

# Hagley Flood Events October and November 2019



## Investigation Report

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# 1. Introduction

On 26<sup>th</sup> and 27<sup>th</sup> October 2019 there was flooding reported across the country, the Midlands and across Worcestershire after a moderate rainfall event. In Hagley there were four properties internally flooded in Chestnut Drive.

On 14<sup>th</sup> and 15<sup>th</sup> November 2019 there was a similar story, with another moderate rainfall event causing a great deal of disruption and further flooding. In Hagley there were six properties internally flooded near Market Way.

A combination of organisations, local councillors and the local community worked together to respond to the initial flood event emergencies and then to deal with the ongoing recovery process.

This report summarises the investigation carried out by Worcestershire County Council, as the designated Lead Local Flood Authority, under its statutory duty within section 19 of the Flood & Water Management Act (2010) to investigate and report on flooding it deems to be significant.

The investigation has examined the flood events, the immediate response to it and the ongoing recovery from it and it has developed a number of key recommendations for future action.

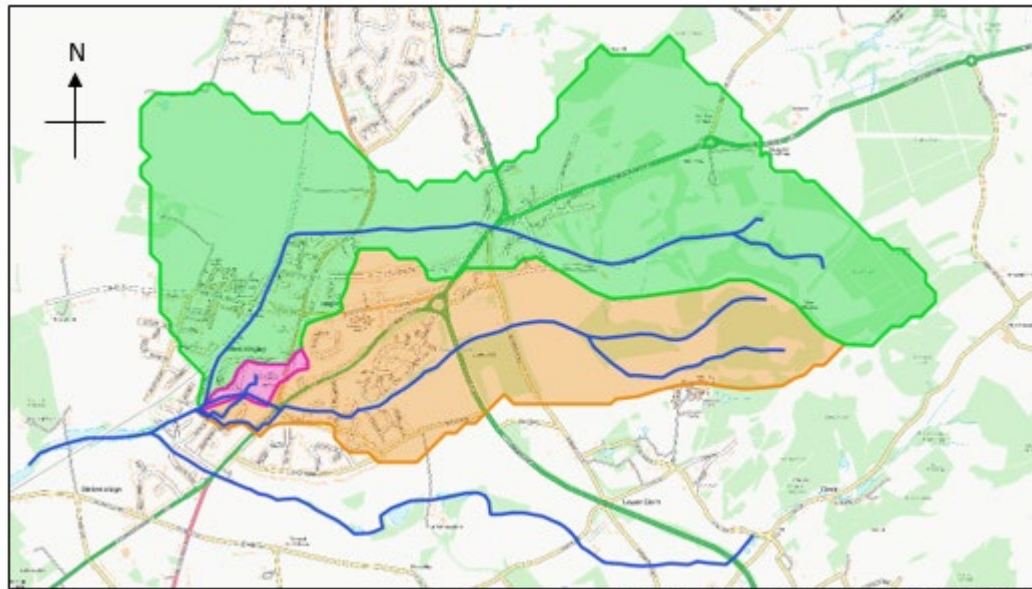


Photo taken during the October flood event looking over the Greenway culvert.



## 2.2 Local watercourses and drainage

Hagley drains from east to west via various arms of the Gallows Brook as shown in Figure 2.<sup>1</sup>



**Figure 2.** Catchments (shaded green, orange and purple) and watercourses (blue) in and around Hagley.

A close-up of the watercourses and culverts near Market Way is shown in Figure 3. The northern arm of the Gallows Brook drains the area shown in green in Figure 2, which is around 3.5 km<sup>2</sup>. The portion of this catchment upstream of Market Way is around 1.8 km<sup>2</sup> in area.

Market Way is located near the confluence of two watercourses, both part of the Gallows Brook watercourse system. One culverted (piped) watercourse comes down the A456 and discharges in front of the properties. The other watercourse comes from Hagley Hall estate and discharges at the back of the properties, mainly in an open fashion with the exception of a twin culvert underneath a private garden on Market Way. The two watercourses meet in the road (A456) in front of the Wychbury Inn.

Surface water runoff from the properties discharges into a piped system that connects to the Highway Drainage system present underneath Market Way. This system discharges into the northern watercourse underneath the A456. There is no surface water sewer system in the area.

<sup>1</sup> The catchment boundaries have been derived using data from the FEH web service, LiDAR data interrogated using tools in GRASS GIS software, and local knowledge and on-site investigations, in particular from North Worcestershire Water Management.





**Figure 5.** Close-up of watercourses and culverts near the Greenway

The northern arm of the Gallows Brook is labelled 'A'. The first confluence is with the small unnamed tributary (labelled 'B') at The Oasis, which drains a very small catchment area of around 0.06 km<sup>2</sup> shown in purple in Figures 2 and 4. This watercourse had been dry for decades prior to the early 2000s when South Staffs Water ceased to abstract and utilise groundwater in the area. It then has two confluences with the eastern arm of the Gallows Brook which drains an area of 1.85 km<sup>2</sup> shown shaded orange in Figure 2. These are marked 'C' and 'D' in Figure 5. Culverts C and D originate from the same watercourse and bifurcate underground near the junction of Worcester Road and Western Road. They remain separate until they cross paths at a manhole chamber on Cavendish Drive and then they flow into the main arm of the Gallows Brook at The Greenway, the confluence of culvert D being underground upstream of The Greenway and the outfall from culvert C is downstream of the road, visible at the area of open space south-east of The Greenway.

The catchment geology is complex, consisting of a mixture of sandstone and mudstone, but predominantly permeable bedrock. Sitting on top of the bedrock are freely draining acid loamy soils for the majority of the catchment, with more clayey soils in the upper, steeper reaches of the catchment towards Hagley Hall.

## 2.3 Past flooding and drainage issues

The parish of Hagley has a history of sporadic incidents of relatively minor flooding, largely due to sewers being overloaded, but also with incidents of surface water and river flooding. Incidences of large numbers of properties



flooding internally have been rare, so the flood events of October and November 2019 stand out. A scheme was installed by Severn Trent in 2017 to address sewer and surface water flooding issues, particularly in the vicinity of Worcester Road.

The recorded history of flooding in Market Way goes back as far as 1998. There was flooding recorded in both September and December 1998, although it is unknown whether this was internal property flooding. Bromsgrove District Council received further reports of external flooding on Market Way in June 2012 and June 2019.

## **2.4 Risk Management Authorities in Worcestershire**

Risk Management Authorities are organisations with flood-related responsibilities designated in the Flood & Water Management Act (2010). The responsibilities of these organisations in managing flood risk in Worcestershire are outlined in section 4 of the Worcestershire Local Flood Risk Management Strategy. In the autumn flood events the following risk management authorities were involved in the response and recovery efforts.

- Environment Agency – responsible for the management of flooding from Main Rivers (larger rivers and watercourses recorded on the Main River map) and the national, strategic overview of flood risk management. The watercourse at the Greenway culvert and Chestnut Drive culvert is designated as Main River.
- Worcestershire County Council in its role as Lead Local Flood Authority – responsible for the management of flooding from surface water and ordinary watercourses (smaller watercourses not recorded as Main Rivers). This includes the watercourse at Market Way.
- Worcestershire County Council in its role as Highway Authority – responsible for the management of highway drainage and flooding from the highway.
- Bromsgrove District Council – jointly responsible for enforcement of the Land Drainage Act with regard to the management of ordinary watercourses via its North Worcestershire Water Management Team (shared with the other north Worcestershire district councils).
- Severn Trent Water Ltd – responsible for the sewer network and clean water supply.

## **2.5 Other council responders**

In addition, a number of other County and District council functions are typically involved in response to and recovery from a flood event and this was the case at Hagley. They include:

- Worcestershire County Council - Emergency Planning, Adult and Social Care
- Bromsgrove District Council – Environmental Services, Housing, Emergency Planning

- County & District shared service – Worcestershire Regulatory Service

## 2.6 First responders

The emergency events were also responded to by Hereford & Worcester Fire & Rescue Service.



Photo taken during the October flood event from The Oasis access road.

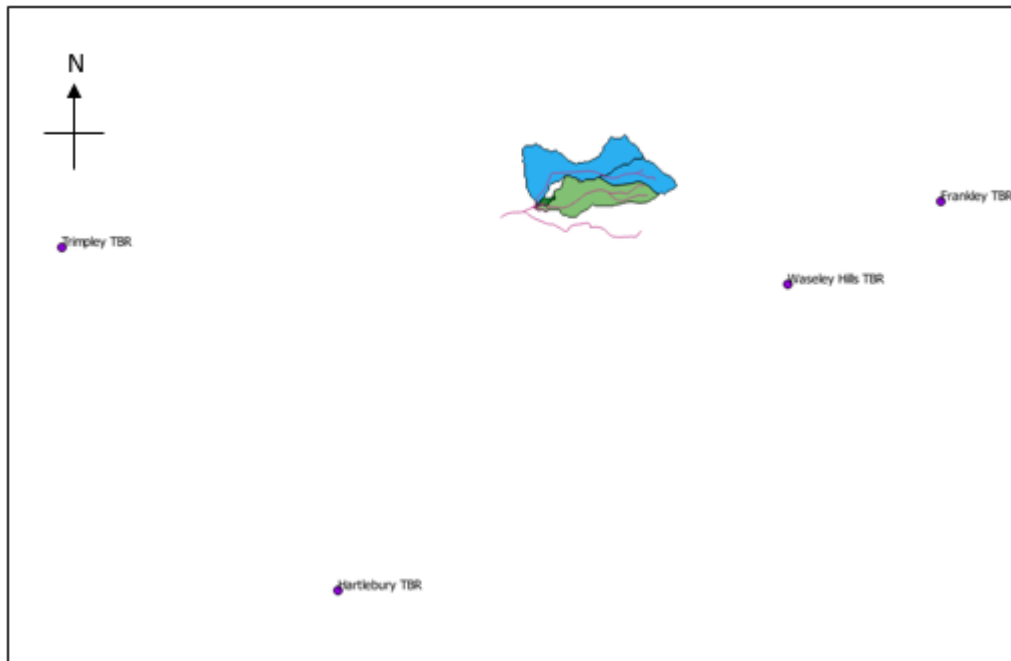
## **3. Flood event**

### **3.1 Weather / rainfall data**

Although neither the October nor November rainfall events were extreme (neither was a storm named by the Met Office for example), both caused significant flooding across Worcestershire and much of the country. The reason for this lies in the antecedent conditions: moderate rainfall on saturated catchments meant that a large proportion of the rain became surface water runoff, making areas of soil and grass behave more like tarmac. The National River Flow Archive reported that the June to October period in the Severn-Trent region in 2019 was the wettest on record (since records began in 1910). As a result, exceptionally high river flows were recorded in the Midlands on 25<sup>th</sup> and 26<sup>th</sup> October, as well as many incidences of surface water flooding, resulting from rainfall totals of 80-120mm in the Severn catchment. Nearly double the long-term average rainfall fell on the Severn catchment in October. On 27<sup>th</sup> October there were more than 300 Flood Alerts and Flood Warnings in place for England and Wales.

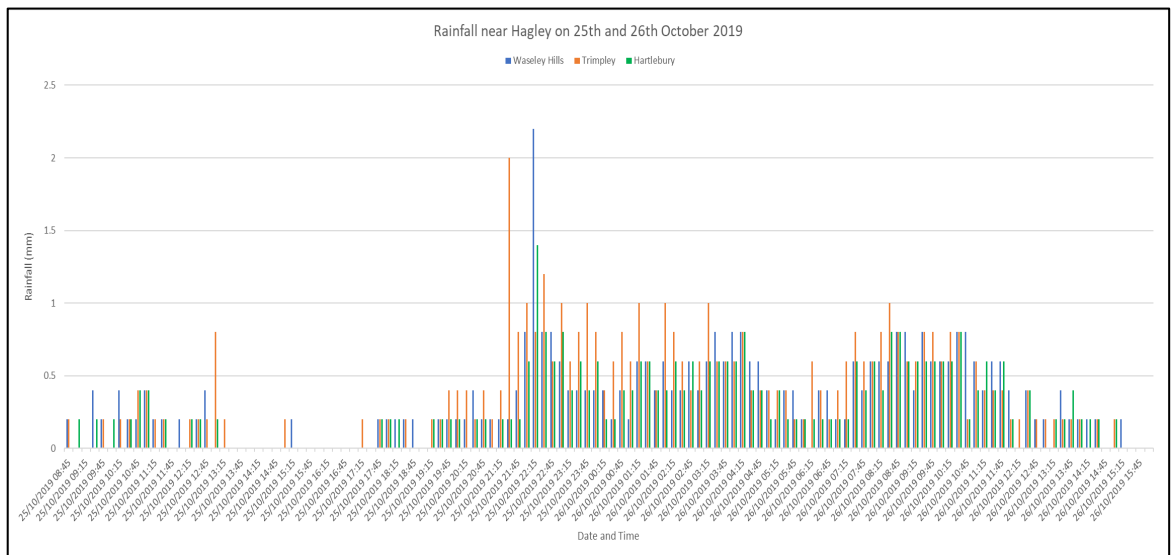
In November 2019, after all the rainfall in October, the soils were even more saturated across the Severn catchment. On 7<sup>th</sup> November a low-pressure system stalled over central England and high rainfall totals were recorded, and there were over 150 Flood Alerts and Flood Warnings in place for England and Wales. Overall it was the fifth wettest autumn in England and Wales since 1766.

Rain gauge data for the event was gathered from the Environment Agency and Severn Trent. The location of the nearest rain gauges to the Hagley catchments are shown in Figure 6.

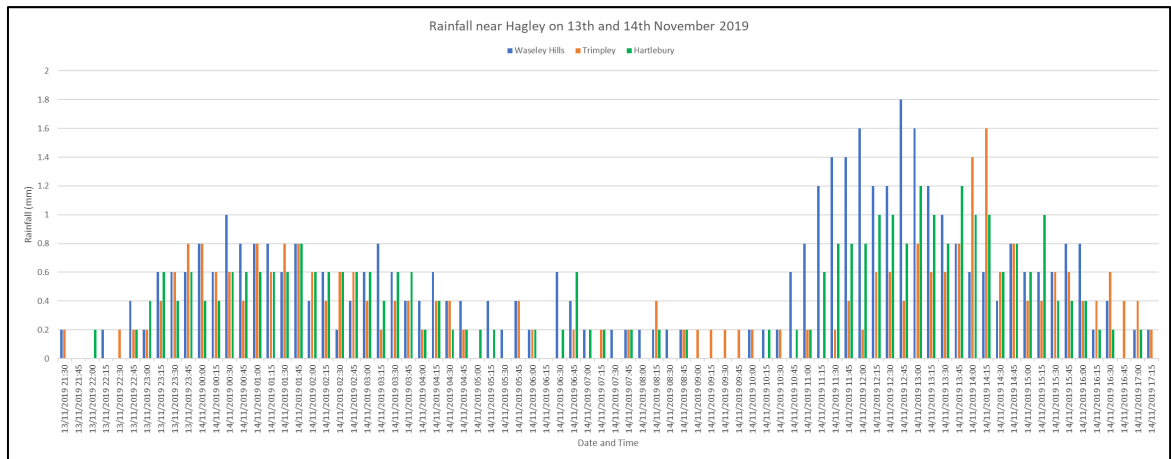


**Figure 6:** Location of rain-gauges relative to the Hagley catchments

The nearest rain-gauges to the East, West and South are Waseley Hills, Trimpley and Hartlebury. The rainfall recorded at each of these gauges at 15 minute intervals for the October and November events is shown in Figures 7 and 8 and reproduced in Appendix B



**Figure 7:** Recorded rainfall at Waseley Hills, Trimpley and Hartlebury on 25<sup>th</sup> and 26<sup>th</sup> October 2019



**Figure 8:** Recorded rainfall at Waseley Hills, Trimpley and Hartlebury on 13<sup>th</sup> and 14<sup>th</sup> November 2019

Analysing these rainfall events using the Duration Depth Frequency model to assess the rainfall event return periods, which is the method normally adopted in flood hydrology, would result in low return periods for both events. For both events the rainfall in any 15 minute interval rarely exceeds 1mm. However, both hyetographs demonstrate that in both the October and November events there was a sustained period of rainfall, which we know took place on a saturated catchment, and it is this which resulted in the runoff exceeding the infiltration capacity of the soils and the drainage capacity of the infrastructure in many parts of the country, and the resultant flooding. The fact that the Chestnut Drive culvert blocked had a significant impact on the flooding experienced in this location. The flood return period is difficult to estimate effectively, since it would require more in-depth analysis of the hydrogeology of each specific location to fully incorporate the effect of the antecedent conditions, which is beyond the scope of this investigation and report.

## 3.2 Flood event description

The **flood event in October** evolved gradually with constant rainfall from 7pm on Friday 25<sup>th</sup> October until around 3pm on Saturday 26<sup>th</sup>, progressively causing more and more surface water flooding issues across the county. There was a blockage in the culvert at Chestnut Drive due to branches that had been left on the bank of the watercourse being washed into the culvert and a large branch becoming wedged where the culvert diameter decreases. The blockage became obvious to residents at around 7.25am with the flooding of gardens to the rear of properties on Willow Close. Flooding issues were also appearing elsewhere in the County, with Responders already becoming stretched. At around 10am a car became stranded in the access road to the Oasis. The first surface water flooding happened on Chestnut Drive itself at around 1pm, and an hour later homes on Chestnut Drive started to flood internally. It was not until the afternoon of Sunday 27<sup>th</sup> October that the blockage could be removed, after nearly 24 hours without

further rain, and then water levels dropped quite rapidly. Drain Jet Surveys, one of the contractors working for Worcestershire County Council Highways, cleared the blockage.

Flood Zone 2 of the Environment Agency Flood Risk for Planning map (Appendix C) shows the mechanism of flooding on Chestnut Drive in October 2019, although the flood extent was more confined than that indicated in this map. Water backed up from the culvert under Chestnut Drive near the Play Area and flowed onto Chestnut Drive, where it flowed south along the road before flowing west, via four houses, into the Sweetpool Nature Reserve and then back into the Gallows Brook. Surface water sewers also outfall to this culvert and water was seen coming out of the manhole cover on Chestnut Drive and also flowing south along the road.

On the **14th November 2019**, following prolonged rainfall on already saturated ground, the watercourse behind Market Way backed up behind the privately-owned culvert and overflowed for the third time in six months. From here the flood water discharged to the front of the properties. The drains at the front of the properties were not able to take the excess water because they were already full following the prolonged rainfall. Flood water entered habitable areas of five houses and one garage.

Site visits undertaken by North Worcestershire Water Management and Worcestershire County Council Highways after the event, including examination of the culverts and liaison with residents, suggest that the privately-owned twin culvert caused a local pinch point as the two pipes combined have a lower conveyance capacity compared to other culverts in the vicinity. This was exacerbated during the event by some (but not excessive) silt and debris being present in the vicinity of and within the twin culvert, and possibly debris partially blocking the makeshift trash screen installed at the entrance of one of the two pipes of the twin culvert.

Some of the key flow paths have been captured from discussion with residents and Risk Management Authority response staff and the major flow path is shown in Appendix D.

### **3.3 Flood impacts**

The combined impacts of the flooding in Hagley in autumn 2019 are as follows:

- 10 residential properties confirmed as internally flooded (4 in October and 6 in November);
- Several roads temporarily closed including The Oasis, The Greenway and Chestnut Drive (in October) and Market Way (in November);
- 1 car written off.

Whilst this impact was significant, the biggest impact – as is often the case with flooding – has been upon the residents themselves. The impact on

mental wellbeing is impossible to accurately measure or articulate, not least because for many it is ongoing. Some residents were forced to relocate in order to allow repairs to be carried out to their properties.

The economic impact of the flood event will include property and infrastructure repairs and replacement, response and recovery efforts and development and implementation of future flood risk and impact reduction measures. This is likely to exceed a quarter of a million pounds.

## **4. Flood event response, recovery & investigation**

### **4.1 Timelines**

Timelines of the key events and response / recovery activities have been compiled from discussions with the Risk Management Authorities, first responders, local councillors, residents and records held by individuals and relevant organisations. The timelines can be found in Appendix E of this report and they include the following activities.

- Liaison with residents and provision of advice and support including house to house visits.
- Deployment of pumps.
- Deployment of the National Flood Forum to give specialist advice and support to residents.
- Updates for residents.
- Organisation of meetings and site visits with residents and riparian landowners.
- Organisation and attendance of frequent multi-agency co-ordination meetings.
- Reviewing the emergency response.
- Removal of debris.
- Removal and temporary erection of trash screens.
- Installation of a basic early warning system.
- Construction of an overland flow route.

### **4.2 Risk Management Authority & first responder evaluation**

#### **4.2.1 Local Resilience Forum de-brief**

It is routine procedure that the response to an emergency event is reviewed via a standard de-brief process. This process is established and administered by the Local Resilience Forum, a partnership of emergency response organisations based upon police administrative regions.

The multi-agency de-brief after the county-wide October and November 2019 flood events took place in January 2020. It was carried out by members of the West Mercia Local Resilience Forum and involved representatives from all of the Risk Management Authorities and some other first responders. Some of the key issues and lessons learned from this process, which are relevant to the flooding in Hagley, are listed within section 6 of this report and the resulting key recommendations are listed in section 7.



## 4.2.2 Resident feedback

Feedback from residents has been sought and gathered in a number of ways including the following.

- Discussions with individuals during the emergency response.
- Discussions with individuals during visits to properties.
- Discussions between local councillors and residents.
- Via social media.
- Directly via correspondence with the Risk Management Authorities.
- At the public meeting with residents and councillors on 4<sup>th</sup> November 2019.

Much of the specific feedback was responded to and acted upon immediately but more general feedback has been fed into the investigation process and it is reflected in this report.



Photo taken during the October flood event looking over The Greenway culvert towards Chestnut Drive.

## **5. Drainage infrastructure & watercourse investigation**

Immediately after the flood events Worcestershire County Council, North Worcestershire Water Management, the Environment Agency and Severn Trent Water Ltd began a thorough inspection of all highway drainage infrastructure, sewer infrastructure and the network of local watercourses:

### **5.1 Watercourses**

Worcestershire County Council, North Worcestershire Water Management, the Environment Agency, riparian landowners and residents carried out initial inspections of watercourses following the floods and this was followed up by more detailed inspections over the following months. While the maintenance of the watercourses is the responsibility of riparian landowners, the Risk Management Authorities have assisted in improving the conveyance of these watercourses in order to reduce flood risk.

Work on watercourses has included the following.

- Clearance of vegetation from the overgrown sections.
- Removal of debris from near the watercourse.
- Installation of a basic early warning system and two temporary trash screens.
- Construction of an overland flow route for Market Way.

### **5.2 Highway drainage infrastructure**

Worcestershire County Council checked and jetted the entire highway drainage system, including the area near Market Way, in December 2019.

Highway Engineers have continued to inspect and survey culverts beneath roads and any gullies suspected of being damaged or blocked.

### **5.3 Sewer infrastructure**

Staff from Severn Trent Water Ltd responded to reports of sewer network issues in the immediate aftermath of the flood events and followed this up with pro-active inspection of key pieces of infrastructure over the following weeks.

## 6. Key issues and lessons learned

A number of issues and learning points have emerged from the flood event via the Local Resilience Forum de-brief, discussions with other Risk Management Authorities and feedback from residents. The key points include the following.

### 6.1 Response & Recovery

- The widespread flooding across Worcestershire in both October and November meant that resources for Category 1 and 2 responders were stretched during both October and November flooding in Hagley.
- This impacted on the emergency response from Risk Management Authorities and first responders.
- The nature of the surface water flooding meant that incidents developed prior to river flooding alerts and warnings being issued around the County.
- When the ground is saturated it is even more important that communities and responders are on alert for potential surface water flooding after relatively moderate rainfall events.
- The response from residents was prompt and good, but residents were reliant on already stretched authorities and first responders for material assistance during the events.
- For both events, on a county-wide scale, there was good partnership working, communication and co-ordination between the Risk Management Authorities and other responders.
- Advice and support provided by the National Flood Forum was extremely valuable.
- The response from insurance companies has been varied.

### 6.2 Investigation and causes of flooding

- Highway drainage and sewer infrastructure was in generally good working order – although it was overwhelmed by the volume of rain water.
- The blockage in the culvert under Chestnut Drive was a major cause of the flooding in October 2019. This was in part due to debris being left near the river bank and in part due to the sudden reduction in the diameter of the culvert. A similar blockage is likely to happen in the same location in the future unless this is addressed.
- The watercourses are in generally good order, with few obstructions, although they were overwhelmed by the volume of rain water.
- A lack of resources meant that the flood investigations were not complete prior to the more severe flooding in February, further delaying the post-flood investigations and reporting.

### 6.3 Mitigation & Resilience

- Removing, or at least smoothing, the sudden change in diameter of the Chestnut Drive culvert will reduce the likelihood of blockages in the future.

- Replacing the twin culvert at Market Way with a single larger culvert would increase the conveyance.
- Well designed, installed and maintained trash screens in the right locations may help to reduce the risk of culverts blocking in the future.
- Well designed, installed and maintained warning systems will help to reduce the impacts of future flooding.
- An active Flood Action Group with a flood resilience plan developed in liaison with the Parish Council, District Council, County Council, Environment Agency and Severn Trent would help to reduce the impact of future flooding.
- Reprofilng works to the highway or footway in the vicinity of the culvert on Chestnut Drive could enable flood water to flow back into the watercourse without entering properties.



Photo taken during the October flood event looking over the Chestnut Drive culvert towards The Greenway.

## 7. Key recommendations

The following key recommendations have emerged from the flood event response debrief for the October and November flood events across Worcestershire, from the investigation and from community feedback. The actions associated with these are in the Action Plan in Appendix F. Some of these are specifically relevant to Hagley whilst others are relevant to flood risk management across Worcestershire.

	<b>Recommendation</b>	<b>Lead</b>
<b>Response &amp; Recovery</b>		
KR1	Produce standard advice and support materials for distribution to impacted communities during future surface water flooding events	Worcestershire County Council
KR2	In future surface water flood events always assume there might be quick development of flooding impacts and proactively ramp up resources	Risk Management Authorities
KR3	Pursue specific unsatisfactory reinstatement issues from insurance companies	National Flood Forum
KR4	Establish community Flood Action Group and resilience plans which enable local communities to take pro-active action to mitigate flooding without over-reliance on over-stretched Category 1 responders and Risk Management Authorities.	National Flood Forum
<b>Investigation</b>		
KR5	Continue with multi-agency investigation and flood recovery	Worcestershire County Council
KR6	Continue to investigate potential measures to reduce flood risk near Market Way (outlined in Appendix G).	North Worcestershire Water Management
KR7	Clarify history of The Chestnut Drive culvert's approval, construction and ownership etc and any ongoing responsibility / liability	Worcestershire County Council
KR8	Continue to investigate the feasibility of improving the sudden reduction in diameter of the Chestnut Drive culvert.	Worcestershire County Council
KR9	Continue to investigate appropriate warning systems to raise early awareness of potential flooding in future.	Environment Agency
KR10	Investigate the feasibility of getting the whole of Chestnut Drive culvert upgraded / opened up (COMPLETED)	Worcestershire County Council

KR11	Investigate the potential to undertake works near Chestnut Drive to enable water which has backed-up from the culvert to go back into the channel downstream without entering properties.	Worcestershire County Council
KR12	Continue to investigate options for slowing the flow in the catchment upstream of Hagley.	Worcestershire County Council and Environment Agency
KR13	Explore with residents the potential (possible benefits and costs) of residents installing PFR on their properties.	Environment Agency and National Flood Forum
<b>Mitigation / Resilience</b>		
KR14	Secure funding and implement scheme(s) which are demonstrated to be beneficial from the investigations	All
KR15	Secure future potential access to adequate pumps	Worcestershire County Council
KR16	Put together a maintenance plan for the best possible maintenance of the culvert and the open space above it	Ground Solutions
KR17	Confirm the benefit and feasibility of a permanent trash screen upstream of the Chestnut Drive culvert to reduce the risk of future blockages	Environment Agency
KR18	Promote awareness of relevant responsibilities to riparian owners and encourage their implementation through advice, support and enforcement if necessary	North Worcestershire Water Management and Environment Agency
KR19	Continue to implement works proposed to decrease the proportion of culverted flows outfalling at the upstream end of The Greenway culvert (through culvert 'D' in Figure 5) - COMPLETED	North Worcestershire Water Management and Worcestershire Highways

## 8. Next steps

1. Discuss this report and its key recommendations with partners, stakeholders and particularly the impacted community.
2. Continue to support the multi-agency Hagley Flood Risk Management Plan Group.
3. Continue to support the local community flood action group.
4. Continue to develop the detailed action plan, based on the key recommendations, the implementation of which will be monitored by the Worcestershire Flood Risk Management Strategic Co-ordinating Group.
5. Continue to develop the detail of specific actions in the plan and identify and secure funding.
6. Continue to implement the action plan.



Photo taken during the October flood event – flooded rear gardens in Willow Close.

## 9. Conclusion

Although neither the October nor November 2019 rainfall events were extreme, the saturated ground conditions resulted in widespread surface water flooding across Worcestershire, including the Parish of Hagley, exacerbated by the blockage of culverts in specific locations, notably at Chestnut Drive in Hagley.

There is often little warning before surface water flood events occur, particularly when the ground is saturated and relatively moderate rainfall results in significant runoff.

When flooding occurs, it often affects a large area and the resources of responders and Risk Management Authorities are stretched. The more that communities can be active in increasing their resilience to flooding, the lower the impact of flooding will be.

When new planning applications are made, it is important that the sizing of culverts is considered from a catchment flood risk perspective. In practice this happens for all new developments in Worcestershire, since North Worcestershire Water Management comment on all developments with surface water drainage implications on behalf of WCC. Any changes to an existing culvert also requires an environmental Permit (designated main rivers) or Land Drainage Consent (other watercourses). Culverting of watercourses is discouraged in Worcestershire, except for access.

The economic cost of the October and November 2019 flood events in Hagley alone is likely to total in excess of a quarter of a million pounds.

The recovery and post flood investigations have been delayed and hampered by the further, more extreme, flood event in February 2020 and the Covid-19 pandemic and associated lockdown.

There are a number of key lessons to be learned in terms of the both the emergency response and the ongoing recovery effort and the partnership of agencies and the community are committed to making changes to address them.

There are also a number of measures which can be taken by the agencies and the community which will reduce the scale of the impact of a future potential flood event and possibly even, to some extent, also reduce its likelihood.



# **Appendix A – Flood & Water Management Act (2010)**

## **s19 duty to investigate flooding**

Worcestershire County Council, within its role as Lead Local Flood Authority, has a duty to investigate flood events it deems to be 'significant' as detailed in Section 19 of Part 3 of the Flood and Water Management Act (2010) as follows:

### **Section 19**

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 flood.

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

(a) publish the results of its investigations; and

(b) notify any relevant risk management authorities.

### **Worcestershire County Council Triggers**

All flood events will be investigated informally but flood events resulting in one or more of the following impacts will normally be formally investigated under the Flood & Water Management Act:

- Danger to life
- 10 or more properties internally flooded
- 10 or more businesses severely disrupted
- 1 or more pieces of critical infrastructure severely impacted

A formal investigation under the Flood & Water Management Act might also be triggered if there is one or more of the following:

- Very frequent flooding
- Impact on particularly vulnerable people
- Severe economic disruption
- Significant environmental impact
- Requests of a significant weight

## **Appendix B – Recorded rainfall hyetographs near Hagley from October and November flood events**

**Appendix C – Flood Zone 2 near Chestnut Drive**

## **Appendix D – Flooding Mechanism near Market Way**

## Appendix E – Flood events, response and recovery timelines

The timelines below focus on the activity in Hagley. Alongside these events in Hagley there was also the wider County Council and partners' responses to flooding across Worcestershire and the county-wide co-ordination of this response and recovery by WCC and its partners, both in October and November, although including all of this activity is beyond the scope of this report.

### October Flood Event

Day / time	Event / activity
<b>Friday 25<sup>th</sup> October</b>	
19.00	Rainfall event started.
<b>Saturday 26<sup>th</sup> October</b>	
07.25	Residents in Willow Close awoke to find 2 feet of water in their gardens. The flooding is reported to the Environment Agency.
08.00	Residents ascertain that there is a blockage in the culvert underneath Chestnut Drive and the flooding is reported to the Fire Service.
08.03	The flooding is reported to Cllr Colella who also informs the Environment Agency.
08.05	Residents attempt to report flooding to Worcestershire County Council but receive a recorded answer.
08.15	Approximately 4 - 6 feet of water backed up in the Chestnut Drive culvert and rising flood water in gardens in Willow Close and access road to Oasis.
09.00	Online report made to Worcestershire County Council Highways.
ca 10.00	Vehicle stranded in rising waters in The Oasis.
ca 11.00	Vehicle from Bromsgrove Council arrived in Chestnut Drive with sand bags for residents adjacent to culvert. An attempt was made to clear the culvert with long pole.
ca 11.10	Environment Agency again informed of the developing situation.
ca 12.30	Cllr Colella on site talking to residents.

12.54	Environment Agency informed that surface water flooding developing on Chestnut Drive.
13.25	Call to fire service
13.41	Fire Service arrives on site. Informed EA at 14.02
14.32	Fire Service Stop message "ELECTRICS IN PROPERTY ISOLATED, AWAITING ARRIVAL OF ENV AGCY, ADVICE GIVEN TO RESIDENTS"
14.00 – 15.00	Response from public services - more sandbags arrived as homes in Chestnut Drive begin to flood.
	Cllrs May and Daisley on site talking to residents.
	Two officers from EA Field Team arrived on site to assess the situation.
	WCC Highways arrived on site to assess situation.
	Surface water flooding occurring in The Greenway.
	Gardens in Willow Close now have approximately 4 ft of flood water and rising. Real threat to homes becoming flooded if no action taken to remove blockage.
ca 15.00	Rainfall stops.
15.00 – 17.00	WCC Highways drains maintenance vehicles on site attempting to flush culvert and drains. Fire service (called 15.53, arr. 16.20) on site dealing with flooded homes in Chestnut Drive.
	Bromsgrove District Council staff out on site
ca 17.00	Over-pumping of water from culvert area into watercourse commenced. Fire Service pumps support with blocked culvert.
ca 18.00	Worcestershire County Council Highways bring two larger pumps on site.
ca 19.00	Over-pumping with larger pumps works and water levels stabilised upstream in The Oasis and Willow Close. Approximately 7 feet of water evident in gardens and threatening to inundate properties.
20.00 onwards	Very slow improvement to water levels upstream. More pumping equipment from Worcestershire County Council arrived on site. Fire Service pumps and High Volume Pump set up.
22.00	Situation under control and being managed. Actions to remove flood waters working. Pumping continued throughout the night.
<b>Sunday 27<sup>th</sup> October</b>	

06.00	Water levels in gardens at Willow Close approximately 1 foot.
10.00	Watercourse back within its channel but Chestnut Drive culvert still blocked.
10.00 onwards	Pumping continued throughout the morning. Culvert unblocked by WCC Highways' jetting crew during the course of the day. Fire service left at 13.21
<b>Monday 28<sup>th</sup> October onwards</b>	<b>Actions Post-flooding</b>
Monday 28 <sup>th</sup> October	WCC inform Severn Trent regarding the flooding.
October 2019 onwards	Severn Trent checked surface water sewers and flap valves on outfalls in the area to make sure that no debris had been deposited from the culverts.
October 2019 onwards	The National Flood Forum, working on behalf of the councils, visited flooded residents and it has continued to provide support and advice.
4 <sup>th</sup> November 2019	Public meeting with Hagley residents.
November 2019	Temporary trash screen and warning system installed upstream of Chestnut Drive culvert by WCC Highways.
November 2019 onwards	Multi-agency group established to carry out the investigation, including representatives from Worcestershire County Council (Flood Risk Management, Highways, Structures), Bromsgrove District Council, North Worcestershire Water Management, the Environment Agency and Severn Trent Water Ltd.
January 2020	Multi-agency site visit with riparian landowners (Ground Solutions) and WCC organised by the EA to discuss flood event and its causes, roles and responsibilities of all present, next steps and how to reduce likelihood of further flooding. Positive meeting-Ground Solutions decided to undertake works to reduce likelihood of debris collecting in culvert structures in future. Stronger understanding gained by GS on their role to ensure flow is not restricted and importance of maintenance and challenges around parts of the Greenway and Chestnut Drive culverts under their ownership and section of open watercourse in between.
Jan 2020 onwards	The multi-agency group has met several times and group members continue to communicate on an ongoing basis while undertaking their agreed tasks.

Jan 2020 onwards	Further discussions have been held with Ground Solutions, the owners of the Chestnut Drive culvert and the open space upstream of it.
Feb 2020	Debris from the open space between The Greenway and Chestnut Drive removed.
Feb 2020	The grille at the downstream outlet of the Greenway culvert removed by Ground Solutions in response to the recommendations of the multi-agency group.
Feb 2020 onwards	The investigation team has begun to explore the wider upstream catchment in order to identify potential interventions to slow and hold back the flow.

### November Flood Event

Day / time	Event / activity
<b>Wednesday 13<sup>th</sup> November</b>	
22.30	Rainfall event starts.
<b>Thursday 14<sup>th</sup> November</b>	
Afternoon	Water starts backing up behind culvert to the rear of properties in Market Way and starts flowing to the front of the properties.
Afternoon	Residents call Bromsgrove District Council to report potential flooding.
17:15	Rainfall event ends.
Evening	Water starts entering properties.
Evening	Residents call Fire Service to report flooding.
Evening	Fire Service arrive on site to support residents.
<b>Friday 15<sup>th</sup> November</b>	
Morning	North Worcestershire Water Management Officer and WCC Highways officers on site to support residents.
<b>Monday 18<sup>th</sup> November onwards</b>	<b>Post-flooding actions</b>
November 2019 onwards	Bromsgrove District Council clears vegetation from the overgrown unregistered area of land to expose the outlet of the twin culvert and allow for inspection of the open watercourse present in this area. Upstream sections of the watercourse are also inspected by North Worcestershire Water Management in the various back gardens. The services of a specialised drainage contractor are



	utilised to cleanse and survey the piped drainage systems in the area. No excessive amounts of silt or debris are found, and no defects either.
November 2019 onwards	Liaison starts with the respective landowners regarding potential measures that might impact their assets. Tentative work starts to assess the (technical) feasibility and associated costs of potential measures. As a short-term, no regret measure, an overland flow route is constructed on top of the twin culvert that should allow any excess water to flow back into the southern watercourse, keeping the flood water away from the houses.

## **Appendix F – Action Plan from Hagley Investigation and Recovery Group**

## **Appendix G – Potential measures to reduce flood risk near Market Way**