

Hertfordshire County Council Section 19 Flood Investigation Report Welwyn Garden City



Welwyn Garden City in 2010
Aerial Photography © GeoPerspectives.co.uk

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Revision Schedule

Hertfordshire County Council Section 19 Flood Investigation Report

October 2017

Version 4

Rev	Date	Details	Author	Checked and Approved by
1	18/08/17	For internal FRM team consultation	James Lester, Flood Risk Management Project Officer	Ryan Thomas, Partnership & Scheme Development Officer
2	28/09/17	Draft for Internal FRM Review	James Lester, Flood Risk Management Project Officer	Ryan Thomas, Partnership & Scheme Development Officer
3	02/10/17	Preliminary Draft for HCC review	Ryan Thomas, Partnership & Scheme Development Officer	Andy Hardstaff Flood Risk Management Team Leader
4	11/10/17	Final Draft	Ryan Thomas, Partnership & Scheme Development Officer	Matthew King, Head of Waste Management & Environmental Resource Planning

Explanation of Acronyms

Acronym / Term	Explanation
FWMA 2010	Flood and Water Management Act 2010 – Legislation that was developed and enacted as a result of the review in to the serious flooding in 2007. It brings new powers and duties to local authorities and other regulatory bodies.
HCC	Hertfordshire County Council
LDA 1991	Land Drainage Act 1991 – Legislation that sets out a range of roles and responsibilities relating to flood risk management. It is also the legislation that gives powers to local authorities to manage flood risk and highlights the role of the landowner to manage watercourses on their land to maintain the flow of water.
LLFA	Lead Local Flood Authority – This is the role assigned to the unitary or county council for an area with a range of duties and powers to support the management of local flood risk.
RMAs	Risk Management Authorities – Bodies identified in the FWMA 2010 with roles and powers to manage flood risk. In Hertfordshire this includes the County Council, district councils, Highway Authority, Highways England, the Environment Agency, the Bedfordshire and River Ivel Internal Drainage Board, Thames Water and Anglian Water Services Limited.
Adopted Highway	The term has been used in this report to include all highways maintainable at public expense. This includes historic highways as well as those formally adopted through section 38 of the Highways Act 1980 and preceding powers.
Antecedent conditions	Antecedent conditions is a term used to describe the relative wetness or dryness of a catchment, which changes continuously and can have a very significant effect on surface water flows during wet weather. Antecedent moisture conditions are high when there has been a lot of recent rainfall and the ground is moist. Antecedent moisture conditions are low when there has been little rainfall and the ground becomes dry.
Attenuation	The processes of water retention on site slowly being released to a surface water/combined drain or watercourse.
Storage	An area or structure where surface water flows are retained.
TWUL	Thames Water Utilities Limited

Executive Summary

During the late afternoon of 23 June 2016, Welwyn Garden City was affected by flooding. It was one of a number of areas in Hertfordshire where flooding occurred as a result of exceptionally intense rainfall.

In the areas covered by this investigation, 47 properties were flooded internally and a further 11 properties were flooded externally. This flooding was from surface water, not from rivers or water coming up out of sewers or from water pipes.

Hertfordshire County Council (HCC) in its role as Lead Local Flood Authority on becoming aware of a flooding issue has the responsibility to begin an investigation.

The main findings of this investigation are:

- Rainfall event on the 23rd June 2016 was intense with there being a 3% chance of rainfall this bad or worse happening in any given year.
- There had been significant rainfall preceding the event on the 23rd June resulting in the surrounding area already being wet. The level of saturation would have meant that surface water runoff would have been high.
- The intensity of the rainfall on the 23rd June resulted in the piped drainage systems in this area were overwhelmed.

The recommendations from this investigation for reducing the risk of flooding from surface water are:

- The Lead Local Flood Authority should conduct a feasibility study to identify if a property level resilience scheme for those properties at risk of flooding in Welwyn Garden City would provide the necessary flood reduction measures and be successful in applying for government funding.
- The exploration of surface water attenuation features as a means to channel surface water run-off. This would attempt to intercept and store water that would otherwise inundate highway and property if the current drainage systems are at their full capacity. This would attempt to reduce the risk of flooding from the more frequent rainfall events.
- The Lead Local Flood Authority to investigate surface water drainage at Autumn Grove to clarify it is functioning to its design capacity
- The Lead Local Flood Authority should work with key stakeholders and resilience professionals to investigate if any actions could be taken in Desborough Close to help residents becoming more resilient to the risks of surface water flooding.

1. Introduction

1.1 LLFA Investigation

Under Section 19 of the Flood and Water Management Act (FWMA) 2010 Hertfordshire County Council as Lead Local Flood Authority (LLFA), on becoming aware of a flood in its area, must, to the extent that it considers it necessary or appropriate:

- Investigate the incident;
- Identify the Risk Management Authorities (RMAs) with relevant flood risk management functions;
- Establish if the relevant RMAs have responded to the flood event or are proposing to respond;
- Publish its findings; and
- Inform the relevant RMAs of its findings.

An RMA (as defined under Section 6, subsection 13 of the FWMA 2010), has certain powers to manage, regulate, assess and mitigate flood risk. The activities of the following RMAs have been examined as part of this Section 19 flood investigation for Welwyn Garden City:

- Hertfordshire County Council as the Lead Local Flood Authority (LLFA).
- Hertfordshire County Council as the local Highway Authority (HA).
- Thames Water Utilities Limited (TWUL).
- Welwyn Hatfield Borough Council (WHBC).

Following the flood event experienced in Welwyn Garden City on the 23 June 2016, four distinct and separate sites met the criteria in Policy 2 of HCC's Local Flood Risk Management Strategy for a detailed Section 19 Investigation to be undertaken. The factors that triggered the investigations at each site are detailed in Table 1, with Hyde Brook East and Hyde Brook West having more than one trigger.

Table 1: List of flooding sites and associated trigger mechanisms

	Flooding Site	Trigger Mechanisms
1	Hyde Brook East	<ul style="list-style-type: none">• More than five properties flooded internally• A business flooded internally
2	Hyde Brook West	<ul style="list-style-type: none">• More than five properties flooded internally• A business flooded internally• Property flooded internally more than once within the last ten years• External flooding within property boundary five or more times within a ten year period
3	Handside Lane	<ul style="list-style-type: none">• Property flooded internally more than once within the last ten years
4	Brocket Road	<ul style="list-style-type: none">• External flooding of property five or more times within a ten year period

The four investigation areas are all within Welwyn Garden City, Figures 1 and 2 identify the general location and the individual flooding sites. Figure 3 identifies the flooded sites in relation to areas predicted to be at risk of flooding from surface water on the national Risk of Flooding from Surface Water mapping published by the Environment Agency (EA).

Position of Welwyn Garden City in Hertfordshire

Scale: 1:100,000
 Date: 26/09/2019

Figure 2: The location of the four investigation sites within Welwyn Garden City

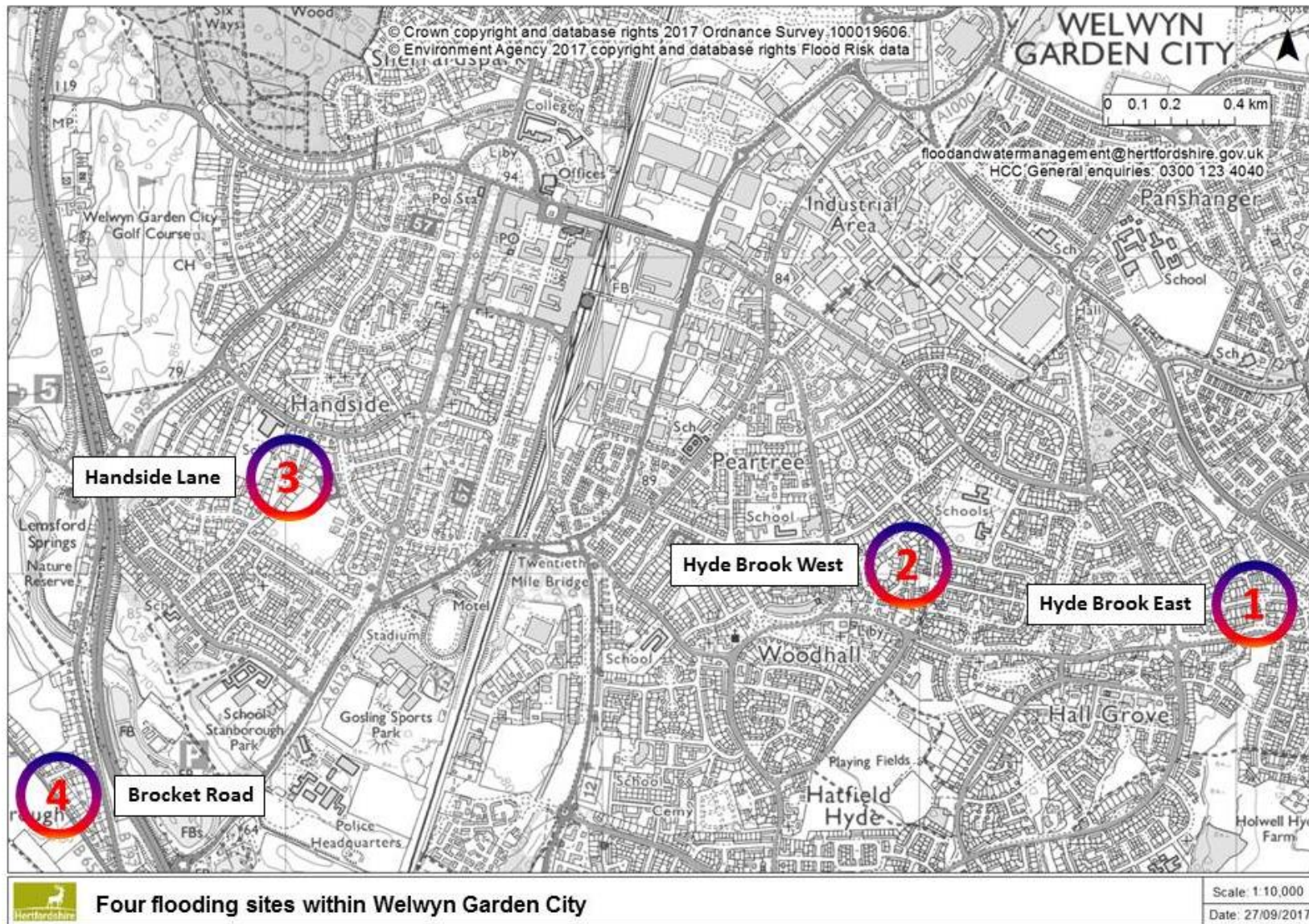
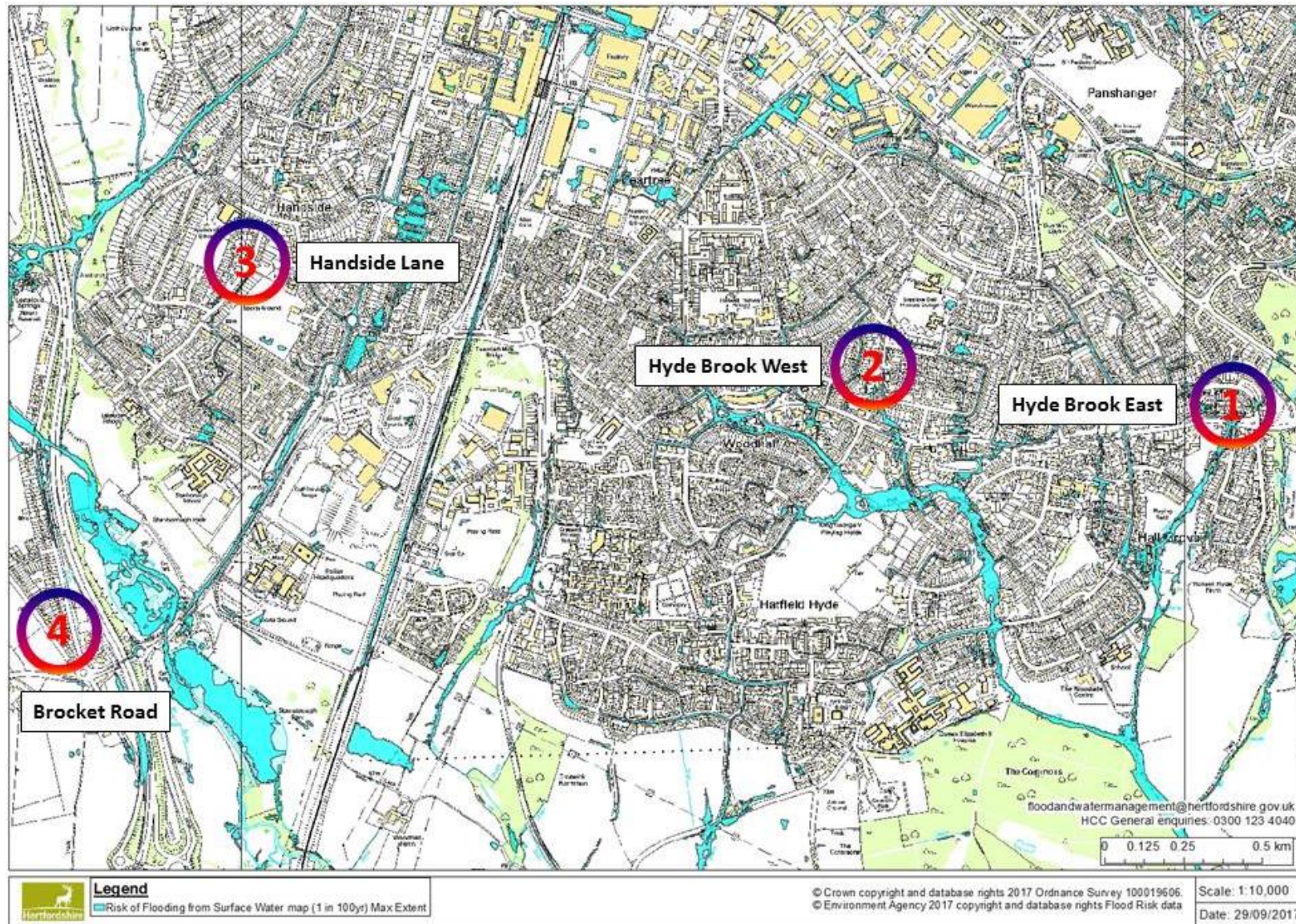


Figure 3: Risk of Flooding from Surface Water map (1 in 100 year) Maximum Extents including the four flooded sites



2. Background and History of Flooding

2.1 Previous flood events

There has been only one historical report to the LLFA of flooding in the areas listed in Table 1. This was internal flooding of a single property which occurred on the 16-17 July 2015. This property also flooded on the 23 June 2016. The LLFA has only been recording flood events since 2010; therefore the LLFA will be unaware of any flood events prior to that date. Flood events prior to 2010 identified by residents as part of this investigation will be added to the LLFA Flood Incident Record.

Hertfordshire County Council in its capacity as the Highway Authority keeps records of all highway faults made by members of the public, which includes flooding to and from adopted Highways. Previous to this flood event, there has been no recorded historical flooding to property from the highway for the vast majority of the areas identified in this investigation. The exception of this is Brocket Road and Cole Green Lane. For the predominance of reported highway flooding, water has drained away through the existing drainage network before the site has been visited (within a 12 hour window).

The 2009 Welwyn Hatfield Borough Council Strategic Flood Risk Assessment (SFRA) recorded flooding historically on Wellcroft Close however no further information was available.

3. Assessment of the 23 June 2016 flood event

3.1 Summary of 23 June 2016 event for Hertfordshire

On the afternoon of 23 June 2016, torrential rain and thunderstorms caused flash flooding across the South East of England. In Hertfordshire, a corridor of severe rainfall swept across the county starting in Northwood and heading north-east, affecting Bushey, Carpenders Park, South Oxhey, Radlett, London Colney, Hatfield and Welwyn Garden City. There was also localised flooding in Hitchin, Baldock, Stevenage and Royston.

3.2 Observations

A questionnaire survey was sent out to all residents in Hertfordshire who may have been impacted by the 23 June 2016 flood event. This was conducted by HCC as the LLFA. The purpose of the questionnaire was to establish the extent of the flood event, the number of properties impacted and an indication of the mechanisms that caused flooding to property or critical infrastructure.

In Welwyn Garden City, questionnaires were sent to properties that had been reported as flooding as well as those in the local vicinity that may also have been affected. Properties were identified using reports from media, the fire service and the HA. This was then cross referenced with the EA's map of the predicted risk of surface water flooding (see Figure 3). In total 130 properties were sent questionnaires and 58

responded reporting flooding, of which 47 reported that they had been flooded internally. The results of the survey are summarised in Table 2.

Table 2: Questionnaire responses

Questionnaire Response	Number of properties
Flooded internally	47
Flooded externally only	11
Did not flood	7
Did not respond	65
Sent in total	130

Observations provided by residents during the investigation included:

- That water in some areas pooled on roads and was pushed towards properties by passing cars.
- Some gullies in the highway were full of silt, particularly along Great Ganett and Howlands.
- That flood water flowed down Handside Lane and then overland towards properties.
- Residential properties within the flood investigation areas which are lower than the road were especially badly affected.

3.3 Rainfall and antecedent conditions

The Met Office issued Amber Severe Weather Warnings of heavy rain for London, South East England and the East of England for the 23 June 2016. Amber Warnings suggest that travel could be disrupted and localised flooding of low-lying areas and property could result. However warnings are general for county areas and are not location specific.

A storm tracked north-easterly across the south east of England. It was raining across most of Hertfordshire at the time of the flooding however as can be seen from the rainfall radar in Figure 4, the areas of most intense rainfall (grey areas) were localised and moving along a narrow band within the storm.

The Environment Agency provided rainfall data from gauges at Wheathampstead and Mill Green, with return period estimations for the rainfall event, see Figure 5 identifying the locations and Figure 6 which visually represents the recorded rainfall at both gauge locations during the 24-hour period from 23 to 24 June 2016.

Legend of Rainfall Intensity (mm/hr)

Zero values are not shown

0-0.25
0.25-0.5
0.5-1
1-2
2-4
4-8
8-16
16-32
32-64
64-96
128-128
128+

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Figure 5: Location of rain gauges, Wheathampstead and Mill Green circled

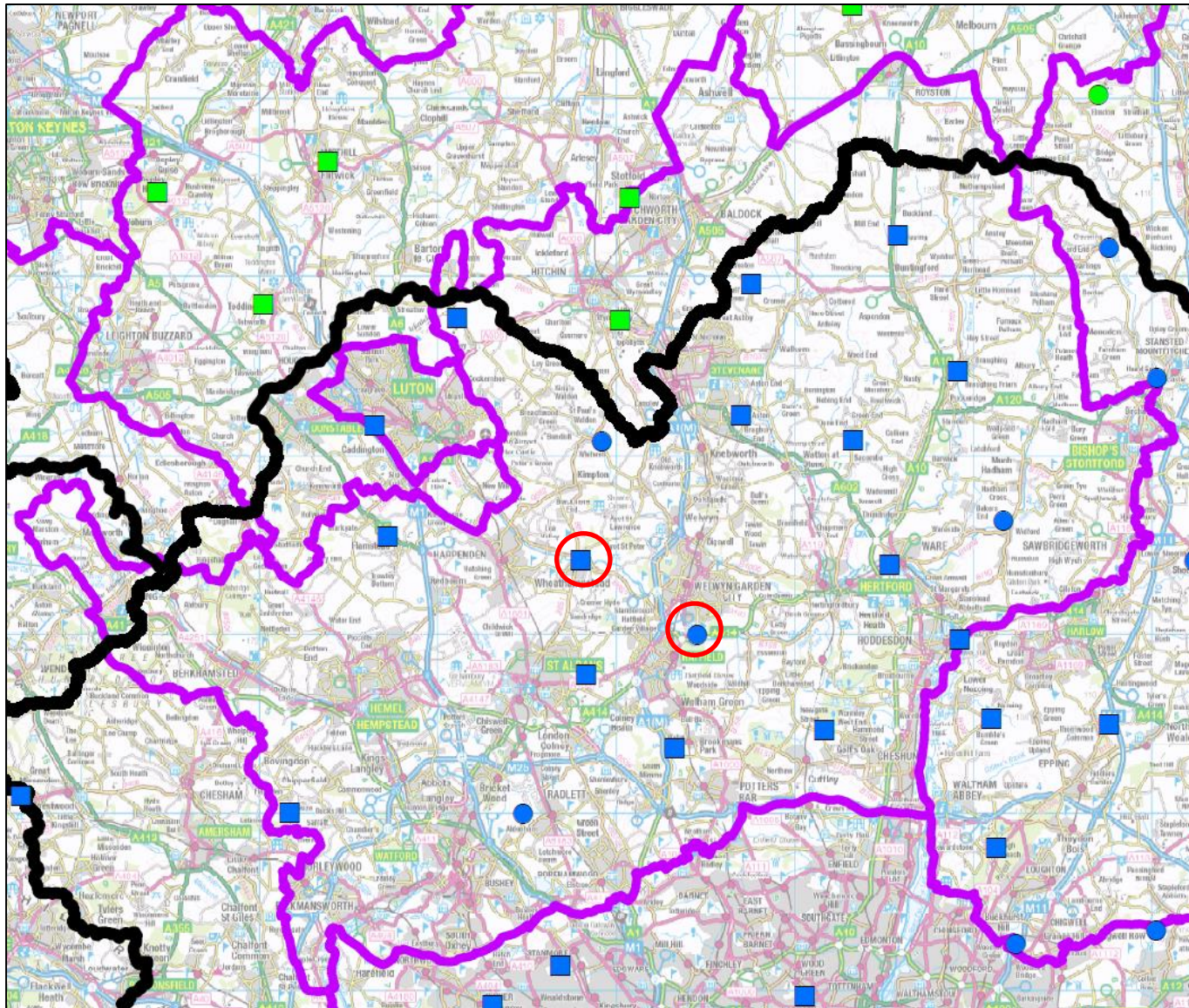
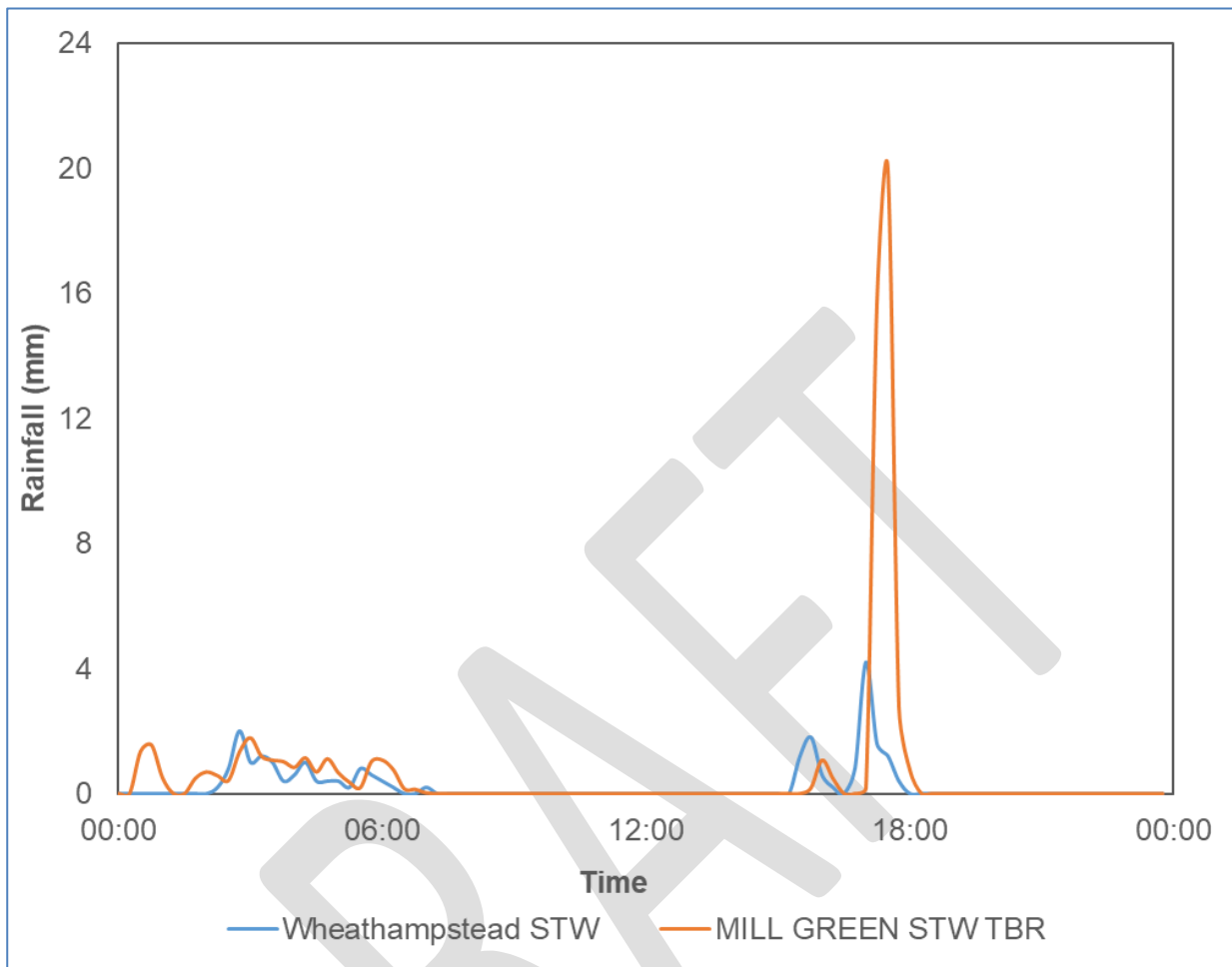


Figure 6: EA tipping bucket rain gauge data at 15 minute intervals for Wheathampstead and Mill Green



The gauge at Mill Green is considered the most relevant because it is the closest to the affected areas in Welwyn Garden City. Figure 6 confirms that in the morning of the 23 June there was a rainfall event that fell evenly across the county however the afternoon rainfall event was vastly different. A substantial peak of intensity was recorded at Mill Green compared to Wheathampstead, justifying the Met Office Amber Severe Weather Warning of **localised** flooding. This is typical of summer thunderstorms, where rapid rainfall can occur in a very short space of time.

Over 60mm of rainfall is recorded at Mill Green to have fallen during an 18-hour window. This is more than the long-term average monthly rainfall for June in this area, which is 53mm. The most significant rainfall event occurred during the late afternoon and early evening of 23 June 2016 when 41mm of rain was recorded to have fallen over two and a quarter hours with a peak intensity of approximately 20mm in 15 minutes. This two and quarter hours of rainfall was exceptional and intense. According to current predictions, there is only a 3% chance of getting more rainfall than 20mm in a 15-minute period in any given year.

In addition to the period of exceptionally intense rainfall, there had been heavy rainfall in the early morning, and 40mm of rainfall already in June prior to 23 June 2016, including 15mm on 20 June 2016.

It is therefore reasonable to assume that the ground would already have been saturated and less able to absorb water when the afternoon rainfall fell.

Rain gauges only measure the amount of rain falling into the actual rain gauge. As can be seen from Figure 4, storms like the one on 23 June 2016 can vary significantly across the area they affect. From the rainfall data shown in Figure 5, it looks as though the measurements from the rain gauge at Mill Green provide a reasonable estimate of the rain which fell on Welwyn Garden City.

3.4 Drainage

The surface water and foul water sewer network in Welwyn Garden City is the responsibility of Thames water Utilities Ltd (TWUL). In this catchment the sewer networks for foul water and surface water are separate. Hertfordshire County Council in its capacity as the Highway Authority is responsible for draining the rainfall that falls on the highway and has a network of gullies to drain this water off the highway. These gullies are connected to the surface water sewer system operated by TWUL.

The TWUL surface water network serving the area affected by the flood event in Welwyn Garden City discharges to main rivers south of the catchment, apart from the surface water sewer network on Bocket Road which drains to local soakaways. All the gullies within the investigation areas are on the 18-month cyclical gully clean programme.

Highway gullies are designed to capture and drain moderate rainfall from the highway. Their ability to drain water is affected by the volume and velocity of water running over the gullies. Even where gullies are placed to receive large volumes of water the volume that they can discharge is limited by the outlet pipe sizes and the available capacity in the downstream network. Overland flow that enters the highway from adjacent land adds to the volumes of water that the gully network is required to drain away.

During this flood event, gullies would not have been able to drain the large volumes of water that fell on the highway in such a short amount of time and the additional overland flows would have exacerbated the situation.

It is likely that the TWUL surface water network would have been running at or near design capacity which would in any case have limited the potential for gullies to discharge water to the wider drainage network.

Most surface water sewer networks are only designed for managing a defined level of rainfall. Thames Water estimates that the rain that fell on 23 June 2016 was roughly the same volume of water as the maximum capacity of their surface water sewer can manage, which is a storm with a 3% chance of happening in any one year.

In Welwyn Garden City the amount of runoff coming on to the highway when it rains is more than would have been the case in the past. This is due to an increase in the number of impermeable surfaces (such as driveways) in the urban area. As a result, a greater proportion of rainfall will now result in surface runoff. Any surface water not captured by the drainage network or in excess of its design capacity will runoff overland towards the lowest local point.

There were no reports to TWUL during or after the flood event of flooding caused by the surcharging of the surface or foul water sewer networks. However, residents in Desborough Close did report to this investigation that some shower drains did surcharge within individual properties. As the properties in this location are only single storey the bathrooms are at ground floor level and the internal drains would have been lower than the level of the surrounding flood water.

None of the Information provided by TWUL along with that contained within the 2009 SFRA showed that any of the investigation area had been previously affected by sewer flooding due to failure or capacity issues.

3.5 Surface water runoff

The intensity of the rainfall on the 23rd June 2016 was such that water would not have been able to soak into the ground as quickly as it fell. As a result, water would have pooled and flowed to the lowest local points. Surface water runoff would have been collected by drainage systems where it was able to enter them and to the extent that the systems were able to accept it.

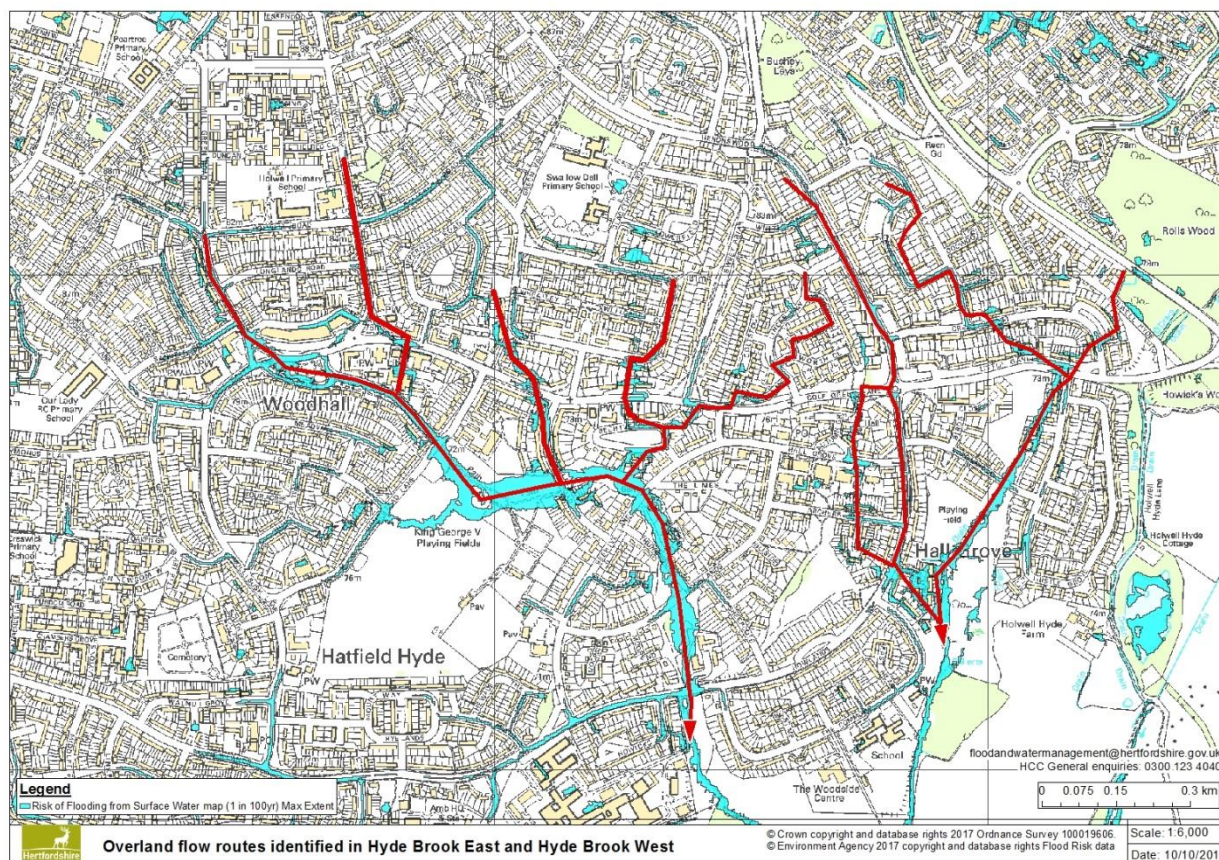
The paths which surface water runoff was observed to have taken during the flood event broadly matched the surface water flow routes predicted by the Environment Agency's Risk of Flooding from Surface Water map (RoFSW), see Figures 7, 9 and 10 with corresponding arrows identifying the overland flow paths. The RoFSW map is a predictive map produced at a national scale based on a number of assumptions therefore there may be anomalies in the mapping that could be refined with more detailed hydraulic modelling.

3.5.1 Hyde Brook East

The area described as Hyde Brook East incorporates the roads of Great Ganett, Little Ganett, Birds Close, Autumn Grove, Hall Grove, Howlands, Thistle Grove and Desborough Close. There were three separate surface water overland flow paths meeting at Cole Green Lane, which eventually drain into Hatfield Hyde Brook, which is designated a Main River by the EA.

The two flow paths to the west are on Bushey Ley and Heronswood (roads), which are at natural low points and collect water from areas upstream including Ridgeway and Great Break. Once the excess surface water had flowed onto the road it continued towards Cole Green Lane. Water from Heronswood flowed west at the roundabout and overtopped the kerb at the lowest point on Cole Green Lane, running into Autumn Grove. Water from the Bushey Ley area flowed towards a natural depression between Great Ganett and Little Ganett, causing flooding to properties on both roads before it merged with water on Cole Green Lane. Another flow path from the east of Great Ganett acted in the same way; collecting water higher up in the catchment from the Cypress Avenue area, which was channelled towards the east of Great Ganett Holywell Hyde before meeting at Cole Green Lane.

Figure 7: Predicted surface water, Hyde Brook East and Hyde Brook West.



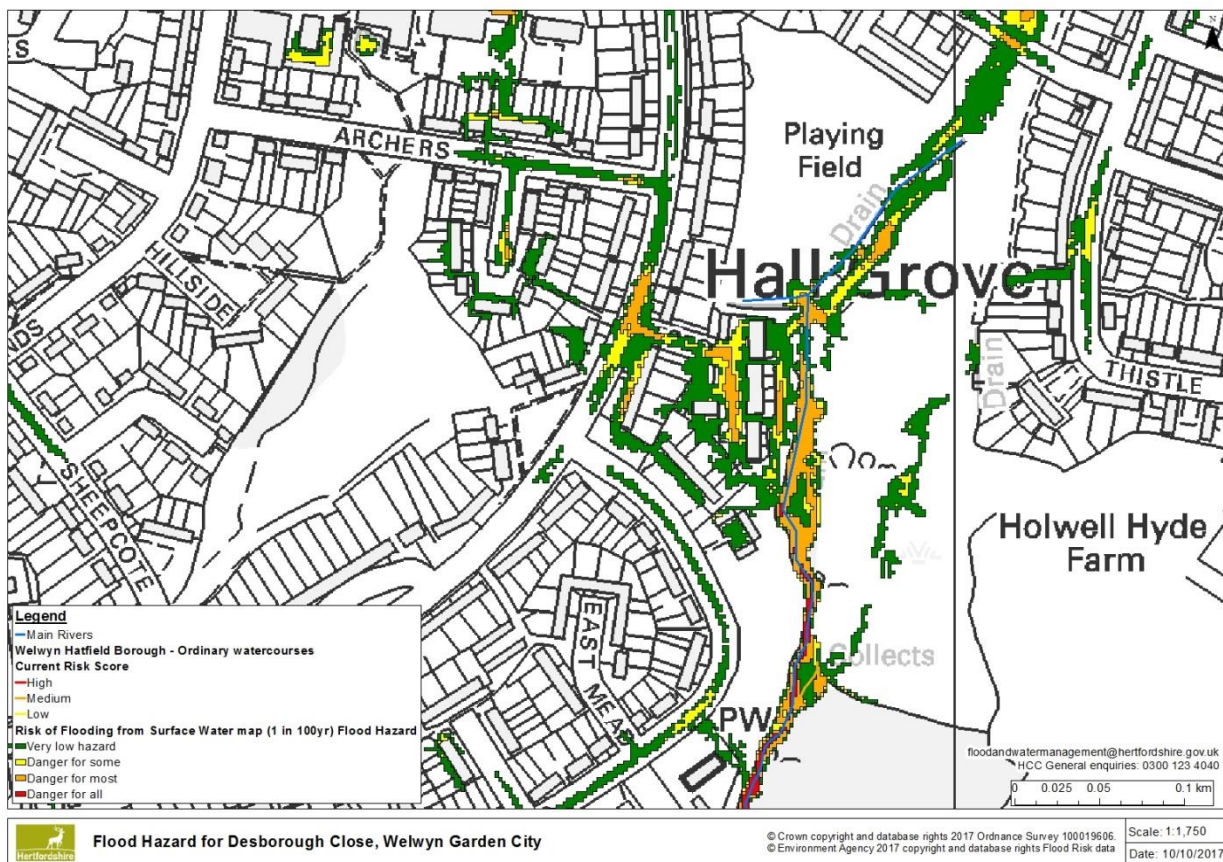
Overland flows then follow the natural depression which continues to the west of Thistle Grove, through to Hall Grove and Desborough Close. Properties on the west side of Thistle Grove and east side of Howlands and Desborough Close flooded internally and externally. The depth and speed of flow would have overwhelmed the local drainage network in the Cole Green Lane area. There are confirmed reports that bow waves, created by passing traffic, caused water to weir over kerbs that had already acted to retain water, this then caused properties to flood that may not otherwise have done so. There is also a series of dropped kerbs to facilitate car access which allowed water to leave the highway quicker than if a kerb was in place. However, given the magnitude of this flood event it may have only delayed the onset of flooding occurring as the water is likely to have been deeper than the kerbs in these locations.

Flooding to the properties at Desborough Close has additional significance and risk as these are designated for older residents, some of whom may also have mobility restriction. One adaptation for this means that property thresholds (the lowest point of a property where water could enter) are lower and properties are single storey. As a result, water was able to enter properties more quickly and some residents were unable to leave their properties easily or move to an upper floor to escape flood water.

Nationally recognised Flood Hazard Ratings have been developed by the EA as there is an acceptance that not all flood risks can be managed and there is a requirement to

estimate the current risks from flooding to people, the economy and the environment. A national flood hazard rating methodology was developed and applied to the RoFSW¹. In line with this, four national flood hazard classes were developed in order to better and more simply highlight risk. Desborough Close has a hazard rating of between 0.75 and 1.25, which is second out of the four classifications. This is further defined as a 'Moderate' degree of flood risk (the other 3 classifications being Low, Significant and Extreme). Moderate risk can present more of a hazard for vulnerable groups, such as children and the elderly. For the flood hazard map in relation to Desborough Close, see Figure 8.

Figure 8: Flood Hazard Map for Desborough Close



Surface water flooding was also reported outside of the flow routes described in Figure 7, with properties along Birds Close experiencing internal flooding. Even though properties were outside of the predicted surface water flow routes, the large volumes of water that fell in such a short amount of time combined with smaller natural depressions between opposite sides of the road caused flooding to property.

¹ Environment Agency. (2006). Flood Risks to People. London: Defra (Available at: http://evidence.environment-agency.gov.uk/FCERM/Libraries/FCERM_Project_Documents/FD2321_3437_TRP_pdf.sflb.ashx).

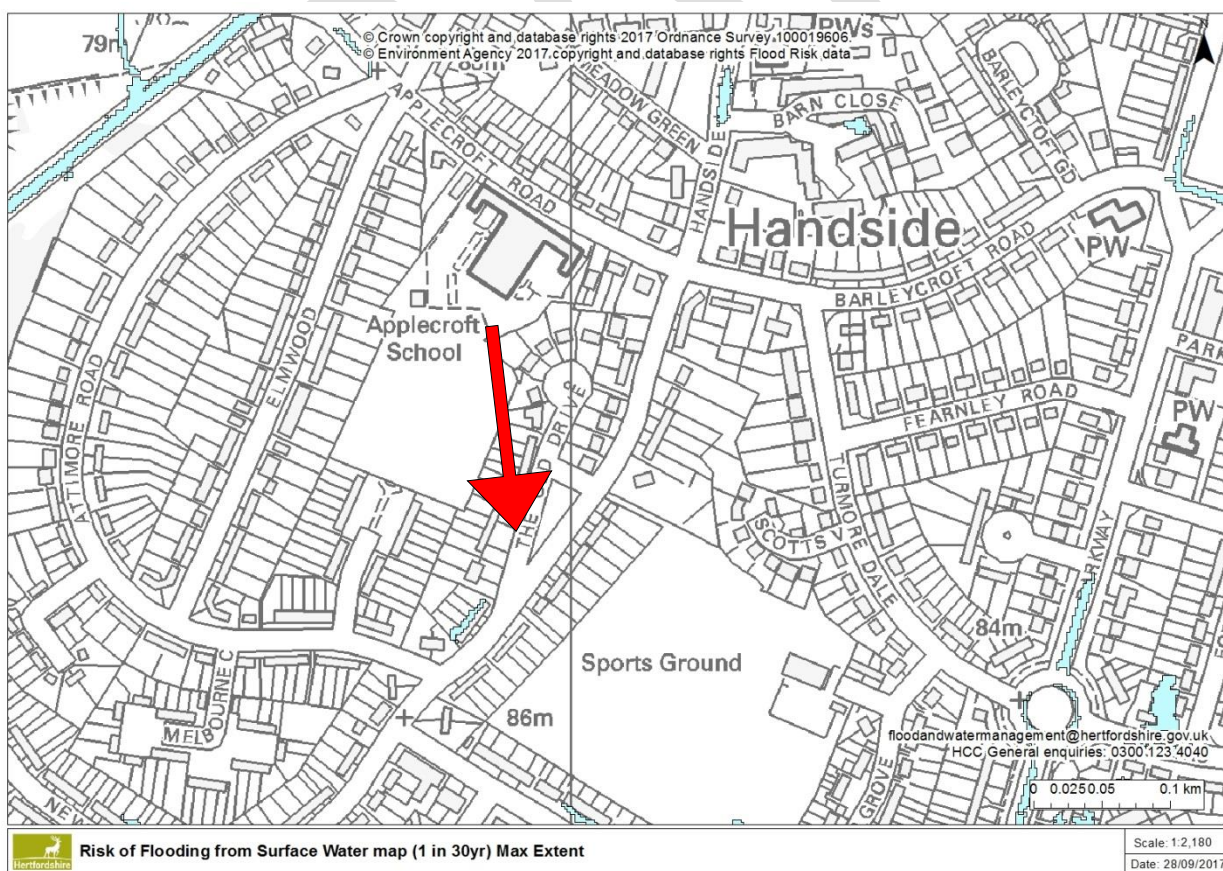
3.5.2 Hyde Brook West

Hyde Brook West incorporates Wheatley Road, Wellcroft Road, Wellcroft Close, Dunsters Mead, Hyde Valley, Cole Green Lane and Beehive Green. Five separate flow paths follow the topographical low points, going between and through houses and crossing roads. The housing estate has been built on a slope with property within the natural depression. Driveways to facilitate access are also present throughout the catchment, increasing the risk of flooding in much lower rainfall events than this flood event. In some cases, the gradient is substantial, with property thresholds over a meter lower than the road. Flood waters converged at the top of the King George V Playing Fields and behind Beehive Green. The flow route drains to Hatfield Hyde Brook, designated a Main River by the EA.

3.5.3 Handside Lane

The land in this area slopes away from Applecroft School and surface water runoff follows this gradient. Flood water routed overland toward the affected properties from The Old Drive and Handside Lane further north. Properties along the east of Handside Lane are lower than the road so if water is not contained within the road then these properties will be flooded. Flood waters pond around the external grounds of multiple properties and flows from the front to the rear. Low thresholds increase the risk of water coming inside a house.

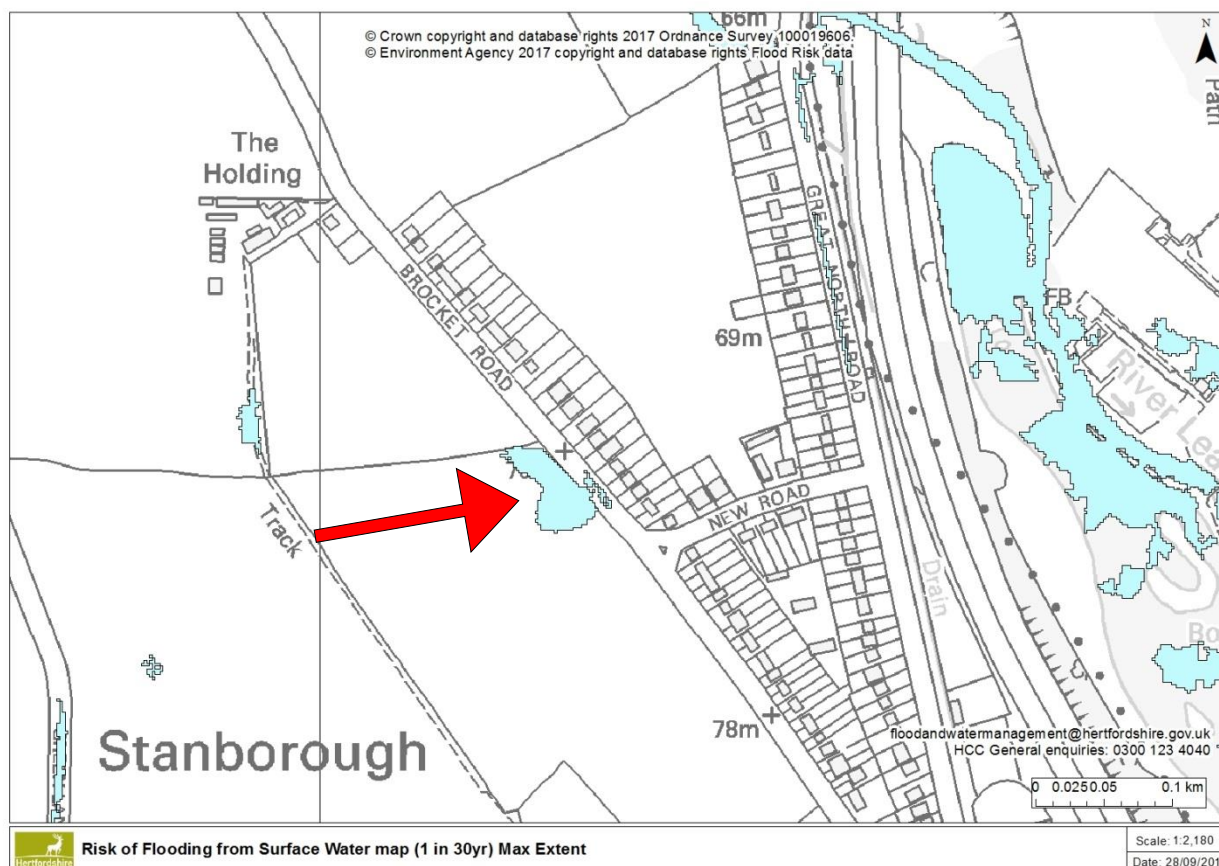
Figure 9: Predicted surface water, Handside Lane



3.5.4 Brocket Road

Brocket Road experiences repeat flooding to the Highway, from flood water that takes time to drain into the soakaway drainage system. During this flood event, bow waves created by road traffic caused water to flood properties externally, but it is likely that water would have entered the property if the resident hadn't had taken preventative action. Property thresholds are lower than the road and all properties have drop drives to facilitate access.

Figure 10: Predicted surface water, Brocket Road



3.6 Causes of flooding

The rainfall information discussed in Section 3.2 highlights that volumes of water that fell in such a short amount of time would have exceeded capacity of the urban drainage network for all four areas identified in the study. The ground in the upper and surrounding catchment was likely to have been saturated following recent heavy rainfall. This will have contributed to overland flows that drained towards low lying properties which then eventually made their way to watercourses to the south of Welwyn Garden City.

Flooding is also likely to have occurred to a number of properties from traffic driving through flood waters causing bow waves with enough energy to overtop road kerbs and flood property.

In some cases, flooding was worse than predicted by the RoFSW map for this size of flood event, for instance in Autumn Grove and on Handside Lane. This could be for a variety of reasons, including bow waves as mentioned above, infrastructure such as fences changing flow direction or the rainfall that fell in these particular areas was much greater than recorded at what the local gauging stations.

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4. Responsible authorities and landowners

Part of the role of HCC as the LLFA in accordance with s19 of the FWMA 2010 is to identify the risk management authorities (RMA's) that have flood risk management functions relevant to the flooding which took place. Those RMA's and their relevant powers and functions are set out below.

4.1 Hertfordshire County Council as Lead Local Flood Authority

HCC as the LLFA for Hertfordshire has fulfilled its responsibility to carry out a Flood Investigation under Section 19 of the FWMA 2010, to;

1. Identify the relevant RMAs and;
2. Establish if those authorities intend to utilise their own powers and to what extent. The actions that the relevant RMAs have agreed to take are set out in Section 6 of this report.

In order to achieve the responsibilities under Section 19, HCC as LLFA must first establish the cause and impacts of the flooding and then, where possible, identify actions to reduce the flood risk.

HCC as the LLFA for Hertfordshire has powers to carry out flood risk management works, in accordance with the Local Flood Risk Management Strategy for Hertfordshire, for flooding from surface runoff and ground water.

4.2 Hertfordshire County Council as the Highway Authority

HCC are the responsible authority to maintain and manage adopted highways including associated drainage infrastructure such as gullies, drainage pipes, and soakaways etc. which have been provided for the sole purpose of draining the public highway.

The roads and surrounding highways are maintainable at public expense by HCC as the Highway Authority and are impacted by the flooding.

HCC as the Highway Authority have powers to manage water falling on the public highway under the Highways Act 1980, however where this water originates from third party land and not from runoff from the highway these powers are limited.

HCC as the Highway Authority is required, as far as is reasonably practicable, to keep highways open and usable by the public.

In extreme flood events, the majority of excess surface water will eventually flow onto the highway as roads act as manmade conduits for such water.

HCC as the highway authority has fulfilled its responsibilities of maintaining the highway drainage network by carrying out a programme of cleansing and responding to reported faults.

4.3 Thames Water Utilities Limited (TWUL)

TWUL manages the public surface water and foul water sewer networks; it therefore has been identified as a relevant RMA. TWUL, like all water companies, are required to keep a register of all instances of internal and external flooding of properties, this is referred to as the DG5 register. When asked during this investigation, TWUL had no reports of flooding from either the foul or surface water network in the areas covered by this investigation.

Only TWUL has the authority to alter the surface water sewer and to manage the flood risk associated with it. Thames Water manages flooding from their network in line with their business plan approved by OfWAT.

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5. Conclusions, potential mitigation options and recommendations

5.1 Conclusion

The observed impact of the flood event broadly corresponds with what is predicted by the RoFSW published by the Environment Agency. The observed flooding approximately matched predicted surface water flooding for a 1 in 30-year return period rainfall event. The storm had a return period of at least 1 in 33 years and the primary flood mechanism was surface water.

5.2 Potential mitigation options

HCC (the LLFA) only has discretionary power to manage the risk of flooding from surface water runoff. Thames Water alone has the authority to alter the public sewers and to manage the flood risk associated with it. Before any mitigation actions can be considered, a feasibility study should be considered to identify if any potential options could reduce the risk of flooding and be viable for government funding through now - Flood and Coastal Risk Management Grant in Aid (FCRMGiA).. Options put forward for funding must have a strong cost to benefit ratio.

Due to the multiple surface water flow paths identified in Welwyn Garden City, a combination of flood defence options would need to be considered in order to mitigate against the risks of flooding. Those being recommended for further investigation by this s19 investigation are improving property resilience in the areas affected by flooding and providing additional surface water attenuation to reduce the risk of property and road flooding.

5.2.1 Improving property resistance

The localised and complex nature of the flooding in this area means it is unlikely that there will be a viable neighbourhood level scheme to reduce flood risk to all of the properties affected by flooding. So increasing the flood resilience of individual at risk properties needs to be considered as an option.

Property Level Resilience (PLR) measures are appropriate where flooding is not expected to last for a prolonged period of time, water is not moving fast, and where it is generally not deeper than 600 mm. It should be noted that property level protection may not completely stop the entry of flood water and may only serve to delay the time of entry.

Measures such as removable flood gates and flood resistant doors prevent water from entering the property, although it can still pool around the outside and restrict access. Passive measures are preferable to those manual measures which would require residents to put them in place before or during heavy rain. This is impracticable for a number of reasons such as the imprecise nature of warnings and properties being unoccupied during working hours.

Most property resilience can only be effective against limited flood heights. If flood

water exceeds a depth of 600mm, it should be allowed into the property. This is so that the pressure of water pushing on the outside of the wall is balanced by the pressure of water from inside. Otherwise, the structure could be damaged. Some flood resistance systems (such as building skirt systems) may be appropriate to provide flood resistance up to depths of c. 900 mm.

The 'Homeowners Guide to Flood Resilience' illustrates the variety of ways in which a home can be protected through the fitting of various products and installations. The document can be downloaded at;

<http://www.knowyourfloodrisk.co.uk/pdf/protection-guide.pdf>

In the short term, uptake of PLR would be at the discretion of homeowners to install. Properties who are both at risk and have experienced repeat flooding and would like to act quickly to make their property more resilient to events such as that experienced on the 23 June 2016 should consider taking this course of action. A full detailed survey undertaken by a specialist PLR company could identify if and what measures could be installed. Currently PLR is not funded by HCC; it is the responsibility of the property owner to protect their property and this includes any additional resilience measures. However, it is proposed to include an area wide PLR scheme in a feasibility study after the publication of this report. Considering the number of properties impacted, a PLR project may provide a positive cost benefit ratio and therefore be successful in securing government funding. It is likely to take a number of years to identify if this is feasible and to secure any funding, so residents should not see this as an option that could be implemented in the short term.

5.2.2 Attenuation of surface water

Welwyn Garden City has many green areas that could be used to store the many surface water flow routes identified within this report. These features would essentially be landscaping features that would be designed to store water during heavy rain. The land could still be used for other purposes other than in times of flooding. Runoff would be diverted into these features which would release the water slowly.

Some areas have already been identified that could be used to attenuate water. These are identified in Figure 11 and Figure 12. It is proposed to conduct a feasibility study to explore if these and any more green areas could be used to attenuate water in Welwyn Garden City and to identify if this would provide a benefit in reducing the risks posed by surface water flooding.

Figure 11: Areas where flood flow attenuation features could be built with arrows which are indicative of the major flood flow paths.

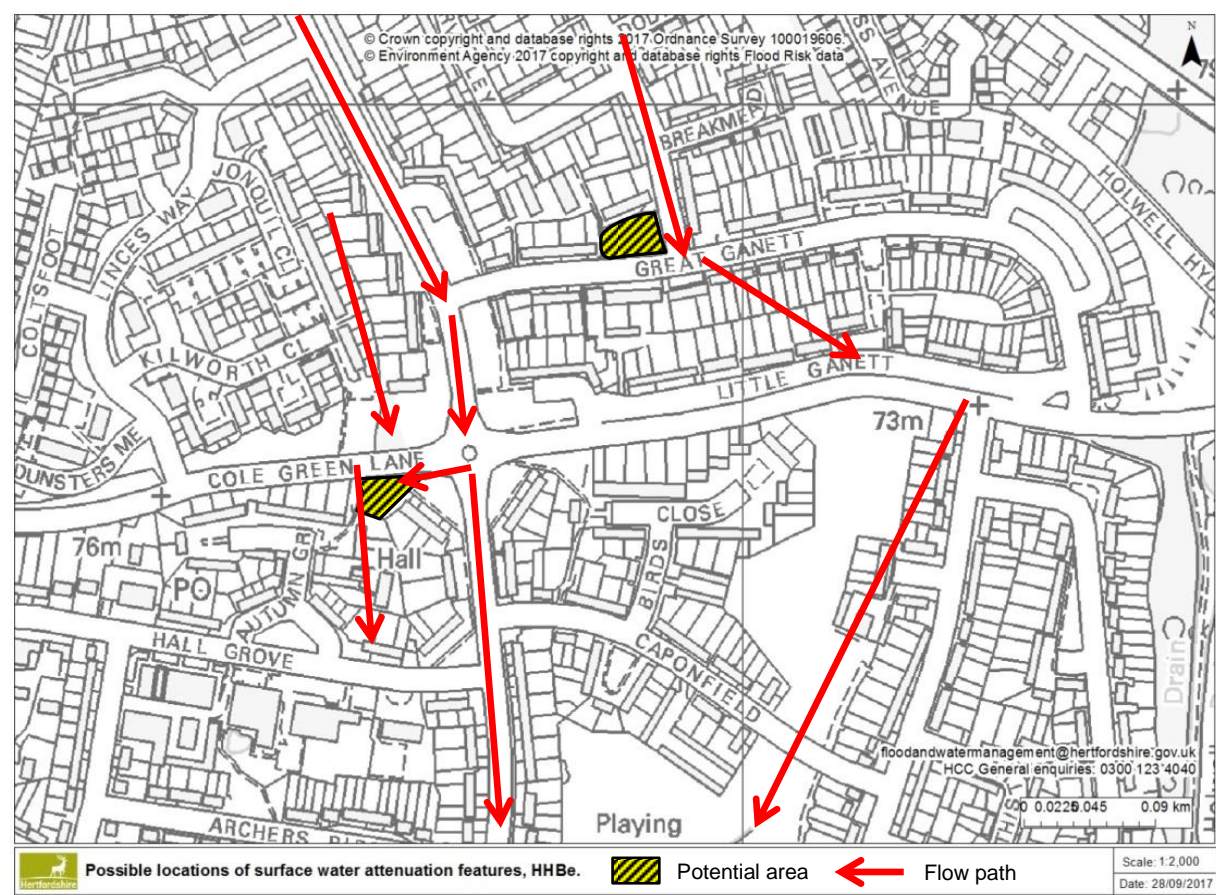
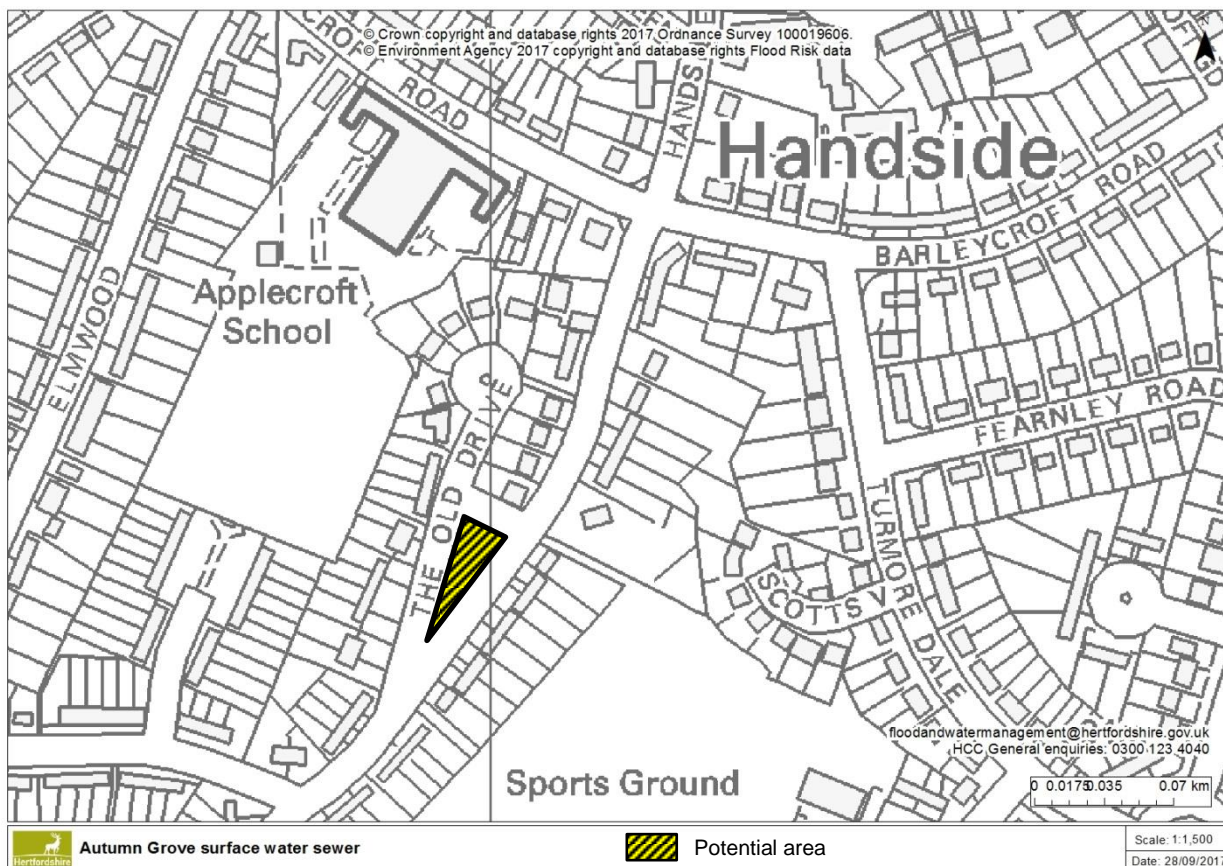


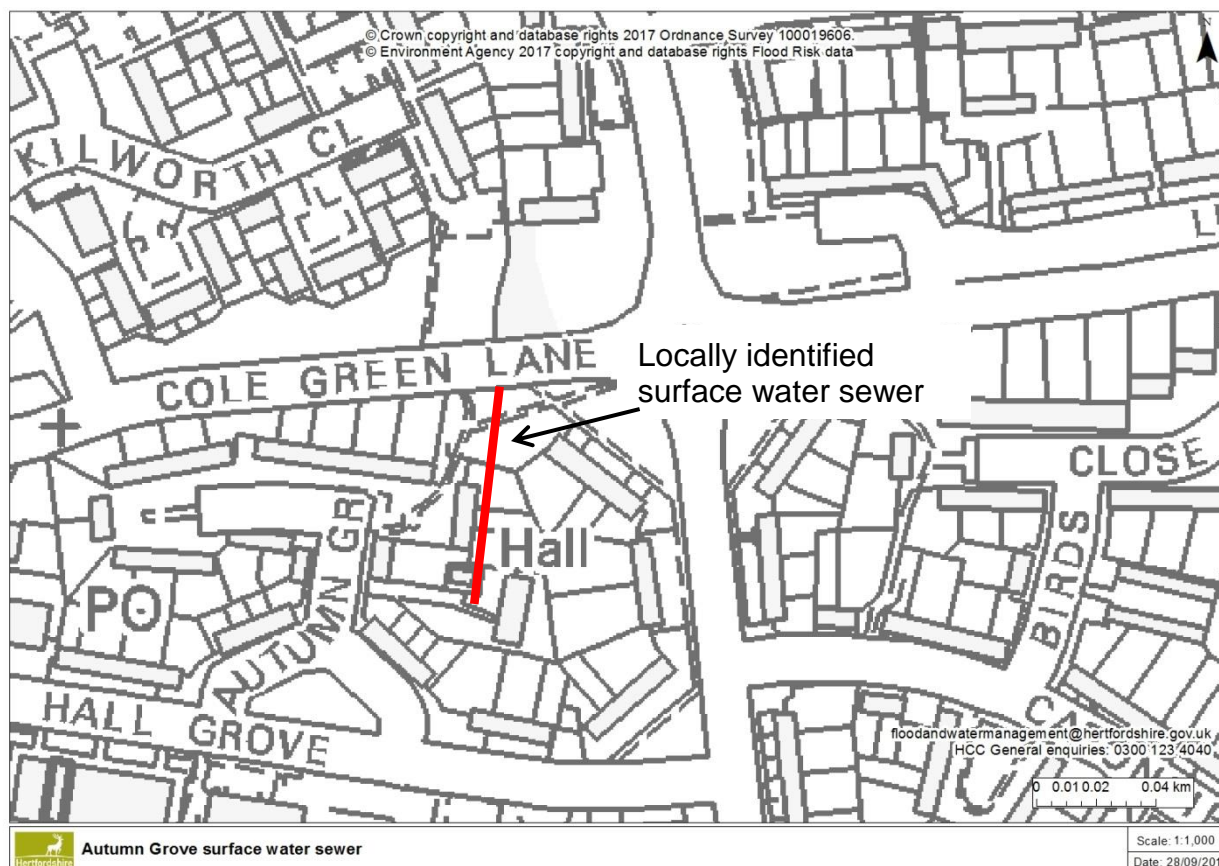
Figure 12: Proposed area for surface water attenuation.



5.2.3 Sewer investigation

Autumn Grove was among the worst affected areas by flooding on 23 June 2016. Residents reported to the LLFA that a sewer (location shown in Figure 13) was dry during this flood event. However it is on the same line as a significant overland flow path and would be expected to be carrying water. The LLFA recommends that this section of sewer should be investigated by TWUL to ensure that it is operating appropriately.

Figure 13: Autumn Grove and surrounding area with one part of the surface water sewer network which has been identified locally highlighted



5.2.3 Desborough Close – Flood resilience measures

Properties in Desborough Close experienced internal flooding. The nature of summer thunderstorms like the one experienced in Welwyn Garden City in this flood event makes it incredible difficult to accurately warn members of the public that they could be at risk of imminent flooding and to either be prepared or to take action appropriate action. This is due to the many factors that are required to predict surface water flooding, such as accurately identifying where the rainfall will be at its most extreme and how saturated the catchment has been following proceeding rainfall. It is likely that any surface water flood warning service that could be offered wouldn't have enough accurate data to be able to make informed decisions and would therefore lack the required confidence in the system. It would be likely that many false alarms would result and public perception on the reliability of the warning service would not be positive. However, due to the hazards and risks identified from this flood investigation at Desborough Close, an investigation should be led by the LLFA, working alongside the Welwyn Garden City Housing Association and key stakeholders, to identify if any improvements could be made to improve the resilience response to the future risks posed from surface water at this location. This could be in the form of encouraging residents to receive Met Office weather warnings, or providing information of what to do during a flood event. The LLFA should work alongside flood resilience professionals to identify any preventative actions that could help vulnerable residents in dealing with those hazards associated with surface water flood risk.

6. Actions Undertaken by RMA's

6.1 Hertfordshire County Council as the Lead Local Flood Authority

1. Posted questionnaire surveys after the flood event
2. Commissioned RAB Consulting to provide technical advice on the production of the Section 19 Investigation
3. Draft section 19 flood investigation report published to RMA's and residents of Welwyn Garden City
4. Organised a public engagement meeting workshop to be held on the 17 October 2017.

6.2 Hertfordshire County Council as the Highway Authority

- 1 A soakaway has been disconnected and a new soakaway crate has been installed along Bocket Road, along with the installation of a new gully to try and capture more highway drainage.

7. Next Steps and Proposed Actions

7.1 Hertfordshire County Council as the Lead Local Flood Authority

The following are agreed actions to be undertaken by HCC in its capacity as LLFA;

1. Make this draft report available to the affected residents of Welwyn Garden City.
2. Hold a public meeting for residents at Welwyn Garden City, currently programmed for 17 October 2017.
3. Record comments from both the community, Risk Management Authority and Key Stakeholders and produce a Final Report.
4. To distribute final copies of the report to all relevant Risk Management Authorities and other appropriate parties.
5. Investigate the feasibility of the options for managing flood risk in the investigation area.

7.2 Hertfordshire County Council as the Highway Authority

- 1 Handside Lane - Investigations have identified that the gullies along Handside Lane were of Swan neck design in the highway drainage system and are to be removed.
2. Cole Green Lane (opposite Wheatley Road) - this area has been programmed to be inspected.
3. Howlands - Concrete identified in a gully has been programmed for a 'dig-out', this is to be completed this financial year.

8. Disclaimer

This report has been prepared as part of Hertfordshire County Council's responsibilities under the Flood and Water Management Act 2010. It is intended to provide context and information to support the delivery of the local flood risk management strategy and should not be used for any other purpose.

The findings of the report are based on a subjective assessment of the information available by those undertaking the investigation and therefore may not include all relevant information. As such it should not be considered as a definitive assessment of all factors that may have triggered or contributed to the flood event. HCC expressly disclaims responsibility for any error in, or omission from, this report arising from or in connection with any of the assumptions being incorrect.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the time of preparation and HCC expressly disclaim responsibility for any error in, or omission from, this report arising from or in connection with those opinions, conclusions and any recommendations.

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