3.5 GROUNDWATER FLOODING

MECHANISMS OF FLOODING

3.5.1 Groundwater flooding occurs as a result of water rising up from the underlying aquifer or from water flowing from abnormal springs. This tends to occur after much longer periods of sustained high rainfall, and the areas at most risk are often low-lying where the water table is likely to be at shallow depth. Groundwater flooding is known to occur in areas underlain by principal aquifers[7], although increasingly it is also being associated with more localised floodplain sands and gravels.

3.5.2 Groundwater flooding tends to occur sporadically in both location and time, and tends to last longer than fluvial, pluvial or sewer flooding. When groundwater flooding occurs, basements and tunnels can flood, buried services may be damaged, and storm sewers may become ineffective, exacerbating the risk of surface water flooding. Groundwater flooding can also lead to the inundation of farmland, roads, commercial, residential and amenity areas.

3.5.3 Based on the hydrogeological conceptual understanding of the study area, the potential groundwater flooding mechanisms that may exist are:

- **Claygate Member outcrop area in the areas of Coombe, Chessington and Malden Rushett:** Water levels within the outcropping Claygate Member (and overlying Black Park Gravel Member) will be perched on top of the London Clay Formation aquiclude. This means that basements / cellars and other underground structures in this area may be at risk from groundwater flooding following periods of prolonged rainfall, increased utilisation of infiltration SUDs and / or artificial recharge from leaking pipes.

- **Superficial aquifers along the River Thames, Hogsmill River and Beverley Brook:** groundwater flooding may be associated with the Alluvium, Head and, in particular, River Terrace Deposits, where they are in hydraulic continuity with surface watercourses. Stream levels may rise following high rainfall events but still remain "in-bank", and this can trigger a rise in groundwater levels in the associated superficial deposits. The properties at risk from this type of groundwater flooding are probably limited to those with basements / cellars, which have been constructed within the superficial deposits. It is noted that where surface water courses are concrete lined, the potential for this mechanism to occur will be reduced.

- **Superficial aquifers in various locations:** a third mechanism for groundwater flooding is also associated with the Head and River Terrace Deposits (gravel and sand) where they are not hydraulically connected to surface water courses. Perched groundwater tables can exist within these deposits, developed through a combination of natural rainfall recharge and artificial recharge e.g. leaking water mains. The properties at risk from this type of groundwater flooding are probably limited to those with basements / cellars.

- **Impermeable (silt and clay) areas down slope of superficial aquifers in various locations:** a fourth mechanism for groundwater flooding may occur where groundwater springs / seepages form minor flows and ponding over impermeable strata where there is poor drainage (artificial or natural).

[7] Aquifers allow significant groundwater movement

- **Artificial ground in various locations:** a final mechanism for groundwater flooding may occur where the ground has been artificially modified to a significant degree. If this artificial ground is of substantial thickness and permeability, then a shallow perched water table may exist. This could potentially result in groundwater flooding at properties with basements, or may equally be considered a drainage issue. Areas mapped by the BGS as containing made ground are shown in Figures 1 and 2. It is noted that the artificial deposits are mostly over the River Terrace Deposits and may either form a continuous aquifer with these superficial deposits, or provide a low permeability cap, depending on the composition of the artificial ground.

EVIDENCE OF GROUNDWATER FLOODING

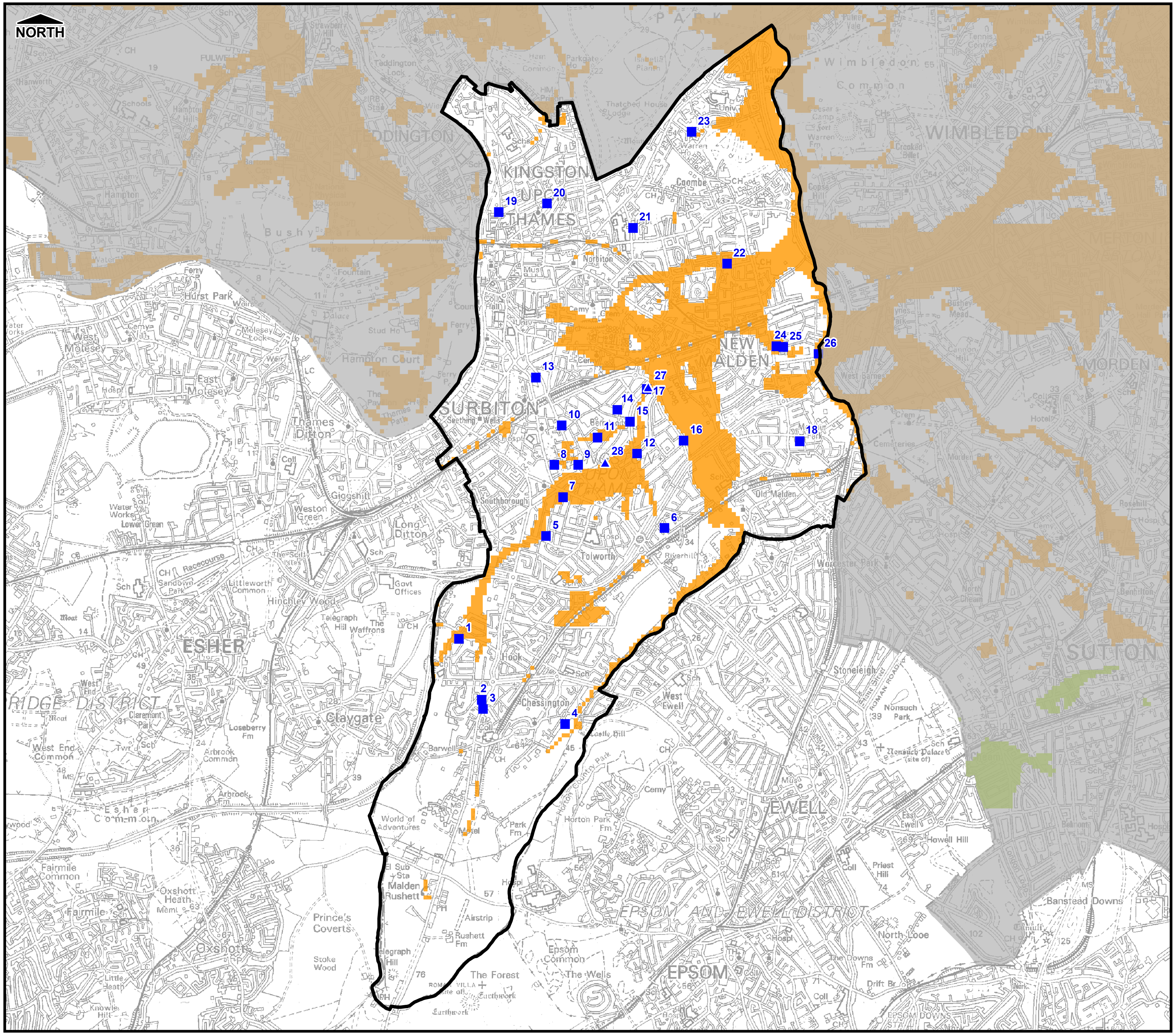
Figure 3.5.1 – Increased Potential for Elevated Groundwater (iPEG) Dataset & Historic Groundwater Flood Incidents

3.5.4 Figure 3.5.1 shows the locations of a number of groundwater flooding incidents between 2000 and 2010 within the study area that have been reported by the Environment Agency and the Royal Borough of Kingston upon Thames. Further details are presented in Table 3-4.

3.5.5 It should be noted that there has not been a statutory obligation to record incidences of groundwater flooding in the past. It is therefore likely that this list of groundwater flooding incidents is not exhaustive.

Table 3-4 Available Groundwater Flooding Records

Bedrock Geological Unit*	Overlying Superficial Deposits*	Location	NGR	Incident N°**	Reported Incident	Year
London Clay Formation	Head deposits	Chessington	517500 164600	1	Water at Foundations	2002
	None	Chessington	517787 163829	2	Waterlogged garden	2005
	None	Chessington	517802 163710	3	Regular flow from garden.	2003
	None	Chessington	518840 163519	4	Water draining from neighbours garden	2001
	Head deposits	Tolworth	518600 165900	5	Flooded Garden	2000
	Edge of Head deposits	Tolworth	520100 166000	6	Groundwater flooding of garden	2000
	Kempton Park Gravel Formation	-	518812 166395	7	Hole appeared at foundations beneath floor	2004
	Edge of RTD - Undifferentiated	Surbiton	518700 166800	8	Water in basement	2000
	Edge of RTD- Undifferentiated	Surbiton	519000 166800	9	Flow from old cast iron pipe in garden	2000
	None	Kingston-on-Thames	518800 167300	10	Water in cellar, waterlogged pitches	2000
	RTD- Undifferentiated	Surbiton	519250 167150	11	Waterlogged garden	2001
	Kempton Park Gravel Formation	Tolworth	519751 166944	12	Void under house filling with heavy rainfall	2002
	None	KT 5 8AQ	518469 167908	13	Boggy garden	2002
	None	Surbiton	519500	14	Basement flooded	2000



0 0.25 0.5 1 1.5 2
Kilometres

THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED

Legend

- Kingston Borough Council
- Groundwater Flood Incident (EA Records)
- Groundwater Flood Incident (Other Records)

Increased Potential for Elevated Groundwater in

- Permeable Superficial Deposits
- Consolidated Aquifers

Notes

1.The increased Potential for Elevated Groundwater map shows those areas within the London Boroughs where there is an increased potential for groundwater to rise sufficiently to interact with the ground surface or be within 2m of the groundsurface. Such groundwater rise could lead to the following:

-Flooding of basements of buildings below ground level;
-Flooding of buried services or other assets below ground level;
-Inundation of farmland, roads, commercial, residental and amenity areas;
-Flooding of ground floors of buildings above ground level; and Overflowing of sewers and drains

2.Incident records shown are generally unconfirmed and may include issues such as water main bursts or non-groundwater related problems.
3.Areas not shown to have increased potential for elevated groundwater should be considered to have a low potential for elevated groundwater - Lack of information does not imply 'no potential' of elevated groundwater in that area.
4.Includes groundwater flood mapping provided by JBA consulting Copyright. Jeremy Benn Associates Limited 2008-2011, partially derived from data supplied by the Environment Agency.

London Borough of Kingston

Royal Kingston

Surface Water Management Plan

Scale at A3	Date	Drawn by	Approved by
1:50,000	22/03/2011	C.Woolhouse	S.Cox

Increased Potential For Elevated Groundwater

Consultants

CAPITA SYMONDS Flood Risk Management
Scott Wilson

URS / Scott Wilson
6 - 8 Greencoat Place
London
SW1P 1PL

Drain London Programme Board Members

Environment Agency
Thames Water
LONDON COUNCILS
GREATER LONDON AUTHORITY

FIGURE 3.5.1

Filepath: D134786 Drain London_Tier 2_Group 8\700 Technical\711 GIS\01 Layout\Kingston\Increased Potential for Elevated GW.mxd

Bedrock Geological Unit*	Overlying Superficial Deposits*	Location	NGR	Incident N°**	Reported Incident	Year
			167500			
	Edge of RTD - Undifferentiated	Surbiton	519662 167346	15	Waterlogged garden. Long term waterlogging, of back gardens	2003
	Edge of Alluvium	-	520341 167109	16	-	2010
	None	-	519871 167763	17	Garden damp	2002
	None	New Malden	521807 167102	18	Information on groundwater soils	2001
	Alluvium	Kingston-on-Thames	518000 170000	19	Soggy cellar	2000
	Langley Silt Member	Kingston-on-Thames	518612 170107	20	Water in cellar	2003
	None	Kingston-on-Thames	519700 169800	21	Water entering block of flats in basement	2002
	Kempton Park Gravel Formation	-	520889 169344	22	Overflowing Manhole in school grounds - likely due to leaking main - recent rainfall making the situation worse.	2003
	Edge of Head deposits	Kingston-on-Thames	520439 171013	23	Water in brickwork at back of house	2000
	Kempton Park Gravel Formation	Thames	521514 168306	24	Groundwater flooding in garden	2009
	Edge of Kempton Park Gravel Formation	-	521600 168295	25	Ground floor dampness	2008
	None	New Malden	522047 168205	26	Water below floorboards	2003
	None	Raeburn Av 1	519890 167783	27	-	-
	Alluvium	Alexandra Drive	519344 166826	28	-	-

Note: * Geology of incident based on plotted location (Figures 1, 2 and 3) and Environment Agency record
** Incident reference number as shown on Figures 1, 2 and 3.

3.5.6 Table 3-4 shows that a number of the reported incidents occurred during 2000 / 2001; a particularly wet period that resulted in both surface and groundwater flooding incidents in a number of locations across the country.

3.5.7 Each recorded incident has been appraised based on the underlying geology and the potential groundwater flooding mechanisms identified in Section 3.1. Incident numbers 2, 3, 10, 13, 14, 17, 18, 21, 26 and 27 are located over the London Clay Formation and have no known overlying superficial deposits. The London Clay Formation is an aquiclude and does not permit groundwater flow. Based on current available information, it can be suggested that these incidents are probably related to poor drainage over clayey soils following heavy rainfall i.e. they are not groundwater flooding incidents.

3.5.8 Flood incidents 4, 6, 8, 9, 15, 16, 23 and 25 are underlain by the London Clay Formation, but are within close proximity to superficial deposits. If the permeability of the superficial deposits is high, during heavy rainfall perched groundwater could emerge at ground surface as springs / seepages and flow to low lying areas over the impermeable London Clay Formation. However, it is likely that surface water runoff following heavy rainfall is the main source of flood waters.

3.5.9 Flood incidents 1, 5, 7, 11, 12, 19, 20, 22, 24 and 28 are reported to be underlain by superficial deposits and the London Clay Formation. A perched water table is often present in these superficial deposits, and so it is possible that these are true groundwater flooding incidents.

POTENTIAL FOR ELEVATED GROUNDWATER

3.5.10 The areas in the Borough where there is an increased potential for groundwater levels to rise within 2m of the ground surface during periods of higher than average recharge are shown in Figure 3. These are separated into permeable superficial deposits and bedrock (consolidated) aquifers. The data set was produced for the whole of the Drain London project area, derived from four individual data sources:

- British Geological Survey (BGS). Groundwater Flood Susceptibility maps;
- Environment Agency (EA). Thames Estuary, 2100 groundwater hazard maps;
- DEFRA. Groundwater emergence maps; and
- JBA. Groundwater flood maps.

3.5.11 However, only the BGS groundwater flooding susceptibility and Environment Agency Thames Estuary data sets are relevant to the Royal Borough of Kingston upon Thames area.

3.5.12 Figure 3 shows that areas in Royal Borough of Kingston upon Thames where there is an increased potential for elevated groundwater are associated with permeable superficial deposits; primarily the low lying areas around New Malden.

3.5.13 In general, the areas identified by the data set as having an increased potential for elevated groundwater are sensible and show a reasonable correlation with recorded groundwater flooding incidents, however there are a number of discrepancies. These are associated with those incidents over the Langley Silt Member or London Clay Formation aquiclude where groundwater may not be the real source of flooding.

3.6 SEWER FLOODING

FLOODING MECHANISMS

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

The rainfall event exceeds the capacity of the sewer system / drainage system;

3.6.2 Sewer systems are typically designed and constructed to accommodate rainfall events with a 3.3% AEP (1 in 30 year return period) 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 Thames Water is concerned about the frequency of extreme events, it is not economically viable to build sewers that could cope with every extreme.

The system becomes blocked by debris or sediment;

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

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

3.6.4 Within the Borough there is potential for river outlets to become submerged due to high river levels. When this happens, water is unable to escape into the river and flows back along the sewer. Once storage capacity within the sewer itself is exceeded, the water will overflow into streets and potentially houses. Where the local area is served by a '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 may again occur but in this instance flooding will contain untreated sewage.

3.6.5 Within the pluvial modelling methodology, the sewer system has been assumed to have a capacity of 6.5mm/hour. This has been represented by removing 6.5mm/hour from the inflow hyetograph for urban areas, and, in accordance with the specification, no connectivity between the sewer system and the above ground surface has been modelled. More detailed analysis of this interaction through the use of a combined surface water and sewer model could be undertaken in the future if thought beneficial.

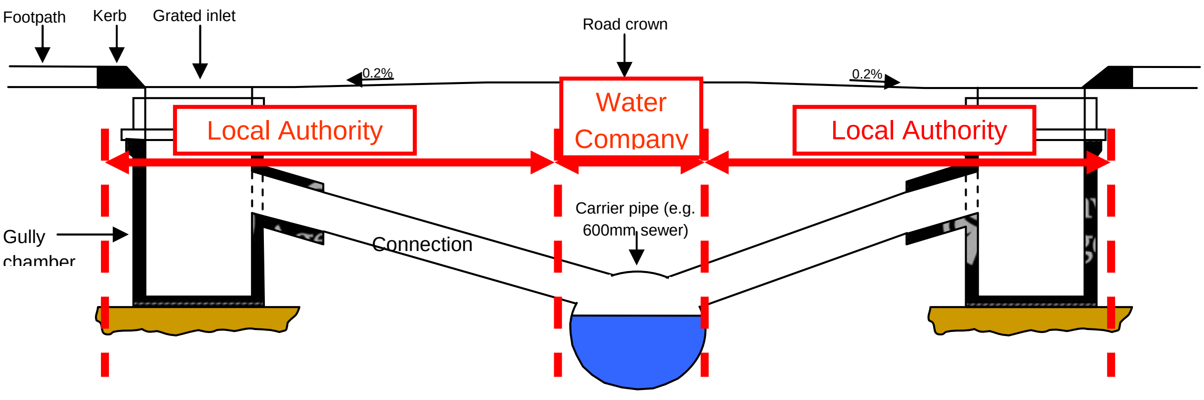
RESPONSIBLE ORGANISATIONS

3.6.6 The Highway Authority (Royal Borough of Kingston upon Thames and TFL) are responsible for the effectual drainage of roads in so far as ensuring that drains, including kerbs, road gullies and the pipe network which connects to the trunk sewers are maintained.

3.6.7 Thames Water are responsible for surface water drainage from development via adopted sewers and are responsible for maintaining trunk sewers into which much of Kingston's highway drainage connects.

3.6.8 Riparian owners are responsible for private drainage networks and in some cases receiving watercourses including small open channels and culverted urban watercourses (see Figure 3.2 below).

Figure 3-2 Surface Water Drainage Responsibility



3.6.9 In addition to the Thames Water network, there are also some sewers and drains which are in private ownership (often within industrial parks). Most of these private systems connect to the Thames Water public sewerage system for treatment, however private owners can also connect foul water to septic tanks and storm water to soakaways.

THAMES WATER DATASETS

3.6.10 Thames Water have provided their DG5 database which details the total number of sewer flood incidents that have affected properties both externally and internally over the last 10 years. The DG5 dataset is provided on a five-digit postcode area, which makes it difficult to determine more precisely where sewer flooding problems may have occurred. In addition, Thames Water focus their efforts on removing properties from the DG5 register, and therefore this dataset may no longer accurately represent those properties which are currently at risk.

3.6.11 Thames Water has also provided details of their utility infrastructure including sewers, pumping stations and outfalls. This information has been overlaid onto critical drainage areas to inform the consideration of potential mitigation options for each location. Thames Water is keen to work with the London Boroughs to mitigate flood risk issues. Thames Water has agreed to make network models available, where they are required in order to inform detailed design of mitigation options.

Figure D4 – Thames Water Sewer Network
Figure D5 – Historic Sewer Flooding Incidents

HISTORIC SEWER FLOODING

3.6.12 A review of Figure D5 shows that there are records of sewer flooding throughout the majority of the Borough. The sewer flooding records highlight the following areas as being at a higher risk of sewer flooding, with 21-50 records of sewer flooding:

- Kingston upon Thames Town Centre, to the north of the railway line (KT2 6)
- Berrylands (KT5 8)
- Berrylands/River Hogsmill (KT5 9)
- Beverley Brook catchment (KT4 8)

It is important to note that Berrylands and the Beverley Brook catchment are both heavily influenced by the location of nearby watercourses which may be blocking sewer outfalls, causing sewerage to surcharge within the Thames Water network.

3.7 OTHER INFLUENCES

MAIN RIVERS

3.7.1 The Environment Agency has responsibility over flooding from designated Main Rivers within the Borough, which include the River Thames, the Beverley Brook and the River Hogsmill.

3.7.2 The River Thames forms the north western boundary of the Borough and it an integral part of the Boroughs identity with Kingston upon Thames town centre located on the banks of the river.

3.7.3 The Beverley Book is located to the east of the Borough, close to the A3 corridor and forms the eastern boundary with the London Boroughs of Sutton, Merton and Wandsworth. The watercourse flows in a northerly direction, in places within a confined channel which has caused fluvial flooding of property with the London Borough of Sutton. As the watercourse flows through the Royal Borough of Kingston upon Thames it enters a more natural channel within Wimbledon Common and enters the London Boroughs of Merton and Wandsworth before reaching its confluence with the River Thames at Barnes.

3.7.4 The River Hogsmill flows through the centre of the Borough in a north westerly direction. The watercourse to the east is located within a well defined river valley and effective planning controls have prevented development from encroaching heavily upon the river corridor. The catchment becomes more urbanised as it flows to the south of Kingston upon Thames town centre to its confluence with the River Thames. There are two tributaries to the River Hogsmill, firstly the Surbiton Stream which rises in Claygate and Hook to the south west of the Borough. This watercourse flows in a north easterly direction to the rear of property and enters culverted sections beneath highways before its confluence with the River Hogsmill at Berrylands. The second tributary, known locally as the Bonesgate Stream, rises in open land near to Malden Rushett and flows in a north easterly direction in part following the eastern Borough boundary to its confluence with the River Hogsmill at the A240 Kingston Road to the south east of Tolworth.

3.7.5 The risk of fluvial flooding from main rivers has been assessed as part of the Royal Borough of Kingston upon Thames Strategic Flood Risk Assessment (December 2008) and are therefore, not re-visited as part of this surface water study.

3.7.6 The Royal Borough of Kingston upon Thames regularly meets with the Environment Agency to discuss flood risk including maintenance of main rivers and ordinary watercourses.

Figure 3.4.1 – Watercourses Flood Zones & Fluvial Flood Incidents
Figure D3 – EA Main Rivers and Flood Zones

3.8 Critical Drainage Areas

3.8.1 Fourteen CDAs have been identified within or straddling the Royal Borough of Kingston upon Thames administrative boundary. CDA_008 Acre Road/North Kingston overlaps into Richmond, while Kingston is considered to be the ‘lead’ authority in terms of managing flood risk within this CDA, Richmond also has a role to play in addressing flood risk within this area. The same applies to CDA_022 Worcester Park which overlaps with Sutton. In this case, Sutton is the ‘lead’ authority in terms of managing the flood risk within the CDA, however Kingston will have a role to play in addressing flood risk here.

3.8.2 The remainder of this section provides a description of each CDA including details of the flooding mechanisms and interaction between flooding locations within the CDA, the level of validation, any specific assumptions made, and the number and types of receptors identified to be at risk.

Property Counts

3.8.3 Pluvial modelling completed as part of Phase 2 of the Drain London Project affords an improved understanding of the level of flood risk facing the Royal Borough of Kingston upon Thames. In order to provide a quantitative indication of potential risks, a property count for the 1% AEP (1 in 100 annual probability) for the whole Borough has been undertaken using the Environment Agency’s National Receptors Dataset (NRD) and follows the methodology defined in the Drain London Data and Modelling Framework. Results are shown in Table 3-5 below.