Caution)

Revision Details	By	Check	Check Date	Suffix

Purpose of Issue: FINAL

Client: Camden

Project Title: LONDON BOROUGH OF CAMDEN STRATEGIC FLOOD RISK ASSESSMENT

Drawing Title: **Hazard: 1 in 1000 Year Flood Event**

Drawn	Checked	Approved	Date
CB	EY	MT	02/07/2014

URS Internal Project No.	Scale at A3
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Drawing Number: **FIGURE 3 vii** Rev: **Rev 1**

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NORTH

0 0.5
KILOMETRES

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LEGEND

London Borough Camden Boundary

Flood Hazard (m)

- >2.5 Extreme (Danger for all)
- 1.25 - 2.5 Significant (Danger for most)
- 0.75 - 1.25 Moderate (Danger for some)
- <0.75 Low (Caution)

Revision Details	By / Check	Check Date	Suffix

Purpose of Issue: FINAL

Client: Camden

Project Title: LONDON BOROUGH OF CAMDEN STRATEGIC FLOOD RISK ASSESSMENT

Drawing Title: **Hazard: 1 in 1000 Year Flood Event**

Drawn	Checked	Approved	Date
CB	EY	MT	02/07/2014

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Rev: **Rev 1**

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NORTH

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LEGEND

London Borough Camden Boundary

Flood Hazard (m)

- >2.5 Extreme (Danger for all)
- 1.25 - 2.5 Significant (Danger for most)
- 0.75 - 1.25 Moderate (Danger for some)
- <0.75 Low (Caution)

0 0.5 KILOMETRES

Revision Details	By	Check	Date	Suffix

Purpose of Issue: FINAL

Client: Camden

Project Title: LONDON BOROUGH OF CAMDEN STRATEGIC FLOOD RISK ASSESSMENT

Drawing Title: **Hazard: 1 in 1000 Year Flood Event**

Drawn	Checked	Approved	Date
CB	EY	MT	02/07/2014

URS Internal Project No.: 47070547

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Drawing Number: **FIGURE 3 ix**

Rev: **Rev 1**

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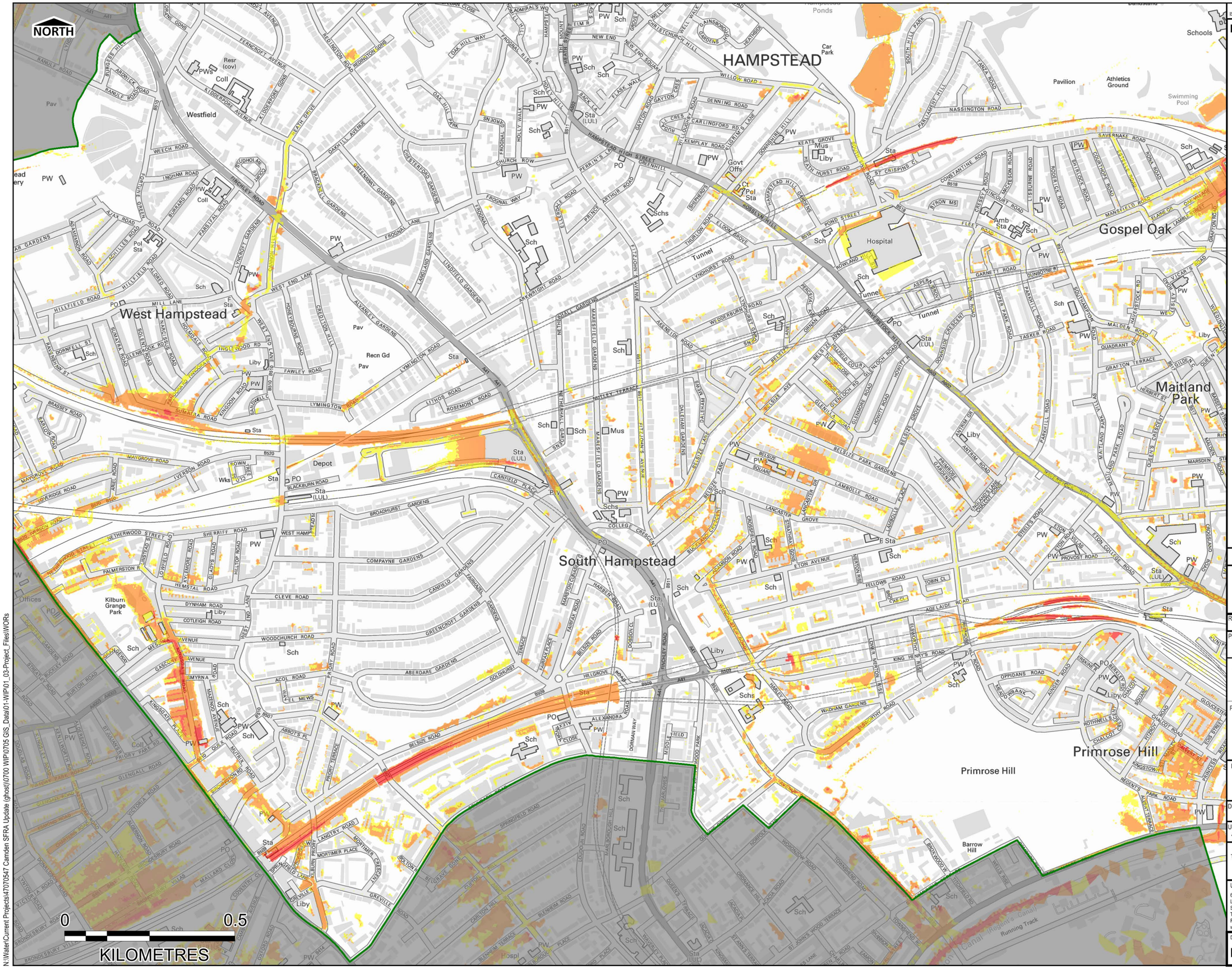

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LEGEND

London Borough Camden Boundary

Flood Hazard (m)

- >2.5 Extreme (Danger for all)
- 1.25 - 2.5 Significant (Danger for most)
- 0.75 - 1.25 Moderate (Danger for some)
- <0.75 Low (Caution)

Revision Details	By / Check	Check Date	Suffix

Purpose of Issue: FINAL

Client: Camden

Project Title: LONDON BOROUGH OF CAMDEN STRATEGIC FLOOD RISK ASSESSMENT

Drawing Title: **Hazard: 1 in 1000 Year Flood Event**

Drawn	Checked	Approved	Date
CB	EY	MT	02/07/2014

URS Internal Project No.	Scale at A3
47070547	1:15,000

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Drawing Number: **FIGURE 3 x** Rev: **Rev 1**

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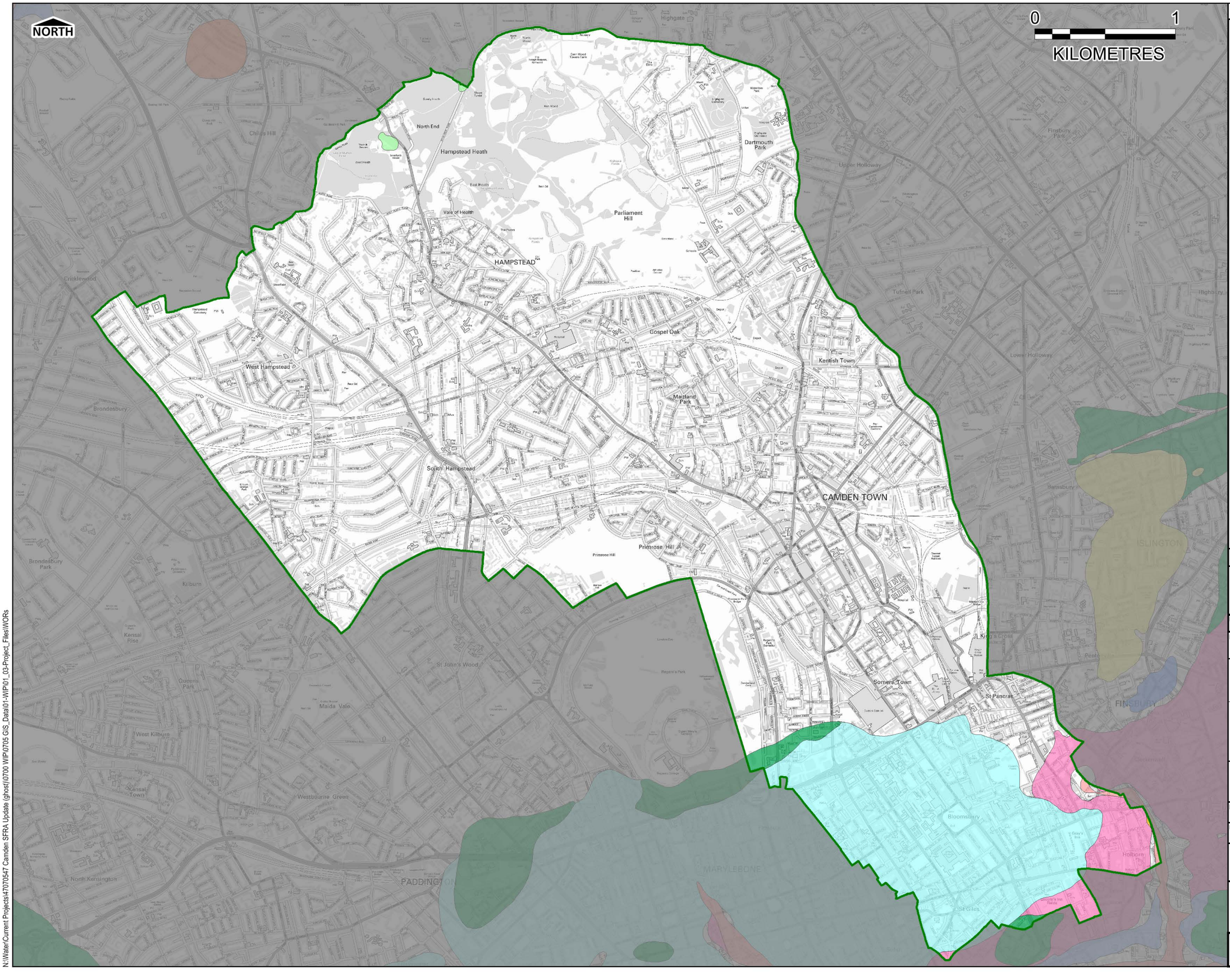

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LEGEND

- London Borough Camden Boundary
- HACKNEY GRAVEL
- LANGLEY SILT
- LYNCH HILL GRAVEL
- STANMORE GRAVEL

Revision Details	By / Check	Check Date	Suffix

Purpose of Issue: FINAL

Client: Camden

Project Title: LONDON BOROUGH OF CAMDEN STRATEGIC FLOOD RISK ASSESSMENT

Drawing Title: British Geological Society Superficial Deposits Geology

Drawn	Checked	Approved	Date
CB	JS	MT	03/07/2014

URS Internal Project No.	Scale at A3
47070547	1:40,000

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Drawing Number: FIGURE 4a

Rev: Rev 1

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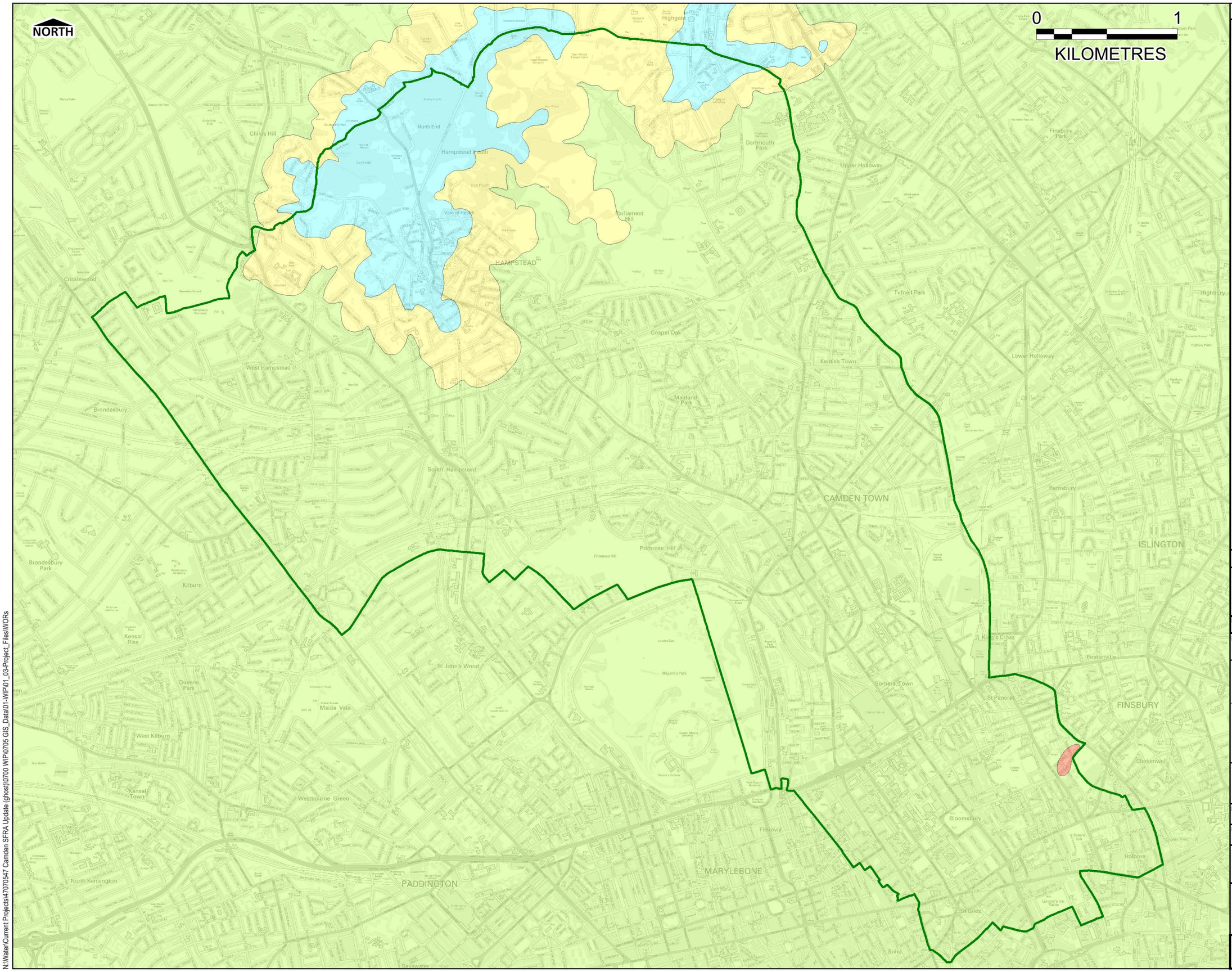

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LEGEND

- London Borough Camden Boundary
- Bagshot Formation
- Claygate Member
- Lambeth Group
- London Clay Formation

Revision Details	By / Check	Check Date	Suffix

Purpose of Issue: FINAL

Client: Camden

Project Title: LONDON BOROUGH OF CAMDEN STRATEGIC FLOOD RISK ASSESSMENT

Drawing Title: British Geological Society Bedrock Geology

Drawn	Checked	Approved	Date
CB	JS	MT	03/07/2014

URS Internal Project No.	Scale at A3
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Drawing Number	Rev
FIGURE4b	Rev 1

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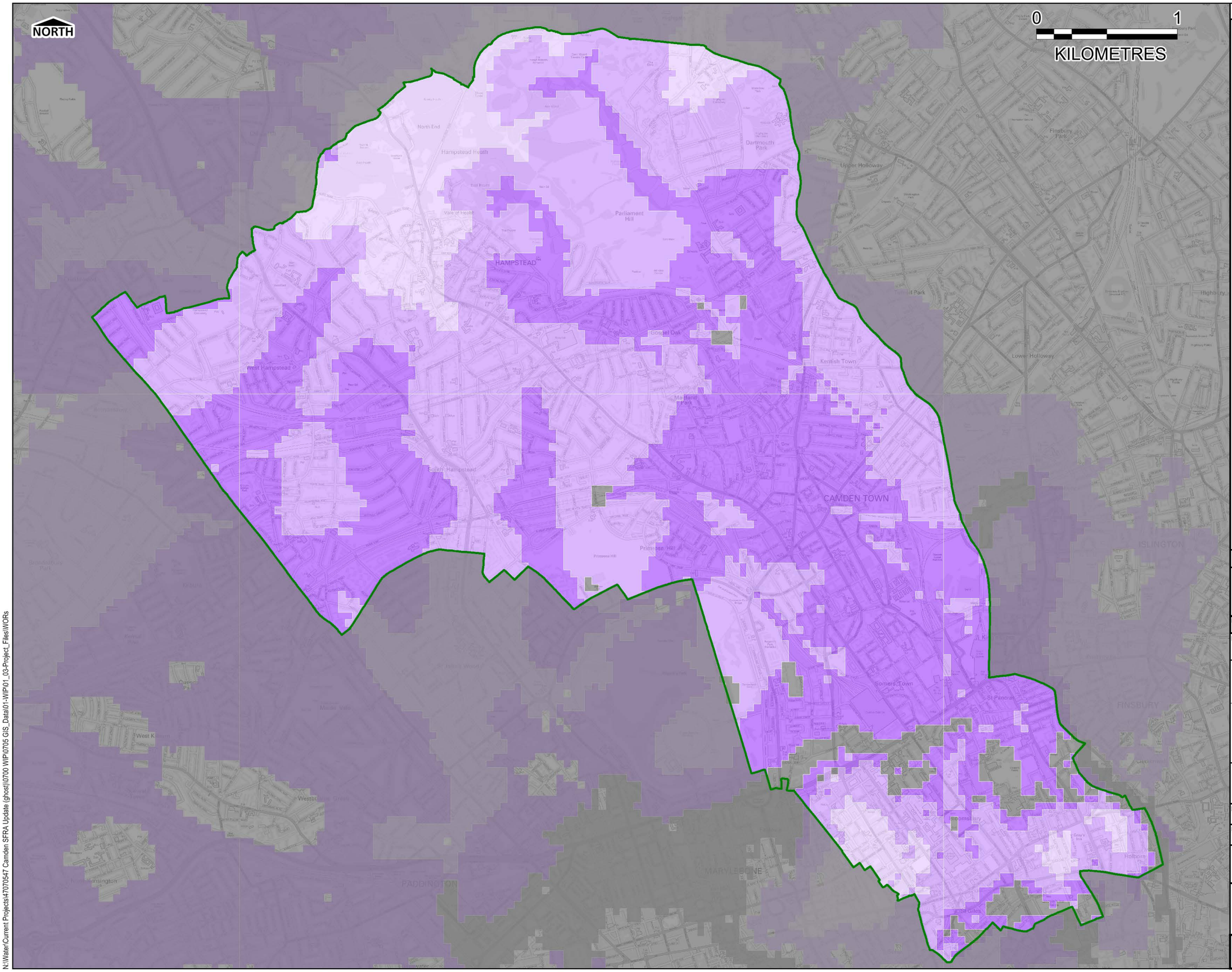

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LEGEND

- London Borough Camden Boundary

BGS Infiltration SuDS Map

- Highly compatible for infiltration SuDS
- Probably compatible for infiltration SuDS
- Opportunities for bespoke infiltration SuDS
- Very significant constraints are indicated

Revision Details	By / Check	Check Date	Suffix

Purpose of Issue: FINAL

Client: Camden

Project Title: LONDON BOROUGH OF CAMDEN STRATEGIC FLOOD RISK ASSESSMENT

Drawing Title: British Geological Society SuDS Drainage Potential

Drawn	Checked	Approved	Date
CB	JS	MT	03/07/2014

URS Internal Project No.	Scale at A3
47070547	1:40,000

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Drawing Number: **FIGURE 4c**

Rev: **Rev 1**

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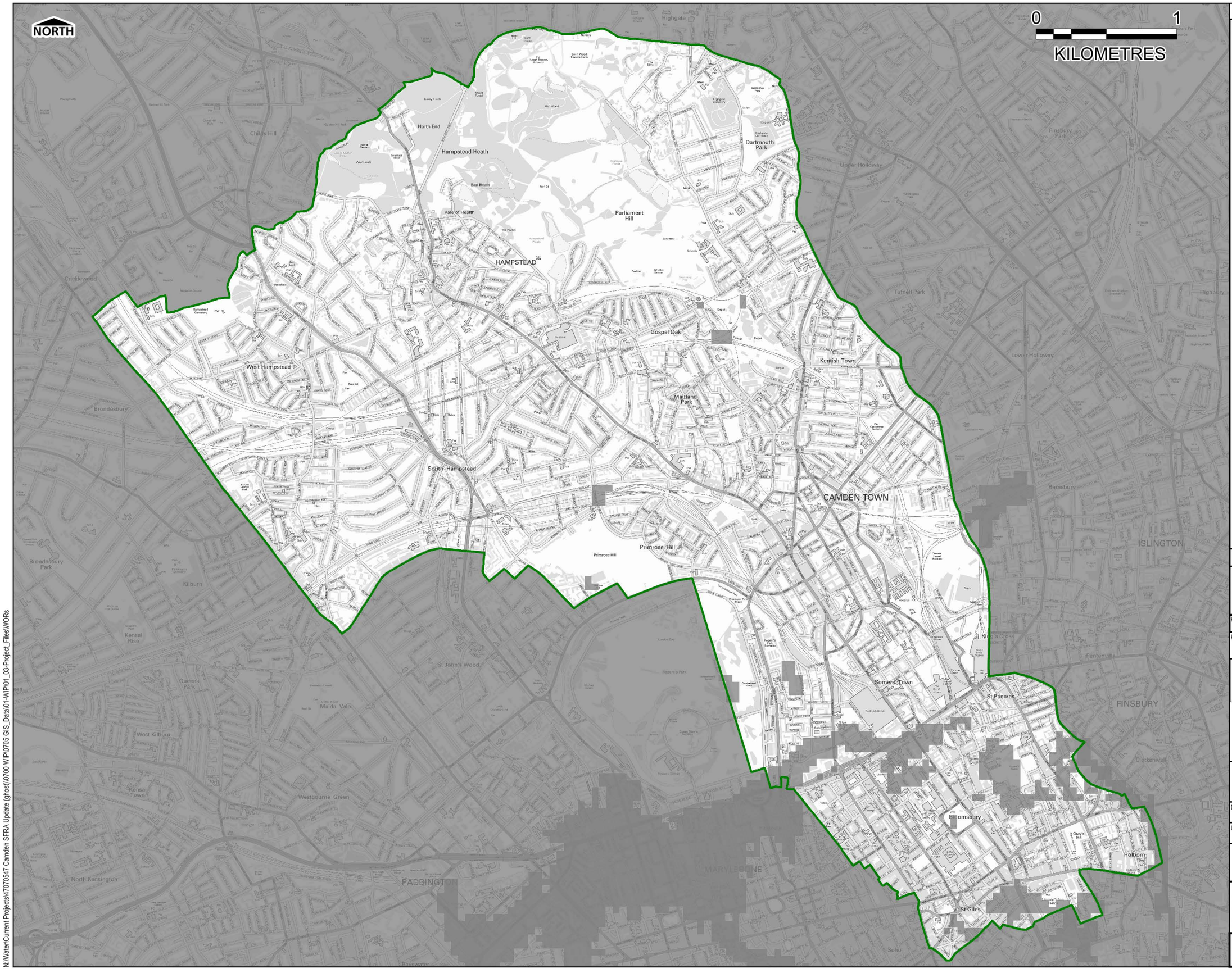

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LEGEND

London Borough Camden Boundary

Infiltration Constraints

Very significant constraints are indicated

Revision Details	By / Check	Check Date	Suffix

Purpose of Issue: FINAL

Client: Camden

Project Title: LONDON BOROUGH OF CAMDEN STRATEGIC FLOOD RISK ASSESSMENT

Drawing Title: British Geological Society SuDS Infiltration Constraints

Drawn	Checked	Approved	Date
CB	JS	MT	03/07/2014

URS Internal Project No.	Scale at A3
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Drawing Number	Rev
FIGURE 4d	Rev 1

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NORTH

0 1

KILOMETRES

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LEGEND

- London Borough Camden Boundary
- LBC Historic GW Flooding Record
  No. Properties affected
  - 1
  - 6
  - 7
  - 8
- Increased Susceptibility to Elevated Groundwater
- Environment Agency groundwater flood incidents

Revision Details	By / Check	Check Date	Suffix

Purpose of Issue: FINAL

Client: Camden

Project Title: LONDON BOROUGH OF CAMDEN STRATEGIC FLOOD RISK ASSESSMENT

Drawing Title: Increased Susceptibility to Elevated Groundwater

Drawn	Checked	Approved	Date
CB	JS	MT	03/07/2014

URS Internal Project No.	Scale at A3
47070547	1: 40,000

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Drawing Number: FIGURE 4e

Rev: Rev 1

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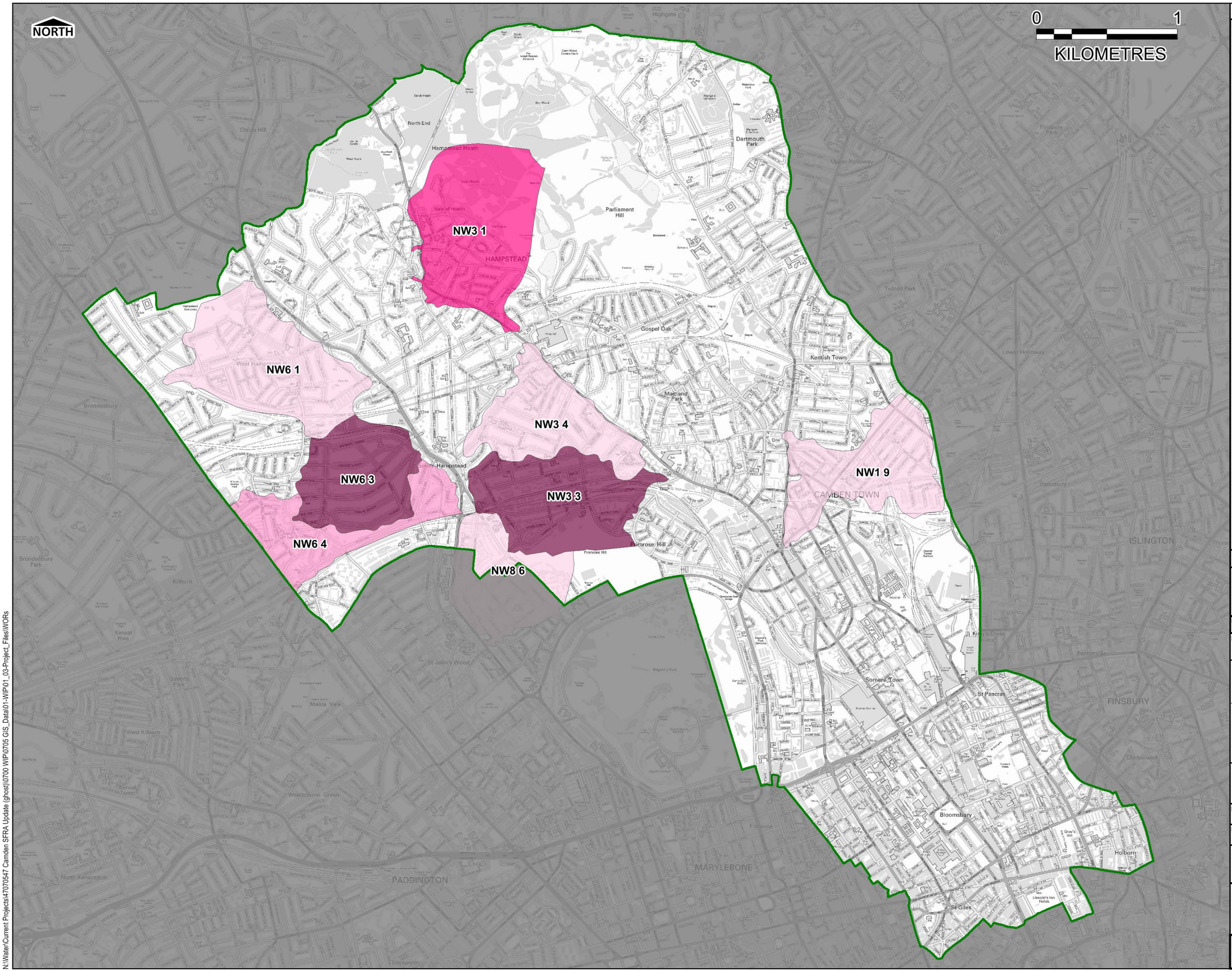

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LEGEND

London Borough Camden Boundary

Internal Sewer Flooding
No. of Properties affected

- 1
- 2
- 4
- 8

Revision Details	By / Check	Check Date	Suffix

Purpose of Issue: FINAL

Client: Camden

Project Title: LONDON BOROUGH OF CAMDEN STRATEGIC FLOOD RISK ASSESSMENT

Drawing Title: DG5 Internal Sewer Flooding

Drawn	Checked	Approved	Date
CB	JS	MT	03/07/2014

URS Internal Project No.	Scale at A3
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Drawing Number	Rev
FIGURE 5a	Rev 1

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NORTH

0 1

KILOMETRES

NW3 1

NW3 5

NW6 2

NW6 3

NW6 4

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LEGEND

London Borough Camden Boundary

Exterior Sewer Flooding
No. of Properties affected

- 1
- 2
- 4
- 18

Revision Details	By / Check	Check Date	Suffix

Purpose of Issue: FINAL

Client: Camden

Project Title: LONDON BOROUGH OF CAMDEN STRATEGIC FLOOD RISK ASSESSMENT

Drawing Title: DG5 External Sewer Flooding

Drawn	Checked	Approved	Date
CB	JS	MT	03/07/2014

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Drawing Number	Rev
FIGURE 5b	Rev 1

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NORTH

0 1
KILOMETRES

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LEGEND

- London Borough Camden Boundary
- Critical Drainage Area
- Local Flood Risk Zone

Group3_001
Group3_010
Group3_005
Group3_003
Group3_011

Hampstead Heath
HAMPSTEAD
Parliament Hill
Frognal Lane
Cannon Hill
West Hampstead
Sumatra Road
Goldhurst
Kingsgate
Maitland Park
Gospel Oak
Kentish Town
CAMDEN TOWN
Primrose Hill
King's Cross
North Swinton Street
South East Regent's Park
Bloomsbury
Holborn
Farringdon
FINSBURY
SLINGTON
MARYLEBONE
PADDINGTON

Revision Details	By / Check	Check Date	Suffix

Purpose of Issue: FINAL

Client: Camden

Project Title: LONDON BOROUGH OF CAMDEN STRATEGIC FLOOD RISK ASSESSMENT

Drawing Title: Critical Drainage Areas / Local Flood Risk Zones

Drawn	Checked	Approved	Date
CB/EB	EY	MT	04/06/2014

URS Internal Project No.: 47070547

Scale at A3: 1:40,000

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Drawing Number: FIGURE 6

Rev: Rev 2

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