Croydon Flood Investigation Report – 24th August 2015

Final Version
October 2016

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Introduction

1.1 The Flood Event

During August 2015, the London Borough of Croydon experienced severe surface water flooding in several locations around the Borough due to torrential rain. Areas particularly affected included Purley Cross Underpass, Purley Oaks Road and localised highway flooding in Kenley, Purley, Coulsdon and New Addington. Flooding affected a number of commercial and residential properties and major transport routes as well as more localised incidents.

1.2 Why has this flood been investigated?

Croydon Council (LBC) is the Lead Local Flood Authority (LLFA) for the area, and has a responsibility to record and report flood incidents, as detailed in Section 19 of Part 1 of the Flood and Water Management Act 2010 (FWMA).

FLOOD AND WATER MANAGEMENT ACT 2010

Part 1: Flood and Coastal Erosion Management

3. Supplemental powers and duties

19. Local authorities: investigations

(1) On becoming aware of a flood in its area, a lead local flood authority must, to the extent that it considers it necessary or appropriate, investigate:

(a) which risk management authorities have relevant flood risk management functions, and

(b) whether each of those risk management authorities has exercised, or is proposing to exercise, those functions in response to the flood.

(2) Where an authority carries out an investigation under subsection (1) it must:

(a) publish the results of its investigation, and

(b) notify any relevant risk management authorities.

LBC has developed a Flood Investigation Protocol which outlines the process that will be followed to determine the need for an investigation.

The requirement for an investigation is determined on a case-by-case basis, considering factors such as the source and impact of the flooding event, e.g. the number and type of receptors (homes, businesses and critical infrastructure) affected by the flooding event. The Protocol provides guidance to aid decision-making and threshold levels set out in this are used as a guide to determine when an investigation should be carried out. However, it should be noted that these remain under review. The key thresholds from the Protocol are listed in Table 1.1, along with where these were exceeded during the Croydon Surface Water flooding in August 2015.

Table 2-1 Flood Investigation Protocol Threshold Exceedance for the LBC Surface Water August 2015 Flood Event

Key thresholds	Threshold exceeded?
There has been a fatality or serious injury as a direct result of flooding.	No fatalities or serious injuries as a result of the flood event
Depth greater than 0.10m over ground floor threshold of a residential property ***or*** more than 3 residential properties flooded.	No residential properties were reported to have flooded during the event
Flooding has prevented the operation of the critical infrastructure for more than 2 hours.	No critical infrastructure was prevented from operating over the threshold for the event
More than 3 commercial properties been affected by flooding ***or*** the flooding is deemed to have caused significant economic disruption.	**Multiple commercial properties were inundated during the event at Station Approach, Purley Oaks Road**
It is unclear which Risk Management Authority (RMA) is responsible ***or*** whether the appropriate duties have been carried out.	RMAs are known on this occasion
The weight of public interest justifies the need for investigation (to be decided internally after review).	**A significant number of calls were placed to emergency services by members of the public concerned about risk to their properties and impacts were widespread across the Borough**

Although this flood event was not particularly severe in most locations, there is evidence to suggest a pump failure and surcharge of existing surface water sewer systems may have contributed to the flooding and be increasing the risk at the affected sites. An investigation has therefore been carried out to establish a way forward for managing future flood risk in these locations.

1.3 Aims and Objectives

This report aims to meet the requirements of Section 19 of the FWMA as well as provide a useful reference for the effective future management of this source of flooding in Croydon through;

- Providing details of the flooding incident
- Undertaking analysis of the flood history of the area
- Identifying the responsibilities of Risk Management Authorities (RMAs) and the actions which were carried out
- Identifying successful response measures and lessons learned, and
- Recommending the next steps.

1.4 Data Collection and Review

Data relating to flood incidents and emergency response has been requested from the following organisations for input to this investigation;

- Croydon Council (LBC)
- Transport for London (TfL)
- The Environment Agency
- Thames Water Utilities Ltd (TWUL)
- London Fire Brigade (LFB)
- Metropolitan Police (MPS)

1.5 Duties and Responsibilities

1.5.1 Risk Management Authorities

Under the definition of Section 6(13) of the FWMA, the RMAs with responsibilities on this occasion were as follows:

a) Lead Local Flood Authority – LBC

b) Environment Agency

c) Water Company – TWUL

d) Highways Authority – LBC, TfL

Additionally, emergency response roles were carried out by:

- London Fire Brigade (LFB)
- Metropolitan Police (MPS)

The legal duties of these organisations in relation to flood risk are summarised below.

1.5.2 Croydon Council

As a LLFA, the FWMA[1] requires that LBC lead the management of local flood risk from surface water, groundwater and ordinary watercourses within the Borough. Duties include investigation of significant flood events, maintaining a register of structures and features influencing flood risk and developing a Local Flood Risk Management Strategy for Croydon.

The FWMA outlines that LLFAs have powers to designate structures and features that affect flooding in order to safeguard assets that are relied upon for flood risk management. Once a feature is designated, the owner must seek consent from the authority to alter, remove or replace it (FWMA Schedule 1, Section 1).

As a Highways Authority, the Highways Act 1980[2] requires that LBC ensure that highways are drained of surface water and where necessary maintain all drainage systems.

LBC is a Category 1 Responder under the Civil Contingencies Act 2004[3] and therefore has a responsibility, along with other organisations for developing emergency plans, contingency plans and business continuity plans to help reduce, control or ease the effects of an emergency.

1.5.3 Environment Agency

The Environment Agency has a responsibility to provide a strategic overview for all flooding sources and coastal erosion. The Environment Agency takes a risk based approach to flood risk management and have a number of roles and responsibilities including as a statutory consultee on flood risk throughout the planning process and regulation of third party works on main rivers.

The FWMA outlines that the Environment Agency has powers to designate structures and features that affect flooding in order to safeguard assets that are relied upon for flood risk management. Once a feature is designated, the owner must seek consent from the authority to alter, remove or replace it (FWMA Schedule 1, Section 1). The Environment Agency is also a Category 1 Responder under the Civil Contingencies Act 2004.

1.5.4 Thames Water Utilities Limited

Under the FWMA, TWUL is responsible for managing the risks of flooding from surface water, foul and/or combined sewer systems where the sewer flooding is wholly or partly caused by an increase in the volume of rainwater (including snow and other precipitations) entering or otherwise affecting the system.

TWUL has a duty to provide and maintain a system of public sewers so that the areas for which they are responsible are effectually drained (Water Industry Act, 1991[4]). Since the late 1970s, and with the publication of Sewers for Adoption[5] in 1980, sewer systems have typically been designed and constructed to accommodate a rainfall event with a 1 in 30 probability of occurrence in any given year (3.3% AEP) or less. Therefore, rainfall events with a rainfall probability of greater than 3.3% AEP would be expected to result in surcharging of some of the sewer system.

[1] Flood and Water Management Act (2010) http://www.legislation.gov.uk/ukpga/2010/29/contents
[2] Highways Act (1980) http://www.legislation.gov.uk/ukpga/1980/66/contents
[3] Civil Contingencies Act (2004)http://www.legislation.gov.uk/ukpga/2004/36/contents
[4] Water Industry Act (1991): http://www.legislation.gov.uk/ukpga/1991/56
[5] The Sewers for Adoption guide was first issued in 1980 by WRc. Since then the document has become the standard for the design and construction of sewers to adoptable standards in England and Wales. It acts as a guide to assist developers in preparing their submission to a sewerage undertaker before they enter into an Adoption Agreement under Section 104 of the Water Industry Act 1991

TWUL is a Category 2 responder under the Civil Contingencies Act 2004 and therefore has the responsibility to co-operate and share information with Category 1 responders (e.g. LBC, Environment Agency) to inform multi-agency planning frameworks.

1.5.5 Transport for London

TfL are responsible for the effectual drainage of surface water from adopted roads along red routes by ensuring that drains, including kerbs, road gullies and ditches and the pipe network which connect to the sewers, are maintained.

TfL are a Category 2 responder under the Civil Contingencies Act 2004 and therefore has the responsibility to co-operate and share information with Category 1 responders (e.g. LFB, MPS, LBC) to inform multi-agency planning frameworks.

1.5.6 London Fire Brigade

The Fire Service is a Category 1 Responder under the Civil Contingencies Act 2004 and therefore has a responsibility, along with other organisations for developing emergency plans, contingency plans and business continuity plans to help reduce, control or ease the effects of an emergency.

1.5.7 Metropolitan Police

The Police are a Category 1 Responder under the Civil Contingencies Act 2004 and therefore has a responsibility, along with other organisations for developing emergency plans, contingency plans and business continuity plans to help reduce, control or ease the effects of an emergency.

1.5.8 Local Residents

Residents who are aware that they are at risk of flooding should take action to ensure that they and their properties are protected.

Residents should report flooding incidents or potential problems (such as blockages) to the LLFA or appropriate organisation if known.

2 Background

The London Borough of Croydon is located within Greater London, and is one of the largest London Boroughs. It is bounded to the north by London Boroughs of Merton and Lambeth, to the east by London Borough of Bromley, to the west by London Borough of Sutton and to the south by Surrey.

The Borough is highly urbanised. With increasing distance from the Croydon Metropolitan Centre, density of development begins to open out and there is more park land and rural land in the south and south east of the Borough around Coulsdon and New Addington.

The topography is characterised by steep slopes in the south of the Borough which then level off to flatter land in the north. Brighton Road is located in the natural valley of the topography, which is the flow path of the former River Wandle, now entirely culverted until it emerges at Wandle Park in South Croydon.

2.1 History of Surface Water Flooding in the London Borough of Croydon

Due to the topography and pattern of development, the London Borough of Croydon has high susceptibility to surface water flood events in certain locations. The most significant surface water flood on recent record was the 20th July 2007, where intense periods of rainfall caused flash floods and the capacity of the existing drainage system to be exceeded in numerous locations across the Borough. Purley town centre experienced some of the worst flooding with significant flooding to property and the transport network.

The Local Flood Risk Management Strategy (LFRMS) and Surface Water Management Plan (SWMP) identify the parts of Croydon which are particularly susceptible to surface water flooding, including Brighton Road through Purley up to Central Croydon and the A22 Godstone Road. Numerous records are held of historic flooding incidents in these low lying areas.

3 Flood Mechanisms: August 2015

3.1 Event Conditions

On the 24th August 2015, significant rainfall was experienced across the Borough over a 24 hour period. The rain gauge at Purley Oaks (TQ 32139 62248) recorded 56 mm of rainfall during this period (data provided by the Environment Agency), with 39.2 mm (66%) of the total rainfall that day falling within a 4.5hr period between 12:45 and 17:15. For comparison, the rainfall event almost exceeded the monthly August average rainfall for the area of 58.6 mm[6] recorded at the nearby Kenley Met Office climate station (approx. 4.6km south). The rainfall event experienced on the 24th August is therefore considered to be of high intensity over a relatively short period of time.

The Flood Estimation Handbook (FEH) software has been used to estimate the return period of the rainfall event recorded at Purley Oaks rain gauge. This method has determined the event to have a return period of 1 in 38 years or a 2.63% chance of occurring in any given year.

3.2 Flood Warnings

The Environment Agency has a strategic overview for all sources of flooding. During the August 2015 rainfall event a flood alert was issued for the River Wandle on the 24th August 2015.

3.3 Sources of Floods

As noted above, exceptionally high rainfall on 24th August 2015 caused significant surface water flooding across the Borough and beyond in the catchment of the River Wandle. Table 3-1 breaks down some of the sources identified in the 2015 flood.

Table 3-1 Sources of Flooding

Type	Description	Role in August 2015 Flood
Surface Water	Usually occurs when high intensity rainfall generates runoff which flows over the surface of the ground and ponds in low lying areas, before the runoff enters a watercourse or sewer.	• Short and intense periods of rainfall led to surface water runoff accumulating in topographically low areas. • High rainfall intensity exceeded the hydraulic capacity of road gullies and drain gratings.
Sewer Flooding	Flooding from the sewer system may occur if: a) a heavy rainfall event exceeds the capacity of the sewer system / drainage system, b) interaction with groundwater within the sewer system / drainage system, c) the system becomes blocked by debris or sediment and/or, d) the system surcharges due to high water levels in receiving watercourses.	• Short and intense periods of rainfall led to surface water runoff putting pressure on the road drainage network resulting in lifting of sewer manhole covers. • Pump failure at the Purley Cross Underpass led to flooding at the underpass and backing up of the sewer system.
Fluvial	Flooding resulting from water levels exceeding the bank level of a watercourse, because flow exceeds the capacity of the channel	• The River Wandle is a main river, which runs in an open section in Wandle Park before entering a culvert and flowing into the London Borough of Sutton. It was reported by the Environment Agency to have burst its banks in some locations during the August 2015 event. However, as these were all outside the London Borough of Croydon they have not been considered further in this investigation. This does however indicate the River Wandle was flowing at high levels.

[6] Met Office website, available at http://www.metoffice.gov.uk/public/weather/climate/gcpgvgqmw. Date accessed 3rd May 2016.

4 The Flood Event: Locations of Flooding

4.1 Overview

Due to the expanse of areas affected during this flood event, this section breaks down some of the events by location to give an overview of what happened and when. Table 4-1 highlights the key locations in Croydon where flooding was reported during this event.

Table 4-1 Reported Flooding during August 2015 Flood Event (source: LBC and TfL)

Area	Specific Location	Reported Impacts	Section
Purley	Purley Cross	Flooding of the pedestrian underpass and approaching footpaths. Highway flooding on the northern and western side of the roundabout.	**0**
South Croydon	Purley Oaks Road (Station Approach)	Manhole surcharge and five properties (commercial) flooded	**4.3**
Purley	1 Brancaster Lane	Residential flooding (unconfirmed) (LFB attended)	**4.4**
	46 Brancaster Lane	Residential flooding (external) – garage flooded	
	Junction of Smitham Downs Road and Brighton Road	Highway flooding	
	Sunnydene Road	Highway flooding (from number 1 to 41 Sunnydene Road)	
	Old Lodge Lane	Multiple sources of flooding (manhole surcharge, sewer and highway flooding) (from number 2 to 16 Old Lodge Lane)	
	Lower Barn Road	Highway flooding	
	Warren Road	Highway flooding	
South Croydon	28-30 Sanderstead Court	Unspecified flooding (LFB attended)	**4.4**
	Junction of Brantwood Road and Brighton Road	Highway flooding	
	67 Harewood Gardens	Highway flooding	
Coulsdon	Junction of Marlpit Lane and Ullswater Crescent	Highway flooding	**4.4**
	Junction of Marlpit Lane and Marlpit Avenue	Highway flooding	
	Reddown Road	Manhole surcharge (Between numbers 8 and 16)	
	3 Stanley Close	Residential flooding (external) - driveway	
Kenley	Welcomes Road and Valley Road	Unspecified flooding	**4.4**
	6 Park Road	Unspecified flooding (LFB attended)	
	5 Holmes Place	Unspecified flooding (LFB attended)	
Thornton Heath	12 Bensham Manor Road	Highway flooding (blocked gully reported)	**4.4**
	Junction of Melfort Avenue and Carew Road	Footpath flooding (blocked gully reported)	
New Addington	Kent Gate Way	Manhole surcharge and Highway flooding (between Lodge Lane roundabout and Cork Screw Hill)	**4.4**

4.2 Purley Cross

Heavy rainfall in the south of the Borough overwhelmed and exceeded the capacity of the highway drainage network at the Purley Cross roundabout, causing the drainage system to surcharge, lifting manhole covers and leading to the rapid onset of surface water flooding across the roundabout. The deepest flooding was experienced in the pedestrian underpass beneath the roundabout (Figure 4-2 and Figure 4-3), where it was reported to be approximately 1 foot (0.3m) below the underside of the bridge (2.7m clearance), an approximate depth of 2.4m. This flooding was reportedly exacerbated by failure of the pumping system in the underpass.

Flooding was also reported on the surrounding road network, including the northern (Figure 4-2) and western (Figure 4-3) sections of the roundabout, causing travel disruption.

Table 4-2 – Purley Cross Flood Event Photos

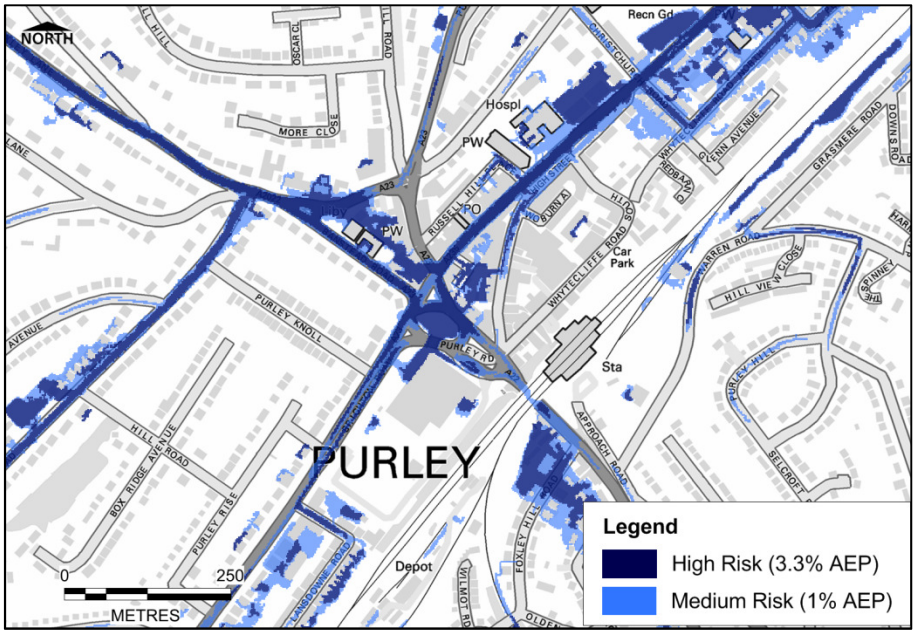

Figure 4-1 – Modelled surface water flood risk in the Purley Cross area according to the 'Risk of flooding from surface water' mapping (Environment Agency)

Figure 4-2 - Northern section of roundabout, looking south east towards Purley Road (source: Croydon Council)

Figure 4-3 - Purley Oak underpass (source: Evening Standard)

This area has been identified as a Critical Drainage Area (CDA_040 Purley Cross) in the SWMP. National surface water flood risk mapping produced by the Environment Agency (Risk of flooding from surface water) identifies Purley Cross to be highly susceptible to surface water flooding due to its location within a topographic depression. Much of the northern half of the roundabout, the central pedestrian area and pedestrian underpass are shown to be at risk from a 1 in 30 year (3.33% annual exceedance probability (AEP)) surface water flooding event occurring in any given year. The approaching roads including the A23 Brighton Road from the south west, A22 Godstone Road to the south east and the A235 Brighton Road to the north are also shown to be at risk from a 1 in 30 year (3.33% AEP) surface water flooding event occurring in any given year.

The high intensity rainfall in an urbanised area combined with asset failure is identified as the flood source at this location. The impermeable road surfaces and building rooftops within the catchment directed surface water towards the highway drainage network. Due to the extreme nature of the rainfall event (estimated return period of 1 in 38 annual probability of this rainfall event occurring in any given year), the volume of surface water exceeded the hydraulic capacity of road gullies and drain gratings (designed for a 1 in 30 year annual probability rainfall event), and as a result, surface water continued to flow overland. The increase in the volume of surface water entering the drainage network further downstream exceeded the network capacity causing the sewer network to back up, surcharge and ultimately flood to significant depths, particularly in low lying areas. Furthermore, the failure of the pump in the pedestrian underpass meant water was unable to drain away from this low point.

Transport for London (TfL) drainage assets from the A22 and A23 and the pedestrian underpass were most affected.

4.3 Purley Oaks Road

Similar to the flooding at Purley Cross, the flood event experienced in Purley Oaks Road was also as a result of the intense rainfall across a large urbanised area. The highway drainage network was overwhelmed and capacity exceeded causing a manhole at the bottom of the road to surcharge. Five commercial properties were flooded, with the road and pedestrian access to Purley Oaks train station temporarily closed by the London Fire Brigade.

Table 4-3 – Purley Oaks Road Flood Event Photos

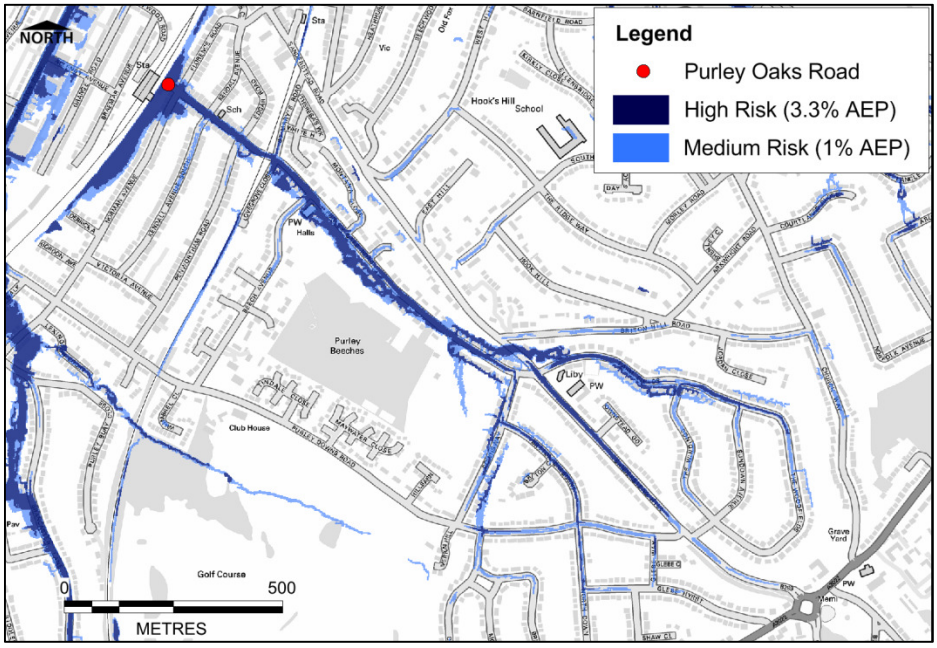

Figure 4-4 – Modelled surface water flood risk in the catchment above Purley Oaks Road according to the 'Risk of flooding from surface water' mapping (Environment Agency)

Figure 4-5 – Purley Oaks Road (source: Croydon Advertiser)

Figure 4-6 – Flooded commercial properties on Purley Oaks Road (source: Croydon Advertiser)

The surface water flood risk map (Figure 4-4) indicates that the road and commercial properties (Figure 4-5 and Figure 4-6) are located in a topographic depression (approx. 70 mAOD) situated at the bottom of a surface water catchment. The

surface water catchment is shown to extend from the uphill areas to the south east along Purley Oaks Road, Farm Fields, Sanderstead Hill and Downsway up to approximately 150 mAOD.

The high intensity rainfall in an urbanised area is identified as the flood source. The impermeable road surfaces and building rooftops within the catchment directed surface water towards the highway drainage network. Surveys undertaken of the drainage network along Purley Oaks Road indicate that the soakaway situated in the road outside of the commercial properties has five inflows consisting of;

- Three road gullies (each with a 150mm diameter outflow) which drain surface water from the road area outside the commercial properties,
- A concrete pipe (225m diameter) 32m in length, possibly longer (unable to survey further) which is likely to drain the pedestrian access up to the station and in front of the commercial properties, and
- A concrete pipe (300mm diameter) 23m in length, connecting to the upstream soakaway, which receives upstream road drainage from Purley Oaks Road.

The surveys also found there to be only one outflow from the soakaway, consisting of a single 150mm concrete pipe, 2m in length, draining to a combined sewer manhole. The small diameter outflow is likely to have created a 'bottleneck', and in combination with the extreme nature of the rainfall event, the volume of surface water is likely to have caused the highway drainage network to back up, surcharge and flood.

4.4 Other floods across the Borough

The intense rainfall also caused other more localised surface water flooding events throughout the Borough, with the location of these events recorded and mapped in Figure 1 Appendix A. The majority of these flood events were nuisance flooding of roads and footpaths as reported by LBC or members of the public, and did not cause significant disruption or damage. The LFB reported some external residential property flooding (i.e. garages and driveways). Unconfirmed reports of flooding have also been mapped, whereby the flooding receptor has not been identified.

Table 4-4 – Other Flood Event Photos

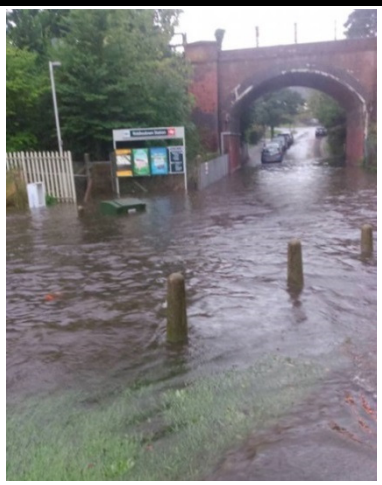

Figure 4-7 – Lower Barn Road, Purley (source: Croydon Council)

Figure 4-8 – Junction of Melfort Avenue and footpath into Thornton Heath Recreation Ground, Thornton Heath (source: Croydon Council)

Figure 4-9 - Harewood Gardens, South Croydon (source: Croydon Council)

Figure 4-10 – Warren Road, Purley (source: Croydon Guardian)

The locations of these flood events correlate closely with areas identified as being at between High and Medium risk of surface water flooding (between a 3.3% AEP and 1% AEP) in the surface water flood risk map produced by the Environment Agency. Whilst most of Bensham Manor Road is mapped at very low risk of surface water flooding, the reported incident coincides with a small area of mapped risk, likely to be associated with a low point in the road. Flooding was reportedly exacerbated by blocked gullies.

The high intensity rainfall in an urbanised area is identified as the flood source for this flood event. The impermeable road surfaces and building rooftops within the catchment directed surface water towards the highway drainage network. Due to the extreme nature of the rainfall event, the volume of surface water exceeded the hydraulic capacity of road gullies and drain gratings, and as a result, surface water continued to flow overland. Flooding was further exacerbated in some locations by blocked gullies and drains.

5 The Flood Event: Risk Management Authority Response

As discussed in Section **Error! Reference source not found.**, LBC is the LLFA and responsible for leading the management of local flood risk within the Borough, as well as coordinating the response from the other RMAs. A summary of responses by each authority during the flood event is summarised in Table 5.1.

5.1 Response of Relevant Authorities

Table 5-1 – Summary of relevant RMA actions during the flood event

Authority	Actions carried out during flood (brief summary)
Croydon Council	• LBC CCTV department notified the Resilience Team of flooding issues at Purley Cross • Kier (London Highways Alliance Contractor) were instructed to attend Purley Cross (including the underpass) to attend to lifted man hole covers and drainage issues • Kier enforced appropriate road closures and traffic management during floodwater removal from Purley Cross underpass • Kier remained on standby to assist TfL with sandbags and gulley sucker • Coordinated with MPS around areas of flooding concern • CCTV surveys of reported blocked drain at Bensham Manor Road
Environment Agency	• Issued Flood Alert for the River Wandle Catchment on 24th August 2015. • Attended areas of reported garden flooding, low lying flooded areas and blockages throughout the Wandle Catchment
Thames Water	• No actions advised by Thames Water
Transport for London	• Hydra Cleansing (TfL contractor) called to Purley Cross Underpass with a 18,000 litre tanker and a 32,000 litre tanker, both equipped with pumps. • The first tanker arrived on site at 18:10 on 24th August, and the last tanker left site at 02:00 on 25th August 2015, removing a total estimated volume of 296,000 litres of flood water. • Blackwall tunnel electricians (TfL Contractor) called to Purley Cross Underpass to assess pump • Two Flowline (TfL contractor) 400 gallon gully suckers attended to assist with the cleanup of silt and debris after flood water had been cleared • Sandbags were placed around the pump control panel
London Fire Brigade	• Attended four properties in response to unconfirmed residential property flooding (internal and external)
Metropolitan Police	• Jointly monitored both LBC and MPS systems, as well as contacting informants with updates

5.2 Assessing Responses and Lesson Learnt

The relevant authorities flood risk management functions undertaken are listed below under their corresponding sub heading.

5.2.1 Croydon Council

- Issued relevant updates to staff, Councillors, the media and contractors
- LBC officers attended all flood event locations as listed in Table 4-1, with the exception of the four locations where the LFB attended.
- Following the flood event at Purley Oaks Road, CCTV surveys and a detailed investigation have been undertaken on the drainage network at Purley Oaks Road.

5.2.2 TfL

- Drainage engineers were in attendance at Purley Cross actively dealing with the removal of flood water by tanker, and the repair of the pumps.
- TfL has advised that a scheme is programmed to start in 2016/17 to make changes to the Purley Oaks underpass pump, including the relocation of the control cabinet to a higher level to prevent it from being submerged by flood water in the future.

5.2.3 Environment Agency

- No main watercourses are present at any of the flood event locations, therefore the Environment Agency was only required to provide a strategic overview role in this instance.

5.2.4 TWUL

- TWUL have not advised of any planned actions related to this flooding event.

5.2.5 Summary and Lessons Learnt

It is concluded that LBC, TfL and the Environment Agency carried out their appropriate response duties as required by the FWMA, the Land Drainage Act 1991 and the Highways Act 1980 in responding to the surface water flood events reported across the Borough. However, the events highlighted a number of issues which should be addressed in ongoing flood risk management in the Borough through;

- Further engagement with TWUL and TfL about Purley Cross to determine whether sewer condition or affiliated assets are influencing local flood risk.
- Further engagement with TWUL regarding the drainage mechanisms and interaction with the sewer network at Purley Oaks station
- Review of drainage capacity at flooded locations and a review of the regularity of gully cleaning schedules.

6 Next Steps

6.1 Summary of Findings

The flood events reported across the Borough on 24th August 2015 are considered to be as a result of an exceptional rainfall event, which exceeded the design capacity of road gullies and the highway drainage network. Whilst some road gullies were reportedly blocked, the volume of water meant the flood events are considered to be largely unavoidable, without increasing the design capacity of drainage networks throughout the Borough.

Specifically at Purley Cross, the drainage network upstream and downstream of the pump station does not have sufficient capacity to manage the volume of water encountered. In addition, the extreme nature of the rainfall event had a knock on effect leading to the failure of the TfL operated pumps at the pedestrian underpass due to flooding of the control box, further exacerbating the flooding at this location.

The key lessons learnt have been documented and will feed into improving procedures to cope with future emergencies.

6.2 Way Forward

Based on the findings of this Section 19 investigation, it is recommended that:

- TfL carry out improvement works and relocation of the pump control panel;
- LBC review gully cleaning regimes and check functionality of gullies and soakaways in flooded locations;
- LBC investigate options to enhance the drainage capacity at Purley Cross and/or manage water coming into the catchment;
- LBC investigate options to enhance the drainage capacity at Purley Oaks station, particularly reviewing the soakaway outfall pipesize with TWUL in addition to alternative ways of managing water coming into the catchment;
- LBC and TWUL work together to plan future upgrades to the system where flood risk is known to be greatest;
- All RMAs continue to improve their cooperation, coordination and communication with one another, particularly with regard to their flood risk management functions and during times of emergency;
- All RMAs continue to raise awareness of flood risk and increase the resilience of communities and businesses to flood risk,

Appendix A. Map of flooded locations

About AECOM

AECOM (NYSE: ACM) is a global provider of professional technical and management support services to a broad range of markets, including transportation, facilities, environmental, energy, water and government. With approximately 100,000 employees around the world, AECOM is a leader in all of the key markets that it serves. AECOM provides a blend of global reach, local knowledge, innovation, and collaborative technical excellence in delivering solutions that enhance and sustain the world's built, natural, and social environments. A Fortune 500 company, AECOM serves clients in more than 100 countries and has annual revenue in excess of $6 billion.

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