Section 19 Investigation Report

Stockport Metropolitan Borough Council

June 2016 Flood Events

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Contents

Executive Summary

This report documents the investigation into the June 2016 floods in Stockport, undertaken on behalf of Stockport Metropolitan Borough Council under Section 19 of the Flood and Water Management Act 2010.

The aim of the investigation is to identify those communities affected, to determine why they were flooded, review responses during and post event, and to recommend further actions for each relevant authority to consider going forward.

Widespread flooding hit Stockport on four separate occasions on the 8 June, 10 June, 11 June and the 16 June 2016, causing significant borough wide impacts. Rainfall data collected suggest that May was a particularly wet month, resulting in heavily saturated ground conditions leading up to June. Once the intense rainfall events occurred, this resulted in large quantities of surface water runoff entering urban areas and local watercourses. This then caused the overwhelming of surface water sewers, direct surface water flooding and fluvial flooding. In total, Stockport received equal to or above 200% of the long-term average rainfall in June 2016.

295 properties reported flooding across the month, with many properties flooding on more than one occasion. Flooding also caused disruption to road users as highways were closed, along with disruption to the rail services as the Stockport to Disley line was also closed for two weeks following a landslip at Middlewood Station. The Council have also estimated over £950,000 worth of flood damages, investigation and repair work to highway, parks, greenspaces and public rights of way as a result.

The worse impacted communities included Hazel Grove and Offerton Green on the 11 June, with 186 properties flooded. On the 8 June and the 16 June, 75 and 77 properties reported flooding respectively. The worst affected communities across all events included Bramhall, Cheadle, Edgeley, Hazel Grove, Offerton Green and Reddish.

During the flood events, the Council, the Environment Agency and United Utilities responded, proving support to the local communities on site, delivering sandbags, closing roads, undertaking immediate flood mitigation works, and providing evacuation centres and arranging emergency accommodation. Emergency services from across Greater Manchester, including the Greater Manchester Police service and the Mountain Rescue Team, also responded.

Following the flood events, and in addition to supporting this investigation, each authority has been undertaking surveys, investigations and providing further community support. This has included to the provision of over 130 flooding grant funding, the freezing of council taxes for those affected, and culvert and sewer surveys, repairs and blockage removal.

This report recommends 26 general and community specific actions to help reduce or mitigate the impacts of future flooding within the borough for each authority to consider. The delivery of these actions will be dependent on the authorities securing funding and other internal priorities. In addition, the authorities will continue to work together to engage with the communities affected and to identify all potential options for each location reduce flood risk across Stockport.

1. Introduction

1.1 Flood Event Overview

In June 2016, the borough of Stockport received approximately double the long-term average amount of rainfall through prolonged and intense rainfall. On ground already saturated through May, this resulted in four noticeable flood events across many areas of Stockport on the 8 June, 10 June, 11 June and 16 June.

On the 8 June, extreme rainfall overloaded local drains and sewers, which caused surface water flooding to 75 properties, with Offerton Green the worst affected area. Two days later on the 10 June, a second extreme rainfall event overloaded the local drainage system, resulting in surface water flooding to 30 properties across Cheadle and Reddish. The next day on the 11 June, prolonged and heavy rainfall caused river levels to rise and local drainage systems to become overwhelmed affecting Bramhall Green, Hazel Grove, Heald Green and again in Offerton Green, with 186 properties affected. Later on the 16 June, a fourth intense rainfall event also overloaded local drains and sewers, principally in Edgeley and Cheadle. During the event, surface water flooding affected 77 properties.

Over the whole month of June 2016, 295 properties suffered some form of flooding, with certain properties flooded on more than one occasion. A number of roads also became impassable (See Figure 1.1) and a landslip caused significant disruption to the local railway network. Stockport Metropolitan Borough Council (the Council) estimated the cost of local infrastructure repairs at near £1m.

In response to the events, the Council, the Environment Agency and United Utilities as Risk Management Authorities (RMAs) have been working together to support affected communities and understand what happened. This included responding to the incidents both during and after the event and flood management works.

Figure 1.1 : Flooding of Bramhall Green roundabout - 11 June 2016

1.2 Section 19 Investigation Requirements

The Flood and Water Management Act 2010 (the Act) places a number of duties on Lead Local Flood Authority (LLFAs) in relation to local flood risk management. One of the principal duties of the LLFA, as laid out in the Act, is the responsibility to record and investigate flooding incidents within their area (known as Section 19 Investigations).

Section 19 – 'Local authorities: investigations' of the Act states:

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.*

1.3 Purpose

The aim of this independent investigation is to provide a factual record of the flooding to meet the requirements of Section 19 of the Act.

Based on technical evidence and flood incident data recorded by the Council, the Environment Agency and United Utilities during and after the event, the report provides an overview of the event including a description of the communities affected and the total number of properties flooded (Section 2.2). In doing so, the investigation may also be able to determine the source, cause and impact of these events in those communities affected.

The main body of this report documents in detail the findings of the investigation for each community significantly affected, including commentary of properties and infrastructure affected. Certain issues of local concern, such as the potential impact of local development outside of Stockport on flood risk within the borough, and the impact of the A6 to Manchester Airport Relief Road (A6MARR) are also considered.

The report does not include options and actions to reduce flood risk for every community that flooded. It does however include, where possible, high-level recommendations (Section 5), to manage future flood risk in Stockport, which will require involvement from the Council, as LLFA, and the other RMAs within the borough.

In many locations there is ongoing investigations and engagement with the affected communities and stakeholders to identify the full range of options available to manage risk going forward. This investigation is an important first step to help the Council and other RMAs manage flood risk, inform future schemes and continue to work together effectively in Stockport.

1.3.1 Scope

The Stockport Local Flood Risk Management Strategy (LFRMS)[1] states that the Council must record and investigate flood events within Stockport according to the procedures set out in the Association of Greater Manchester Authorities (AGMA) policy document "Recording and Investigation of Flood Events". This policy requires that a full investigation to be carried out if the Council deem the flood event to be a 'significant' incident.

This policy provides the following 'significance' thresholds:

- Five or more residential properties flooded internally, and/or;

[1] Stockport Council (2016) Local Flood Risk Management Strategy for Stockport. Available online at http://www.stockport.gov.uk

- Economic disruption from commercial property flooding – could be just one property if sizeable enough and/or;
- Flooding to critical services such as hospitals, care homes, schools and emergency services.

Given that the flooding events across Stockport in June 2016 affected a large number of residential properties and critical infrastructure, such as rail links, bridges and 'A' roads, the event meets the above 'significant flooding' triggers and therefore a full investigation is required.

For the purposes of this report, only communities with more than five property flooding incidents are discussed in Section 3 to 3.7. Section 3.8 provides a summary of all other communities affected, where five or less flooding incidents were recorded, and Section 4 covers the flood effects on local critical infrastructure.

1.4 Relevant Risk Management Authorities

The responsibilities for managing flooding in the UK is divided between different RMAs as defined in the Act. RMAs have powers and duties to manage the different forms for flooding that can occur, as listed in Table 1.2. Although each RMA has their own responsibilities, managing local flood risks often requires RMAs to work together.

Table 1.1 : RMAs within Stockport and their areas of responsibility

Flood Source	Environment Agency	Lead Local Flood Authority (the Council)	Water Companies (United Utilities)	Highway Authority (the Council & Highways England)
Main River	ü*			
Ordinary Watercourse		ü*		
Surface water from highway				ü
Surface water from other sources		ü		
Sewer flooding			ü	
Groundwater flooding		ü		
Water supply infrastructure			ü	
Reservoirs	ü**	ü**	ü**	ü**

** Main Rivers have been designated as such by the Environment Agency. These tend to be major rivers or rivers with a high flood risk. Ordinary Watercourses are all other rivers and streams not classified as Main Rivers.*

*** RMAs have varying responsibilities for reservoirs, including asset management, regulation and emergency planning*

The Act and the Stockport LFRMS provide a full description of RMA responsibilities. Relevant RMAs to this investigation are outlined below.

1.4.1 Environment Agency

The Environment Agency has a strategic overview of all sources of flooding and coastal erosion. They are also responsible for flood and erosion risk management activities on Main Rivers and the coast, regulating reservoir safety, and working in partnership with the Met Office to provide flood forecasts and warnings.

1.4.2 Stockport Metropolitan Borough Council

The Council has a joint risk management role in its capacity as district council, highway authority and LLFA. As a highway authority, the Council has a duty under the Highways Act 1980 to maintain highways that are maintainable at public expense. This requires attention to the drainage requirements of the public highway.

As LLFA, the Council has a number of duties and powers as laid out under the Act, in addition to the duty to investigate flooding set out above. These include, but are not limited to, a duty to develop and apply a LFRMS for its area, a duty to develop a register of structures or features that might affect flood risk, the power to undertake works for manging flood risk and power to take enforcement action where there is an obstruction to an Ordinary Watercourse.

The Council also takes an overseeing role to ensure that RMAs and landowners are fulfilling their responsibilities adequately.

1.4.3 Highways England

Highways England has responsibility as a highway authority for the motorways in Stockport. It shares the same flood risk management duties as the Council as a highway authority.

1.4.4 Water Companies

Under Section 94 of the Water Industry Act 1991, water companies have a duty to provide and maintain sewers for the drainage of buildings and the associated paved areas within property boundaries. They are also now responsible for transferred sewers under the 'Transfer of Private Sewer Regulations 2011' and lateral drains, which communicate with the public sewers.

United Utilities are the local water company serving the borough of Stockport. With regards to local flood risk management, they are responsible for any flooding which is directly caused by its assets – i.e. water or sewerage pipes, and must maintain a register of properties that have flooded due to hydraulic incapacity of the sewerage network, and have a duty to cooperate with other relevant authorities.

1.4.5 Riparian Landlords and Residents

Riparian landowners are those who own land adjoining or containing a watercourse. They have certain rights and responsibilities, including the maintenance of watercourses and assets within their ownership to ensure flood risks are not increased upstream or downstream of their land. Private drains are also the responsibility of property or landowners to maintain.

Residents who are concerned they may be at risk of flooding should take appropriate action to protect themselves and their property. These actions include registering to receive Flood Warnings, obtaining a personal supply of sandbags, and moving valuable items to higher ground. They also include more resilient and permanent property protection measures including water resistant doors, airbrick covers, floodgates, raised electrical sockets and the fitting of non-return valves on pipes.

2. Overview of Flood Events

2.1 June 2016

Four rainfall events occurred during the month of June 2016 resulting in significant flood events within Stockport; these took place on 8 June, 10 June, 11 June and 16 June.

This section of the investigation provides an overview of the hydrological conditions that led to the flooding events in Stockport. In order to do so, three key datasets were reviewed:

1) **Environment Agency Water Situation Reports**[2] - the Environment Agency issues monthly water situation reports for England that provide an overview of various hydrological information for that month, including rainfall, soil moisture and river flows.
2) **Centre for Ecology and Hydrology Hydrological Summary Reports**[3] - the Centre for Ecology and Hydrology issues reports for the UK, which, similar to the Water Situation Reports, provide analysis of various hydrological records for the month.
3) **Environment Agency Radar Imaging** - the Environment Agency provided radar imaging of the storms on the 8 and 11 June. Whilst these images help provide an understanding of where and when the storms were most intense, they do not necessarily provide a good overall picture of the event and as such have not been used in this section of the report, but have been used in the site-specific analysis.

The Hydrological Summary Report states that the first week of June 2016 was dry and settled, but showers and storms dominated the rest of the month, bringing substantial rainfall. According to the report, Stockport received equal to or above 200% of the 1971 to 2000 long-term average rainfall in June 2016.

The Environment Agency Water Situation Reports provide a measure of Soil Moisture Deficit at a very high level across the UK (40 x 40 km grid resolution), which is a measure of how saturated the ground is; low values reflect more saturated ground conditions, high values reflect less saturated ground conditions.

For the area covering Stockport, the report states that the Soil Moisture Deficit was below the 1961 to 1990 long term average at the end of May 2016 (by 25 to 6 mm) and even further below the long term average at the end of June 2016 (by 50 to 26 mm). The report also classes the absolute value of the Soil Moisture Deficit in seven bands as a relative indication of soil moisture. For Stockport, the Soil Moisture Deficit fell from the second lowest band (11 to 40 mm) to the lowest band (<=10 mm) from the end of May to the end of June 2016.

In summary, the two reports indicate that the ground conditions were heavily saturated through May and leading up to June, with ground in the Stockport area being more saturated than average. These saturated ground conditions meant that, once the rainfall events hit on the 8, 10, 11 and 16 June, more surface water runoff than typical for the time of year would have been generated (from unpaved areas), with a greater potential for rapid surface water flooding and rapid increases in river levels.

2.1.1 Rainfall Records

There is only one Environment Agency rain gauge in Stockport, which is located at the Meadowbank School in Cheadle. The rain gauge is a tipping bucket rain gauge recording at 15-minute intervals.

Figure 2.1, which presents the daily rainfall totals recorded during the month of June 2016, shows that the rain gauge did not record any rainfall at the start of June, and that the rain only started on the 7 June and built to a peak on the 11 June. Following the 11 June, the data shows rainfall generally decreasing day on day until 16 June, when a standalone day of heavy rainfall was recorded.

[2] https://www.gov.uk/government/collections/water-situation-reports-for-england
[3] http://nrfa.ceh.ac.uk/monthly-hydrological-summary-uk

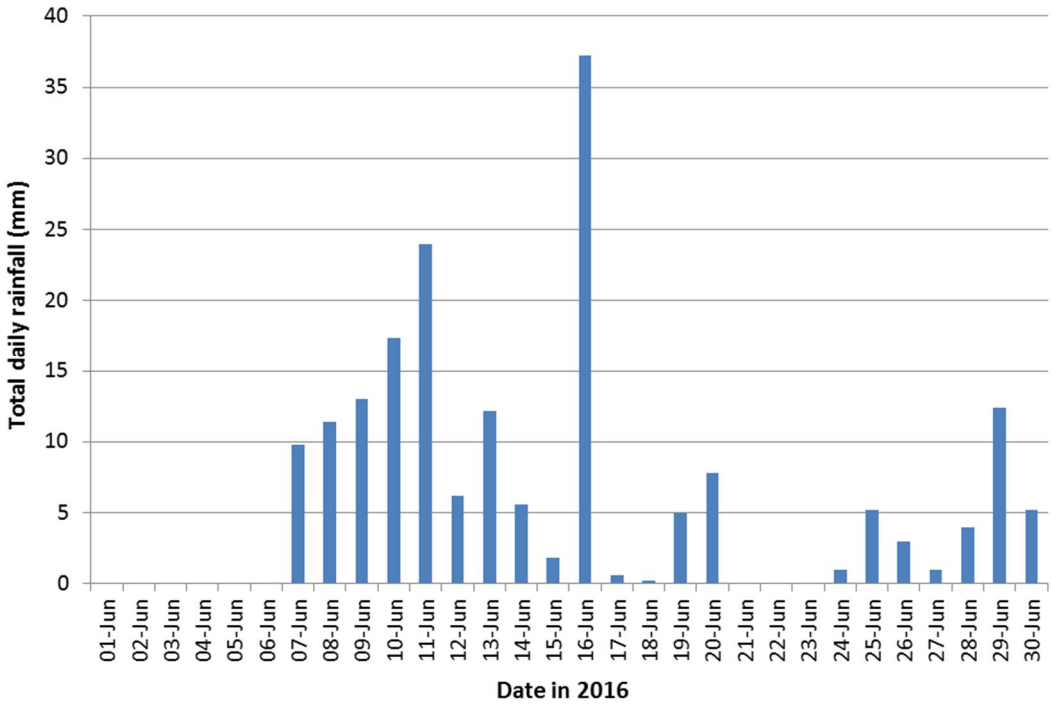
The total daily rainfall recorded on 16 June exceeded that of 11 June. The data shows that the gauge recorded rainfall on most days during the rest of the month, but the daily rainfall totals generally do not exceed those recorded in the first half of the month.

Four days of increasing amounts of rainfall leading to the 11 June would suggest that the ground conditions in Stockport would have been saturated before the flooding incident on the 11 June, supporting the Environment Agency's Soil Moisture Deficit values. This data also supports the analysis that a larger proportion of the rainfall on the 11 June would have resulted higher levels of surface water runoff, which would have then entered into the local watercourses.

The gauge recorded a greater amount of rainfall on the 16 June than on any other day during the month of June. This equated to more property flooding in Cheadle and Edgeley (a neighbouring suburb), whilst other areas of Stockport suffered greater impacts on the 8 June, 10 June and 11 June.

This highlights the spatial variation of rainfall across Stockport, and whilst one location would receive significant rainfall, other areas of Stockport would not. This could also indicate that the duration over which rain fell on each day was important to the flooding that occurred.

Figure 2.1 : Daily rainfall totals recorded during June 2016 at Meadowbank School rain gauge



On closer inspection of the detailed rainfall recorded on the key flooding dates, it shows that:

- 8 June - the rainfall was high in intensity and short in duration: the rainfall event began at 15:00 and ended at 16:30, with a peak intensity of 20 mm/hr.
- 10 June - the rainfall was very high in intensity and short in duration: the rainfall event began at 13:45 and ended at 15:15, with a peak intensity of 30 mm/hr.
- 11 June - the rainfall was lower in intensity but much longer in duration: the rainfall event began at 10:00 and ended at 18:00, with a peak intensity of 11 mm/hr.
- 16 June - the rainfall was very high in intensity and short in duration: the rainfall event began at 16:45 and ended at 19:30, with a peak intensity of 38 mm/hr.

From these conditions, one might expect:

- 8 June, 10 June and 16 June - short duration and high intensity rainfall events would overwhelm urban drainage systems and result in predominantly surface water flooding.
- 11 June - a lower intensity but longer period of rainfall over a river catchment would allow river levels to build, resulting in predominantly fluvial flooding. Urban drainage systems are also better at coping with lower intensity rainfall.

2.1.2 River Level Records

Of the river catchments in Stockport where fluvial flooding occurred in June 2016, Poise Brook is the only gauged watercourse for which a record is available for the event. This gauge is located on the outlet debris screen of the reservoir on Poise Brook at the head of Cooper Street in Hazel Grove. The Environment Agency primarily use it to determine if the debris screen requires clearing, but it is also used to provide Flood Warnings to properties located in vulnerable areas along this watercourse.

During the month of June 2016, the river gauge records show a clear peak on the 11 June followed by slightly elevated levels on 12 June. The gauging station became operational during October 2014 and consequently the historical record is short. However, the peak level recorded on the 11 June 2016 was the highest level recorded in the station's history, with a peak level of 2.04m. The average level recorded since the station opened was approximately 0.06m.

Section 3.2 and 3.3 makes further detailed analysis of the impacts of raised levels on Poise Brook on flooding in the Hazel Grove and Offerton Green.

2.2 Property Impacts

295 properties suffered flooding across June 2016, with some properties flooded on more than one occasion. The most significant impacts were observed on the 11 June, with 186 properties across Stockport reported to have been affected by flooding. The second most extensive flooding event occurred on the 16 June, when 77 properties were affected by flooding, followed by the 8 June, when 75 properties were affected and 10 June, when 30 properties were affected.

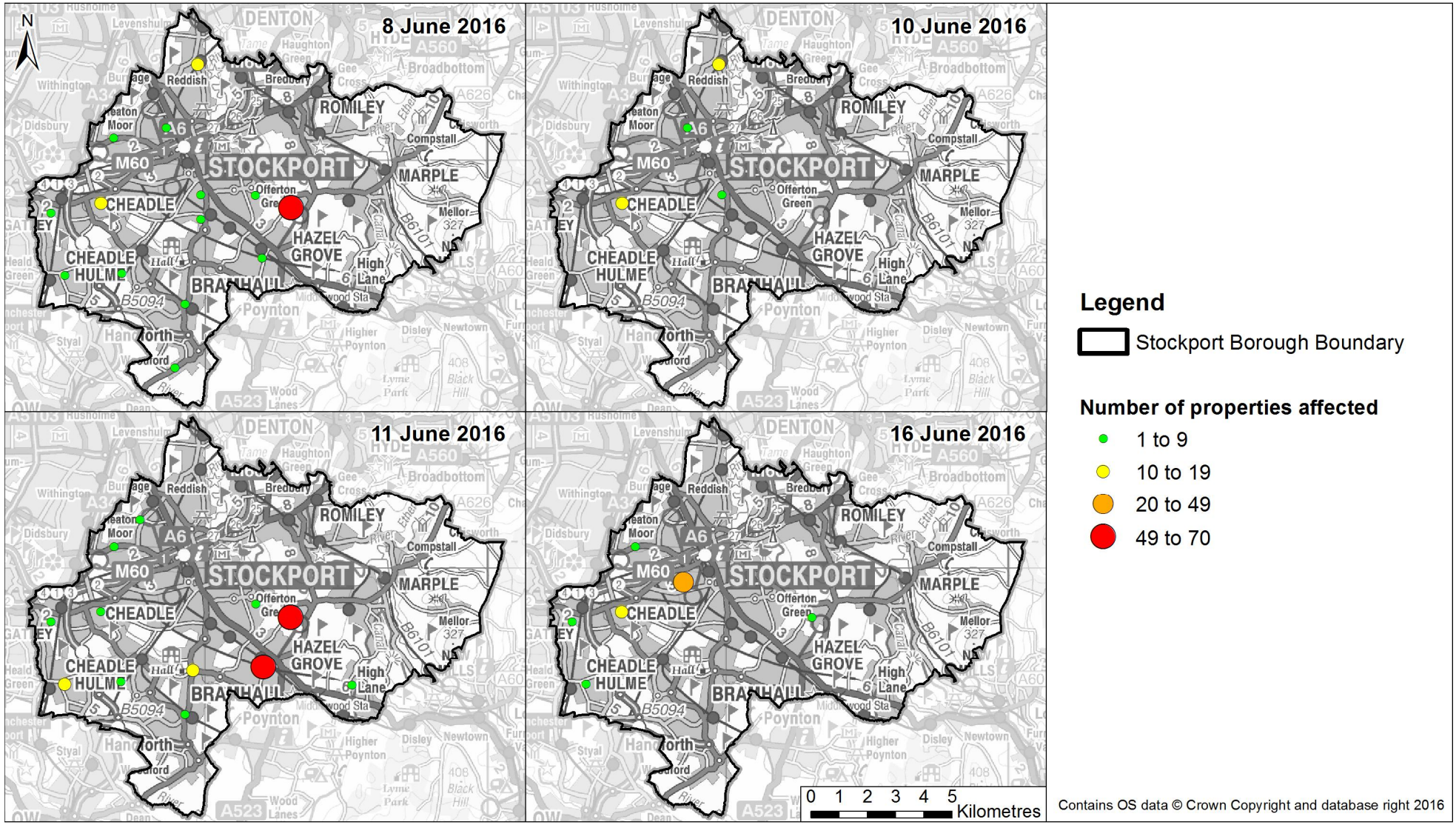
Each flood event in June 2016 differed in terms of the location affected, the cause of flooding and whether interior or exterior property flooding occurred. Figure 2.2 presents the locations of the communities affected by each flooding event and the scale of property flooding. The following report sub-sections provide an overview of each flood event, the general cause of flooding and specifically where property flooding was recorded.

The Council have provided financial assistance to those properties impacted by the June 2016 floods in the form of grant funding and council tax freezes, where it can be demonstrated that a property was flooded internally. Over 130 flooding grants have been approved to householders during the period from the start of July to the end of November 2016.

This report does not identify the locations of individual properties reported to have flooded during June 2016 events for reasons of confidentiality. Instead, the total numbers of properties affected are aggregated by communities and then on a road-by-road basis. The numbers of properties affected have been derived from a combination of data provided by the Council, the Environment Agency and United Utilities.

Caution must be taken then quoting the figures in this report, as there will be a number of outlining reasons why a property may or may not have reported flooding. For example, there may be cases residents were unavailable when contacted by each RMA or where residents did not want to report their property flooding.

Figure 2.2 : Location and extent of property flooding – June 2016



2.2.1 8 June 2016

Eleven separate communities in Stockport reported property flooding on the 8 June, which were generally located on the western half of the borough. Table 2.1 provides a detailed breakdown of the number of property flooding incidents by community and impact (whether internally flooded or externally flooded only).

Offerton Green was the worst hit area, with over 75% of the reported property flooding occurring here. Other communities through Stockport were affected by this event, but no more than five properties were affected in any single community. Analysis of the flood incident records reveals that all of the reported property flooding was caused by sewer flooding on this date.

Table 2.1 : Communities affected – 8 June 2016

Community	Number of properties affected		
	Internally	Externally (only)	Total
Bramhall	1	1	2
Cheadle	3	0	3
Cheadle Hulme	5	0	5
Davenport	1	0	1
Gatley	0	1	1
Hazel Grove	1	0	1
Heald Green	0	1	1
Heaton Mersey	0	1	1
Offerton	0	2	2
Offerton Green	17	40	57
Woodford	0	1	1
Total	**28**	**47**	**75**

2.2.2 10 June 2016

Four separate communities in Stockport reported property flooding on 10 June 2016, which were generally located in the north-west of the borough. Table 2.2 provides a detailed breakdown of the number of property flooding incidents by community and impact (whether internally flooded or externally flooded only).

The majority of flooding occurred in the communities of Reddish and Cheadle; only a couple of incidents were recorded near Stockport town centre in Cale Green, and one incident in Heaton Norris. Analysis of the flooding incident records reveals that approximately 80% of the flooding incidents on this date were the result of sewer flooding, and the remaining 20% were caused by groundwater flooding.

Table 2.2 : Communities affected - 10 June 2016

Community	Number of properties affected		
	Internally	Externally (only)	Total
Cale Green	2	0	2
Cheadle	10	0	10
Heaton Norris	1	0	1
Reddish	16	1	17
Total	**29**	**1**	**30**

2.2.3 11 June 2016

Twelve separate communities in Stockport reported property flooding on the 11 June, which, like the 8 June, were generally located on the western half of the borough. Those communities suffering significant property flooding include Offerton Green, Hazel Grove, Bramhall Green and Heald Green. Table 2.3 provides a detailed breakdown of the number of property flooding incidents by community and impact (whether internally flooded or externally flooded only).

Nearly 75% of the reported flooding incidents occurred in Hazel Grove and Offerton Green, with roughly the same number of properties affected in each location. United Utilities records show that 50 properties in Offerton Green that flooded in on the 8 June, flooded again on the 11 June. Bramhall Green and Heald Green shared a similar degree of property flooding, although the flooding at these locations was much less extensive than at Hazel Grove or Offerton Green.

In contrast to the 8 June flood event, fluvial flooding was a significant driver of the property damage caused, in combination with sewer flooding and groundwater flooding to a lesser degree.

Table 2.3 : Communities affected - 11 June 2016

Community	Number of properties affected		
	Internally	Externally (only)	Total
Bramhall	0	1	1
Bramhall Green	12	6	18
Cheadle	1	1	2
Cheadle Hulme	0	3	3
Gatley	1	3	4
Hazel Grove	17	47	64
Heald Green	3	11	14
Heaton Mersey	1	0	1
Heaton Moor	0	2	2
High Lane	1	4	5
Offerton	2	2	4
Offerton Green	66	2	68
Total	**104**	**82**	**186**

2.2.4 16 June 2016

The flood event of the 16 June was the least extensive of the three events, with incidents confined largely around the communities of Edgeley and Cheadle. Table 2.4 provides a detailed breakdown of the number of property flooding incidents by community and impact (whether internally flooded or externally flooded only).

Approximately 50% of the property flooding incidents occurred in Edgeley, with about 25% of the incidents recorded in nearby Cheadle. United Utilities records indicate that seven properties, which were flooded in Offerton Green on the 8 June, also flooded on the 16 June. In terms of source of flooding, this event was similar to event of the 8 June, with sewers the main source of flooding. Fluvial flooding to properties was not reported.

Table 2.4 : Communities affected - 16 June 2016

Community	Number of properties affected		
	Internally	Externally (only)	Total
Cheadle	18	1	19
Edgeley	33	7	40
Gatley	1	1	2
Heald Green	4	4	8
Heaton Mersey	0	1	1
Offerton Green	0	7	7
Total	**56**	**21**	**77**

3. Communities Affected

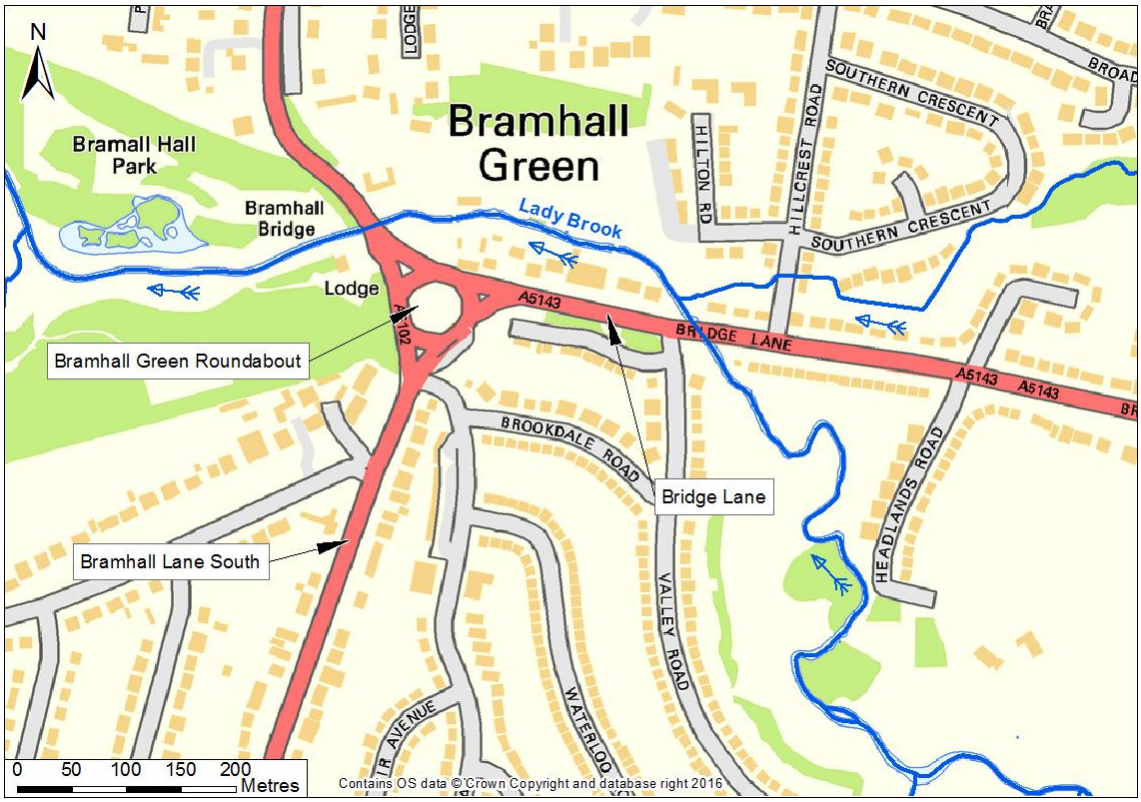
3.1 Bramhall Green

3.1.1 Site Overview & Flooding Impacts

Bramhall Green is a suburb of Stockport and is located between Cheadle Hulme to the west and Hazel Grove to the east. Lady Brook is a Main River, which flows from east to west through the area; there are also several smaller tributaries of Lady Brook that drain through the area.

Eighteen properties located on Bridge Lane (residential and commercial) suffered flooding on the 11 June, of which twelve properties suffered internal flooding. The Bramhall Green roundabout (shown in Figure 1.1) and Bridge Lane were flooded and were subsequently closed to traffic. The flooding also led to the evacuation of some of the local residents.

Figure 3.1 : Bramhall site overview



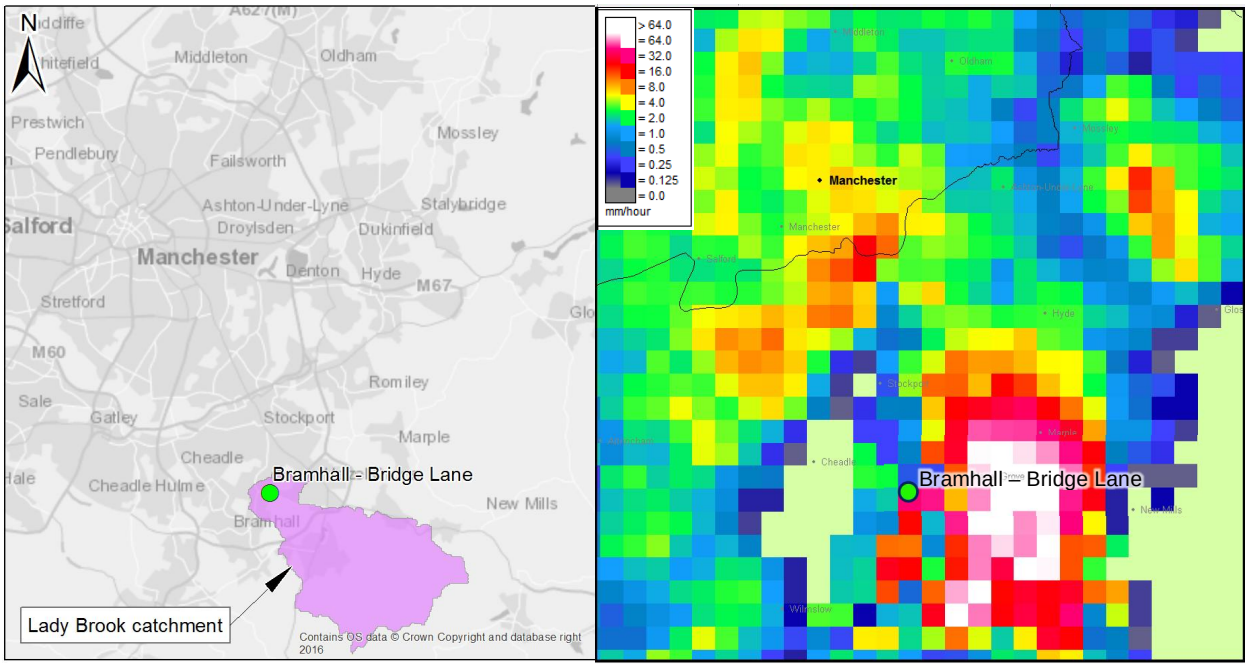
3.1.2 Flooding Analysis

Data suggests that Bridge Lane on the 11 June was flooded by a combination of surface water flooding and fluvial flooding. In the early to late afternoon, heavy rainfall resulted in the highway drainage on Bridge Lane becoming overwhelmed; consequently, rainfall pooled on Bridge Lane and at the Bramhall Green roundabout, encroaching on the front of the properties. In the early evening, steadily rising levels on Lady Brook then overtopped into the rear of the properties on Bridge Lane and flowed towards the road.

The rainfall radar snapshot at 14:00 on the 11 June, presented in Figure 3.2, would indicate that the Bridge Lane area of Bramhall received intense rainfall during the day (at least, for a period). The evidence suggest that the volume of rainfall overwhelmed many of the highway drains in the Bramhall area and that runoff flowed along Bramhall Lane South and contributed to the flooding on Bridge Lane. The Environment Agency Flood

Map for Surface Water[4] confirms that surface water runoff originating south of Bridge Lane naturally drain towards Bridge Lane via Bramhall Lane South.

Figure 3.2 : Radar rainfall intensities at 14:00 on 11 June 2016 at Bramhall (source: Environment Agency)



Comparing the catchment of Lady Brook (left image) with the rainfall radar snapshot (right image) of Figure 3.2, it can be seen that a significant proportion of the catchment was located within the most intense part of the rainfall event and a significant amount of rain would have fallen on the catchment of Lady Brook.

Given that the ground conditions were already highly saturated before the storm hit, it is likely that a significant proportion of the rain that fell on the Lady Brook catchment would have resulted in direct runoff. Based on the Meadowbank School rain gauge record (Section 2.1.1); the event on the 11 June lasted for approximately eight hours. This means that runoff into Lady Brook would have been generated over a long period, allowing the water levels to rise.

No water level gauges are located on Lady Brook, however based on reports of the flooding it took approximately 4 to 4.5 hours from the time of the rainfall radar snapshot above for water levels to rise significantly enough in Lady Brook to overtop the banks at Bridge Lane. The Environment Agency issued a Flood Alert for this area at 19:42 on the 11 June, but river flooding had already occurred by this time.

Analysis of the local topography shows that Bridge Lane is low-lying when compared to the surrounding area, which would explain why it is more prone to flooding from the river. There are two single span access bridges, which cross Lady Brook between Bramhall Bridge and the Bridge Lane crossing and information suggests that debris did not block these bridges during the flood event. Because water levels rose above the soffit level at the upstream face of Bramhall Bridge, it is possible that this structure is a pinch point controlling water levels in this reach of watercourse.

In partnership with the Council, the Environment Agency will seek to obtain funding for further investigations including a review of the existing detailed hydraulic model for the designated Main River Lady Brook.

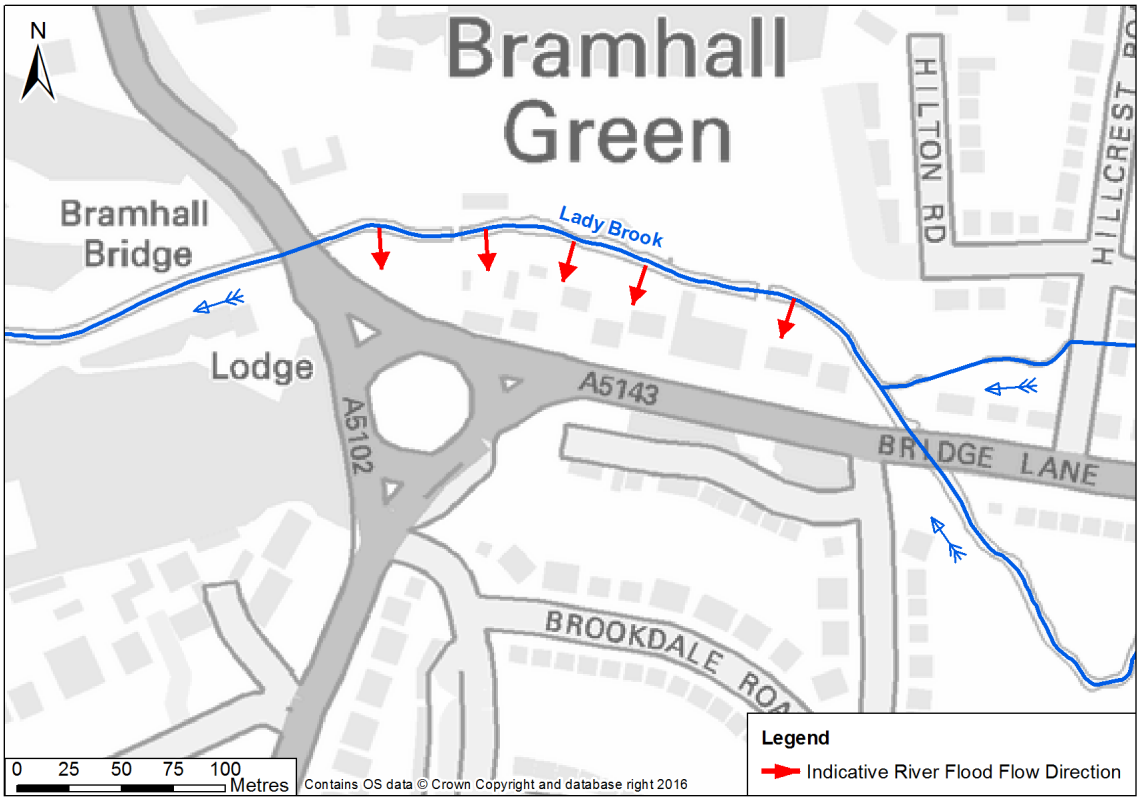
The flooding in the Bridge Lane area of Bramhall on the 11 June 2016 was not unprecedented. The BBC's Domesday Project (1986) has an entry regarding flooding in Bramhall in July 1973[5]; this entry records that

[4] Available at: https://flood-warning-information.service.gov.uk/long-term-flood-risk/

[5] Domesday Reloaded, 1986 'The Flood' http://www.bbc.co.uk/history/domesday/dblock/GB-388000-384000/page/19 (Accessed 22/08/2016)

Bridge Lane is prone to flooding, and in July 1973 a violent thunderstorm resulted in spilling from the drainage sewers and Lady Brook bursting its banks in places. During this event, shops and houses were reportedly under water to a depth of three feet. The Manchester Evening News[6] also reports that Lady Brook flooded the gardens of properties on Bridge Lane more recently, in April 2010.

Figure 3.3 : Lady Brook flood flow routes



During the rainfall event on the 11 June, a manhole on the Bramhall Green roundabout was reported to lift and spill water on to the highway. This was also not the first time that flooding from this manhole had been reported. Following the event, the Council investigated the connecting pipework, and discovered that certain sections were in poor structural condition and partially blocked by roots.

In response, the Council have replaced approximately 18 metres of pipework and have installed a new manhole chamber on the system to aid investigations. Investigations and discussions are ongoing between the Council and United Utilities to confirm which authority is responsible for maintaining the system.

Regarding the impact of new development within the area on local flood risk, construction of the A6MARR was ongoing at the time of the June 2016 flood events, which follows a route adjacent to Norbury Brook and crosses Lady Brook near Norbury Moor. Earthworks for this section of the new road were under construction during June 2016 and were unlikely to have contributed a significantly greater volume or rate of runoff to either Norbury Brook or Lady Brook compared to a pre-construction case. The area being developed for the road is small in relation to the total catchment area of Lady Brook and as a result, the Scheme is considered to have had a negligible impact on the flooding at Bramhall from Lady Brook.

It is also worth highlighting that as a planning condition the completed highway must not increase the runoff received by any of the local watercourses; the road drainage systems must mimic the existing drainage mechanisms of the area developed. As such, local flood risk should not be increased as a result of this scheme.

[6] MEN article from 19/04/2010 - http://www.manchestereveningnews.co.uk/news/local-news/flooding-misery---and-theres-more-966675 (accessed 22/08/2016)

Over 5km of the Macclesfield Canal passes through the catchment of Lady Brook. The Canal and River Trust were contacted and confirmed that the rainfall events during June 2016 did not affect the canal as they reported that no water level alarms were triggered, no manual releases were made and no flooding from the canal was reported.

3.2 Hazel Grove

3.2.1 Site Overview & Flooding Impacts

Hazel Grove is a suburb of Stockport and is located between Norbury Moor to the south and Offerton Green to the north. The Main River Hazel Grove Brook[7] flows in a northerly direction through Torkington Park and Hazel Grove. It becomes Poise Brook downstream of Bosdenfold Road, where it receives flow from the Poise Brook reservoir located at the head of Cooper Street. Offerton Green is located approximately 500m downstream of Hazel Grove on Poise Brook; the flooding here is discussed in Section 3.3 of this report.

64 residential properties were reported to have suffered flooding in Hazel Grove on 11 June; the majority of this flooding was only to the outside of properties and caused no internal damage. External flooding was reported at 47 properties: 23 properties on Nelson Street, 15 properties on Hazelwood Road, five properties on Wellington Street, two properties on Knowsley Road and one property on each of Buckwood Close and Macclesfield Road. Internal property flooding was also reported at 17 properties: five properties on Hazelwood Road, four properties on Torkington Road, three properties on Buxton Road, two properties on each of Chester Road and Kintore Avenue, and one property on Offerton Road.

Torkington Park was also flooded (see Figure 3.4) and both Torkington Road and Hazelwood Road were closed to traffic because of flooding on the highway (see Figure 3.5).

Figure 3.4 : Torkington Park Flooding – 11 June

Figure 3.5 : Torkington Road Flooding – 11 June – looking east from Hazelwood Road junction

[7] For clarity, Hazel Grove Brook is often referred to as Poise Brook through this part of Hazel Grove; this report uses the Environment Agency naming conventions for the local watercourses – this is less misleading when referring to river gauge locations.

Figure 3.6 : Hazel Grove (north) site overview

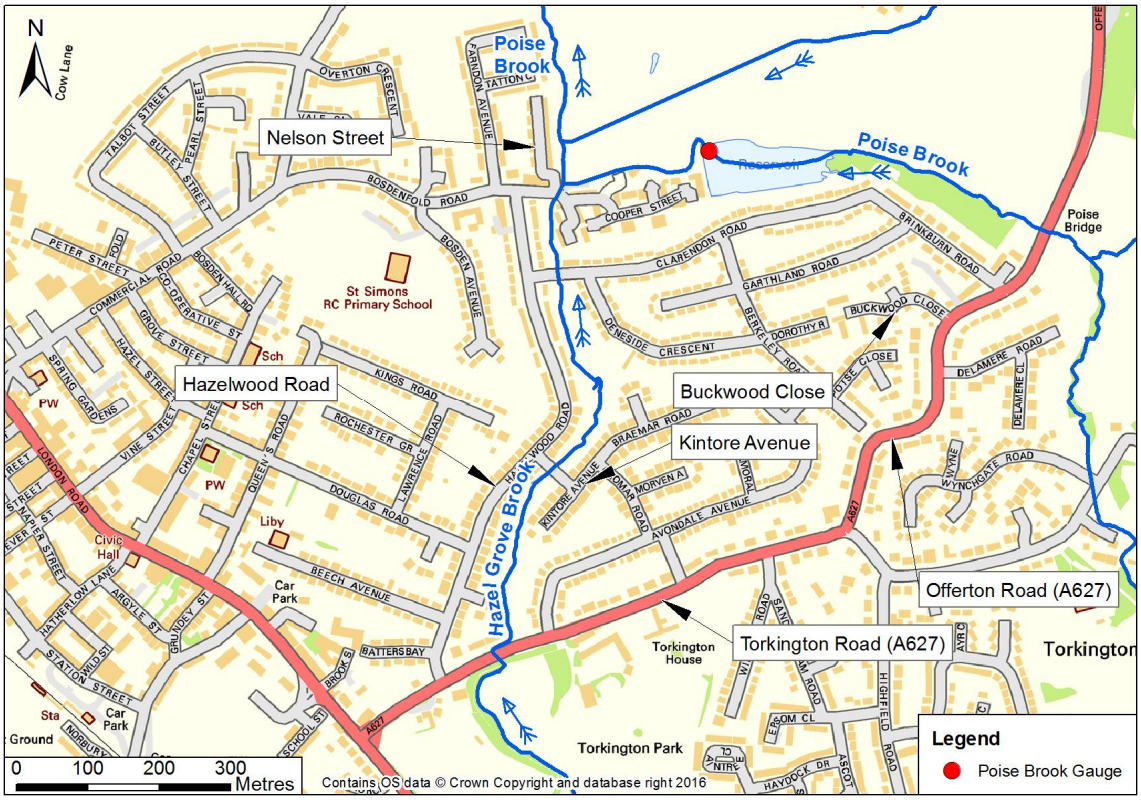
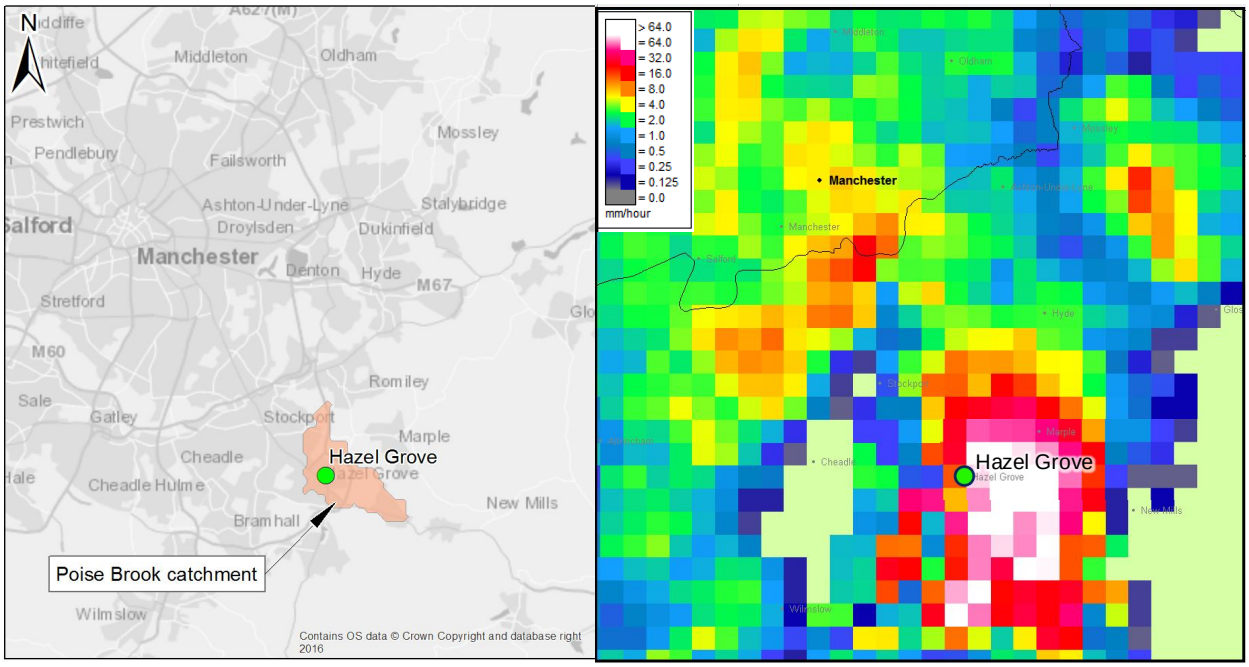


Figure 3.7 : Hazel Grove (south) overview

3.2.2 Flooding Analysis

Figure 3.8 presents the rainfall radar snapshot at 14:00 on the 11 June, which shows that Hazel Grove was located within a large area of extremely intense rainfall within the storm. The majority of properties within Hazel Grove were flooded by Hazel Grove Brook, however highway, sewer and groundwater flooding was also a factor.

Figure 3.8 : Radar rainfall intensities at 14:00 on 11 June 2016 at Hazel Grove (source: Environment Agency)



Whilst the rain that fell directly over Hazel Grove resulted in relatively little impact in terms of surface water flooding, the impact of the rain that fell on the catchment of Poise Brook and drained to the river was much more detrimental.

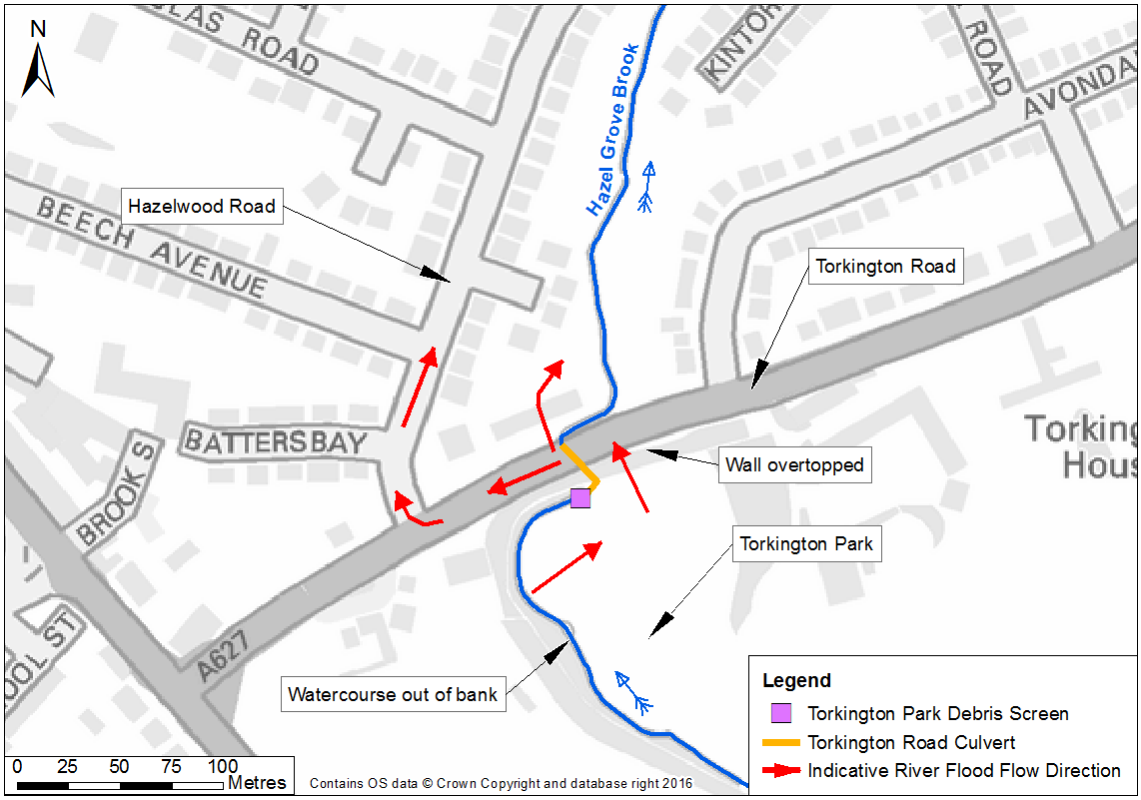
From the local rain gauge record, Section 2.1.1, it is possible to assume that rain fell continuously on the Poise Brook catchment for up to eight hours on the 11 June. Comparing the catchment of Poise Brook (on the left of Figure 3.8) with the rainfall radar snapshot (to the right), it can be seen that the entirety of the catchment area draining to Poise Brook (and Hazel Grove Brook) was also located within the most intense part of the storm at one time. These rainfall conditions, combined with already saturated ground conditions (which would have converted more of the rainfall directly into runoff) would have allowed the water levels on Poise Brook (and Hazel Grove Brook) to stay elevated for long enough for significant volumes of water to spill out of bank, resulting in the flooding observed.

Data from the water level gauge at the Poise Brook reservoir would suggest that the river took a couple of hours to fully respond to the rain that fell on the catchment, with water levels shown to rise sharply from approximately 13:30 until they their peak at 16:00. It is likely that Hazel Grove Brook responded in a similar manner.

Starting upstream, Hazel Grove Brook burst its banks within Torkington Park and flooded the park. The wall between Torkington Park and Torkington Road was overtopped, flooding the road and two properties internally. This floodwater passed onto and flowed north along Hazelwood Road; it is understood that this floodwater caused highway or driveway flooding. Figure 3.9 illustrates this flooding mechanism.

Hazel Grove Brook is culverted under Torkington Road from the downstream end of Torkington Park. A debris screen is installed on the culvert inlet (see Figure 3.9) to help reduce the risk of flooding caused debris build up within culverts, with internal blockages significantly more difficult to remove.

Figure 3.9 : Hazel Grove Poise Brook flood flow routes



The Environment Agency started clearing the debris screen on the 8 June and returned on the 10 June to complete the clearance as works were disrupted by the rainfall event on the 8 June. The debris screen was therefore clear of any blockage prior to the start of the flooding event on the 11 June. Material washed into the watercourse during the event on the 11 June is reported to have caused some blockage of the screen; this may have contributed to elevated levels on Hazel Grove Brook within Torkington Park. The Environment Agency attended site on the 12 June to clear the screen following the event, once levels on Hazel Grove Brook had receded and it was safe to undertake the clearance works.

Downstream of the Torkington Road culvert, Hazel Grove Brook spilled out of bank and directly flooded the gardens of several properties on Hazelwood Road and five properties internally. The front gardens of 23 properties on Nelson Street (See Figure 3.9) were also flooded directly from Poise Brook, halfway up to the properties.

United Utilities investigated the reported flood on Buckwood Close and Buxton Road and the cause of flooding was found to be related to private sewers (and therefore outside of United Utilities' remit). One property on Chester Road was found to have suffered groundwater flooding. United Utilities investigated the remaining properties on Chester Road, Knowsley Road, Macclesfield Road and Offerton Road and it was found that flooding resulted from United Utilities sewers, which were operating as designed but were overwhelmed by the exceptional rainfall event. Reports also identified highway flooding on Kintore Avenue, with water entering two properties.

Regarding the impact of new development on local flood risk, the catchment of Poise Brook does not extend outside the borough of Stockport, so only development within the borough could potentially affect the flood risk on this watercourse. Construction of the A6MARR was ongoing at the time of the June flood events, with a section of this road construction within the runoff catchment of Poise Brook further upstream from Torkington Park.

Earthworks for this section of the new road were undertaken construction during June 2016 and included some earthworks drainage to Ox Hey Brook (upstream of Hazel Grove Brook) via an attenuation pond. It is

considered unlikely that the construction works contributed a significantly greater volume or rate of runoff to Ox Hey Brook compared to a pre-construction case, and thus this investigation concludes that the Scheme had a negligible impact on the flooding from Hazel Grove Brook. As per the earlier comment regarding the impact of the A6MARR on the flooding at Bramhall, it is a planning condition that the scheme must not increase the local risk of flooding.

Approximately 1km of the Macclesfield Canal passes through the catchment of Hazel Grove Brook. As per the earlier comment in the analysis of the Bramhall flooding, the Canal and River Trust confirmed that the rainfall events during June 2016 did not impact the canal, as such it has been determined that the canal did not contribute to the flooding in Hazel Grove.

3.3 Offerton Green

3.3.1 Site Overview & Flooding Impacts

Offerton Green is a suburb of Stockport and is located between Marple to the east and Hazel Grove to the south. The Main River Poise Brook flows in a northerly direction through the area. The river flows adjacent to Minsmere Walks, flows under and then follows Bean Leach Road for approximately 300m before meandering away from Bean Leach Road and onwards towards its confluence with the River Goyt. Hazel Grove is located approximately 500m upstream of Offerton Green.

Offerton Green was affected by property flooding following all three extreme rainfall events during June 2016; however, the events of the 8 June and 11 June were most significant. 57 residential properties were affected by flooding on the 8 June, 17 of which suffered internal flooding; the properties impacted were located on Shearwater Road, Fulmar Drive and Holiday Lane.

Figure 3.10 : Offerton Green site overview

Three days after the first flood event, Offerton Green was affected again, with 68 residential properties suffered flooding on the 11 June, nearly all of which (66) suffered internal flooding, leading to the evacuation of some of the local residents.

United Utilities records show that 50 of the properties that flooded in Offerton Green on the 8 June also flooded again on the 11 June. Flooding was concentrated in two areas around Shearwater Road and Fulmar Drive, where 23 and 25 properties respectively flooded internally, and at Minsmere Walks where 12 properties flooded internally. Internal flooding was also reported at three properties on Bean Leach Road, at two properties on Teal Close and slightly further away at one property on Marple Old Road.

The Greater Manchester Fire Service attended the scene supported by the North West Ambulance Service Hazard Area Response Team (HART) and by Mountain Rescue. Because of the flooding, several local roads including Shearwater Road, Bean Leach Road and Fulmar Drive were closed.

The severity of flooding in Offerton Green was significantly lower in response to the rainfall event of 16 June; none of the housing that flooded earlier in the month in the Shearwater Road area was affected this time, however seven properties that flooded on Holiday Lane on 8 June were flooded again.

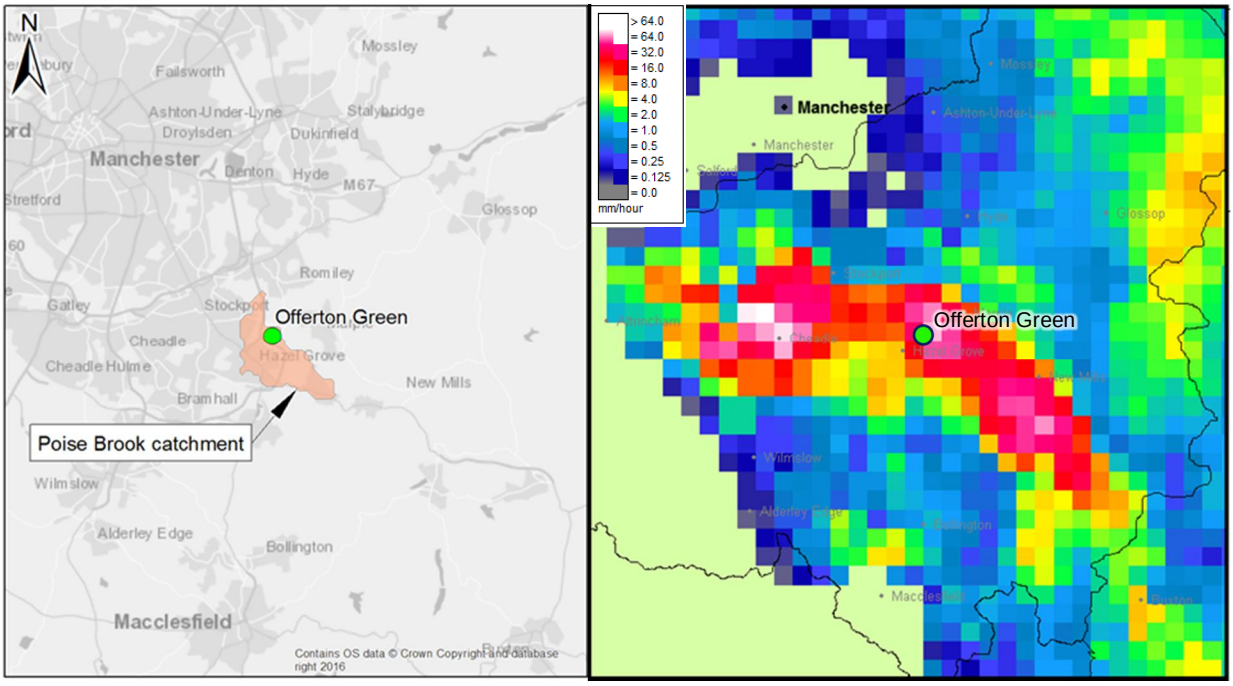
3.3.2 Flooding Analysis

3.3.2.1 8 June 2016

United Utilities reports indicate that the intensity and duration of rain that fell on the suburb on the 8 June 2016 overwhelmed the surface water sewers in the Offerton Green. As a result, rainfall pooled and caused external and internal flooding to properties in the area. Offerton Green has been highlighted on the snapshot of the rainfall radar at its peak during this storm event in Figure 3.11; this confirms that the area received particularly intense rainfall during this event

United Utilities reports that levels in Poise Brook were also high during this event; this may have affected the outfall of the local surface water sewer, reducing the capacity of the sewer and contributing to the observed flooding. Levels were not elevated at the Poise Brook reservoir on the 8 June as this gauge is not situated directly on the river itself.

Figure 3.11 : Radar rainfall intensities at 15:05 on 8 June 2016 at Offerton Green (source: Environment Agency)



3.3.2.2 11 June 2016

Three days later on the 11 June, flooding hit Offerton Green again. However, this time from both surface water flooding and fluvial flooding from Poise Brook. The information available on the timeline of events suggests that the area initially affected by surface water flooding, then later by river flooding.

Similar to the flooding event of the 8 June, the surface water sewer was overwhelmed following prolonged intense rainfall, resulting in surface water flooding and sewer flooding. The rainfall radar snapshot at 14:00 on the 11 June, presented in Figure 3.12, shows that Offerton Green was located within a large area of extremely intense rainfall within the storm; up to 78mm/hour was recorded at the most intense area of rainfall.

Figure 3.12 also indicates that the entirety of the Poise Brook catchment was subject to the worst impacts of the storm at this time. Data from the water level gauge at the Poise Brook reservoir suggests that the river took a couple hours to respond to the rain that fell on the catchment, with water levels shown to rise sharply starting from around 13:30 until they reached their peak at 16:00. This would correlate with reports from the residents that surface water and sewer flooding occurred first, followed by river flooding.

The rise in water levels on Poise Brook is likely to have further exacerbated surface water flooding by impeding the local surface water sewer outfall and preventing the ability of the sewer to drain effectively.

Figure 3.12 : Radar rainfall intensities at 14:00 on 11 June 2016 at Offerton Green (source: Environment Agency)

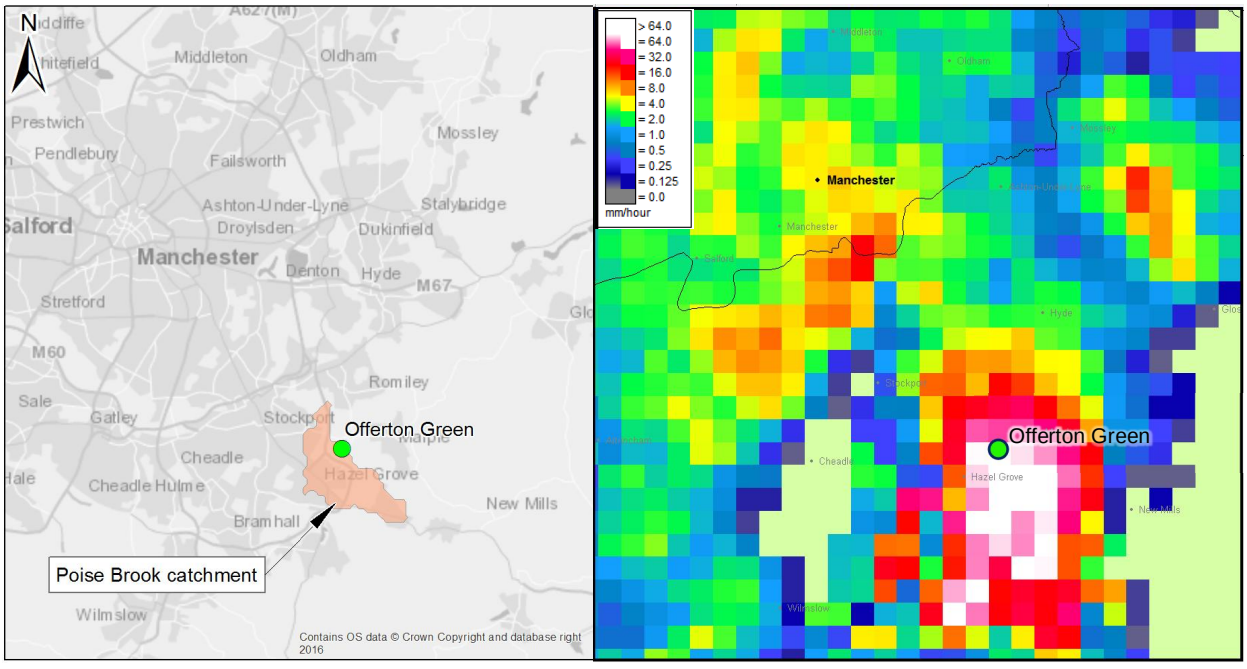


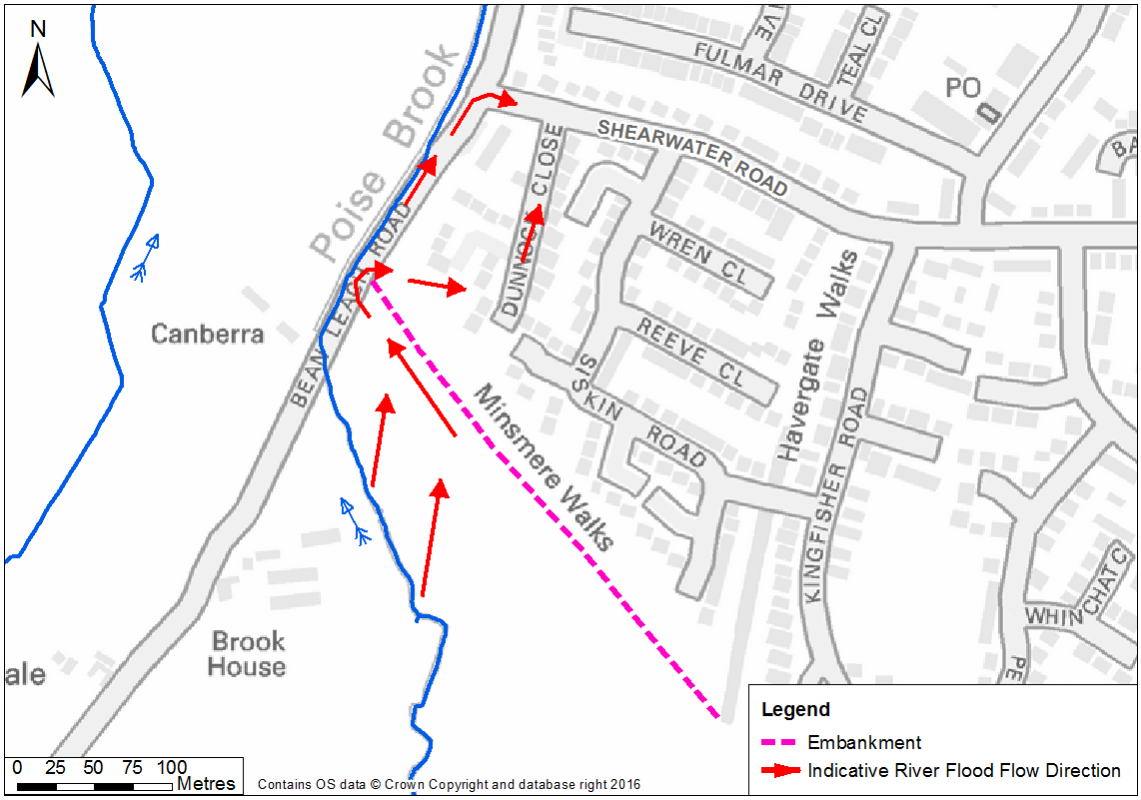
Figure 3.13 illustrates the flood flow routes from Poise Brook into the housing estate. The raised embankment shown in the figure is a privately owned landscaped feature and not an Environment Agency built and maintained defence. However, when the flood map for Poise Brook in this area was first produced (2005) and later revised (2012) the area north of the embankment was shown as benefitting from a defence as this landscaped feature retains floodwater from Poise Brook. The fluvial flood map in this area is scheduled to be updated in 2017 and the overland flow route will be reviewed in line with the flood event on the 11 June 2016. Private embankments are recorded in the Environment Agency Asset Inventory Management System (AIMS) and are inspected to highlight issues to third parties.

On the 11 June, Poise Brook spilled out of bank upstream of the Bean Leach Road crossing. Floodwater was obstructed behind the embankment and diverted onto Bean Leach Road, from where it flowed into the housing estate.

Inspection of the topography of Offerton Green reveals that Shearwater Road, Fulmar Drive and Teal Close (where the majority of properties were flooded) are located in the lowest topographic area of Offerton Green. The Environment Agency Flood Map for Surface Water shows that overland flow from the Offerton Green area naturally flows towards this area and collects. Bean Leach Road also lies at a higher elevation than the adjacent housing estate, so consequently, if Poise Brook floods onto Bean Leach Road, floodwater will naturally flow towards the lower lying areas of housing.

As Hazel Grove Brook becomes Poise Brook upstream of Offerton Green, the same comments made regarding the impact of development in the area and the construction of the A6MARR on the risk of flooding in Hazel Grove also apply to Offerton Green. Construction of the A6MARR is considered to have had a negligible impact on the flooding from Poise Brook in Offerton Green on the 11 June 2016.

Figure 3.13 : Poise Brook flood flow routes – 11 June 2016



United Utilities attended site in response to the 8 June and 11 June flood events and surveyed the local sewer network, but found no evidence of any blockages within the system that could have contributed to the flooding. United Utilities confirmed that the local surface water sewers were overwhelmed in response to the rainfall events.

A site visit on the 6 September 2016 found that the outfall for the surface water sewer draining this area was submerged in water to approximately half the bore of the pipe. Given that a period of dry weather was being experienced at the time of the site visit, this would indicate that the sewer would not be able to discharge effectively during a storm event, meaning that the system would not perform at maximum efficiency.

3.3.2.3 16 June 2016

Radar data of this rainfall event is not available at the time of this investigation; however, given that the Shearwater Road area of Offerton Green did not flood again on the 16 June, it would suggest that the storm on the 16 June was localised within Stockport, even within Offerton Green. The main cause of external property flooding to seven properties on Holiday Lane has been identified as hydraulic inadequacy in the local combined sewer network.

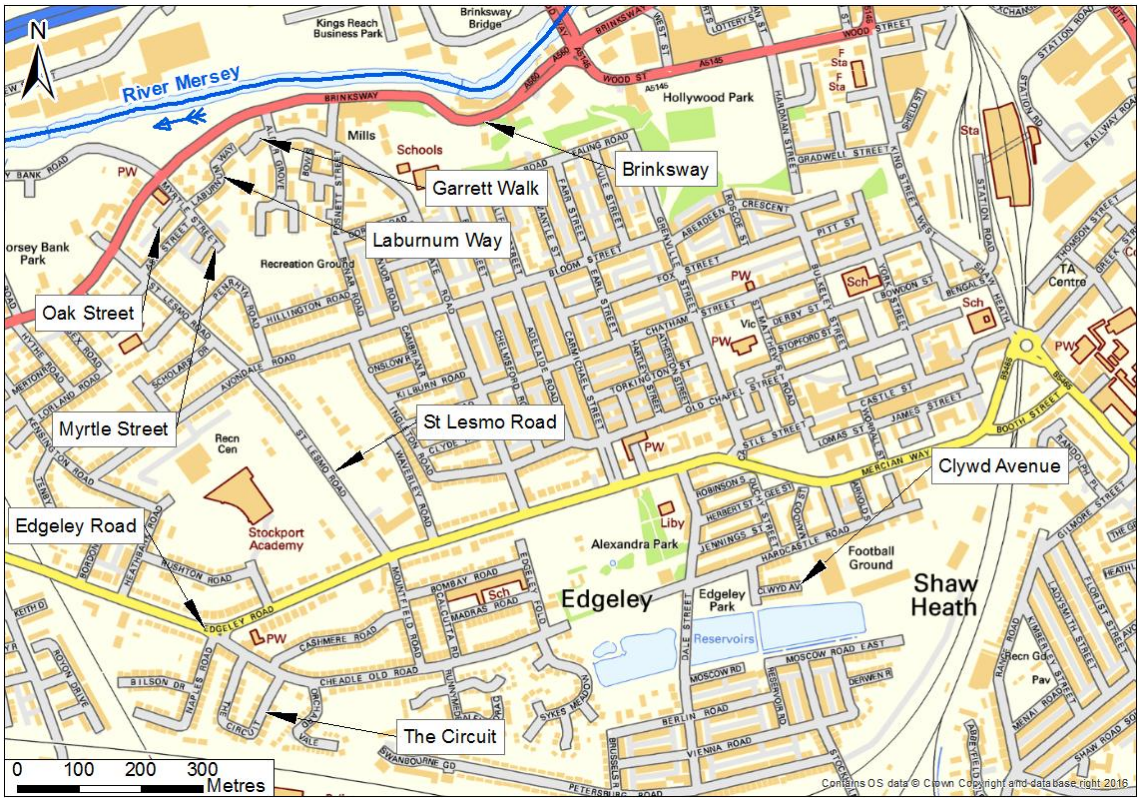
3.4 Edgeley

3.4.1 Site Overview & Flooding Impacts

Edgeley is a suburb of Stockport located directly to the west of Stockport town centre. During the evening of the 16 June, 40 residential properties across Edgeley suffered flooding; at all properties but one this was caused by sewer flooding. The greatest impact of this rainfall event was concentrated around Edgeley Road, where 25 properties were flooded; all but one of these properties flooded internally. Other locations affected included six properties on Oak Street, four on St Lesmo Road, two on Clwyd Avenue and one on The Circuit.

Besides property flooding, significant highway, pavement and driveway flooding occurred at the eastern end of Laburnum Way. Surface water ponding also affected the junction of Myrtle Street and A560 Brinksway.

Figure 3.14 : Edgeley site overview



3.4.2 Flooding Analysis

Radar data of this rainfall event was not available at the time of this investigation; however, the Meadowbank School rain gauge is located directly to the west of Edgeley and provides a good representation of the storm at this location. The rain gauge data shows that rain fell for approximately two hours starting at 17:00 and that the peak rainfall intensity reached nearly twice that of the 8 June and over three times that of the 11 June. The timing of the storm correlates with accounts from residents of the flooding occurring in the evening.

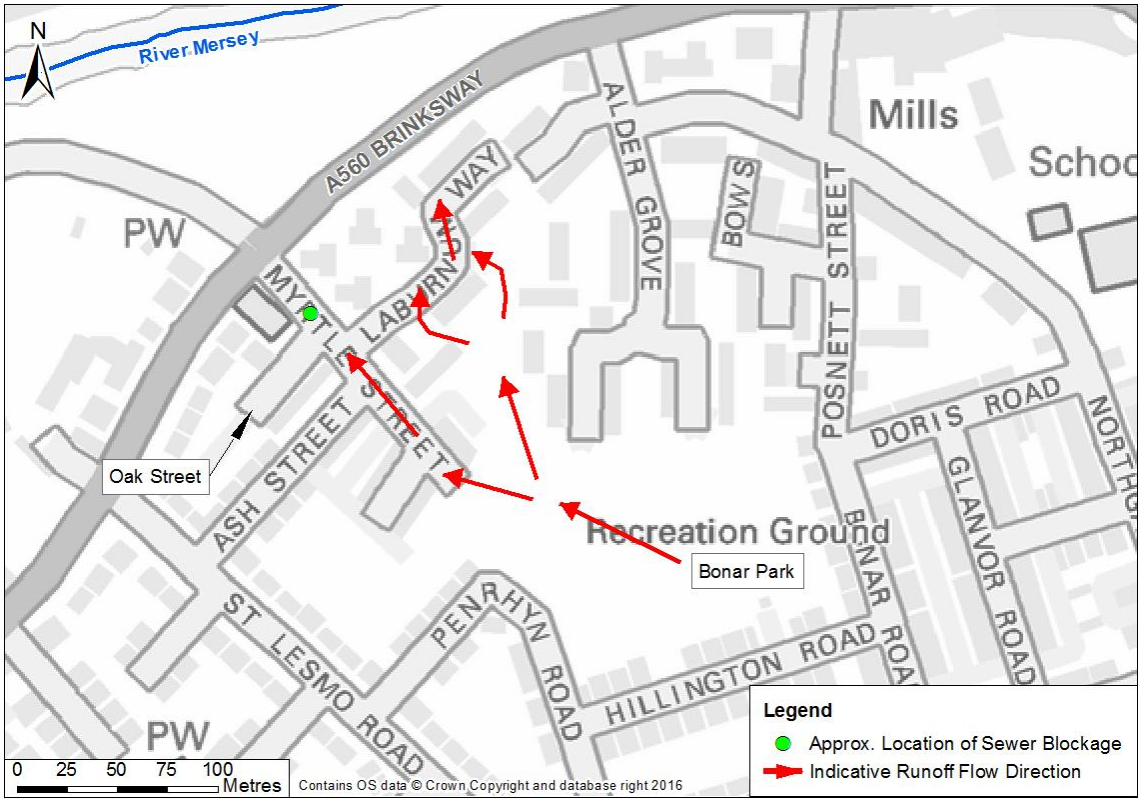
Bonar Park (labelled Recreation Ground in Figure 3.15) is understood to be the main source of surface water runoff contributing to the flooding in the Laburnum Way. The topography and heavily saturated ground conditions are likely to have resulted in significant runoff from the park flowing towards the River Mersey. The runoff from the park is reported to have flowed directly onto Myrtle Street and through the alleyways behind Laburnum Way and onto Laburnum Way itself, as illustrated in Figure 3.15.

It was later found that a blockage in the main surface water sewer flowing north-west along Myrtle Street was present at the time of the event, and as a result, surface water flooding would have occurred as the highway

drainage on Myrtle Street would have been ineffective. Surface water was then reported to have flowed down Myrtle Street and onto Oak Street, resulting in property flooding, and then onwards to the junction with Brinksway, where surface water pooled causing highway flooding.

Approximately 40m from the junction of Laburnum Way and Myrtle Street, Laburnum Way slopes towards the east. The surface water drainage on Laburnum Way connects into the sewer on Myrtle Street, and due to the blockage, the highway drainage would have been ineffective in draining the runoff from the park, causing it to pool at the low end of Laburnum Way.

Figure 3.15 : Runoff flow routes from Bonar Park



United Utilities attended site during the flooding event and removed the blockage from the Myrtle Street sewer to allow floodwater to drain. In the days following the flood event, United Utilities also inspected the local sewers and undertook root removal. United Utilities are also currently reviewing potential options required for remedial work on the Myrtle Street sewer. The Council is also aware that many of the gullies on the paths in Bonar Park and alleyways behind Laburnum Road are blocked, and that the land drainage within the park itself requires maintenance.

The Council has on record a history of flooding to Laburnum Way and to the rear gardens of the properties on Oak Street; however, the extent and severity of the 11 June 2016 was unprecedented and the urban drainage network would likely have been overwhelmed.

United Utilities have also investigated other property flooding incidents reported in Edgeley and have determined that the sewers were overloaded by the exceptional rainfall event, and no blockages or other defects on the combined public sewer network were found. This is the case at all properties except for the two that flooded on Clwyd Avenue, where it was determined that flooding resulted from a private sewer at one property, and as a result of groundwater flooding at the other.

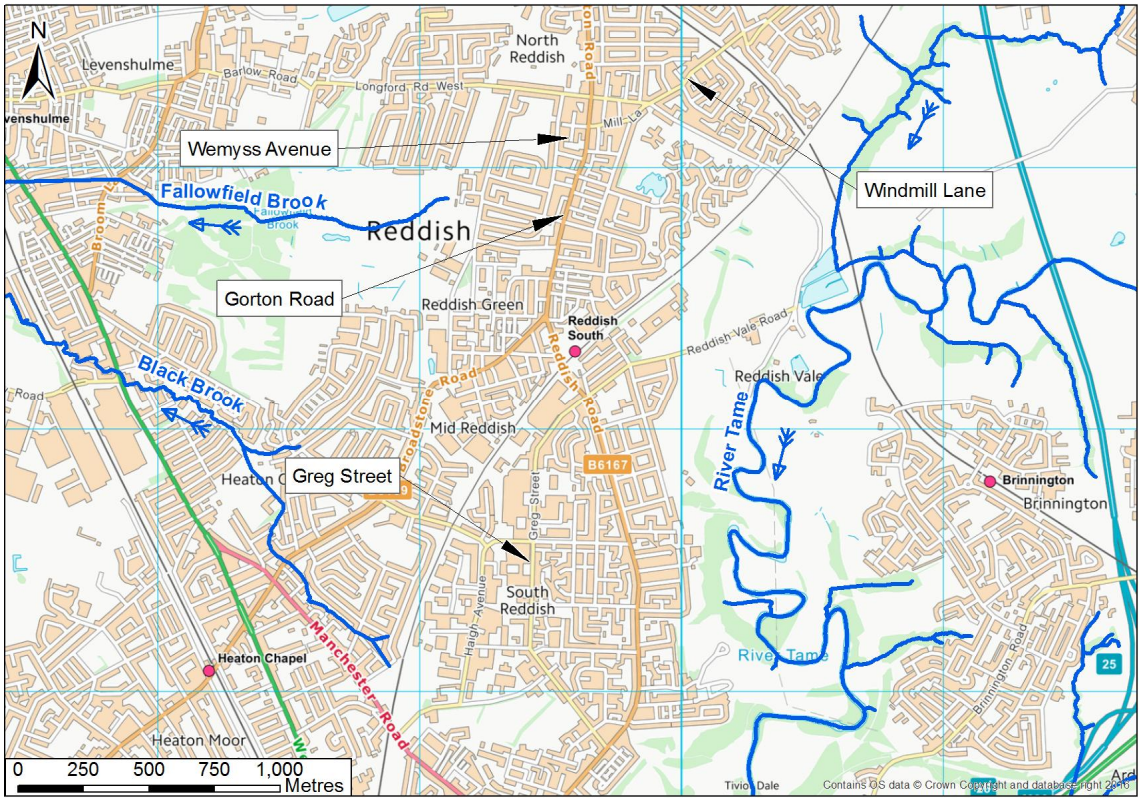
3.5 Reddish

3.5.1 Site Overview & Flooding Impacts

Reddish is an area of Stockport encompassing several suburbs. It is located north of Stockport town centre and the M60, between Brinnington to the east and Heaton Chapel to the west. The River Tame flows in a southerly direction towards the River Mersey immediately to the east of Reddish along with two smaller watercourses, Fallowfield Brook and Black Brook, which flow in a westerly direction.

Sewer and groundwater flooding affected seventeen residential properties across Reddish on the 10 June. Internal flooding was reported at eleven properties on Windmill Lane, four properties on Gorton Road and two properties on Greg Street. External flooding was reported at one property on Wemyss Avenue.

Figure 3.16 : Reddish site overview



3.5.2 Flooding Analysis

The property flooding on Gorton Road and Greg Street has been identified as a groundwater flooding issue and sewer flooding has been identified as the main source of the property flooding on Windmill Lane. Investigations undertaken by United Utilities following the event found no issues with the functioning of the sewer, therefore it was determined that the sewer was unable to cope with the intensity of extreme rainfall on the day of the event.

Sewer flooding was also identified as the cause of the external flooding to the property on Wemyss Avenue; however, following investigations by United Utilities a blockage in the sewer system was found to be the cause and has since been cleared.

Rain radar data was not available at the time of this investigation. However, based on the information that the Meadowbank School rain gauge recorded more rainfall on other days during June and the Reddish area did not flood again during June 2016, it is considered likely that a localised downpour caused the flooding on Windmill Lane (where the sewers were operating normally), which was not repeated during June 2016.

The causes of groundwater flooding are more difficult to analyse without more detailed local monitoring data; however, the properties impacted by groundwater flooding also did not flood again later in the month, and so this may have been caused by localised changes to the groundwater table that were not repeated.

3.6 Cheadle

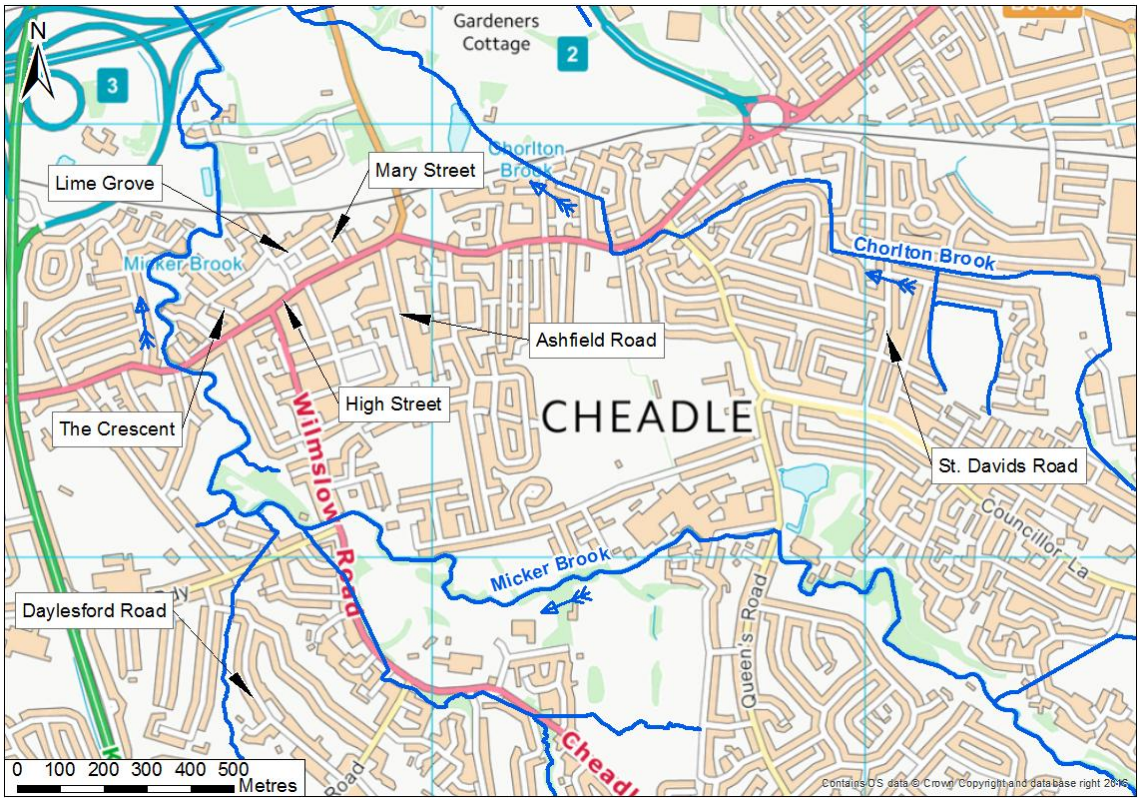
3.6.1 Site Overview & Flooding Impacts

Cheadle is a town within the borough of Stockport and is located approximately 3km east of Stockport town centre. The town of Gatley to the west and the town of Cheadle Hulme to the south border it. Two Main Rivers, Chorlton Brook and Micker Brook, flow in a north-westerly direction through the area towards the River Mersey, beyond the M60.

Property flooding was reported in Cheadle during all four rainfall events, albeit to varying degrees; this means that Cheadle flooded on more occasions during June 2016 than any other area within the borough. The largest numbers of properties were affected on 16 June: nineteen properties reported flooding, of which nine were residential properties and 10 non-residential.

The 10 June was the next most severe event: ten properties, including eight residential and two non-residential were affected by flooding. Fewer properties were affected on 08 June, with three residential properties reported to have flooded. Only two properties flooded on 11 June, one residential, one non-residential. Reports suggest that highway flooding or sewer flooding caused the majority of property flooding.

Figure 3.17 : Cheadle site overview



3.6.2 Flooding Analysis

Analysis of the Meadowbank School rain gauge data showed that the rainfall intensities of the four events in June 2016 could be ranked in the following order (from highest to lowest): 16 June, 10 June, 8 June, 11 June. This correlates well with the property flooding incidents in Cheadle in June 2016, which rank from highest to lowest in the same order of events.

United Utilities investigated the flooding incidents following the events and determined that flooding incidents in Cheadle were caused as a result of blockages in either United Utilities maintained sewers, highway drainage systems or privately maintained sewers.

Cheadle flooded on more occasions during June 2016 than any other part of Stockport; property flooding was reported for each of the four rainfall events. Some properties in Cheadle also reported flooded two or three times during June 2016.

3.6.2.1 8 June 2016

The flooding in Cheadle on the 8 June focused mainly on the town centre in the High Street area. The least extensive flooding of the four flooding events within this community in June 2016 was on the 8 June; when three residential properties were flooded. Two of the affected properties were located on Ashfield Road, and one property was located on Mary Street. All properties were flooded internally by sewers.

United Utilities investigated the flooding incidents following the event and reported that blockage had occurred on United Utilities maintained sewers. United Utilities have since cleared the blockages.

3.6.2.2 10 June 2016

Two days after the flooding on 8 June, properties within Cheadle town centre flooded again with a total of ten affected, all of which were flooded internally. Four properties were located on Ashfield Road, three on Mary Street, two on High Street and one on Lime Grove. All properties except for those on High Street were residential properties.

United Utilities have investigated the flooding incidents and determined that blockage of United Utilities maintained sewers were the main cause of flooding at these properties, except for one property on High Street where flooding was caused by a blockage within either the highway drainage system or a private sewer.

3.6.2.3 11 June 2016

Two properties were reported to have flooded in Cheadle on the 11 June 2016 because of blockages in United Utilities sewers. One non-residential property on High Street flooded internally and one residential property on St. David's Road flooded externally. United Utilities have investigated both incidents and have cleared the blockages.

3.6.2.4 16 June 2016

Similar to the 8 June and 10 June event, property flooding was concentrated around the town centre on 16 June; again, all properties reported internal flooding. Businesses in Cheadle were more affected by this event than any other during June, with 10 non-residential and one residential property flooded on High Street. Seven of the commercial properties on High Street were reported to have flooded as a result of surface water ponding on the highway outside the front of the properties. United Utilities' investigations identified blockages as the cause of the flooding at the three other properties on High Street; however, one of the blockages was located on a private sewer.

The other reported residential property flooding included four properties on Ashfield Road, one property on Daylesford Road, one property on Lime Grove, one property on Mary Street and one property on The Crescent.

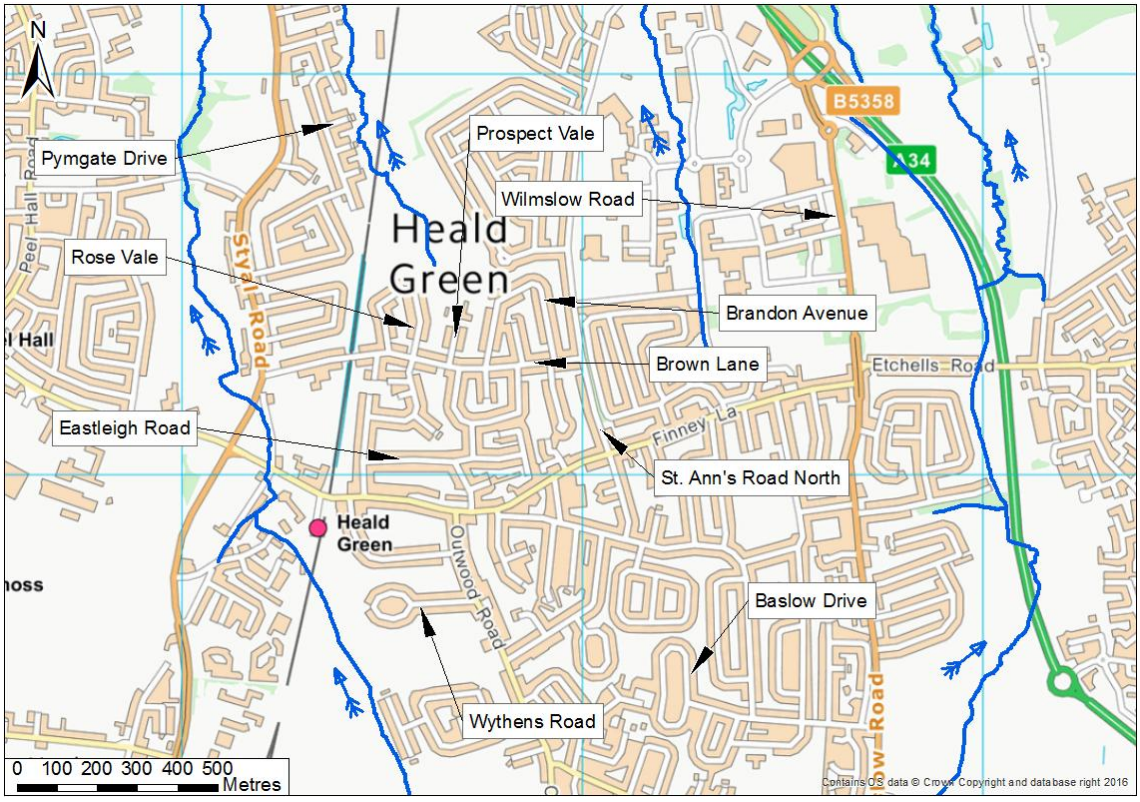
3.7 Heald Green

3.7.1 Site Overview & Flooding Impacts

Heald Green is a suburb of Stockport located approximately 5km south-west of Stockport town centre and boarders the town of Gatley to the north and Cheadle Hulme to the east.

Nineteen residential and non-residential properties were affected by flooding during the month of June 2016, four of which flooded on more than one occasion. All three flooding events during June affected Heald Green, with the most significantly event being the 11 June. Records show that all property flooding in Heald Green in June 2016 was caused by sewer flooding.

Figure 3.18 : Heald Green site overview



3.7.2 Flooding Analysis

3.7.2.1 8 June 2016

Only one incident of property flooding was reported in Heald Green, which is assumed to relate to the rainfall event of 8 June 2016. One residential property on St. Ann's Road reported to be affected by external property flooding. United Utilities investigated this incident in response and identified the main cause as a blockage on a United Utilities maintained sewer; the blockage has since been cleared by United Utilities.

3.7.2.2 11 June 2016

14 properties in total reported sewer flooding on 11 June 2016 in Heald Green. Analysis of the locations of the flooding incidents shows that property flooding was spread throughout Heald Green, rather than concentrated in just the one location. United Utilities investigated the incidents following the June events and identified a mixture of blockages causing the flooding in response to the rainfall event and sewers which were not blocked but which were overwhelmed by the intensity and/or volume of rainfall. All blockages on United Utilities assets have since been cleared.

The locations and causes of property flooding on 11 June are as follows:

- One non-residential property on Wilmslow Road flooded externally. Main cause identified as a blockage on a non-United Utilities sewer.
- One residential property on Wythens Road flooded externally. Main cause identified as an unconfirmed issue with a non-United Utilities asset.
- One residential property flooded externally on Eastleigh Road. Main cause identified as a blockage on United Utilities sewer.
- One non-residential property flooded internally on Prospect Vale as a result of a United Utilities sewer becoming overwhelmed by the rainfall event.
- Eight residential properties flooded externally on Brown Lane, three as a result of United Utilities sewer blockage, five as a result of a United Utilities sewer becoming overwhelmed by the rainfall event.
- One residential property on Rose Vale flooded externally as a result of a United Utilities sewer becoming overwhelmed by the rainfall event.
- One residential property on Pymgate Drive flooded externally as a result of a United Utilities sewer blockage.

3.7.2.3 16 June 2016

Seven properties in total reported sewer flooding on 16 June 2016 in Heald Green. Similar to 11 June, upon investigation of the incidents United Utilities identified a mixture of blockages in United Utilities sewers which caused property flooding and simply overwhelmed sewers. Again, all blockages on United Utilities assets have since been cleared. Four properties which flooded on 11 June also reported flooding on 16 June.

The locations and causes of property flooding on 11 June are as follows:

- One residential property on Baslow Drive flooded internally as a result of a United Utilities sewer blockage.
- Three residential properties on Brandon Avenue flooded internally as a result of a United Utilities sewer blockage.
- Two residential properties on Brown Lane flooded externally as a result of a United Utilities sewer becoming overwhelmed by the rainfall event.
- One property on Eastleigh Road reported external flooded. This was identified as resulting from a blockage in a United Utilities sewer.
- One property on Rose Vale flooded externally as a result of a United Utilities sewer becoming overwhelmed by the rainfall event.

Four properties that reported flooding on 11 June also reported flooding on 16 June.

3.8 Other Local Incidents and Impacts

3.8.1 Local Property Impacts

Outwith those communities ‘significantly’ impacted, there were a number of areas throughout Stockport that experience local flooding, with five or less properties flooded. Whilst these events are still considered as important, especially for those residents affected, they do not meet the ‘significance’ thresholds set for this investigation and within the AGMA “Recording and Investigation of Flood Events” policy.

Due to the number of these smaller incidents, it is not possible to cover them in detail as part of this investigation. However, to provide a complete investigation, Table 3.1, Table 3.2, Table 3.3 and Table 3.4 contains a list of other communities, which experienced flooding to five or less properties during June 2016.

Following the flood event, United Utilities have investigated each incident list in the tables and where possible the source of flooding has been determined. In some cases, this was found to be associated with non-United

Utilities assets, such a private drains, which are the responsibility of the homeowner, and surface water and groundwater sources. These have been reported to the Council. Where blockages in United Utilities sewers were found, these have since been cleared.

Table 3.1 : Local flood incidents - 8 June 2016

Community	Source of flooding	Property type	Main cause of flooding	Number of properties flooded		
				Internally	Externally (only)	Total
Bramhall	Non-UU sewer	Residential	Blockage	1	1	2
Cheadle Hulme	UU sewer	Residential	Blockage	2	0	2
	UU sewer	Residential	Hydraulic inadequacy	2	0	2
	UU sewer	Non-residential	Hydraulic inadequacy	1	0	1
Davenport	UU sewer	Residential	Blockage	1	0	1
Gatley	Non-UU sewer	Residential	Not confirmed	0	1	1
Hazel Grove	Non-UU sewer	Residential	Not confirmed	1	0	1
Heaton Mersey	UU sewer	Non-residential	Equipment failure	0	1	1
Offerton	UU sewer	Residential	Blockage	0	2	2
Woodford	UU sewer	Residential	Hydraulic inadequacy	0	1	1

Table 3.2 : Local flood incidents - 10 June 2016

Community	Source of flooding	Property type	Main cause of flooding	Number of properties flooded		
				Internally	Externally (only)	Total
Cale Green	UU sewer	Residential	Blockage	2	0	2
Heaton Norris	UU sewer	Residential	Hydraulic inadequacy	1	0	1

Table 3.3 : Local flood incidents - 11 June 2016

Community	Source of flooding	Property type	Main cause of flooding	Number of properties flooded		
				Internally	Externally (only)	Total
Bramhall	UU sewer	Residential	Blockage	0	1	1
Cheadle Hulme	UU sewer	Residential	Blockage	0	1	1
	Non-UU sewer	Residential	Blockage	0	1	1
	Groundwater	Residential	Unknown	0	1	1
Gatley	UU sewer	Residential	Blockage	1	3	4
Heaton Mersey	Groundwater	Residential	Unknown	1	0	1
Heaton Moor	UU sewer	Residential	Blockage	0	2	2
Offerton	UU sewer	Residential	Hydraulic inadequacy	1	0	1
	UU sewer	Residential	Blockage	1	2	3

Table 3.4 : Local flood incidents - 16 June 2016

Community	Source of flooding	Property type	Main cause of flooding	Number of properties flooded		
				Internally	Externally (only)	Total
Gatley	UU sewer	Residential	Blockage	1	1	2
Heaton Mersey	UU sewer	Non-residential	Blockage	0	1	1

3.8.1.1 High Lane

Five properties in High Lane were reported to flood in response to the rainfall event on 11 June 2016. Four properties on Windlehurst Road are reported to have suffered external flooding. High Lane Brook flows east to west through High Lane and a blockage at the inlet of the culvert carrying High Lane Brook under Windlehurst Road caused the watercourse to spill out of bank during the rainfall event, across Windlehurst Road and back into channel, flooding the gardens of three properties in the process. The blockage has since been cleared from the culvert inlet by the Environment Agency. One further property on Windlehurst Road is also understood to have suffered external flooding as a result of sewer flooding during this event.

The final incident in High Lane was reported at a property on Ashbourne Drive, which flooded internally from a culverted watercourse which passes through the grounds of the property. Neighbouring properties' gardens were also flooded by the watercourse, however the number of properties affected has not been confirmed and therefore these properties have not been officially counted within this report. In response to the incident the Council have undertaken a CCTV investigation of the culvert and have identified a collapse, which is now scheduled for repair.

It is understood that properties on Cromley Road and Hartington Road were also affected by this rainfall event, however this report has only been able to incorporate incidents officially reported to either the Council, the Environment Agency or United Utilities. It is reported that a combination of blockages at culverts on the local watercourses and surface water runoff from the hills to the east of High Lane onto the local highways contributed to this flooding.

4. Infrastructure Impacts

In addition to property flooding, the June 2016 flood events affected a range of infrastructure and services including the road and rail network (and their assets) and greenspaces. Flooding of infrastructure will have direct impacts associated with them (e.g. closure of that network), but they potentially have wider reaching consequences (e.g. people unable to travel to work and water quality issues). The sub-sections below outline incidents associated to infrastructure as recorded by the relevant authorities.

4.1 Road Closures & Highway Structures

Table 4.1 lists all known road closures in Stockport during the flood event of the 11 June. Other roads not listed were affected by flooding but were not closed.

Table 4.1 : Road closures - 11 June 2016

Road closure	Reason
Torkington Road	Fluvial flooding
Hazelwood Road	Fluvial flooding
Bridge Lane & Bramhall Green Roundabout	Surface water flooding and fluvial flooding
Shearwater Road	Surface water flooding and fluvial flooding
Fulmar Drive	Surface water flooding and fluvial flooding
Carrwood Road	Presumed surface water flooding
Bean Leach Road	Fluvial flooding
Minsmere Walks	Surface water flooding and fluvial flooding
Dunnock Close	Presumed surface water flooding
Macclesfield Road	Norbury Bridge deemed unsafe
Strines Road	Fluvial flooding and carriageway collapse

On the 11 June, the Council closed Strines Road, which is approximately 50m south of the Station Road junction in Strines, due to flooding and partial structural failings of the carriageway. The structural failing was a result of a collapsed culverted underneath the road, which carries an Ordinary Watercourse. This resulted in flood flow backing up along the watercourse and causing the highway to flood and damage to the retaining wall of the culvert inlet. The Greater Manchester fire service attended site during the flood event and relieved flooding to the highway by removing the downstream highway boundary wall. This has however had an impact of scouring the downstream embankment.

Since the event, the Council have removed the blockage from the culvert and replaced sections of the original culvert. The Council has also replaced the damaged retaining wall at the culvert inlet with a new headwall, re-established the embankments on both sides of the road and rebuilt the boundary walls.

The Council also reported that the Peak Forest Canal caused highway flooding to Station Road in Marple, but it is not known if the road was closed as a result. The Canal and River Trust stated that they were not aware of the canal flooding at this location.

A local area committee meeting noted that residents had mentioned that some motorists ignored road closure signs and flood warnings, and proceeded to use the flooded highways. This reportedly resulted in the passing vehicles creating bow waves, which may have exacerbated adjacent property flooding.

The June 2016 flood events also caused damage to highway infrastructure in Stockport because of flooding to watercourse crossings including highway bridges and culverts. The Council have identified a number of structures in need of structural inspection, scour inspections, debris removal, repairs and maintenance work.

The Council have estimated initial costs of this work at £151,000 and they are in the process of identifying funding and carrying out the work.

4.2 Rail Network

According to Network Rail, on the 11 June 2016 significant disruption was caused to the Stockport to Disley railway line following a landslip of approximately 6,000 tonnes of earth on to the tracks at Middlewood Station[8]. This resulted in the closure of the line for two weeks from 11 June 2016 until the 25 June 2016, whilst Network Rail undertook repairs.

Delays were also caused to the rail service on the Styal Line, which runs between Manchester Piccadilly and Wilmslow (and includes the connecting line to Manchester Airport) due to flooding of the line on 11 June 2016. The flooding was reported to be due to a blocked sluice on a culvert underneath the railway, which prevented runoff from Rose Vale Park effectively draining from the park and under the railway. Since the event, Network Rail have undertaken remedial tree and vegetation works to alleviate the residual risk of future blockages at the culvert. The Council are also considering longer-term options to attenuate surface water runoff within Rose Vale Park and reduce the risk of flooding to the railway line.

4.3 Parks, Greenspaces and Public Rights of Way

Flooding to recreational areas and other public open spaces will also have direct damages associated with repair work, but flood damage could also have wider environmental and ecological impacts associated with water quality, habitat removal and water logged ground.

The Council have reported a total of £280,000 of flood damage repairs to greenspace infrastructure in response to the June 2016 flood events. The most substantial impact was to Bramhall Happy Valley park, where floodwater damaged or swept away over 0.5km of footpaths.

Floodwater also swept away over 2km of footpaths on public rights of way, including two footbridges on Bollinhurst Brook in Disley and High Lane, during the June floods. The Council have estimated the repair works, including footpath and footbridge reconstruction and debris removal at £523,000. Since the event, the Council has reconstructed one of the damaged footbridges on Bollinhurst Brook and the other footbridge is in the process of being reconstructed by Cheshire East Council. The Council are in the process of identifying funding to undertake the remaining repair works.

Flooded watercourses also damaged riverbanks and trees and transferred debris through parks, including the Bramhall Happy Valley Park. At the time of undertaking this investigation, the Council have started to undertake repair works to Bramhall Happy Valley Park and are identifying available funding to carry out the remaining repairs across the other damages greenspaces.

[8] Network Rail website news article: https://www.networkrail.co.uk/news/2016/jun/railway-buxton-manchester-reopens-after-landslip/ (accessed 22/08/2016)

5. RMA Responses

This section of the report details response delivered by each RMA during and post event. Recommended future actions are outline in Section 6.

5.1 Responses during the Flood Events

Table 5.1 outlines the RMA responses undertaken across the whole of the borough, whilst Table 5.2 outlines community specific responses.

According to the information provided, the impacts of the flooding on the 11 June required the greatest response, with all RMA responding with support from the emergency services who provided invaluable assistance, coordinating with the authorities to assist residents safely away from their flooded properties and to close impacted roads. The Mountain Rescue Team and the North West Ambulance Service Hazardous Areas Response Team (HART) also supported.

Table 5.1 : RMA immediate responses – Stockport wide

Lead RMA	Event	Response
Council Highways Department	11 June	Coordination with emergency services and SK Solutions to close roads
Council as LLFA	All	Major emergency response staff available 24 hours a day (and all year round)
	11 June	Forward Incident Officers and Silver Commander attended the scenes of flooding
	11 June	Coordination with emergency services and SK Solutions to close roads
	11 June	Arranged for delivery of sandbags to residents
	11 June	Identified and co-ordinated with most vulnerable residents
	11 June	Arranged for emergency accommodation for those in need
United Utilities	All	Customer support and incident logging
Environment Agency	All	Flood support provided via incident hotline
	11 June	On-site response to provide support to residents and investigate flooding incident

Table 5.2 : RMA immediate responses – community specific

Lead RMA	Event	Response	Community
Council as LLFA	11 June	Evacuation centre established at Hazel Grove Life Centre (later closed as all residents who evacuated had accommodation)	Hazel Grove
	11 June	Attended site and visited individual properties, assisting residents	Offerton Green
	16 June	Attended site and visited individual properties, assisting residents	Edgeley
United Utilities	8, 11 June	Attended site to assist affected customers	Offerton Green
	16 June	Blockage on Myrtle Street jetted and cleared	Edgeley
Environment Agency	11 June	Flood Alert issued at 19:42 on 11 June for the Bridge Lane area, located within the Middle River Mersey Catchment (see Section 5.1.1)	Bramhall Green
	11 June	Flood Alert issued at 19:42 on 11 June for Poise Brook, located within the River Mersey Uplands Catchment (see Section 5.1.1)	Hazel Grove, Offerton Green

5.1.1 Environment Agency Flood Warnings

The Environment Agency issue flood warnings to allow communities to prepare for flooding from main rivers. Three different flood warning codes are used depending on the severity of flooding expected (see Table 5.3); these are also issued at different intervals in advance of flooding. Flood Alert areas generally cover a large area, whilst Flood Warning areas are usually focused to specific locations. Locations within a Flood Alert area are also not necessarily within a Flood Warning area.

According to the Environment Agency, no Flood Warnings were issued during the June 2016 event in Stockport. However, Flood Alerts were issued in Bramhall Green, Hazel Grove and Offerton Green (See Table 5.2)

Table 5.3 : Environment Agency Flood Warning Codes

Flood Warning Code		What it means	When it's used	What to do
	**Flood Alert**	Flooding is possible, be prepared	Two hours to two days in advance of flooding	· Be prepared to act on your flood plan · Prepare a flood kit of essential items · Monitor local water levels and the flood forecast on the Met Office website
	**Flood Warning**	Flooding is expected, immediate action required	Half an hour to one day in advance of flooding	· Move family, pets and valuables to a safe place · Turn off gas, electricity and water supplies if safe to do so · Put flood protection equipment in place
	**Severe Flood Warning**	Severe flooding, danger to life	When flooding poses a significant threat to life	· Stay in a safe place with a means of escape · Be ready should you need to evacuate from your home · Co-operate with the emergency services. · Call 999 if you are in immediate danger

5.2 Responses post Flood Events

Table 5.4 outlines the RMA responses undertaken post event across the whole of the borough, whilst Table 5.5 outlines community specific responses immediately after and in the days following the June 2016 flooding events

Table 5.4 : RMA post event responses – Stockport wide

Lead RMA	Event	Response
Council Highways Department	11 June	Re-opening of highways and bridges once determined safe
	11 June	Debris clearance from roads and highway structure inspections
	11 June	All highway drainage gullies in flooded areas cleaned and known hotspots prioritised for inspection
Council as LLFA	11 June	Recovery Coordination Group set up to manage the ongoing response to the flooding incidents, supporting local residents and businesses
	11 June	Skips provided in a number of areas to remove damaged furniture and furnishings from properties
	11 June	Flood grants made available and publicised on the Council website
	11 June	Inspection of parks, greenspaces and Public Rights of Way to identify damage and repairs required
	11 June	Independent review into the flooding commissioned (this report)
	11 June	Meetings with other RMAs to establish a coordinated response for the recovery and support of local residents

Lead RMA	Event	Response
	11 June	Additional staff called in to manage increased demand at the Council Contact Centre
	11 June	Clean-up of parks and greenspaces
	11 June	Arranged and publicised public drop-in sessions arranged at Hazel Grove High School and Warren Wood Primary School
United Utilities	All	Assisted with clean-up operations and provided support to affected customers
	All	All reported flooding incidents investigated
	All	All blockages found on United Utilities maintained sewers cleared
	All	Contacted customers eligible for discretionary payment system
	11 June	Supported community drop-in sessions
Environment Agency	11 June	Door-to-door survey and support in areas affected by fluvial flooding
	11 June	Data gathering and follow-up investigations into fluvial flooding
	11 June	Supported community drop-in sessions

Table 5.5 : RMA post event responses – community specific

Lead RMA	Event	Response	Community
Council Highways Department	11 June	Engineer inspected Bramhall Bridge and confirmed safe to re-open	Bramhall Green
	16 June	High Street highway drainage system investigated., blockages removed and cleaning work undertaken	Cheadle
Council as LLFA	11 June	Inspection and replacement of damaged section of sewer on Bramhall Green Roundabout	Bramhall Green
	11 June	Site inspections carried out at Bramhall Park, Bramhall Green roundabout and along Lady Brook	Bramhall Green
	11 June	Site inspection carried out at Torkington Park	Hazel Grove
	11 June	Repairs to culvert on Strines Road, including road embankments	Strines
	16 June	Clean up after flooding of Laburnum Way	Edgeley
	16 June	Laburnum Way area flooding investigated. Blocked gullies and land drainage issues on Bonar Park reported to Council Greenspace Team	Edgeley
	8, 11 June	Attended site at Shearwater Road on the 5 July to establish potential engineering works required with support from the Environment Agency and United Utilities	Offerton Green
United Utilities	8, 11 June	Sewers cleaned out (as a “belt and braces” measure despite no blockages being found)	Offerton Green
	8, 11 June	Sewer modelling exercise planned to improve understanding of flooding mechanism	Offerton Green
	16 June	Removed blockage from Myrtle Street sewer	Edgeley
	16 June	Reviewing Myrtle Street sewer and how to prevent future blockages	Edgeley
Environment Agency	11 June	Cleaned Torkington Park debris screen following the event	Hazel Grove

6. Recommended & Ongoing Actions

6.1 Recommended & Ongoing Actions across Stockport

The purpose of this report is to document the investigations carried out into the flood events that affected the communities of Stockport in June 2016 and for RMAs to consider and prioritise actions relevant to each authority. In this way, communities can be clearer on what has happened since the floods, and what each authority is planning to do to reduce or mitigate the impacts of future flooding within the borough.

The section of the report contains general actions, which apply across the whole borough of Stockport (Table 6.1) and where available ongoing or planned actions to be taken in specific locations (Table 6.2). Due to the widespread nature of the flooding, it is not possible to identify detailed actions for each community affected.

Table 6.1 : Recommended and ongoing actions – Stockport wide

Lead RMA	Recommended Action	
Council Highways Department	1.1	Maintain efficient operation of highway drains
	1.2	Ensure necessary maintenance is carried out to local highway drains following flood events
	1.3	Consider ways to raise awareness of damage caused by driving through floods
Council as LLFA	2.1	Consider provision of Property Level Protection for properties at risk
	2.2	Review response to and management of road closures during flood events
	2.3	Ensure property owners are aware of their responsibilities as riparian owners of watercourses (whether open or culverted watercourses)
	2.4	Investigate and address issues identified as relating to private drains
	2.5	Continue to manage flood risk from new development through local strategic planning and development management process, with advice from the Environment Agency where required. Seek flood risk benefits from new development where possible.
United Utilities	3.1	Maintain efficient operation of surface water and combined sewers
	3.2	Ensure effective communication with the Council regarding flooding events/ potential flood issues
Environment Agency	4.1	Review borough-wide flood management
	4.2	Ensure watercourses are suitably maintained
	4.3	Review trigger levels for Flood Alerts in this area
	4.4	Ensure effective communication with the Council regarding flooding events/ potential flood issues
Property Owners	5.1	Consider installation of Property Level Protection

Table 6.2 : Recommended and ongoing actions – community specific

Lead RMA	Recommended Action		Community
Council Highways Department	6.1	Consider options to improve highway drainage in the Kintore Avenue area	Hazel Grove
Council as LLFA	7.1	Consider options to improve drainage of Bonar Park and surrounding pavement (currently being reviewed)	Edgeley
	7.2	Consider options to increase highway drainage capacity in the Myrtle Street area (e.g. additional gullies or combined kerb and drainage solutions)	Edgeley
	7.3	Consider options to direct runoff safely away from properties (e.g. raised kerbs on Myrtle and Ash Street)	Edgeley
United Utilities	8.1	Review options to relieve flooding from the surface water sewer (including investigation of the performance of the surface water sewer outfall)	Offerton Green

Lead RMA	Recommended Action		Community
	8.2	Review cause of blockage on Myrtle Road sewer and how to prevent in the future (currently being undertaken)	Edgeley
Environment Agency	9.1	Consider options to reduce fluvial flood risk on Lady Brook	Bramhall Green
	9.2	Consider options to reduce fluvial flood risk on Hazel Grove Brook	Hazel Grove
	9.3	Review performance of Torkington Park debris screen during event	Hazel Grove
	9.4	Consider options to reduce fluvial flood risk on Poise Brook	Offerton Green
	9.5	Review Flood Warnings and trigger levels for the Poise Brook flood warning area	Offerton Green

6.2 Next Steps

At this stage, the actions listed are recommendations only and their delivery is likely to depend on the RMA securing funding and on other commitments and priorities within each authority. Any major works requiring capital investment will be considered through the Defra funding programme. That said, the RMAs will continue to work together to engage with the communities affected and to identify all potential options for each location reduce flood risk across Stockport.