

<b>PROJECT</b>	Addendum to Brookhouse Flood Investigation Report
<b>PURPOSE OF NOTE</b>	Additional investigation following flooding of property during Storm Christoph (20 <sup>th</sup> January 2021)
<b>WATERCOURSE</b>	Afon Ystrad
<b>FILE NOTE PRODUCED BY</b>	Neil Taunt
<b>DATE</b>	05/03/2021

## Contents

1	Introduction.....	1
2	Hydrology / Summary of Rainfall .....	1
3	Flood Incident Summary.....	3
4	Conclusions and Next Steps.....	6

## Figures

<b>Figure 1:</b>	Pont y Cambwll gauging station hydrograph .....	2
<b>Figure 2:</b>	Storm Christoph flood extent, indicative flow routes and impacted properties .....	5

## Tables

<b>Table 1.</b>	Rainfall summary rainfall totals during Storm Christoph. ....	2
<b>Table 2.</b>	Maximum return periods recorded at Denbigh STW and Plas Pigot rain gauges during Storm Christoph.....	2
<b>Table 3.</b>	Comparison of Long Term Averages in preceding months to Storm Christoph.....	2
<b>Table 4:</b>	Summary of Flood Investigation questionnaires .....	5

## 1 Introduction

NRW officers received reports of internal residential property flooding during storm Christoph on the 20<sup>th</sup> January 2021. Officers visited the area on 2<sup>nd</sup> February 2021 to investigate the extent of flooding experienced in the area and gather evidence and information from residents. This addendum report summarises the findings of the investigation and provides comment to recommendations previously made, following investigations into Storm Ciara last year.

## 2 Hydrology / Summary of Rainfall

Storm Christoph was a prolonged rainfall event covering the period 18<sup>th</sup> to 21<sup>st</sup> January 2021. NRW does not have any river level or flow monitoring stations within the Ystrad catchment, therefore a summary of rainfall, in conjunction with other nearby relevant data, has been made to provide context and scale to the flooding experienced within the community.

Table 1 provides a summary of rainfall totals across the various days of storm Christoph and for the event in total for the closest relevant rain gauges. This identifies that both sites saw a significant portion of the long-term average (LTA) rainfall for January being observed during the storm event. Table 2 indicates the maximum return periods attributable to the rainfall event at the 2 stations. When considered in isolation these return periods do not appear remarkable and would indicate flooding has occurred for a relatively frequent rainfall event. Consideration needs to be given to antecedent conditions within the catchment prior to the arrival of storm Christoph. Table 3 details the % exceedance of long-term average rainfall totals for each of the preceding 4 months. This gives strong evidence to support heavily saturated conditions within the Ystrad catchment, this is considered a significant contributor as to why the relatively modest rainfall totals associated with Christoph resulted in notable flooding impacts to the residents of Brookhouse.

Pont y Cambwll gauging station is located downstream of the Ystrad confluence and Denbigh on the River Clwyd at SJ0698570963. The hydrograph in Figure 1 shows flow at that site from January 2020 to the end of Jan 2021. Storm Christoph peak is circled. Base flows were high at the start of the event from previous rainfall and whilst this isn't the Ystrad catchment it does give a representation of conditions in the wider Clwyd catchment.

Rain gauge	Daily rainfall totals (mm)				Total rainfall from 18 to 21 January 2021 (mm)	January LTA mm 81-10	% of January LTA
	18/01/21	19/01/21	20/01/21	21/01/21			
Denbigh STW	10.6	17.0	36.4	0.4	64.4	77.9	83%
Plas Pigot	11.6	26.4	34.6	1.8	74.4	120.9	62%

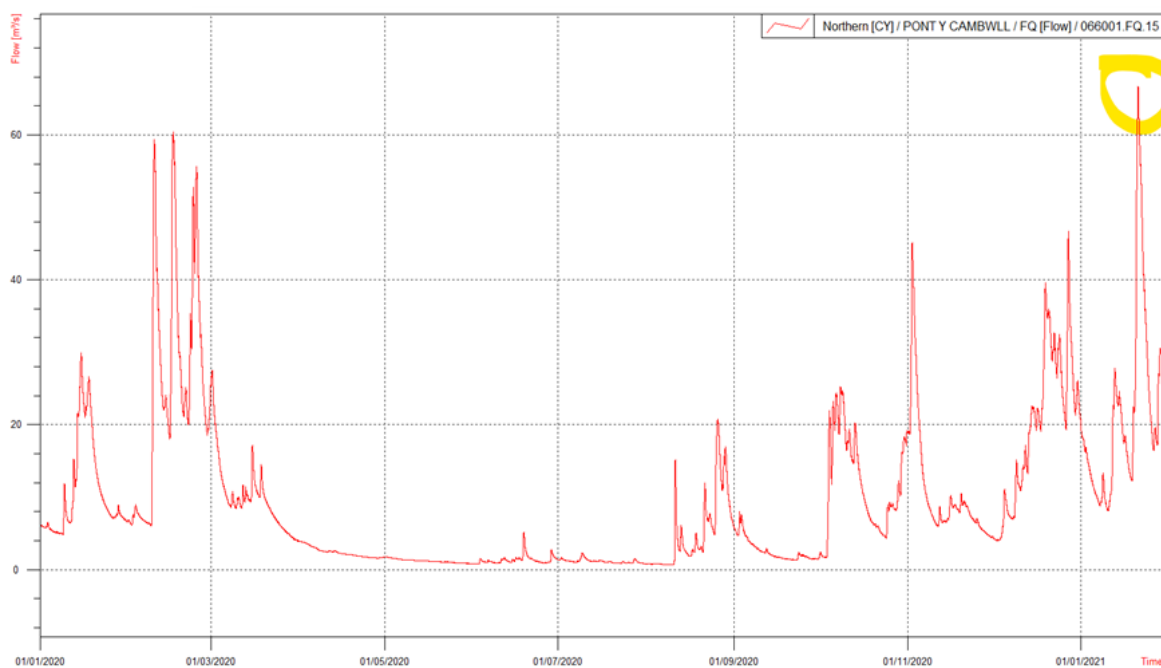
**Table 1.** Rainfall summary totals during Storm Christoph.

Rain gauge	Critical Rainfall (mm)	Duration (hours)	Start date and time of critical rainfall	Return Period (years)
Denbigh STW	54.0	54	18/01/2021 20:15	5
Plas Pigot	76.2	60	18/01/2021 21:45	4

**Table 2.** Maximum return periods recorded at Denbigh STW and Plas Pigot rain gauges during Storm Christoph.

Rain gauge	Oct 2020			Nov 2020			Dec 2020			Jan 2021 (up to 21 Jan)		
	Rainfall mm	LTA	% LTA	Rainfall mm	LTA	% LTA	Rainfall mm	LTA	% LTA	Rainfall mm	LTA (Jan)	% LTA
Denbigh STW	138	90.7	152	48	91.3	53	166	86.9	191	103.2	77.9	132
Plas Pigot	164.6	125.4	131	86.8	137.2	63	217.2	128.2	169	129.6	120.9	107

**Table 3.** Comparison of Long Term Averages in preceding months to Storm Christoph.



**Figure 1:** Pont y Cambwll gauging station hydrograph

### 3 Flood Incident Summary

Discussions with multiple residents of Brookhouse during the site visit of the 2<sup>nd</sup> Feb (summarised in Table 4), in conjunction with observations and evidence collected, confirmed that during Strom Christoph flooding occurred from the river side of the residential properties. Anecdotal and photographic evidence suggests the peak of flooding occurred at approximately 14:30 on the 20<sup>th</sup> January 2021. There was no direct evidence that surface waters either conveyed by or accumulated on the adjacent highway directly resulted in property flooding. Whilst inevitable runoff from adjacent land and the highway drainage networks would have been experienced, it is clear that the overriding source of flooding was fluvial due to elevated levels within the Afon Ystrad.

Elevated river levels immediately downstream of the disused railway embankment (directly upstream of Brookhouse) did result in very marginal overtopping of the raised flood defence asset on the left-hand bank of the Ystrad. This was marginal in nature and no evidence or reports of this causing any impacts have arisen during this investigation.

A notable area of scour was observed adjacent to the weir on the right bank of the watercourse, assumed to have been caused by out of bank flows returning to the channel downstream of the weir.

Adhoc walls on the left bank of the watercourse did not overtop during the event. Photographic evidence contained within Appendix A would suggest water levels were able to equalise across the wall located at the downstream extent of the residential properties. The homeowner of this property did suggest a hole had been installed in the wall to allow this to happen as on previous events surface water had accumulated behind the wall and resulted in internal property flooding as door threshold level had been exceeded by the impounded water

Discussions with residents consistently confirmed that flood waters entered residential properties from the rear. This is directly from the left bank of the Afon Ystrad. It is accepted that elevated water levels resulted in flood waters entering properties via several routes – upwelling through permeable floors, via piped drainage and sewerage and directly seeping through property walls.

A number of properties do benefit from IPP, and where installed this was not breached. Several properties surveyed do not have IPP installed. It is also apparent that those properties that did have IPP installed also flooded but not via the route protected by the IPP.

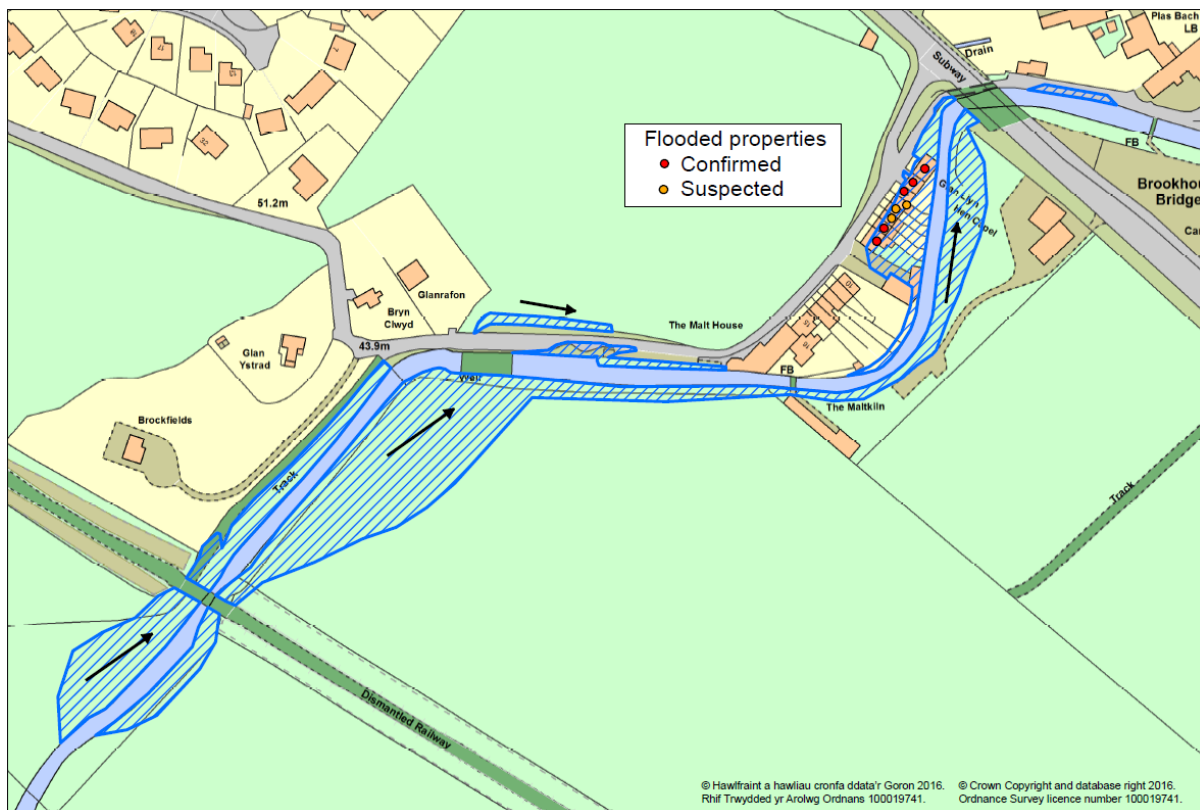
The area is covered by the Clwyd Catchment Flood Alert that was in force at the time of the flooding. Discussions with residents confirmed uptake of this service was variable and it was apparent that several properties had changed ownership recently with associated lack of awareness of this service.

Figure 2 summarises findings of the investigation, indicating affected properties, flood extent and indicative flow routes.

Property	Reported Impact
Glan Llyn	Approximately 5” (13cm) flood water internally. External water level did not breach IPP threshold level (IPP installed). Flood waters appeared to enter property via rear (riverside) external wall (homeowner did not believe waters rose through the floor). Did mention a hole had been made in the base of the garden wall (adjacent to d/s bridge) which allowed water level to equalise across the wall allowing water on the landward side of the wall to escape reducing levels.
Hen Capel	5-10cm on internal flooding. Flood waters came from the rear of the property (no IPP). Front door used to allow waters to pass through

No. 4	Approximately 3" (8cm) flood water internally. Flood water appeared to enter property via drainage connections to shower/bath and through floor.
No. 8	5-10cm on internal flooding. Flood waters came from the rear of the property (IPP fitted) through the floor (not via drains this time).
No. 9	5-10cm Flooding came in at the back of the property, which overlooks the Afon Ystrad, plus flooding came into business shed at rear of the property. No IPP.
Brookhouse Pottery & Malthouse Gallery	Small amount of flooding in rear garden. Across private bridge there was flooding to business studios on Right Bank

**Table 4:** Summary of Flood Investigation questionnaires



**Figure 2:** Storm Christoph flood extent, indicative flow routes and impacted properties.

## 4 Conclusions and Next Steps

Flooding during storm Christoph resulted in inundation of 8 residential properties (5 confirmed, 3 suspected) and one commercial premises. This is attributed to prolonged rainfall falling onto saturated catchments resulting in a significant fluvial response leading to out of bank flows and water permeating through adjacent ground, walls and drainage networks to give rise to internal property flooding. This internal residential property flooding incident is the 5<sup>th</sup> occurrence in recent times – following flooding in Oct. 2000, Dec 2007, Nov. 2012 and February 2020.

The Flood Investigation Report carried out following flooding on 9<sup>th</sup> Feb 2020 made several proposals. To date no progress has been made in considering/actioning these. This addendum report does not propose additional point to those made, but the following observations are made:

**09/02/2020 Proposal: “NRW to consider the viability of the implementation of a river level monitoring site on the Afon Ystrad to assist in earlier warning issued to residents.”**

- Consideration of the ability to provide improved warning and informing to residents, allowing additional time to prepare for flooding, could provide significant betterment at this location.

**09/02/2020 Proposal: “NRW to review the hydraulic modelling to take into account the findings of this 2020 flood investigation report.”**

- Whilst including up to date hydrological and topographical datasets will increase confidence in the understanding of risk to the community of Brookhouse, this will most likely confirm the existing understanding and mechanisms of flooding. Consideration of improved warning and informing services to the community may result in more timely provision of service improvements at this location.

## Appendix 1 – Photographic evidence



Image 1. Extract from local residents' video at the approximate peak river level.





Image 2. Extract from local residents' video showing water levels across the wall at the downstream end at the approximate peak river level.



Image 3. Area of scour on right bank adjacent to weir.