

Warwick Bridge

Flood Investigation Report



Flooded extents at Warwick Bridge on the 6th December 2015

Flood Event 5-6th December 2015

This flood investigation report has been produced by the Environment Agency as a key Risk Management Authority under Section 19 of the Flood and Water Management Act 2010, in partnership with Cumbria County Council as Lead Local Flood Authority.

Version	Prepared by	Reviewed by	Approved by	Date
Working Draft for discussion	David Webborn	Iwan Lawton, EA		22 nd June 2016
Final Draft	Caroline Berry	Iwan Lawton, EA		03/02/17

Contents

Executive Summary	4
The Flood Investigation Report.....	5
Scope of this Report	5
Introduction.....	6
Geographical Setting	6
Flooding History.....	7
Flood Event 5th-6th December 2015	8
Background	8
Rainfall and Fluvial Events.....	9
Existing Flood Defences	12
Investigation	13
Sources of Flooding, Flood Flow Routes & Event Timeline	13
Likely Causes of Flooding.....	14
Fluvial Flooding: River Eden	14
Fluvial Flooding: Cairn Beck.....	19
Surface Water Flooding from Drainage Systems	20
Environment Agency Flood Incident Response	21
Pre-event Warning and Preparation.....	21
Post-event Repairs and Maintenance	21
On-going Maintenance Activities.....	21
Recommended Actions	22
Appendices	26
Appendix 1: Glossary.....	26
Appendix 2: Summary of Relevant Legislation and Flood Risk Management Authorities.....	29
Appendix 3: Highway Drainage surveys	31
Appendix 4: Links to Other Information on Flooding	33
Appendix 5: Flood Warnings and Alerts.....	34
Flood Alerts.....	34
Flood Warning Target Areas.....	35
Appendix 6: Data Capture Map for Warwick Bridge	36

Executive Summary

Warwick Bridge experienced significant flooding on the 5th and 6th of December 2015 following Storm Desmond. This storm caused a period of prolonged, intense rainfall across Northern England and this rainfall fell on catchments that were already saturated and resulted in high river levels and flooding throughout Cumbria and beyond. The flows in the River Eden on the 5th & 6th of December were the highest ever recorded, even higher than 2005.

In response to the Storm Desmond flood event, this *Flood Investigation Report* has been completed by the Environment Agency as a key Risk Management Authority (RMA) working in partnership with Cumbria County Council (CCC) as the Lead Local Flood Authority (LLFA), under the duties set out in Section 19 of the Flood and Water Management Act 2010. This report provides a summary of the flooding that occurred at Warwick Bridge on the 5th and 6th of December, and to do so it has used a range of data collected from affected residents, professional partners, site visits, surveys and general observations, along with river and rainfall telemetry data recorded during the event.

A total of 42 properties were directly affected by flooding (49 if you include properties affected by flooding to Holme Eden Hall but are located on upper floors), with the majority of these located close to the centre of the village. The principal source of flooding was from the River Eden near Warwick Bridge with flood waters flowing over and along the A69, across Downagate Community playing fields before joining flood flows from the River Eden and Cairn Beck on Little Corby Road. There was also reports of surface water flooding on the A69 and Little Corby Road.

Eight actions have been recommended in this report, which will require the involvement of a number of organisations as well as from local communities. One of the main actions is to review the case for flood defences in Warwick Bridge. This review will also incorporate 'quick wins' to address some of the specific issues in the village and will aim to provide a 'joined-up' approach to flood risk management improvements in the Eden catchment as a whole.

In response to the flooding, a number of community meetings have taken place, and these will continue in order to ensure that all those affected are given the opportunity to be involved in helping to mitigate flood risk in Warwick Bridge.

Any additional information that can be provided to the Environment Agency and Cumbria County Council to help develop our understanding of the flooding is welcomed. A lot of information has already been provided, much of which has been used to inform this report. Any additional information should be provided to:

<http://www.cumbria.gov.uk/planning-environment/flooding/floodriskassessment.asp>

The Flood Investigation Report

Under Section 19 of the Flood and Water Management Act (2010) Cumbria County Council, as Lead Local Flood Authority (LLFA), has a statutory duty to produce Flood Investigation Reports for areas affected by flooding. Section 19 of the Flood and Water Management 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.*

This section of the Act leaves the determination of the extent of flood investigation to the LLFA. It is not practical or realistic for Cumbria County Council to carry out a detailed investigation into every flood incident that occurs in the County, but every incident, together with basic details will be recorded by the LLFA.

Only those with 5 or more properties/businesses involved will have investigations published. An investigation will be carried out, and a report prepared and published by the LLFA when the flooding impacts meet the following criteria:

- Where there is ambiguity surrounding the source or responsibility of flood incident,
- Internal flooding of one property that has been experienced on more than one occasion,
- Internal flooding of five properties has been experienced during one single flood incident and
- There is a risk to life as a result of flooding.

As a flood Risk Management Authority (RMA), the Environment Agency have partnered with Cumbria County Council (CCC) to produce the 53 flood investigation reports across Cumbria.

Scope of this Report

This Flood Investigation Report **is**:

- An investigation on the what, when, why, and how the flooding took place resulting from the 5th-6th December 2015 flooding event and
- A means of identifying potential recommendations for actions to minimise the risk or impact of future flooding.

This Flood Investigation Report **does not**:

- Interpret observations and measurements resulting from this flooding event. Interpretation will be undertaken as part of the subsequent reports,
- Provide a complete description of what happens next.

The Flood Investigation Reports outline recommendations and actions that various organisations and authorities can do to minimise flood risk in affected areas. Once agreed, the reports can be used by communities and agencies as the basis for developing future plans to help make areas more resilient to flooding in the future.

For further information on the S19 process, including a timetable of Flood Forum events and associated documentation, please visit the County Council website at:

<http://www.cumbria.gov.uk/floods2015/floodforums.asp>

To provide feedback on the report please email LFRM@cumbria.gov.uk.

Introduction

Geographical Setting

The village of Warwick Bridge is located approximately 8km east of Carlisle on the A69 in north-east Cumbria and is partly situated in the floodplain of the River Eden, which flows past the village to the west and north. Warwick Bridge has a population of approximately 1,300 and is adjoined to the east by the villages of Little Corby and Corby Hill.

Due to its position within the floodplain of the River Eden, parts of Warwick Bridge lie within Flood Zone 3 and are therefore at a high risk of fluvial flooding from this source. Parts of the village are also at risk of fluvial flooding from Cairn Beck, Trout Beck and surface water flooding.

The location of Warwick Bridge and its major rivers are shown in Figure 1.

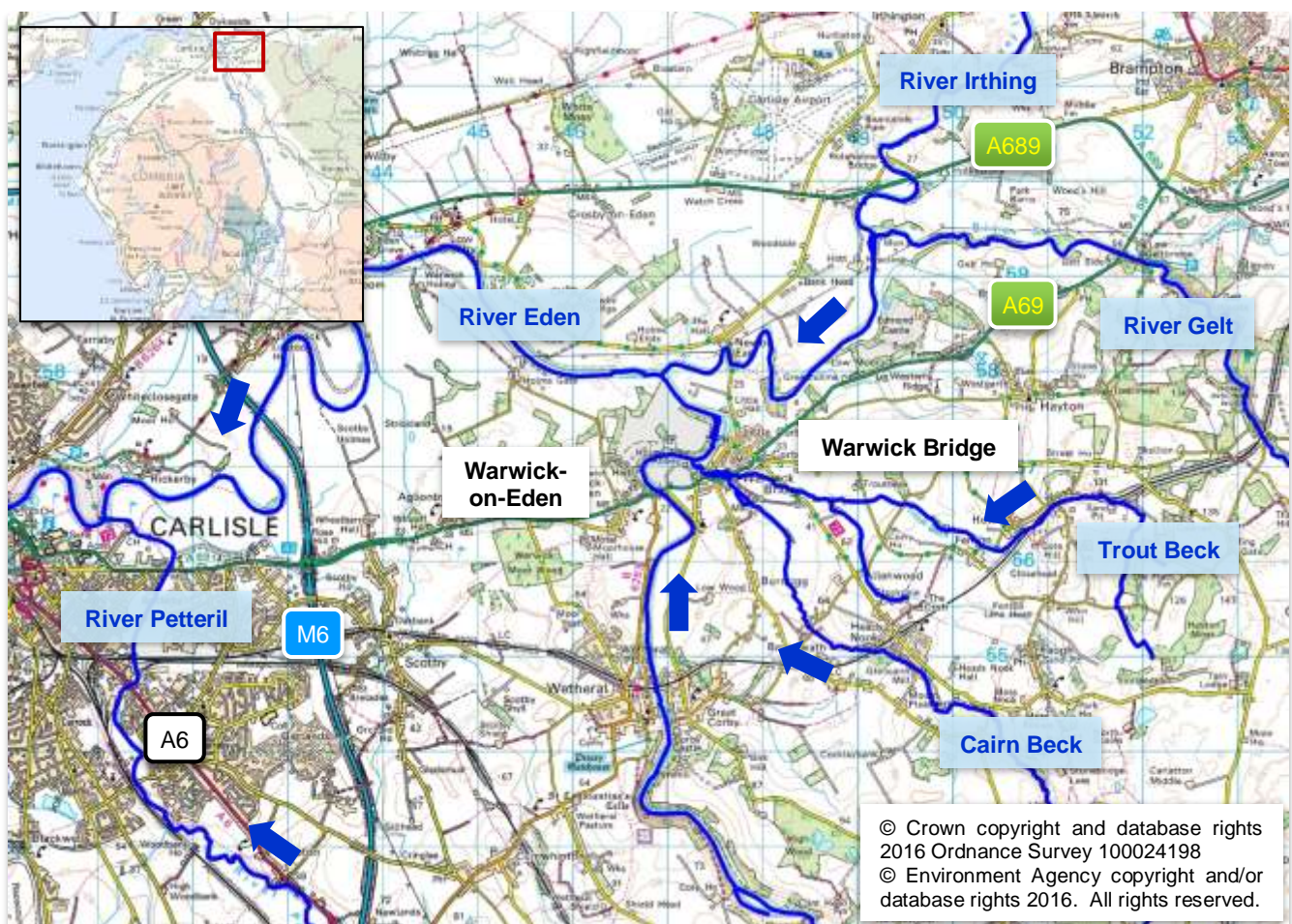


Figure 1: Location of Warwick Bridge and its major rivers

The River Eden drains a mostly rural 2,200km² catchment that includes part of the north-east Lake District National Park. The Cairn Beck and Trout Beck system flows into the River Eden at Warwick Bridge and drains a 40km² catchment due south of the village.

Flooding History

Warwick Bridge and Warwick-on-Eden are located on the River Eden, which is the largest river in north-west England and the area has historically been subjected to significant flood events.

Major flood events occurred on the Eden catchment in 1822, 1856, 1925, 1968, 1972, 1995 and 2005. Properties in Warwick Bridge suffered flooding on three of those occasions - 1968, 1995 and 2005.

Very heavy rainfall on the 7th and 8th January 2005 caused widespread flooding in the Eden valley and resulted in 30 properties flooding in the village including properties in and around Holme Eden Hall, Bridge End cottages and nearby properties on the B6263 road to Wetheral. There are also known flooding problems on Trout Beck in the village where it flows into a culvert underneath the A69.

The 2015 event caused by Storm Desmond was of greater magnitude than past events and the gauged flows in the River Eden were the highest on record.

Table 1 shows the recorded maximum flows in the River Eden during these past flooding events and the numbers of properties affected at Warwick Bridge (where available). The gauging station on the River Eden at Warwick Bridge closed in 1996 and was replaced by a gauge at Great Corby.

Flooding Event	Number of Properties Flooded	Peak Flow in River Eden @ Warwick Bridge	Peak Flow in River Eden @ Great Corby
March 1968	-	1104	-
February 1995	-	812	-
January 2005	30	-	1373.0
November 2009	3	-	817.3
December 2015	42	-	1490.0

Table 1: Recent flood events affecting Warwick Bridge

Flood Event 5th-6th December 2015

Background

On the 5th and 6th December 2015, 42 properties in Warwick Bridge and Warwick-on-Eden suffered significant flooding as a result of Storm Desmond. The storm led to widespread river and surface water flooding across Cumbria, with significant flood events occurring on the Eden, Derwent and Kent catchments.

Figure 2 indicates the extent of the flooding that occurred in Warwick Bridge from all sources following Storm Desmond.

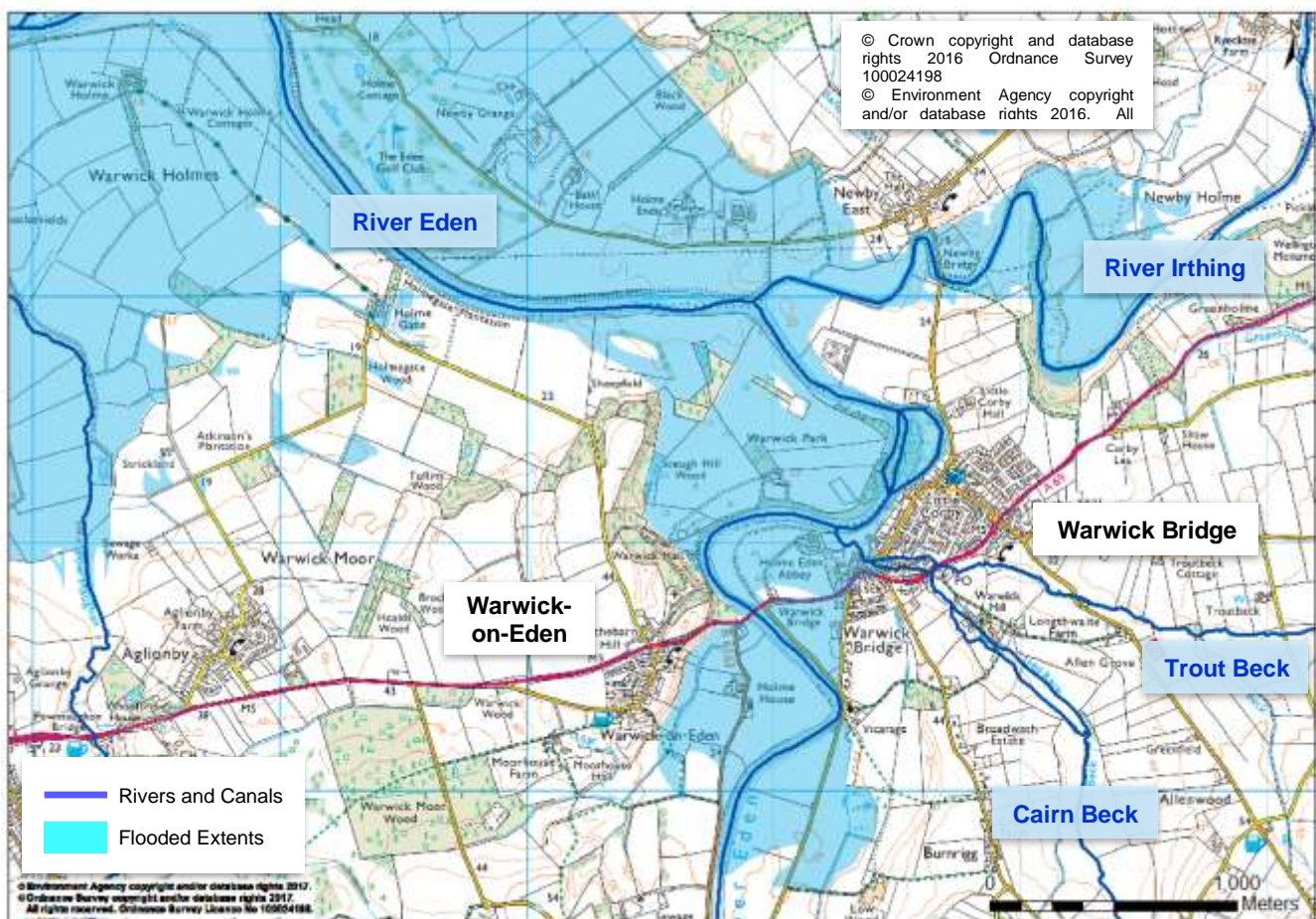


Figure 2: Extent of flooding in Warwick Bridge on 5-6th December 2015

Parts of Warwick Bridge village are located within the natural flood plain of the River Eden as are properties along the B6263 road to Wetheral, all of which are more susceptible to flooding.

During the December 2015 event, flows overtopped the right hand bank of the river upstream of the Warwick Bridge road bridge and spilled onto the A69, with flood water flowing along the road and into the centre of the village. Properties to the north of the A69, including Holme Eden Hall, were severely affected, while properties in and around the junction between Little Corby Road and the A69 in the centre of the village were also flooded.

The high water levels in the River Eden also caused the smaller Cairn Beck tributary to back up and contributed to the flooding in the centre of the village at the A69 Little Corby road junction. This area was also initially affected by flooding from surface water and the highway drainage systems.

Rainfall and Fluvial Events

December 2015 was the wettest calendar month on record for the UK, with much of northern England receiving double the average December rainfall. This also followed a particularly wet November, which resulted in catchments that were already heavily saturated prior to the rainfall event associated with Storm Desmond.

From the 4th to the 7th of December 2015, Storm Desmond created a period of prolonged rainfall across Cumbria, which was particularly intense over 5th-6th December and caused widespread flooding across the county. Over this period, new 24 and 48 hour rainfall records were set for the UK. Both of these were within Cumbria and broke the previous records, also within Cumbria, set in the November 2009 flood event which saw widespread devastation in the towns of Cockermouth and Workington. The record-breaking total rainfall values are presented in Table 2.

Rainfall Period	Storm Desmond			Previous Record		
	Date	Location	Total rainfall (mm)	Date	Location	Total rainfall (mm)
24 hour rainfall	December 2015	Honister Pass	341.4	November 2009	Seathwaite	316.4
48 hour rainfall	December 2015	Thirlmere	405.0	November 2009	Seathwaite	395.6

Table 2: UK Rainfall Records

Within the Eden catchment, Cumwhinton rain gauge recorded a total of 47.8mm of rain between 20:15 on 04/12/2015 and 05:00 on 06/12/2015. This rain gauge is located in the lower part of the Eden catchment which was not as severely affected as the upper Eden catchment. The upper Eden saw rainfall totals comparable to Honister Pass and Thirlmere in Table 2 and explains why the primary cause of the event at Warwick Bridge was the River Eden.

The recorded rainfall at Cumwhinton is that associated with Storm Desmond and it followed a series of smaller rainfall events in the preceding days, which contributed to the already saturated ground conditions in the catchment.

A number of flow gauging stations are located within the catchment of the River Eden¹ (see Figure 3). One of the stations is located upstream of Warwick Bridge on the River Eden at Great Corby, which replaced Warwick Bridge gauging station (now closed) in 1996. Greenholme gauging station gauges flow on the River Irthing, which joins the River Eden approximately 1km downstream of Warwick Bridge and is located approximately 1.7km north-east of the village. Further downstream on the River Eden, Sheepmount gauging station is located in the centre of Carlisle. Together, these stations recorded the fluvial event caused by Storm Desmond and the recorded data is presented in Table 3 and Figure 4.

¹ Flow gauging station data obtained from Environment Agency records and the National River Flow Archive (www.nrfa.ceh.ac.uk)

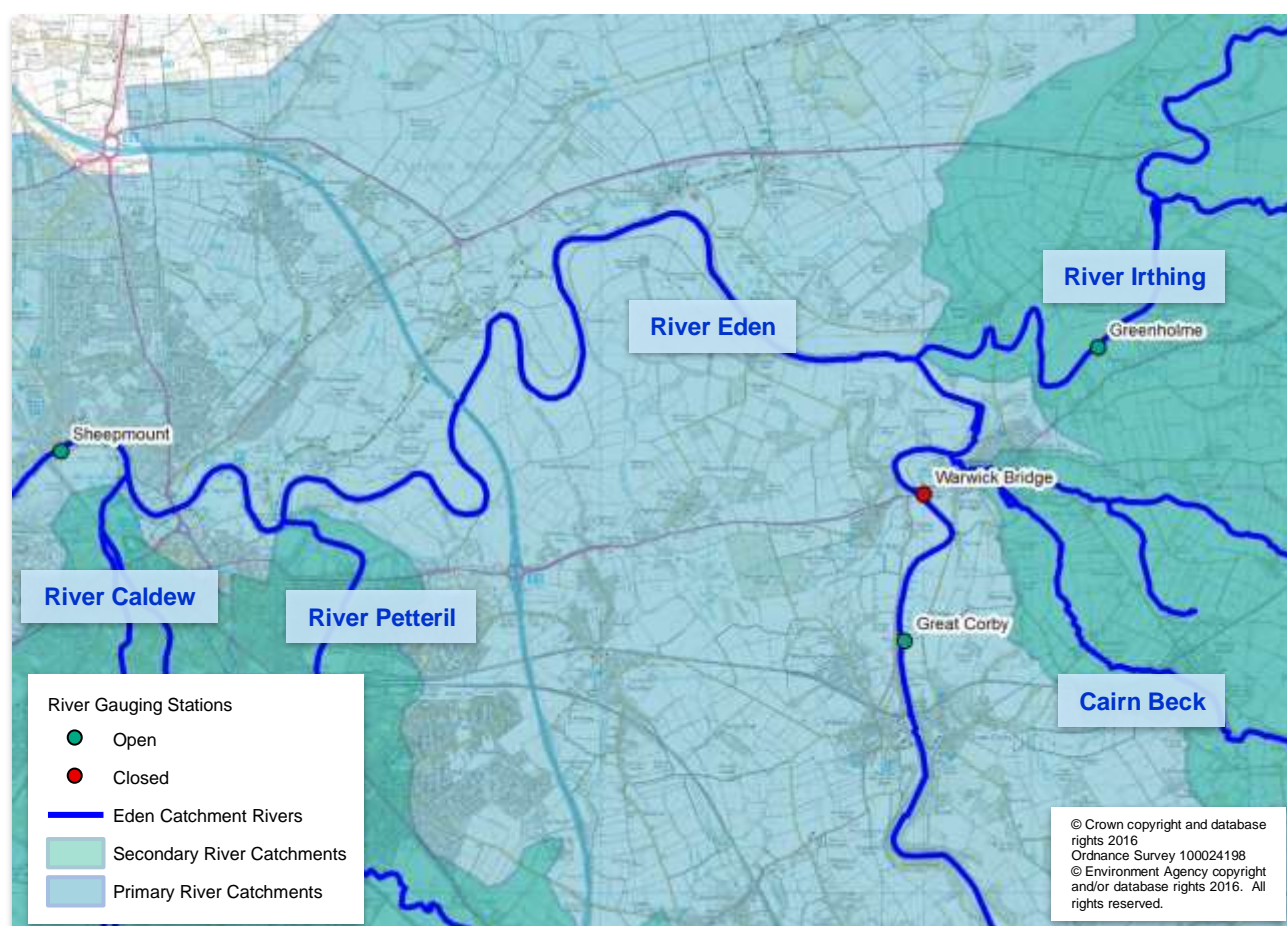


Figure 3: Location of river gauging stations in the River Eden catchment

Gauging Station	River	Peak flow (m ³ /s)	
		Dec 2015	Jan 2005
Great Corby	Eden	1490.0	1,373.0
Greenholme	Irthing	229.0	228.8
Sheepmount	Eden	1680.0	1516.4

Table 3: Recorded peak river flows in the River Eden Catchment

Source: Flow gauging station data obtained from Environment Agency records and the National River Flow Archive (www.nrfa.ceh.ac.uk)

At Great Corby gauging station, the level of the River Eden peaked at 25.6m AOD at 06:00 on Sunday 6th December. This was the highest river level ever recorded and exceeded the previous record level of 25.4m AOD (January 2005).

The recorded peak flow at Great Corby gauging station is greater than any flow previously recorded at this location on the River Eden and initial analysis of this data suggests that the December 5th event had a 0.25% probability of occurring in any given year (0.25% Annual Exceedance Probability or AEP).

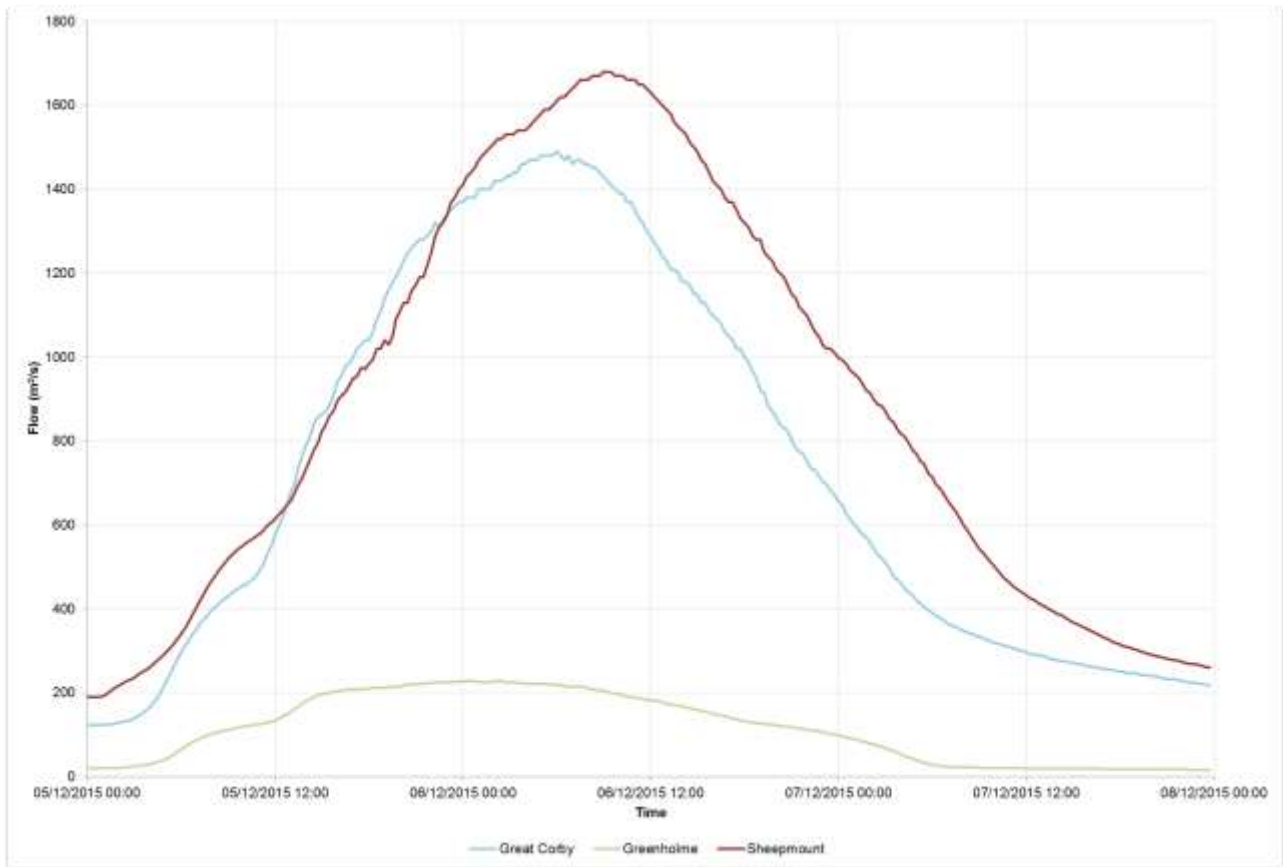


Figure 4: Gauged river flows at various locations in the Eden catchment on the 5th-6th December 2015

Whilst there are no flow gauging stations on the Cairn Beck system, rainfall data for the wider Eden catchment indicates that the catchment of this tributary system did not receive as much rainfall as in other areas of the upper Eden (including the River Eamont, which drains part of the Lake District National Park including Helvellyn). This provides further evidence for the principal cause of the flooding in Warwick Bridge being the fluvial event on the River Eden, and that the flooding on Cairn Beck was mainly caused by flood water backing up the beck from the River Eden.

Existing Flood Defences

There is a small 3rd party flood defence embankment on the right bank of the River Eden downstream of the A69 road bridge. This embankment runs around the inside of the river bend before finishing on the north side of Holme Eden Hall.

Other flood risk management assets are located within the village on Cairn Beck and Trout Beck. These assets include a debris screen and culvert system at the confluence between these two smaller watercourses which flows underneath the A69. Whilst there were no reported issues with the operation of these assets during the Storm Desmond event, there have been problems in the past which has caused localised flooding.

A map of the existing flood defence embankment and other flood risk management assets serving the village is shown in Figure 5.

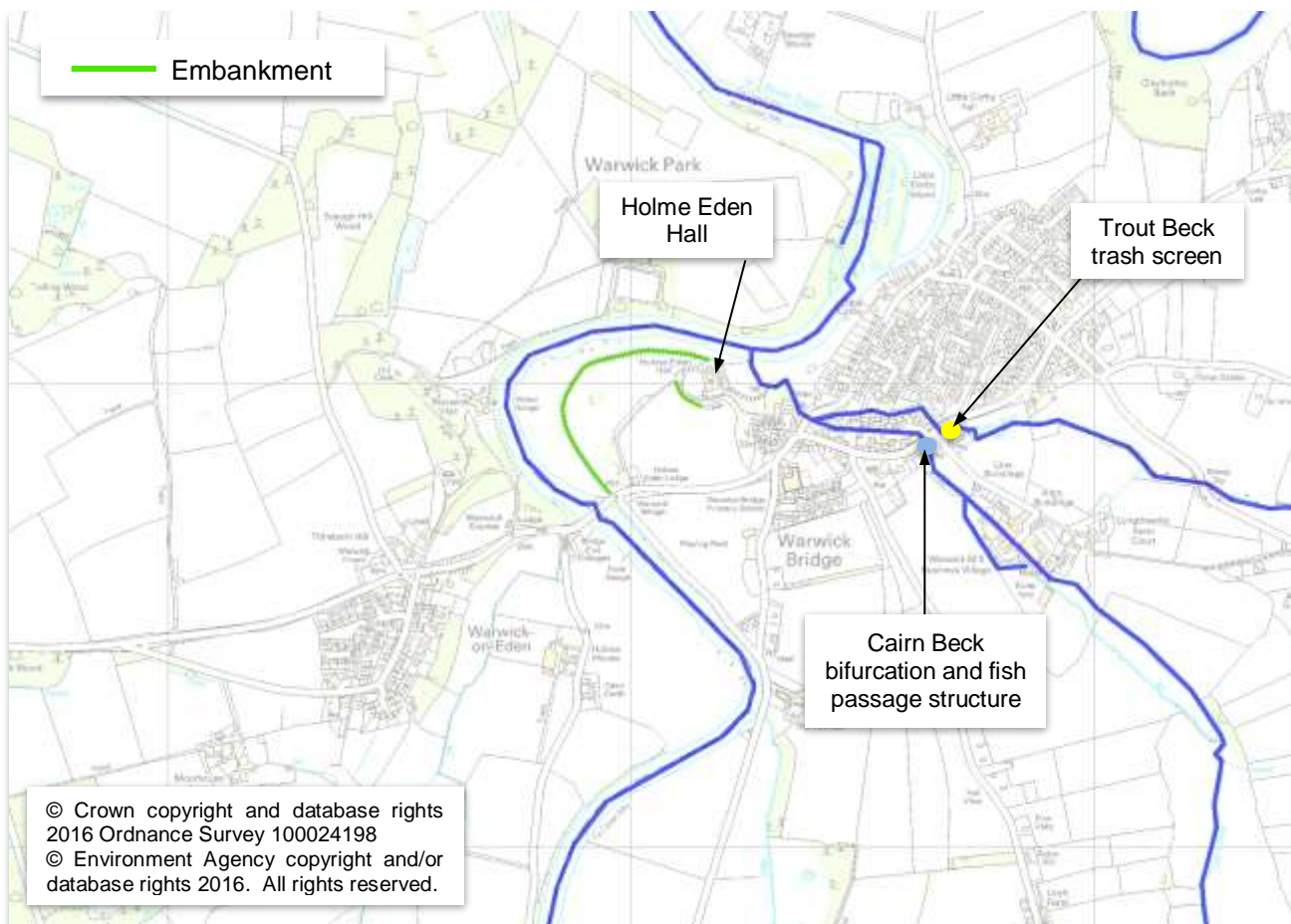


Figure 5: Existing flood defences in Warwick Bridge

Investigation

This section describes the likely causes of flooding and the Environment Agency response in Warwick Bridge. It also provides a timeline of the events that occurred over 5th-6th December 2015.

This investigation was carried out by the Environment Agency using data collected from surveys of the area and from the communities affected with help from Cumbria County Council. This report has compiled this data to provide a detailed record of the flooding in Warwick Bridge.

Sources of Flooding, Flood Flow Routes & Event Timeline

The flooding in Warwick Bridge on the 5th and 6th December 2015 resulted from several sources. To date we have not received information confirming the timings of early onset flooding from surface water and road drainage in addition to flooding from the River Eden

An overview of the principal flood flow routes in and around Warwick Bridge is presented in photo1 as an aerial photograph taken on 6th December 2015 showing the flooded extents in and around Warwick Bridge.



Photograph 1: Flooded extents at Warwick Bridge on the 6th December 2015, looking south

The principal source of flooding was from the River Eden near the A69 road bridge with flooding occurring first to Bridge Cottages, Eden Garth and Holme House located along the B6263 road to Wetheral. Flood waters then flowed over land and along the A69, across Downagate Community playing fields before joining flood flows from the River Eden and Cairn Beck on Little Corby Road. Holme Eden Hall and adjoining properties were also affected by the flooding.

Table 4 provides a summary timeline of the key events as the flooding affected Warwick Bridge.





4 th December 2015	Event
15:10	 Flood Alert issued (Middle River Eden)
20:15	First rainfall associated with Storm Desmond recorded at Cumwhinton rain gauge.
5 th December 2015	Event
10:20	 Flood Warning issued (011FWFNC10A: River Eden at Warwick Bridge, Holme House, Bridge End and Holme Eden Hall).
15:42	 Flood Warning issued (011FWFNC10B: River Eden at Warwick Bridge, Warwick Park and Holme Eden Gardens Area).
16:00	Holme Eden Gardens reported flooding from Cairn Beck
18:30	River Eden reported to flood Holme Eden Gardens
22:40	A69 closed - impassable at Warwick Bridge due to flood water
6 th December 2015	Event
00:12	 Severe Flood Warnings for Warwick Bridge issued.
04:00	Confluence between Cairn Beck and the River Eden completely submerged
06:00	River Eden peak at Great Corby gauging station: 25.6m AOD/1,490m ³ /s.

Table 4: Summary timeline of key events during the Kendal flooding

Likely Causes of Flooding

Fluvial Flooding: River Eden

The principal source of fluvial flooding in Warwick Bridge was from the River Eden. As shown in Photo 1 previously, the river makes a series of broad meanders as it flows past the west side of the village and during the main flood event, the floodplain within these meanders became inundated.

Whilst most of the properties in Warwick Bridge are not located within the flood plain, a number of individual properties outside of the village are located within the flood plain. These properties include Holme House and Eden Garth to the south, together with the Bridge Cottages terrace, situated immediately adjacent to the A69 bridge over the River Eden on its left bank. These properties suffered significant flooding as the river overtopped its banks and the depth of the flooding to Bridge Cottages is shown in Photograph 2. The maximum reported flooding depth at Bridge Cottages was approximately 1.8m (6ft) and hay bales carried downstream from the neighbouring Holme Farm, washed over the hedgerow and were deposited in the yard. Holme Farmhouse was reported to have flooded to approximately 0.9m (3ft).



Photograph 2: Flooding to Bridge Cottages off the A69

On the opposite side of the River Eden the basement of St. Paul's Church was also reported to have flooded. The church lies just outside of Flood Zone 2 and is situated on relatively high ground.

Upstream of the A69 road bridge, the Downagate Community Centre playing fields on the right hand bank of the river were inundated as flows surged towards the A69. The wrack line (Photograph 3) along the wire fence that forms the boundary of the field with the A69 indicates that the floodwater was approximately 1.3m deep in places and as the depth increased, so more water was able to inundate the A69 and flow into the village. The Downagate community centre was reported to have flooded to a depth of approximately 1.8m (6 ft).



Photograph 3: Wrack line along northern boundary of the Downagate Community Centre playing fields

Land to the north of the A69 is separated from the road by a stone wall standing approximately 1.5m high. This wall had a significant impact on preventing excess flood water at the road bridge from crossing over the A69 and being able to flow back into the River Eden downstream of the bridge. Instead, flood water flowed along the A69 into the centre of Warwick Bridge (see **Error! Reference source not found.** and Photograph 4). Properties on both sides of the A69 suffered flooding, while Warwick Bridge primary school only just avoided being flooded.



Photograph 4: Principal flow path along the A69 into the centre of Warwick Bridge

Once in the village, floodwater flowed down the access road to Holme Eden Hall off the junction of the A69 with Little Corby Road. This access road is narrow and flanked by stone walls, meaning that flow velocities were high. The floodwater affected numerous properties in this location, including homes built relatively recently within a former walled garden. Photograph 5 is an aerial photograph taken on 6th December 2015 and shows the extent of flooding within the village, including the flooding to properties within the former walled garden.



Photograph 5: Flooded extents in the centre of Warwick Bridge

Downstream of the A69 road bridge flood flows from the River Eden overtopped the flood embankment and merged with flood water that had entered the village from the Downagate Community Centre playing fields. The defence embankment is shown in Photograph 6.

Photograph 6 also shows evidence of significant scouring of the right hand bank, which occurred immediately downstream of the bridge. The road bridge was temporarily closed following the flooding whilst inspections were carried out.



Photograph 6: Scouring to right bank of the River Eden downstream of the A69

Fluvial Flooding: Cairn Beck

In the centre of Warwick Bridge, flooding from the River Eden was exacerbated to a certain extent as a result of flooding from Cairn Beck. Cairn Beck and Trout Beck meet immediately upstream of the A69 opposite Waters Meet and pass beneath the A69 via a system of culverts. This system also incorporates a bifurcation and fish pass structure which diverts flow from Trout Beck into a Mill Race, which runs parallel to Cairn Beck before returning to the main channel upstream of the Little Corby Road culvert.

During the Storm Desmond event a combination of a high water levels on the River Eden and capacity limitations at the Little Corby Road culvert caused flows in Cairn Beck to back-up and contributed to the flooding on Little Corby Road. Photograph 7 shows the upstream face of the Low Corby Road culvert, which is significantly skewed (i.e. is not perpendicular) to the alignment of the Cairn Beck channel. This type of arrangement has the effect of reducing the overall capacity of the culvert due to the sharp change of direction that flows have to go through. This means less water can get through the culvert and it creates higher water levels upstream of the structure.

Whilst the arrangement of the Little Corby Road culvert may have caused some initial backing-up of flows, the principal cause was the exceptional water level on the River Eden. Photograph 5 shows how the flood from the River Eden extended into this location in the village causing flood flows in Cairn Beck to back-up.



Photograph 7: Little Corby Road culvert (Cairn Beck)

Surface Water Flooding from Drainage Systems

The area on the south side of the A69 at its junction with Little Corby Road has a history of problems with the highway drainage system. The existing infrastructure for receiving surface water run-off in this area includes two kerb drains, a wide inline drainage channel and a large road gully.

Reports suggest that the initial source of flooding in this area was from this surface water drainage infrastructure. Whilst no detailed plans or survey information has been made available, it is likely that this drainage discharges directly to Cairn Beck. Backing-up in the system may have been due to a blockage, the high water levels in Cairn Beck itself, or a combination of the two.

It should however be noted that further investigations are required to confirm the connectivity and condition of the existing drainage in this area. See the Recommended Actions section of this report for further details.

Environment Agency Flood Incident Response

Pre-event Warning and Preparation

A Flood Alert for the River Eden catchment was issued on the 4th of December at 15:10. Following this, Flood Warnings were issued to the flood warning areas for Warwick Bridge between 10:20 and 15:42 on the 5th December. Severe Flood Warnings were issued at 00:12 the following day. The details of the flood warning areas and the timings of these warnings are shown in Appendix 5.

Immediately prior to the flood event the Environment Agency inspected watercourses and operational structures such as debris screens to ensure that there were no blockages which may have caused an increase in flood risk.

Post-event Repairs and Maintenance

Following the flood event the Environment Agency has removed blockages and obstructions from key structures on the River Eden and Cairn Beck. There are relatively few Environment Agency-maintained flood defence assets in this area.

On-going Maintenance Activities

The Environment Agency maintains flood risk management structures and sections of river channel where maintenance actively reduces the risk of flooding to people and property. Activities we undertake are summarised below:

- We conduct yearly visual inspections of flood defence embankments and walls, and deliver a variety of maintenance tasks which include, as necessary:
 - Grass cutting,
 - Tree and bush management,
 - Invasive species control,
 - Vermin control and
 - Expansion joint repairs.
- We deliver targeted maintenance on River Channels where the activity is beneficial to the reduction in flood risk. This could include:
 - Weed Control,
 - Grass Control,
 - Tree and Bush Management,
 - Invasive Non Native Species Control,
 - Gravel Removal, when justified through investigation and survey.
- On operational structures, we undertake:
 - Quarterly operational inspections and
 - Yearly mechanical maintenance
- On culverts, which could pose a risk of flooding to properties, we monitor the risk of flooding through 6 yearly inspections, and deliver the following on a risk based approach:
 - Cleansing works
 - Repairs and reconditioning works

Recommended Actions

The following table details recommended actions for various organisations and members of the public to consider using the Cumbria Floods Partnership's 5 Themes: Community Resilience, Upstream Management, Strengthening Defences, Maintenance and Internal Drainage Boards (IDBs). Some of these recommendations may have already been carried out or are ongoing.

Some of the actions referred to in Table 5 are identified on Figure 6 following this table.

Cumbria Flood Partnership Theme	Action by	Recommended Action	Timescale
Community Resilience	Cumbria Local Resilience Forum*	Review and update plans to enable homes and business to be better prepared for and to reduce the impacts of flooding. For example, review evacuation procedures/emergency response.	2016
	Environment Agency	Review modelling data to ensure that hydraulic models for the River Eden catchment reflect real conditions as accurately as possible and replicate the 5 th -6 th December 2015 flood event to ensure the flooding mechanisms identified are fully understood. Update the models where required and use this information to make any improvements to the flood forecasting and warning service. Assess the interaction between the River Eden and the Cairn Beck system.	On-going
	Environment Agency	Review and update the Flood Warning Areas for Warwick Bridge as required, ensuring they reflect all known fluvial flooding mechanisms in the Warwick Bridge river system as far as possible.	2017
	Environment Agency and Residents	Ensure all properties at risk are registered to receive flood warnings and that all details are up-to-date.	2016
	Residents	Implement flood resilience measures within flooded properties to reduce the impacts of future flooding.	2016
Maintenance	Cumbria County Council	Cumbria County Council (minor roads in village including Little Corby Rd junction) and Roadlink (A69) are undertaking; <ul style="list-style-type: none"> ○ Gulley emptying ○ De-silting and jetting connecting pipework to outfalls to watercourses ○ Survey and mapping highways drainage system. This includes identification of any defects which will be inform programme of additional works 	June/July2016

Cumbria Flood Partnership Theme	Action by	Recommended Action	Timescale
Strengthening Defences	Environment Agency	Review the need for investment in flood defences for Warwick Bridge on the River Eden and Cairn Beck. Including the existing flood embankment between A69 and Holme Eden Hall.	Ongoing
	Cumbria County Council, A69 Roadlink and United Utilities	Review the performance of the existing drainage and sewerage systems, particularly those on the A69/Little Corby Road junction during the event to better understand where improvements are required.	2016/17 On going

Table 5: Recommended actions for consideration

*The Cumbria Local Resilience Forum includes emergency services, local authorities, Cumbria County Council, Environment Agency, Maritime Coastguard Agency and health agencies along with voluntary and private agencies. Under the Civil Contingencies Act (2004) every part of the United Kingdom is required to establish a resilience forum.

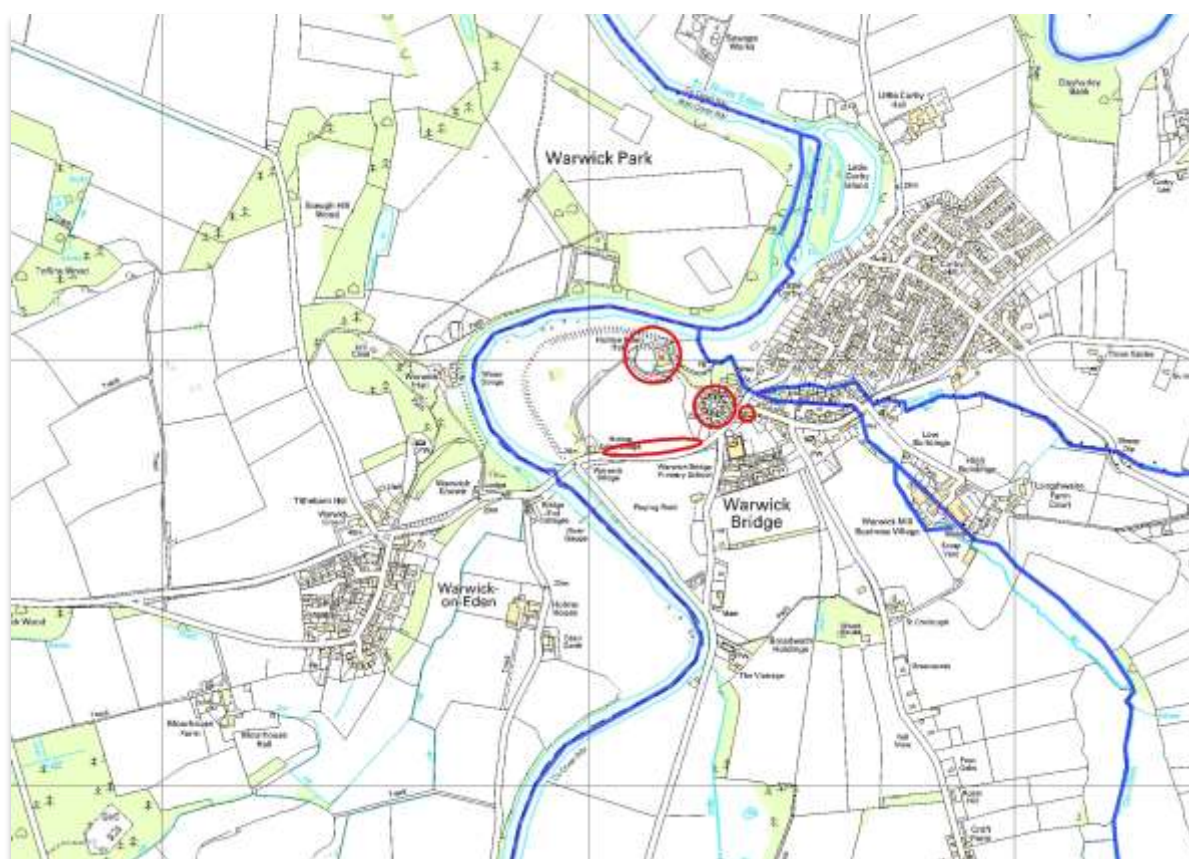
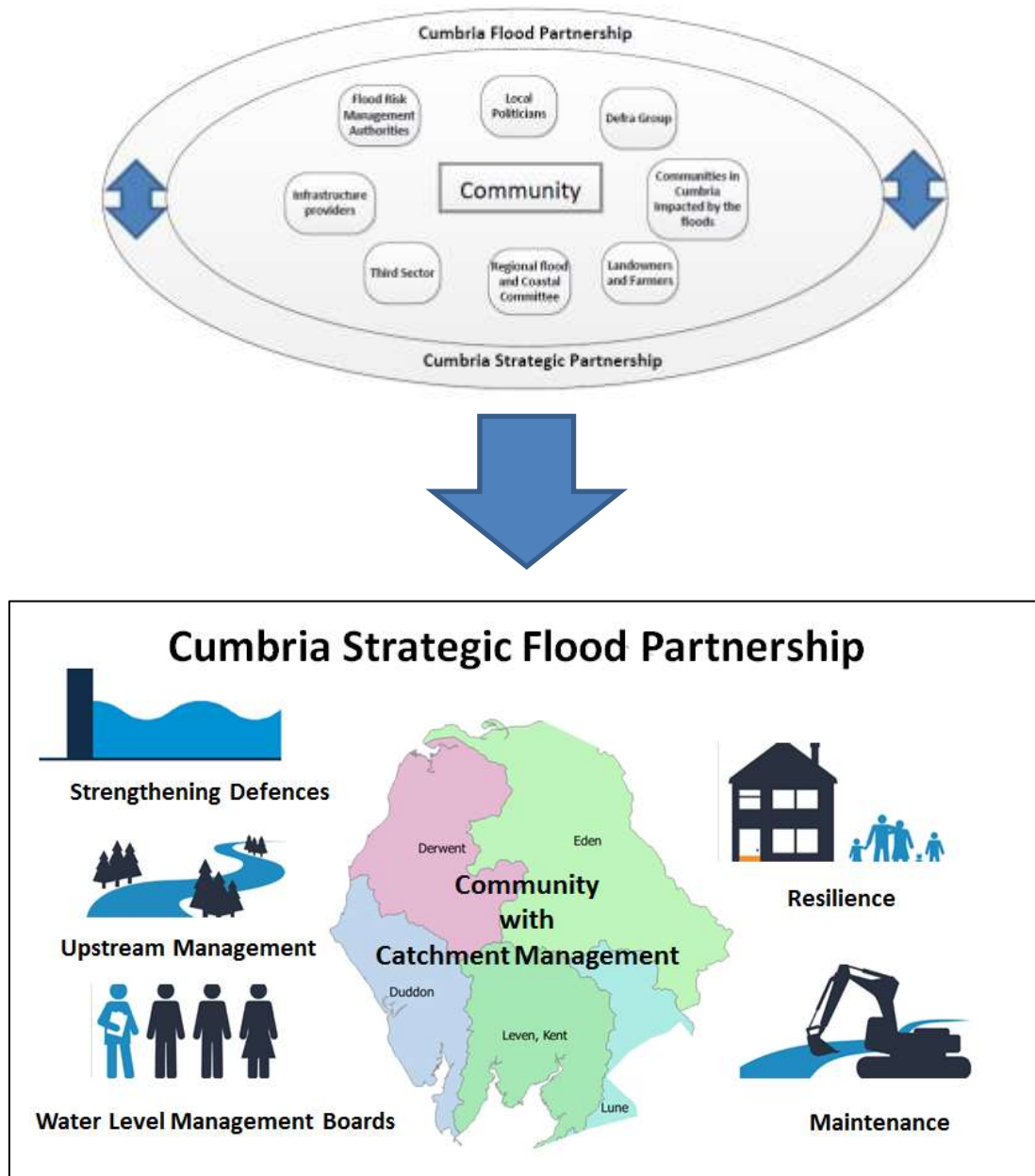


Figure 6: Existing flood defences in Warwick Bridge

Next Steps – Community & Catchment Action Plan

The Cumbria Floods Partnership has brought together a wide range of community representatives and stakeholders from a variety of sectors to plan and take action to reduce flood risk. The Cumbria Floods Partnership, led by the Environment Agency, is producing a 25 year flood action plan for the Cumbrian catchments worst affected by the December 2015 flooding, including Carlisle. The plan will consider options to reduce flood risk across the whole length of a river catchment including upstream land management, strengthening flood defences, reviewing maintenance of banks and channels, considering water level management boards and increasing property resilience. The Cumbria Floods Partnership structure below details how these 5 themes are being delivered in the Flood Action plans which will be completed in July.

The diagrams below help demonstrate how the two partnerships have now come together:





Cumbria Strategic Flood Partnership



Community

RFCC

Cumbria Strategic
Partnership Board

Catchment Management
Group

Eden

Catchment Management
Group

Derwent

Catchment Management
Group

Kent and Leven

Steering Groups
(Various per Catchment)

MSFWG

'Farmers, environmental charities, landowners, private companies, councils and government agencies have joined together with a common goal.

To look at the evidence and potential funding sources to find flood solutions for defences, resilience, maintenance, upstream management and water level management boards, so they can work together to help communities at risk of flooding.'

In a dynamic move the Cumbria Strategic Flood Partnership have created three groups whose aim is to look at all options for how flood risk can be reduced in Cumbria.

This group the first of its kind in the country brings together the expertise of all those whose water and land management experience to look at what can be done to protect communities both residential and farming.

They will then discuss their findings to the communities at risk and plan a way forward.

This landmark move will ensure that fully integrated solutions for land and water management are utilised to protect people and the environment in which they live and rely on.

Appendices

Appendix 1: Glossary

AEP	Annual Exceedance Probability
CCC	Cumbria County Council
DEFRA	Department for Environment, Food and Rural Affairs
EA	Environment Agency
FAG	Flood Action Group
FSR	Flood Storage Reservoir
FWD	Flood Warnings Direct
LLFA	Local Lead Flood Authority
MSfW	Making Space for Water
RMA	Risk Management Authority
SOP	Standard of Protection

Term	Definition
Aquifer	A source of groundwater comprising water-bearing rock, sand or gravel capable of yielding significant quantities of water.
Attenuation	In the context of this report - the storing of water to reduce peak discharge of water.
Catchment Flood Management Plan	A high-level planning strategy through which the EA works with their key decision makers within a river catchment to identify and agree policies to secure the long-term sustainable management of flood risk.
Culvert	A channel or pipe that carries water below the level of the ground.
De Facto Flood Defence	A feature or structure that may provide an informal flood defence benefit but is not otherwise designed or maintained by the Environment Agency
Flood Defence	Infrastructure used to protect an area against floods as floodwalls and embankments; they are designed to a specific standard of protection (design standard).
Floodplain	Area adjacent to river, coast or estuary that is naturally susceptible to flooding.
Flood Resilience	Measures that minimise water ingress and promotes fast drying and easy cleaning, to prevent any permanent damage.
Flood Risk	The level of flood risk is the product of the frequency or likelihood of the flood events and their consequences (such as loss, damage, harm, distress and disruption)

Term	Definition
Flood Risk Regulations	Transposition of the EU Floods Directive into UK law. The EU Floods Directive is a piece of European Community (EC) legislation to specifically address flood risk by prescribing a common framework for its measurement and management.
Flood and Water Management Act	Part of the UK Government's response to Sir Michael Pitt's Report on the Summer 2007 floods, the aim of which is to clarify the legislative framework for managing surface water flood risk in England.
Flood Storage	A temporary area that stores excess runoff or river flow often ponds or reservoirs.
Flood Zone	Flood Zones are defined in the NPPF Technical Guidance based on the probability of river and sea flooding, ignoring the presence of existing defences.
Flood Zone 1	Low probability of fluvial flooding. Probability of fluvial flooding is < 0.1%
Flood Zone 2	Medium probability of fluvial flooding. Probability of fluvial flooding is 0.1 – 1%. Probability of tidal flooding is 0.1 – 0.5 %
Flood Zone 3a	High probability of fluvial flooding. Probability of fluvial flooding is 1% (1 in 100 years) or greater. Probability of tidal flooding is 0.5%(1 in 200 years)
Flood Zone 3b	Functional floodplain. High probability of fluvial flooding. Probability of fluvial flooding is >5%
Fluvial	Relating to the actions, processes and behaviour of a water course (river or stream)
Fluvial flooding	Flooding by a river or a watercourse.
Freeboard	Height of flood defence crest level (or building level) above designed water level
Functional Floodplain	Land where water has to flow or be stored in times of flood.
Groundwater	Water that is in the ground, this is usually referring to water in the saturated zone below the water table.
Inundation	Flooding.
Lead Local Flood Authority	As defined by the FWMA, in relation to an area in England, this means the unitary authority or where there is no unitary authority, the county council for the area, in this case Lancashire County Council.
Main River	Watercourse defined on a 'Main River Map' designated by DEFRA. The EA has permissive powers to carry out flood defence works, maintenance and operational activities for Main Rivers only.
Mitigation measure	An element of development design which may be used to manage flood risk or avoid an increase in flood risk elsewhere.
Overland Flow	Flooding caused when intense rainfall exceeds the capacity of the drainage systems or when, during prolonged periods of wet weather, the soil is so saturated such that it cannot accept any more water.
Residual Flood Risk	The remaining flood risk after risk reduction measures have been taken into account.

Term	Definition
Return Period	The average time period between rainfall or flood events with the same intensity and effect.
River Catchment	The areas drained by a river.
Sewer flooding	Flooding caused by a blockage or overflowing in a sewer or urban drainage system.
Sustainability	To preserve /maintain a state or process for future generations
Sustainable drainage system	Methods of management practices and control structures that are designed to drain surface water in a more sustainable manner than some conventional techniques.
Sustainable development	Development that meets the needs of the present without compromising the ability of future generations meeting their own needs.
Sustainable Flood Risk Management	Sustainable Flood Risk Management promotes a catchment wide approach to flooding that uses natural processes and systems (such as floodplains and wetlands) to slow down and store water.
Topographic survey	A survey of ground levels.
Tributary	A body of water, flowing into a larger body of water, such as a smaller stream joining a larger stream.
Watercourse	All rivers, streams, drainage ditches (i.e. ditches with outfalls and capacity to convey flow), drains, cuts, culverts and dykes that carry water.
Wrack Marks	An accumulation of debris usually marking the high water line.
1 in 100 year event	Event that on average will occur once every 100 years. Also expressed as an event, which has a 1% probability of occurring in any one year.
1 in 100 year design standard	Flood defence that is designed for an event, which has an annual probability of 1%. In events more severe than this the defence would be expected to fail or to allow flooding.

Appendix 2: Summary of Relevant Legislation and Flood Risk Management Authorities

The table below summarises the relevant Risk Management Authority and details the various local source of flooding that they will take a lead on.

Flood Source	Environment Agency	Lead Local Flood Authority	District Council	Water Company	Highway Authority
Rivers					
Main river					
Ordinary watercourse					
Surface Runoff					
Surface water					
Surface water on the highway					
Other					
Sewer flooding					
Sea					
Groundwater					
Reservoirs					

The following information provides a summary of each Risk Management Authority's roles and responsibilities in relation to flood reporting and investigation.

Government: DEFRA develop national policies to form the basis of the Environment Agency's and the LLFA's work relating to flood risk.

Environment Agency: Strategic overview of all sources of flooding and coastal erosion as defined in the Flood and Water Management Act (2010). As part of its role concerning flood investigations, this requires providing evidence and advice to support other RMAs. The Environment Agency also collates and reviews assessments, maps and plans for local flood risk management (normally undertaken by LLFA).

Lead Local Flood Authorities: Cumbria County Council is the LLFA for Cumbria. Part of their role requires them to investigate significant local flooding incidents and publish the results of such investigations. LLFAs have a duty to determine which RMA has relevant powers to investigate flood incidents to help understand how they happened, and whether those authorities have, or intend to, exercise their powers. LLFAs work in partnership with communities and flood RMAs to maximise knowledge of flood risk to all involved. This function is carried out at CCC by the Local Flood Risk Management Team.

District and Borough Councils: These organisations perform a significant amount of work relating to flood risk management, including providing advice to communities and gathering information on flooding. These organisations are classed as RMA's.

Water and Sewerage Companies: Manage the risk of flooding to water supply and sewerage facilities and the risk to others from the failure of their infrastructure. They make sure their systems have the appropriate level of resilience to flooding and where frequent and severe flooding occurs they are required to address this through their capital investment plans. It should also be noted that following the Transfer of Private Sewers Regulations 2011, water and sewerage companies are now responsible for a larger number of sewerage than prior to the regulation. These organisations are classed as RMAs.

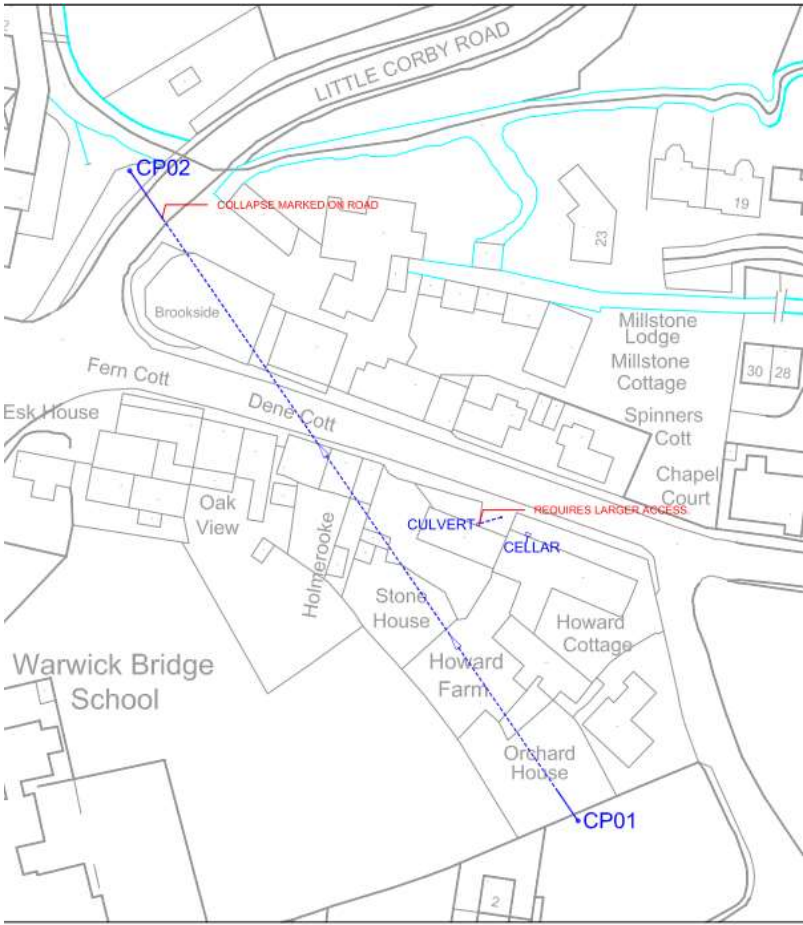
Highway Authorities: Highway authorities have the lead responsibility for providing and managing highway drainage and certain roadside ditches that they have created under the Highways Act 1980. The owners of land adjoining a highway also have a common-law duty to maintain ditches to prevent them causing a nuisance to road users. These organisations are classed as RMAs.

Flood risk in Cumbria is managed through the Making Space for Water (MSfW) process, which involves the co-operation and regular meeting of the Environment Agency, United Utilities, District/Borough Councils and CCC's Highway and LFRM Teams to develop processes and schemes to minimise flood risk. The MSfW Groups will meet approximately 4 times per year to co-ordinate operations and work together to mitigate flood risk in the vulnerable areas identified in this report by completing the recommended actions. As LLFA, CCC has a responsibility to oversee the delivery of these actions.

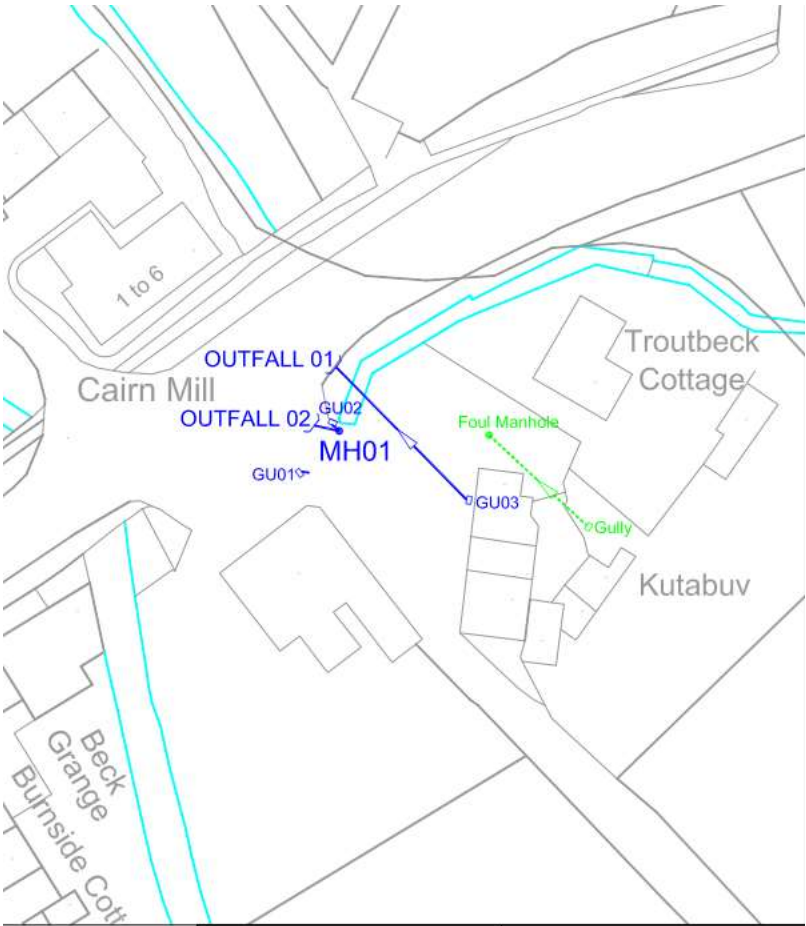
Where minor works or 'quick win' schemes can be identified, these will be prioritised and, subject to available funding and resources, will be carried out as soon as possible. Any major works requiring capital investment will be considered through the Environment Agency's Medium Term Plan process or a partner's own capital investment process.

Flood Action Groups are usually formed by local residents who wish to work together to help reduce flood risk in their area. The FAGs are often supported by either CCC or the Environment Agency and provide a useful mechanism for residents to forward information to the MSfW Group.

Appendix 3: Highway Drainage surveys



Drainage Junc Little Corby Road and A69



Drainage Cairn Mill and A69

Road side drainage Gt Corby Road and Wetheral B6264



Appendix 4: Links to Other Information on Flooding

Sign up for Flood Warnings

<https://www.gov.uk/sign-up-for-flood-warnings>

Environment Agency – Prepare your property for flooding; a guide for householders and small businesses to prepare for floods

<https://www.gov.uk/government/publications/prepare-your-property-for-flooding>

Environment Agency – What to do before, during and after a flood: Practical advice on what to do to protect you and your property

<https://www.gov.uk/government/publications/flooding-what-to-do-before-during-and-after-a-flood>

Environment Agency – Living on the Edge: A guide to the rights and responsibilities of riverside occupiers

<https://www.gov.uk/government/publications/riverside-ownership-rights-and-responsibilities>

Flood and Water Management Act 2010:

<http://www.legislation.gov.uk/ukpga/2010/29/contents>

Water Resources Act 1991:

<http://www.legislation.gov.uk/all?title=water%20resources%20act>

Land Drainage Act:

<http://www.legislation.gov.uk/all?title=land%20drainage%20act>

Appendix 5: Flood Warnings and Alerts

Kendal is covered by a Flood Alert, and certain areas are served by four Flood Warnings as shown in the table below, which summarises the times of the flood warnings issued during this flood event:

Flood Warning	Flood Warning Issued	Severe Flood Warning Issued	Properties	Contacts	% Success *
011FWFNC10A	05/12/15 10:20	06/12/15 00:12	48	156	74
011FWFNC10B	05/12/15 09:53	05/12/15 16:55	58	169	78

The following pages show additional details on the flood alerts and warnings issued during this event.

Flood Alerts

011WAFME: Middle River Eden

Alert issued on Thursday 03/12/2015 at 14:46

Alert removed on Friday 04/12/2015 at 06:49

Alert issued on Friday 04/12/2015 at 15:10

Alert removed on Thursday 10/12/2015 at 22:41

Customers in Flood Alert area registered on FWD: 111

Contacts (landline, mobile, email etc.) in Flood Alert area registered on FWD: 268

Successful contacts: 213

Unsuccessful contacts: 55

Alert Message:

A Flood Alert has been issued by the Environment Agency for the Middle River Eden. Flooding is possible for River Eden and tributaries from Temple Sowerby to the confluence with the River Irthing at Warwick Bridge including Langwathby, Lazonby, Kirkoswald, Armathwaite, Wetheral and Warwick on Eden. Low lying land and roads will be affected first.

Be prepared to protect yourself, family, pets and property.

Heavy and persistent rainfall is forecast to continue throughout today until this evening. With the ground already saturated the river levels are expected to rise and we may see some localised flooding to low lying land and roads. An outlook for the weekend shows although Friday is looking a relatively dry day, the rain will again become heavy and persistent in the early hours of Saturday continuing right through until Sunday. As River levels are already high, we may see some localised flooding throughout Cumbria.

* Contact Successful if at least one attempt to contact a fully-registered recipient registered to the property returned a status of "Acknowledged", "Successfully Received", "Successfully Sent" or "Unacknowledged"

Flood Warning Target Areas

011FWFNC10A: River Eden at Warwick Bridge, Holme House, Bridge End and Holme Eden Hall

Flood Warning issued on Saturday 05/12/2015 at 10:20

Severe Flood Warning issued on Sunday 06/12/2015 at 00:12

Severe Flood Warning removed on Monday 07/12/2015 at 17:29

Date/Time Warning Level Reached: 05/12/2015 13:00

Time customers had to take action: 02:39:20

Customers in Flood Alert area registered on FWD: 48

Contacts (landline, mobile, email etc.) in Flood Alert area registered on FWD: 156

Successful contacts: 115

Unsuccessful contacts: 41

Warning Message:

A Flood Warning has been issued by the Environment Agency for the River Eden at Warwick Bridge, Holme House, Bridge End and Holme Eden Hall.

Flooding is expected for low lying roads, agricultural land and isolated properties adjacent to the River Eden at Warwick Bridge, Holme House, Bridge End and Holme Eden Hall. Immediate action required.

Heavy and persistent rainfall is expected throughout Saturday and in to Sunday. River and lake levels will continue to rise. Please check for updates throughout the weekend.

The river level recording station used for this flood warning is Great Corby.

011FWFNC10B: River Eden at Warwick Bridge, Warwick Park and Holme Eden Gardens Area

Flood Warning issued on Saturday 05/12/2015 at 15:42

Severe Flood Warning issued on Sunday 06/12/2015 at 00:12

Severe Flood Warning removed on Monday 07/12/2015 at 18:16

Date/Time Warning Level Reached: 05/12/2015 15:30

Time customers had to take action: -00:15:00

Customers in Flood Alert area registered on FWD: 58

Contacts (landline, mobile, email etc.) in Flood Alert area registered on FWD: 169

Successful contacts: 131

Unsuccessful contacts: 38

Warning Message:

A Flood Warning has been issued by the Environment Agency for the River Eden at Warwick Bridge, Warwick Park and Holme Eden Gardens Area.

Flooding is expected for Low lying roads, agricultural land and residential properties adjacent to the River Eden at Warwick Bridge, Warwick Park and Holme Eden Gardens Area. Immediate action required.

Heavy and persistent rainfall is expected throughout Saturday. River levels will continue to rise and further Flood Warnings are likely. Please check for updates throughout the weekend. Operational Teams have closed flood defences and are checking watercourses for blockages.

The river level recording station used for this flood warning is Great Corby.

Appendix 6: Data Capture Map for Warwick Bridge

