

Gloucestershire Lead Local Flood Authority summary report

Introduction

The following report summarises the scale of the flooding seen across Gloucestershire on the 23rd and 24th December 2020, alongside its immediate and longer term impacts. It is intended to take a multi-agency overview of the response to the incident, but concentrates specifically on the Gloucestershire County Council (GCC) teams with a direct role in flood risk mitigation, response, recovery and resilience including Gloucestershire Highways, Gloucestershire Fire and Rescue (GFRS), Civil Protection Team (CPT) and the Lead Local Flood Authority (LLFA).

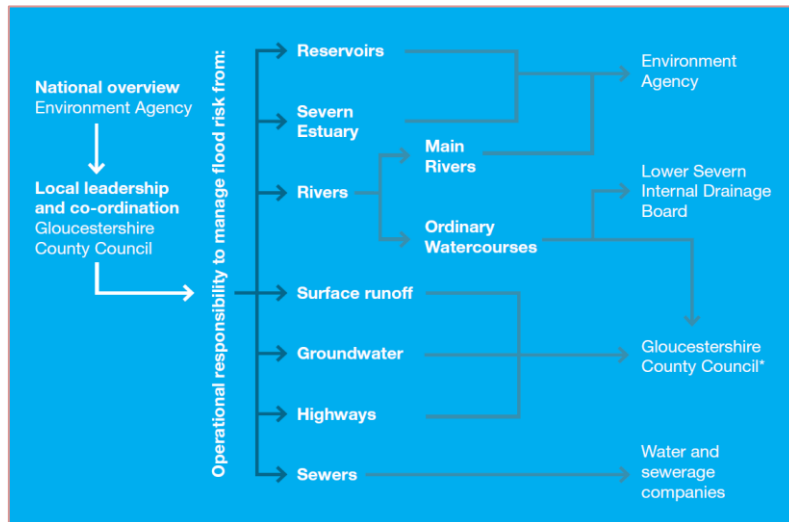
The event was characterised by a short period of intense rainfall that fell on saturated ground and elevated river levels. From the morning of the 23rd until midnight, the county saw nearly 16 hours of rainfall, with some locations reaching nearly 60mm. The rivers responded quickly with levels on some reaching their highest recorded peaks. Over 400 properties were affected, with nearly 300 internally. Drawing comparisons with historical flooding events can be misleading as critical monitoring infrastructure is now much more widely spread, but based on data collected thus far, it is safe to say that December 2020 was the most severe flood event since July 2007. With the accelerating impacts of climate change, short, intense, geographically diverse rainfall events such as these will become the norm as opposed to the exception, and valuable lessons must be learnt and acted upon to increase the county's readiness and resilience. A summary of property flooding across the county is provided in Appendix 1, and a summary of rainfall and river levels is in Appendix 2.

Lead Local Flood Authority

The County Council as LLFA has a wide range of responsibilities under legislation including the Flood and Water Management Act 2010. These include:

- Investigating and reporting flooding incidents;
- Managing flood risk from surface water, groundwater and ordinary watercourses;
- Producing a local flood risk management strategy;
- Statutory consultee on major developments;
- Consenting works on ordinary water courses; and
- Enforcing works to maintain the flow on ordinary water courses.

The LLFA also has as a local coordinating role, working alongside other Risk Management Authorities (RMAs). The following table explains these various roles and responsibilities:



*GCC includes the LLFA, Highways and GFRS and Civil Protection Team (N.b: GFRS and CPT responsibility extends only to incident preparation, response and recovery). It is also essential to note that District Councils also play a pivotal role in flood risk management which covers preparation, response, investigation and recovery. All Gloucestershire RMAs work as part of an extended, collaborative, multi-agency flood risk management team.

As part of the GCC role, a significant annual investment is made to support flood risk management. Since 2008, a minimum of £2.1million a year is made available for teams, projects and schemes to increase the flood resilience of the county. This investment includes GCC-led studies, initiatives and practical resilience measures including management of the highway drainage network and flood alleviation schemes. It also provides funding to contribute towards third-party flood alleviation schemes, often led and delivered by District Councils.

In line with the LLFA coordination remit, very soon after the event a series of District-based, multi-agency flooding debrief events were arranged. These were aimed at comparing notes and reports across the different agencies to build up an accurate picture of the event, to discuss lessons learnt and to agree short and longer term actions. Attendees included:

- LLFA;
- Gloucestershire Highways;
- CPT;
- District Councils (primarily flood risk / water management engineers);
- Environment Agency (EA); and
- Water and Sewage Companies (primarily Severn Trent Water).

This was an unprecedented and successful approach to incident assessment and investigation that will provide an effective working model for future events. The fact that the various RMAs were able to come together in such a short space of time was testament to the commitment to partnership working held by all parties. In addition to lessons learnt and next steps, the sessions provided the basis for the LLFA-led impact and rainfall / river level summaries in Appendices 1 and 2.

Lessons learnt:

Further evidence was provided through the debrief sessions, and by the event in general, of the crucial role played by District Council officers. Not just assisting with incident response during a national lockdown, but the immediate efforts to investigate the full local impacts of the event. Without this valuable and expert resource, response to and recovery from flooding events would be far less effective. These teams are often very small and under-resourced (in some Districts just a single officer). Based on the December event, further consideration will need to be given to how the District resource is supported centrally if it is to fulfil its flood risk management potential.

An additional local resource that helped communities prepare for, and react to, the flooding is provided by local flood wardens and flood action groups. These schemes are more active in some areas than others, but are an example of positive local action that could be replicated in other areas if central support was increased.

Another issue raised during the debrief sessions and in subsequent reports was the need for a clearer, more consistent list of immediate flooding contacts. It was evident that some residents and local councillors were not clear on who to contact for which elements of the flooding incident. The LLFA provides a detailed [flood guide](#) containing information on how to prepare for, react to and recover from flooding which was revised and republished as an online resource shortly before the December event, and distributed via press release and social media channels. This contains all of the relevant contact details for the various RMAs, including how to report incidents on line (including the LLFA's [Flood Online Reporting Tool](#), FORT) but a separate contact list was nevertheless developed immediately after the debrief sessions, agreed by all partners, and subsequently distributed widely / published on line (see Appendix 3).

Whilst there is an extensive resource allocated to flood warnings and river level / rainfall alerts across the RMAs, primarily by the EA, some of the initial warnings leading up to the 23rd may have under-estimated the speed at which the river levels responded to the rainfall and the impacts of surface water flooding. No one organisation has a 'crystal ball', and the response was nevertheless excellent, but attention may need to be given to strengthening this aspect of the county's preparedness, perhaps involving a programme of investigation / assessment / extension of flood warning infrastructure.

Individual property flood resilience funding is often made available by Government following major events, to enable households to be better protected from flooding and to speed their recovery. Eligibility criteria for these grants can often be overly restrictive and key communities can often miss out. To date, no such grants have been announced to cover the December event, and this leaves local authorities across the country facing the decision to fill the immediate need with local funded and delivered grant schemes.

A wider, catchment-scale approach to flood risk management needs to be strengthened alongside 'traditional' flood alleviation schemes. This is already in place in some areas, but this holistic approach, combining upstream land and natural flood management needs to be more widely implemented and centrally supported across the county. The LLFA has recently

combined forces with neighbouring LLFAs to submit an £11 million project proposal to the national Innovation Resilience Programme. If successful, the local proposal, 'Working with Natural Gloucestershire' will see a £1.4 million investment into natural flood management and upper-catchment land management projects over the next six years.

Despite the need for improvement as listed above, two key positive messages arose from the December flooding. Firstly that the significant investment made over recent years has had a noticeable benefit. Whilst the event was severe, the potential impacts were to a certain extent reduced. Investment covering flood alleviation schemes, property level flood resilience measures, a robust approach to managing flood risk in new developments, public awareness raising and an enhanced highway drainage maintenance schedule have all added to the protection of homes and businesses and the overall resilience of the county. That said, there is always more that can be done, and these improvements will continue as long as the funding commitment is maintained. Secondly that all RMAs worked as a highly effective extended flood risk management team; both in the immediate response to the event, and also with regard to post event investigation and assessment, with very few shortfalls or gaps. This solid partnership will continue to work together to increase the resilience of the county and to respond to future flooding events.

Moving forward - Next steps:

Climate change and the short, intense, diverse rainfall events that it leads to present a challenge to the county's readiness and resilience. Responding to this the LLFA will continue to work with all of its partners to put in place a range of short and longer-term actions in line with a robust priority schedule and the statutory Local Flood Risk Management Strategy. Due to the scale of the event, local expectations must however continue to be managed. Initial actions include, but are by no means restricted to:

- Update resource priority schedule inline with recent data;
- Promote further public use of the FORT to inform the priority schedule, and wider distribution of the flood guide;
- Carry out location-based higher level Flood Risk Assessments for the worst-hit areas, where such evidence is either lacking or out of date;
- Facilitate information-sharing with local communities to maximise local involvement and to keep residents and businesses informed of progress;
- Immediate actions in worst-hit areas, including maintenance and improvement of existing flood alleviation schemes and warning systems;
- Investigate provision of recovery / resilience householder / business grants, either with central Government support or potentially on a local basis;
- Investigation into strengthening the District Council officers' roles, accessing funding where required;
- Pursue the Innovation Resilience Programme application to full business case and project roll-out; and
- Develop a longer-term action plan, based on an updated priority schedule, and in line with a full revision of the Local Flood Risk Management Strategy.

Gloucestershire Fire and Rescue Service

Operational response:

GFRS found ourselves in spat conditions which put staff in the Control Room under significant pressure. We established recall to duty for the Control Station Manager and dispatched a Group Manager to Waterwells to support the mobilising of appliances. Three Flexi Station Managers were dispatched to various locations across the county to assess flooding impact and report back. There were some issues regarding vehicular access to risk areas, lone working and lack of welfare (most were driving through significant flood areas for around 6 hours). We also saw issues regarding flat batteries in Airwave radios and mobile telephones due to lack of charging leads in temporary cars. The FRS operational elements have been fed back through our Operational Debrief and Monitoring system.

Resources:

From a resourcing perspective we had high activity and had to prioritise sending resources to where it was thought there was potential risk to life. This meant that many calls did not receive a response for several hours as they were not considered an urgent priority for GFRS due to no life risk. We reacted to information received from 999 calls and partner agency information to decide where our resources were needed most. Information received from the multi-agency Operation Link calls was shared internally by both the On Call Area Manager and Civil Protection Team. Overall, the On Call Area Manager overseeing GFRS response felt that, from a GFRS perspective, we managed well considering the limited resources in the Control Room and the spat conditions.

Lessons learnt:

GFRS recognised that an earlier “heads up” from the Control Room to the Flexi Duty Group would have been beneficial in starting to think about wider impacts and perhaps setting up Operation Link for multi-agency meetings, earlier than we did. From a resourcing perspective we managed limited resources in a timely and efficient manner and the prioritisation put in place ensured we reached those most in need as early as possible.

Civil Protection Team

Throughout the Christmas and New Year period (23rd – 31st December 2020) the County Council’s Civil Protection Team (CPT) was involved in supporting the multi-agency response to the impacts of flooding and ‘Storm Bella’.

CPT response:

During the evening of the 23rd CPT notified GCC Highways, GCC Communications Team and all District Councils that ‘Operation Link’ had been activated to convene a multi-agency meeting in response to the significant surface water flooding. CPT representatives attended the three meetings that were held over 23rd-24th December 2020 and, following the meetings, provided a ‘Common Information Picture’ to key GCC staff involved in emergency

response and all Directors. The Head of Democratic Services also forwarded these updates to all GCC elected Members.

During the evening of the 23rd CPT liaised closely with Tewkesbury Borough Council and GFRS regarding deployment of the High Volume Pump to Tirley and also placed Gloucestershire Emergency Support Team (a volunteer scheme overseen by CPT) on standby should any of the District Councils have required support with Rest Centres.

Evacuation of vulnerable residents:

During the period CPT was also involved in liaising with Tewkesbury Borough Council and GFRS to coordinate the evacuation of two vulnerable residents by boat. This included the evacuation, on Christmas Day, of a lady from Tirley whose home had flooded and was taken to a hotel and a lady from Sandhurst who required urgent hospital treatment.

Other response support:

CPT Duty Officer (24/7) also liaised with relevant partners to respond to a number of queries that came in via the Duty Officer phone during this period. This included liaising with:

- GCC Asset and Management Service, Stroud District Council and GFRS regarding the potential overtopping of the Thames and Severn Canal at Chalford.
- Cotswold District Council regarding sewer flooding in Siddington, Cirencester.
- GCC Health Protection and the EA to provide advice on river levels to Tewkesbury Fields Care Home, where a number of residents supported by GCC Adult Social Care live.
- Police, following a request from Tewkesbury Borough Council, regarding motorists ignoring road closure signs in Sandhurst and getting stuck or causing bow waves.
- GCC Adult Social Care and Cotswold District Council to provide information on vulnerable people potentially affected by flooding in Cirencester.

Contact arrangements:

Previously, elected Members have been provided with a contact number for GFRS Control to report any (non 999) issues affecting communities during an emergency. This was on the understanding that Control would then liaise with CPT Duty Officer or GFRS Officers as appropriate to follow up any such concerns.

However, during the evening of the 23rd GFRS Control were dealing with a huge volume of calls and it is recognised that, unfortunately, some elected Members were unable to make contact via this route. As such, GFRS Assistant Chief Fire Officer, CPT Leader and Head of Democratic Services have since met and agreed that elected Members can contact the on call Principal GFRS Officer (currently also GCC Gold Officer) during emergencies with any particular concerns.

This will ensure that Members are able to make direct contact with a GFRS Principal Officer and free up the CPT Duty Officer number for the emergency services, other GCC Teams, District Councils and partners to make contact on operational issues. Information to this

effect including a flow chart, contact numbers and additional useful contact numbers and websites have been placed on the Members' area of the GCC website.

Debriefs:

Following the December flooding, CPT has also attended the flooding debriefs with District Councils, arranged and facilitated by GCC Flood Risk Team. Members of CPT have also submitted feedback to the online Local Resilience Forum (LRF) Flood Debrief.

Awareness session:

CPT had previously offered elected Members awareness training on GCC and wider multi-agency emergency response. CPT is planning to provide awareness refresher sessions for elected Members going forward. This forms part of the overall longer term project the team is undertaking to build on the County Council's arrangements and preparedness for emergencies and effectively meeting the Council's statutory responsibilities under the Civil Contingencies Act 2004.

Additional response to January / February 2021 flooding:

CPT and GFRS have since also been involved in supporting the multi-agency response to the recent flooding, in light of further heavy rainfall impacting on already saturated ground and elevated river levels. This has included re-deploying the High Volume Pump to Tirley, liaising with relevant partners, notifying partners and attending EA Flood Advisory Service teleconferences, monitoring relevant websites and providing weather and flooding updates to GCC staff involved with emergency response, which again the Head of Democratic Services has been forwarding to elected Members for information.

Gloucestershire Highways

The issue of highway flooding can generally be split into two categories. The first relates to flash flooding as a result of storm events and the second to flooding associated with high river levels. However, as flooding associated with main rivers tends to be more predictable as we usually receive advance notice from partner agencies such as the EA, the following relates to GCC Highways' response to the more reactive and less predictable impact of flash flooding.

Recent events:

This winter, the Gloucestershire highways network experienced a number of storm related weather events that have resulted in heavy rain over an intense period with the most notable being on 23rd December 2020 and 20th January 2021. The December event resulted in wide spread flash flooding on the highway across the entire county resulting in hundreds of issues being reported to us from members of the public and the emergency services. Prior to the forecast heavy rain, we deployed crews to known areas at risk from flooding to ensure that gully gratings and trash screens were cleared, however the intensity of the rain meant that we also experienced issues in areas not normally affected. Storms with rainfall

this intense deliver such a large amount of water in such a short period of time that it overwhelmed some of our drainage systems, and whilst in some cases this was caused by pipes and gully gratings becoming blocked, other key wider assets were also being overwhelmed such as ditches, watercourses and combined sewer systems. In these instances flooding can occur, not because the drainage system is blocked or faulty, but because the outfall of the system has become submerged, slowing the flow of water. In some cases the water level in a ditch or watercourse also exceeds the road level rendering the drainage system ineffective.

In urban areas, flooding is often caused as a result of gully gratings becoming blocked by leaves and other detritus. This is a particular problem where demand for on street car parking is high, which means it can be difficult for our crews to routinely cleanse the drainage systems. Our colleagues in the District Councils also often struggle to sweep the streets to remove debris which can then go on to block the drainage system. On 23rd December GCC Highways received such a volume of calls both to the in hours and out of hours contact centres, it was difficult to deploy resources effectively, which meant we were still dealing with issues over the entire Christmas period and beyond. As a result, we suspended all planned drainage cleansing work at the start of January and redirected resources to flood clear up and remedial activities to allow us to empty gullies and use high pressure jetting to clear blockages in the drainage system. An additional 37 days of reactive jetting resource was used across the county in January as part of the response.

Working practices:

Following the December storm event we undertook a review and established a new approach to dealing with storms to ensure that resources were deployed in the most effective way for future events, the first of which occurred on 20th January in the form of storm Christophe. As part of the new approach, we set up Flood Desks in each of our four operational areas, which were manned by members of the GCC area teams. Calls continued to be taken by the Highway Customer Service Team centrally, however before emergency jobs were raised and passed to the contractor for scheduling, they were triaged by the flood desk. In addition to the flood desk staff, all available GCC area team staff were out on the network and were directed to trouble spots by the flood desk to make an assessment to ensure that the correct response was arranged and to establish the required priority of each incident.

This approach allowed the management of an active list of incidents and the subsequent deployment of the right resource, to the right place in the correct priority order. This process, combined with the suspension of all planned work by works gangs and our jetting fleet, meant that we were able to resolve more issues on the first visit and freed up our resources to allow us to tackle the greatest risk, largest impact and highest profile problems above more minor issues and allowed us to deploy the right resource to the right job.

Key routes:

A number of roads and key transport routes were closed as a result of the flooding. Some of these are outside of the direct control of Gloucestershire Highways, but every effort was

made to reopen routes as quickly and as safely possible. Where routes remained closed, signage was deployed to ensure public safety and reduce the flooding impact of car bow-waves entering neighbouring properties when motorists attempt to drive through flood waters.

One such key route which is often subject to flooding is the A417 near Maisemore. These closures present a persistent challenge for people in the local area and those using it as a regular access route into and out of Gloucester, with resulting significant detours and traffic congestion. The issue has, however, been recognised by GCC. In 2015, we bid for a Department for Transport (DfT) fund towards a [£25M scheme](#) to address the issue. The bid was unfortunately unsuccessful and the escalating cost of the scheme is beyond what GCC would be able to directly fund from existing budgets. More recently, however, fixing this problem has been identified as a key issue in the emerging review of the Local Transport Plan (LTP) and GCC are continuing to seek funding to do so as climate change will only increase the frequency of closures such as these.

Schedule enhancements:

Whilst Storm Christophe did not bring the rainfall we saw in December, it was a great opportunity to test our new process, and whilst there were still learning points to be had, the whole process delivered significant improvements in response and subsequent network recovery time. In addition to the flood desk approach, we are also reviewing the flood locations from December and January as part of an exercise to determine if adjustments need to be made the gully cleansing frequency in the worst affected areas. We also continue to work with the District Councils on joint authority area deep cleans in busy urban areas where residents are contacted to move cars from a street so that we can undertake collaborative works with minimal disruption to residents in locations where street cleansing and gully emptying is otherwise problematic. We have also increased the number of deep cleans undertaken this year and are planning to develop a schedule for further joint operations in the coming financial year.

Conclusion

The flooding associated with the high rainfall event of December 23rd / 24th was some of the worst that Gloucestershire has seen since 2007. The impacts were ameliorated by the work undertaken in the intervening period however, and response to the event was well coordinated and effective as a result of a solid multi-agency partnership. Some clear lessons have been learnt in the immediate aftermath, positive coordinated action on which will lead to improved readiness for, and resilience to, similar future events.

February 2021.

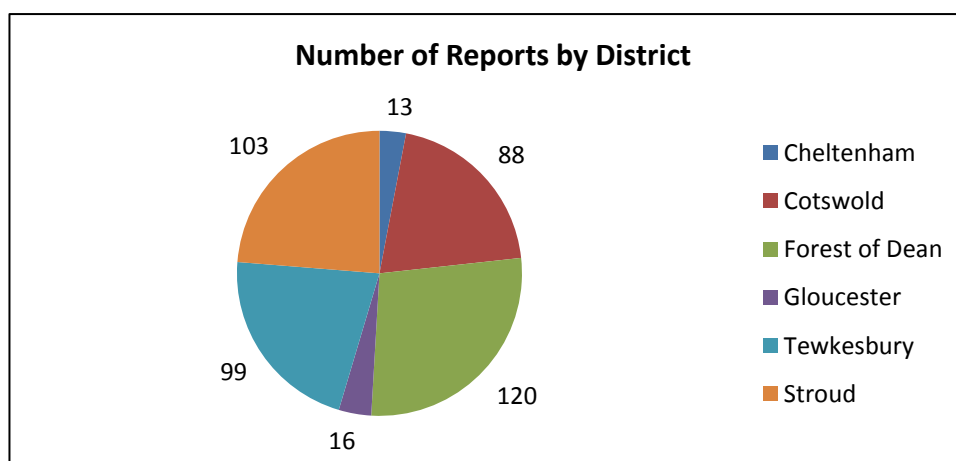
Gloucestershire property flooding reports summary

The following information has been derived from a number of sources, including District Council officer investigations, LLFA investigations and FORT. A source database is used to inform these summaries, but is not included here due to data GDPR restrictions. The database does however include information used to inform targeting of resources, such as source of flooding, which can be useful to other partners, so a condensed GDPR-compliant copy is available on request. Additional data is continually added to the database as further reports are received relating to the December event, but the summaries below are correct as of 15th February 2021.

Flood reports by District:

District	Number of reports*
Cheltenham	13
Cotswold	88
Forest of Dean	120
Gloucester	16
Tewkesbury	99
Stroud	103
Total	439

*Numbers subject to change



Flood reports by type:

Type of Flooding	Number of Reports
Properties Flooded (Internal Flooding)	297
Properties Affected (External flooding)	134
Unknown	8
Grand Total	439

Property Type	Number of Reports
Residential	391
Commercial	47
School	1
Grand Total	439

District	Property Type	Number of Reports	Internal or External Flooding	Number of Reports
Cheltenham	Residential	11	Internal	1
			External	10
			Unknown	0
	Commercial	1	Internal	1
			External	0
			Unknown	0
	School	1	Internal	1
			External	0
			Unknown	0
Cotswold	Residential	83	Internal	68
			External	14
			Unknown	1
	Commercial	5	Internal	5
			External	0
			Unknown	0
Forest of Dean	Residential	106	Internal	98
			External	8
			Unknown	0
	Commercial	14	Internal	13
			External	1
			Unknown	0
Gloucester	Residential	15	Internal	3
			External	12
			Unknown	0
	Commercial	1	Internal	0
			External	1
			Unknown	0
Stroud	Residential	94	Internal	40
			External	51
			Unknown	3
	Commercial	9	Internal	6
			External	2
			Unknown	1
Tewkesbury	Residential	82	Internal	46
			External	33
			Unknown	3
	Commercial	17	Internal	15
			External	2
			Unknown	0

Parishes with 5+ internal property reports:

District	Parish	Number of Reports
Cheltenham	N/A	N/A
Cotswold	Bledington	24
	Cirencester	19
	Lower Slaughter	6
	Moreton-in-Marsh	6
Forest of Dean	Cinderford	10
	Drybrook	5
	Longhope	12
	Lydney	23
	Newent	15
	Rudford and Highleadon	13
Gloucester	N/A	N/A
Tewkesbury	Ashchurch Rural	7
	Gretton	6
	Tirley	12
	Winchcombe	12
Stroud	Brimscombe and Thrupp	12
	Stroud	14

Parishes with 5+ reports (internal and external) or most affected parish if less than 5:

District	Parish	Number of Reports
Cheltenham	Charlton Kings	3
	Lansdown Ward	3
Cotswold	Bledington	25
	Cirencester	20
	Lower Slaughter	12
	Moreton-in-Marsh	9
Forest of Dean	Cinderford	11
	Drybrook	5
	Longhope	14
	Lydney	23
	Newent	16
	Rudford and Highleadon	13
Gloucester	Abbeydale Ward	4
Tewkesbury	Ashchurch Rural	7
	Gretton	24
	Stoke Orchard	5
	Tewkesbury	8
	Tirley	12
	Winchcombe	13
	Woodmancote	6
	Longford	5
Stroud	Brimscombe and Thrupp	12
	Hamfallow	9
	Painswick	13
	Standish	7
	Stonehouse	8
	Stroud	16
	Upton St Leonards	13

Appendix 2:

Rainfall and river level summary

Table 1 shows the rainfall for 23rd December 2020 at various locations across the county and Table 2 shows the peak each river level gauge peaked at, on which date and time, and whether this was its highest level. It should be noted when looking at this table that many of the river level gauges were installed after the 2007 flood event so didn't record this event.

The areas with the highest rainfall appear to be Parkend (near Lydney), Bourton-on-the Water and Dowdeswell (near Cheltenham), which all recorded greater than 50mm over the course of the day. Followed by Newent, Stroud, mid-Cotswolds and areas in Tewkesbury Borough, which all saw rainfall in excess of 40mm. Rainfall in the south of the county seems to have been either less intense or for a shorter period as totals only reached around 20mm.

Table 1 - Rainfall totals for 23rd December 2020:

District	Location	Rainfall Total (mm)
Cheltenham	Dowdeswell (near Cheltenham)	53.4
Stroud	Ebworth (near Painswick)	47.8
	Miserden (near Stroud)	44.4
	Minchinhampton (near Nailsworth)	19
	Kingswood	19.4
Gloucester	Over Farm (near Gloucester)	8
Forest of Dean	Parkend (near Lydney)	56.8
	Taynton (near Newent)	47.8
Cotswold	Broadway	36.4
	Chipping Campden	30.2
	Bourton on the Water	56.1
	Stowell Park (near Northleach)	22.4
	Rapsgate (near Rendcomb)	42
	Shorncote (near South Cerney)	20.3
	Tetbury	20.8
Tewkesbury*	Tewkesbury	45
	Winchcombe	43
	Bishop's Cleeve	45
	Churchdown	30

* There are no rain gauges in Tewkesbury Borough so these values have been estimated using radar data

This rainfall translated into many watercourses across the county rising swiftly and significantly, many nearing their highest recorded level and in some instances exceeding it. It should be noted that many river gauges were installed after 2007 so the recorded levels here will not include the July 2007 flood event.

Table 2 - River Levels:

District	River	Location	Peak (m)	Date and Time of Peak	Record Peak (m)	Record Peak Exceeded?*
Cheltenham	Chelt	Charlton Kings	1.550	23/12/2020 18:00	2.657	No
		Cox's Flume	1.514	23/12/2020 17:14	2.167	No
		College Road	1.521	23/12/2020 19:09	1.442	Yes
		Arle	2.143	23/12/2020 18:28	2.976	No
	Wymans Brook	Prestbury Road	0.323	23/12/2020 18:00	0.320	Yes
		Windyridge Road	1.522	23/12/2020 18:02	1.338	Yes
	Lilley Brook	Moorend Road	1.112	23/12/2020 17:00	1.737	No
Hatherley Brook	Merestones Road	1.524	23/12/2020 17:30	2.750	No	
Cotswold	Evenlode	Moreton	1.492	23/12/2020 21:15	1.461	Yes
		Evenlode Bridge	2.350	23/12/2020 23:45	2.800	No
	Windrush	Bourton	0.352	24/12/2020 14:00	0.597	No
		Windrush				
	Coln	Fosse Bridge	0.346	26/12/2020 22:45	0.420	No
		Bibury	0.462	27/12/2020 12:00	0.524	No
	Churn	Cirencester	0.837	27/12/2020 06:15	1.040	No
		South Cerney	1.401	27/12/2020 09:30	1.470	No
Cerney Wick		0.711	27/12/2020 14:30	0.682	Yes	
Ampney Brook	Ampney St Peter	0.760	27/12/2020 06:00	1.230	No	
Thames	Ewen	0.945	27/12/2020 05:15	1.166	No	
	Somerford Keynes		1.565			27/12/2020 12:00
Forest	Wye	Lydbrook	5.417	21/12/2020 03:15	7.551	No
	Lyd	Parkend	1.347	23/12/2020 22:38	1.268	Yes
		Lydney	1.419	24/12/2020 00:48	1.343	Yes
River Leadon	Wedderburn Bridge	3.210	24/12/2020 03:00	3.799	No	
Gloucester	Horsbere Brook	Clomoney Way	2.092	23/12/2020 17:44	2.043	Yes
	Wotton Brook	Kingcroft Road	1.804	23/12/2020 18:30	1.727	Yes
		Armscroft Place	1.197	23/12/2020 20:45	1.194	Yes
	Twyver	Abbeymead Avenue	1.287	23/12/2020 18:30	1.289	No
		Saintbridge	4.517	23/12/2020 20:45	4.500	Yes
		India Road	0.444	23/12/2020 15:15	0.717	No
	Sud	Cheyney Close	1.975	23/12/2020 21:15	1.072	Yes
		Matson Place	0.900	24/12/2020 03:15	1.040	No
	Whaddon Brook	Shepherd Road	1.226	23/12/2020 18:15	1.030	Yes
Daniels Brook	Bodiam Avenue	2.481* *	23/12/2020 18:59	1.110	Yes	
Dimore Brook	Field Court Drive	0.815	23/12/2020 21:45	0.934	No	
	The Causeway	1.925	23/12/2020 22:30	2.286	No	
Severn	Gloucester	3.982	28/12/2020 23:15	4.919	No	
Stroud	Frome (MI)	Chalford	0.626	24/12/2020 21:12	0.760	No

		Eastington	2.026	24/12/2020 02:43	2.211	No
	River Frome	Egypt Mill (Nailsworth)	0.608	27/12/2020 04:48	0.638	No
		Ebley Mill	1.198	23/12/2020 20:59	1.396	No
	Slad Brook	Slad Road	1.869	23/12/2020 21:02	1.175	Yes
		Merrywalks	1.319	23/12/2020 21:30	1.107	Yes
	River Cam	Cam	1.947	23/12/2020 19:00	2.651	No
		Cambridge	1.017	23/12/2020 19:57	1.375	No
Tewkesbury	Severn	Mythe Bridge	4.325	25/12/2020 11:04	5.498	No
		Deerhurst Flow	5.368	25/12/2020 23:45	6.382	No
		Haw Bridge	5.208	26/12/2020 05:14	6.228	No
		Ashleworth	4.837	26/12/2020 11:15	6.029	No
		Sandhurst	4.390	27/12/2020 09:18	5.376	No
	Hatherley Brook	Sandhurst	4.374	27/12/2020 12:30	5.350	No
	Leigh Brook	Leigh Court	3.219	26/12/2020 05:30	4.236	No
	River Isbourne	Toddington	1.339	23/12/2020 20:30	1.744	No
River Avon	Upper Pound	4.407	25/12/2020 14:49	5.491	No	

*Many gauges were installed after 2007 so this event isn't accounted for in the record peak

**This looks too high and may be an error

In Cheltenham, the notable river levels include the Wymans Brook in Cheltenham, which saw its highest level at around 18:00 on the 23rd. The previous highest at Prestbury Road was in August 2014 and at Windyridge Road in November 2019. The river Evenlode in Moreton-in-Marsh in the Cotswolds, reached its peak at 21:15 on 23rd and was its highest level recorded, exceeding the previous peak from November 2012. The lower reaches of the Churn and the upper reaches of the Thames peaked later, on 27th December. The Churn at Cerney Wick exceeded its peak recorded in November 1990 and the gauge for the Thames at Somerford Keynes exceeded its highest recorded level from December 2012.

In the Forest of Dean, the Lyd at Parkend and Lydney reached the highest peak, which was previously recorded on November 2012 and February 2020 respectively. River levels peaked at approximately 22:38 on 23rd at Parkend and 00:48 on 24th at Lydney. The Slad Brook in Stroud reached its highest recorded level at Slad Road and Merrywalks, which was previously from December 2013. It reached its peak around 21:00 on 23rd.

Finally, in Gloucester, a number of rivers reached their highest levels, a reflection of the rainfall levels in their headwaters rather than in the City itself. They include the Horsbere Brook at Clomoney Way (previous peak in July 2012), the Twyver at Saintbridge Balancing Pond (previous highest recorded in November 2012), and Whaddon Brook at Shepherd Road (previous highest peak from June 2016). River levels peaked between 18:00 and 21:00 on 23rd.

Return Period:

The return period for a rainfall or flood event is a way of calculating the likelihood, and therefore the size, of the event. The underlying principle is that the larger the storm, the less likely it is and therefore the less frequently it will be seen. The return period can be written in two ways; 1 in x years or x% AEP (Annual Exceedance Probability). They mean the same thing so a 1 in 100 year storm will have a 1% chance of happening each year (AEP).

According to the radar data in Meniscus Map Rain (not the rain gauges, which in some cases exceeded the radar rainfall), the return period for the event was relatively low at less than 1 in 5 years (20% AEP) for most areas. The return period at Tewkesbury was 1 in 8 years (12.5% AEP) and 1 in 7 years (14% AEP) for Bishop's Cleeve.

Rainfall for December 2020 and preceding months:

The impact of the rainfall appeared to be worse than what should be expected from the size of the storm according to the return periods. It is likely therefore that the preceding wet weather made the ground saturated so when it rained on the 23rd surface water developed rapidly and the levels of watercourses and rivers rose quickly.

Table 3 shows the rainfall totals for December for various locations across the county. When compared to Table 4, which shows the average rainfall totals for December for 3 locations in or near Gloucestershire, it can be seen that, in addition to the high rainfall on 23rd, December was well above average. Notable totals include Dowdeswell (near Cheltenham), Parkend (near Lydney) and Taynton (near Newent).

Table 2 - Rainfall totals for December 2020:

District	Location	Rainfall Total (mm)
Cheltenham	Dowdeswell (near Cheltenham)	356.6
Stroud	Ebworth (near Painswick)	181.2
	Minchinhampton (near Nailsworth)	160.2
	Miserden (near Stroud)	190.6
Gloucester	Over Farm (near Gloucester)	106
Forest of Dean	Parkend (near Lydney)	272.6
	Taynton (near Newent)	211.6
Cotswolds*	Chipping Campden	130
	Bourton on the Water	125
	Naunton	125
	Cirencester	130
	South Cerney	110
	Fairford	100
Tewkesbury**	Tewkesbury	140
	Winchcombe	150
	Bishop's Cleeve	200
	Churchdown	115

* This information for the rain gauges in the Cotswolds is not yet available so these are estimates based on radar data ** There are no rain gauges in Tewkesbury Borough so these values are estimates based on radar data

Table 3 - 1981-2010 average rainfall totals for December*:

Climate Station	Rainfall Total (mm)
Cheltenham	80.8
Cirencester	82.8
Ross-on-Wye	74.7

*<https://www.metoffice.gov.uk/research/climate/maps-and-data/uk-climate-averages/gcnx0z9e5>

As well as December 2020 being a wetter than average month, October 2020 totals were also above average (in some cases by a similar degree as December totals) and, although November 2020 was generally below average, this amount of rainfall would have led to high levels of saturation of the ground.

Rainfall data in this summary was taken from EA rain gauges unless otherwise specified. River Levels were provided by the EA and, where not available, were taken from Gauge Map website (www.gaugemap.co.uk).

Appendix 3:

Flooding emergency contact list

As mentioned in the main document, the following document was approved by all listed partners. It is designed to work alongside the LLFA flood guide, and not as a replacement.



FLOODING EMERGENCY CONTACT LIST.Gloucestershire.20210122.pdf