Cyfoeth Naturiol Cymru
Natural Resources Wales

Flood Investigation Report
Ruthin
20 January 2021

Cyfoeth Naturiol Cymru
Natural Resources Wales

Document Control Sheet

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Version History

Date	Version No.	Status	Summary of Changes
20/04/2021	1	Draft	
05/05/2021	2	Final	Minor amendments following draft comments

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Executive summary

Under Section 19 of the Flood and Water Management Act, the Lead Local Flood Authority (Local Authority) on becoming aware of a flood in its area must to the extent that it considers 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.

Natural Resources Wales have agreed to investigate all main river flooding as part of this process.

Where a Lead Authority carries out an investigation then the report must be published, and any relevant risk management authorities notified.

This investigation report is a best estimate representation of the flood incident at Ruthin, written as a formal way for Natural Resources Wales to record the incident. It is based on evidence gathered by Natural Resources Wales' officers through several sources and is deemed as fit for purpose at the approved date.

It was considered appropriate to carry out an investigation as 23 residential/business properties suffered from internal flooding following heavy rainfall on the 20 January 2021. The Afon Clwyd overtopped the raised flood embankment between Cae Ddol and the Crispin Yard Car Park on the Clwyd's right bank and flooded 22 properties. One property was also flooded internally by the Clwyd in the Maes Ffynnon estate.

This report provides details of the investigation with conclusions.

1 Location

Ruthin is situated approximately 23 km west northwest of Wrexham, North Wales. The Afon Clwyd, which has its headwaters in Clocaenog Forest, runs through Ruthin in a northerly direction.

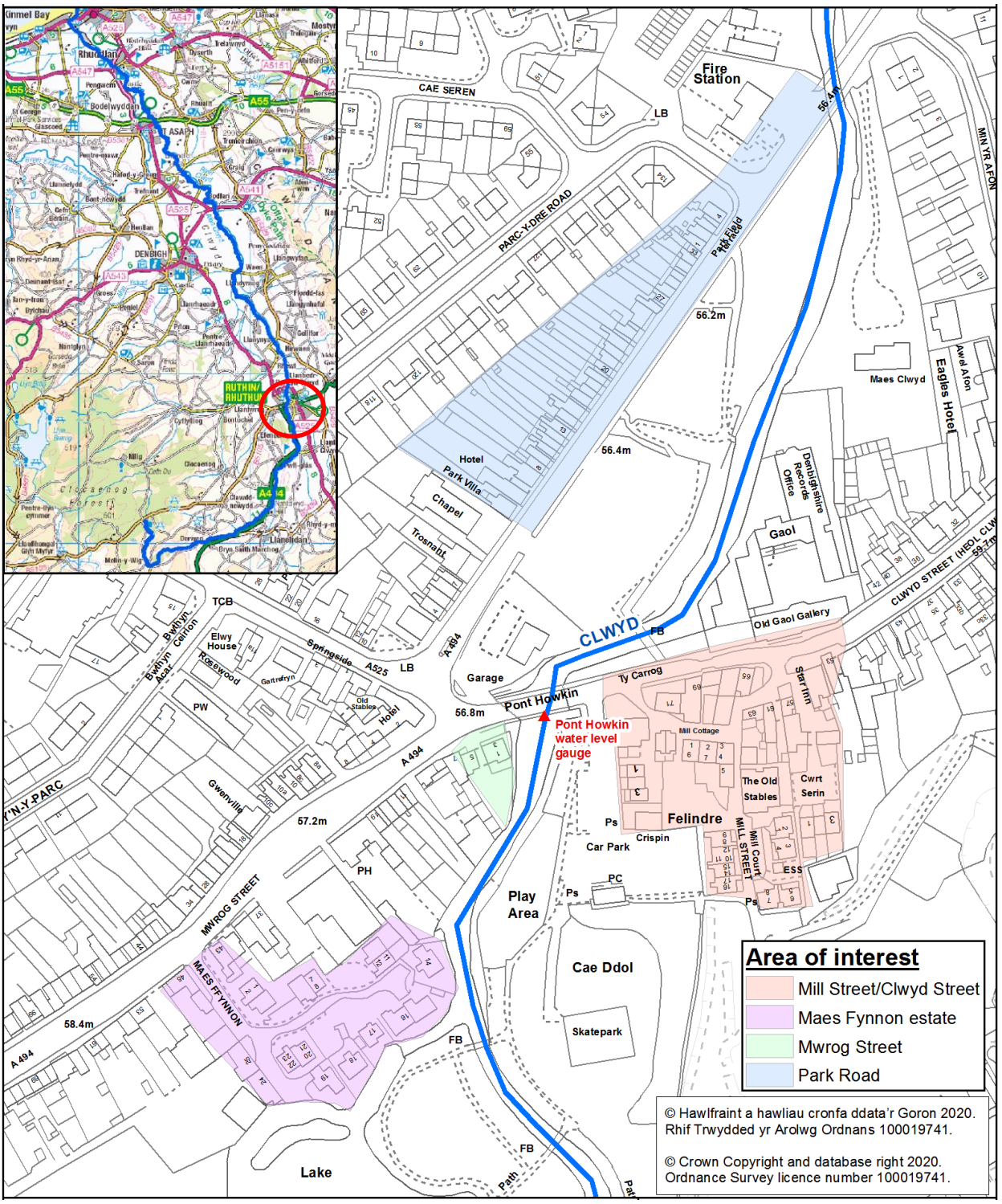

Figure 1: Location Map

2 Flooding History

Ruthin has been affected several times by flooding over the years, with the earliest recorded event occurring in June 1931. The two most significant events occurred in October/November 2000 and November 2012. Further details on Ruthin's flood history can be found in the Ruthin Flood Risk Study[1].

NRW hold historical flood outlines for the events which occurred in 1964, October/November 2000 and 27 November 2012. The flood event outline shown for Ruthin in November 2012 only covers areas where properties flooded. Other areas of land, such as the rugby pitches and fields upstream of Pont Howkin, as depicted by the 1964 event, also flooded but no outlines were picked up during this event.

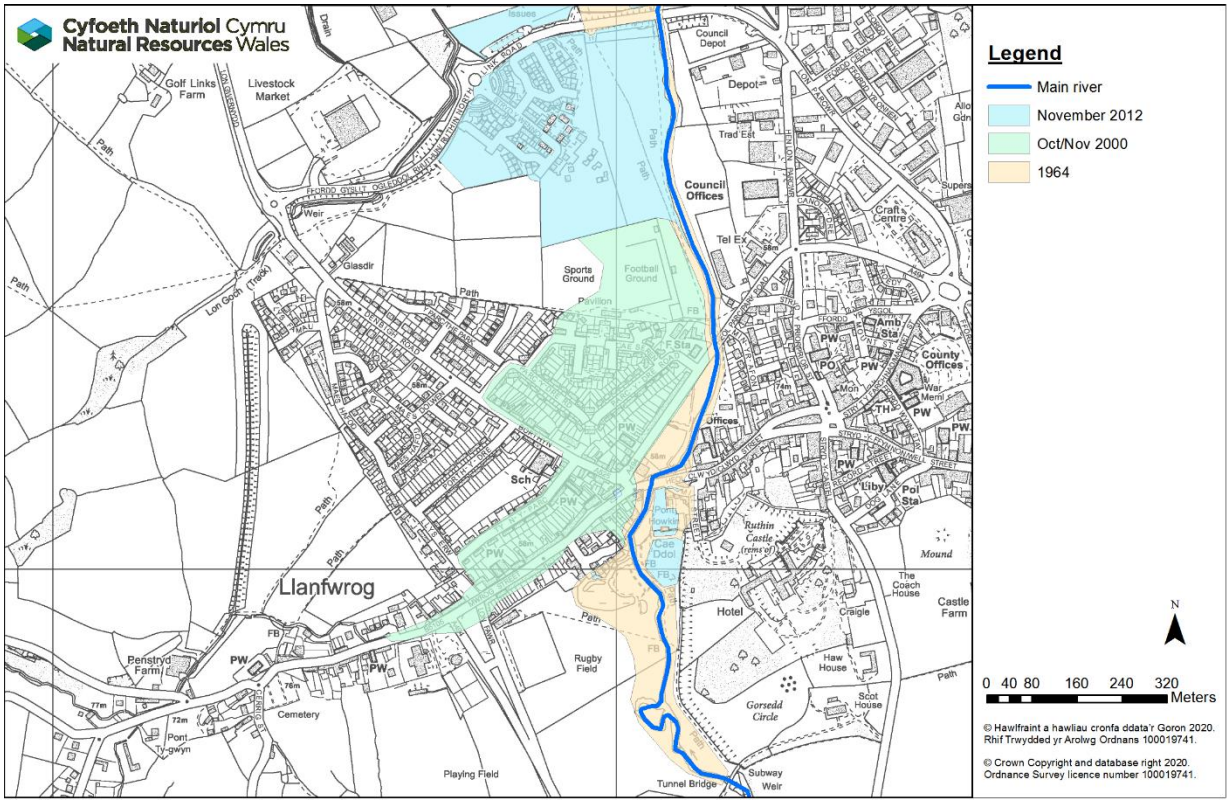

Figure 2: Historic Flood Outlines

[1] Natural Resources Wales, Ruthin Flood Risk Study, April 2014

3 Flood Risk Assets

Following the flooding in 2000, NRW constructed a flood alleviation scheme along the Clwyd which comprise a series of flood walls and embankments. These defences start upstream of Pont Howkin and continue along both banks through Ruthin to around the football ground area. After which, only the defence on the right bank continues to just past the Ruthin weir.

All raised defences in the Ruthin area are visually inspected on a 6-month schedule. All assets have a condition score allocated in reference to the 2012 Condition Assessment Manual[2]. At the time of the January 2021 storm event, majority of NRW maintained flood risk management assets in Ruthin were performing at or above their target condition with only the lower Maes Ffynnon wall slightly below its target condition.

The most recent asset inspection of the Cae Ddol embankment did identify a localised defect with the condition of the embankment adjacent to the castle wall. Whilst not sufficient to decrease the overall condition assessment of the embankment the defect was raised with the Operations team and a repair was due to be undertaken this summer when conditions allowed.

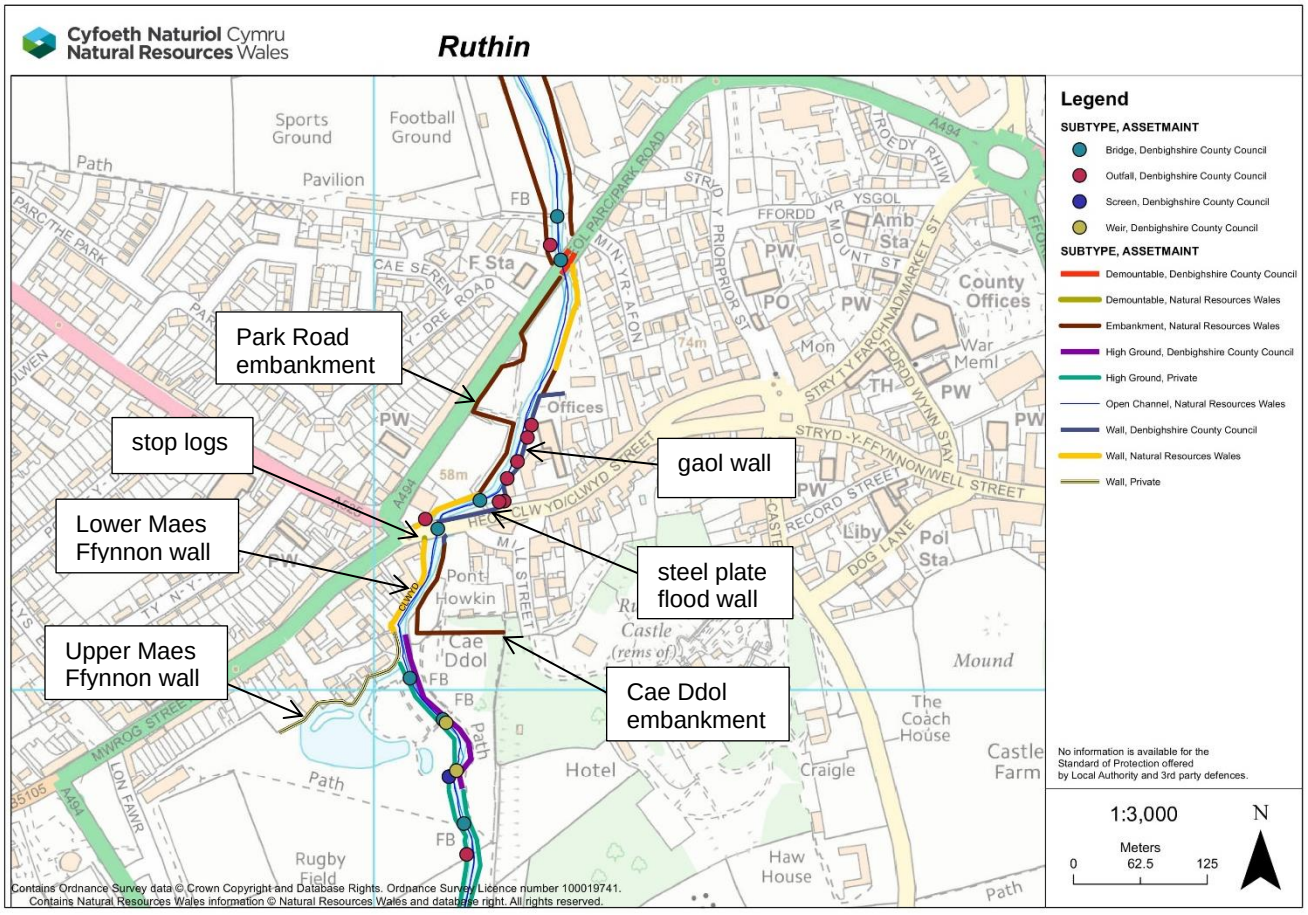

Figure 3: Ruthin flood risk management assets

[2] Environmental Agency, Managing Flood Risk - Condition Assessment Manual (CAM), 2012

4 Flood Event – 20 January 2021

Storm Christoph brought several days of rain to the UK between 18-21 January 2021. Within the Clwyd catchment, the Brynhyfryd rain gauge recorded 76.4 mm of rain over the four days, which is more than the long-term monthly average. For more information in relation to the hydrological data please see Appendix A.

In response to this rain, the river level in the Afon Clwyd through Ruthin rose slowly from about midnight on the 18 January. From about 2:30 pm on the 20 January, the Clwyd river level started to rise more rapidly through Ruthin, peaking at 7:30 pm at the Pont Howkin river level station.

As a result of the rising river level, the Afon Clwyd overtopped the Cae Ddol flood defence embankment and flooded areas of Mill Street and Clwyd Street in Ruthin. Areas around Maes Ffynnon estate and outside of 1 Mwrog Street were also affected by Clwyd floodwater.

Ruthin town was visited by NRW staff on 21 January 2021 and met on site by a Denbighshire County Council representative. The following series of events are based on observations made by the staff and discussions with residents there at the time of the visit. Additionally, Waterco on behalf of Denbighshire County Council, undertook a walkover of various locations through Ruthin during the evening of 20 January. A summary of their observations is provided in Appendix B.

4.1 Mill Street/Clwyd Street

Residents detailed that around 3-4 pm, the Clwyd began to inundate the park areas around Cae Ddol. As the Clwyd continued to rise, the Cae Ddol embankment near the skatepark (see Figure 4) overtopped and floodwater began to fill the Crispin Yard Car Park and the public conveniences.

At about 6:30 pm, floodwater started to enter the bathroom of ‘Crispin’. It entered through the side of the property from Crispin Yard Car Park, south of the property.

Around the same time (6:30 pm), floodwater entered ‘Ty Carrog’. The floodwater had flowed north from the car park (south of ‘Crispin’), towards the car park entrance on Clwyd Street and into Mill Street (see Figure 5). The properties along Mill Street were flooded not long after, with 1 Mill Street reporting internal flooding at about 7:15 pm.

The Clwyd floodwater ponded on Clwyd and Mill streets (Figure 6 and Figure 7) as it was unable to drain back into the river due to the steel plate flood wall (see Figure 9) along Clwyd Street, designed to stop the Clwyd downstream of Pont Howkin overtopping to Clwyd Street. The masonry wall alongside the gaol also trapped the floodwater from returning to the Clwyd.

The roadside gullies along Clwyd and Mill streets were overwhelmed by the volume of water (as they are designed for local runoff) and anecdotal evidence from residents suggested some needed unblocking, so were unable to drain the ponded water efficiently.

The fire service began pumping the floodwater from Clwyd and Mill streets into the Clwyd, downstream of Pont Howkin, at around 8-9 pm.

The floodwater on Clwyd Street peaked at about 9:30-10 pm, reaching the front step (did not enter) of 'Royal Oak' on Clwyd Street.

By midnight, the roadside gullies were able to drain the water efficiently back into the Clwyd.

In total, there were 17 residential and 5 business properties that were flooded internally along Mill and Clwyd streets due to the Clwyd overtopping the Cae Ddol embankment.

The location of overtopping of the Cae Ddol embankment was similar to that which overtopped during the 2012 flood event. According to residents, in February 2020, sandbags were placed along the crest of the Cae Ddol embankment which stopped the Clwyd from overtopping to the car park, it is presumed that Denbighshire CC undertook this work as NRW has no knowledge of this.

Figure 4: Cae Ddol embankment near skatepark (source: NRW staff)

Figure 5: Floodwater at the car park entrance (Source: Real Fans of Ruthin Facebook page)

Figure 6: Flooding on Mill Street (Source: Real Fans of Ruthin Facebook page)

Figure 7: Flooding on Clwyd Street (Source: NWP Rural Crime Team twitter page)

Figure 8: Overtopping of the Cae Ddol embankment (source: Sky News[3])

Figure 9: Steel plate flood wall along Clwyd Street (source: NRW staff)

4.2 1 Mwrog Street

According to observations from Waterco staff, the floodwater from the Clwyd was seeping between the stop logs (Figure 10) immediately upstream of Pont Howkin bridge. This water was flowing towards properties (Figure 11), however there was no reported internal flooding in this area.

Figure 10: Wrack mark at stop logs (Source: NRW staff)

Figure 11: 1 Mwrog Street (Source: Waterco)

4.3 Maes Ffynnon estate

Denbighshire CC have confirmed there was internal flooding at 24 Maes Ffynnon, which was caused by water coming up through the ground outside once the Clwyd levels had a reached a height above ground level. This was also the case for 15 to 19 Maes Ffynnon, with water coming up through the back gardens/patio over a period of 3-4 hours, accumulating in approximately 8-9 inches of water, but not enough to enter through conservatory/back doors. Levels started to drop around 8-9 pm.

The Clwyd did not overtop the Maes Ffynnon wall, peaking about 0.3 m below the top. Nor was water observed to be seeping through the stone wall. Instead, floodwater was coming up through the manhole and roadside gullies.

[3] Sky News, UK weather: Homes being evacuated amid 'danger to life' flood warnings from Storm Christoph, 20 January 2021 https://news-sky-com.cdn.ampproject.org/v/s/news.sky.com/story/amp/uk-weather-boris-johnson-to-chair-emergency-cobra-meeting-over-storm-christoph-flooding-threat-12193179?amp_js_v=0.1&usqp=mq331AQHKAFQArABIA%3D%3D&fbclid=IwAR3uqz_7VFHEeXHob91LrC0s

Figure 12: Maes Ffynnon estate (source: Waterco)

4.4 Park Road

There was no reported internal flooding to properties along Park Road or Parc-y-Dre. Residents were concerned of flooding, which was exacerbated by the emergency services pumping water from the Mill and Clwyd streets increasing the river levels downstream of Pont Howkin. They were concerned that this action would cause the Clwyd to overtop a low spot in the Park Road embankment near Park Road bridge. There was no reported overtopping of the Park Road embankment, nor any evidence to suggest as such.

5 Flood Outlines and Flood Flow Routes

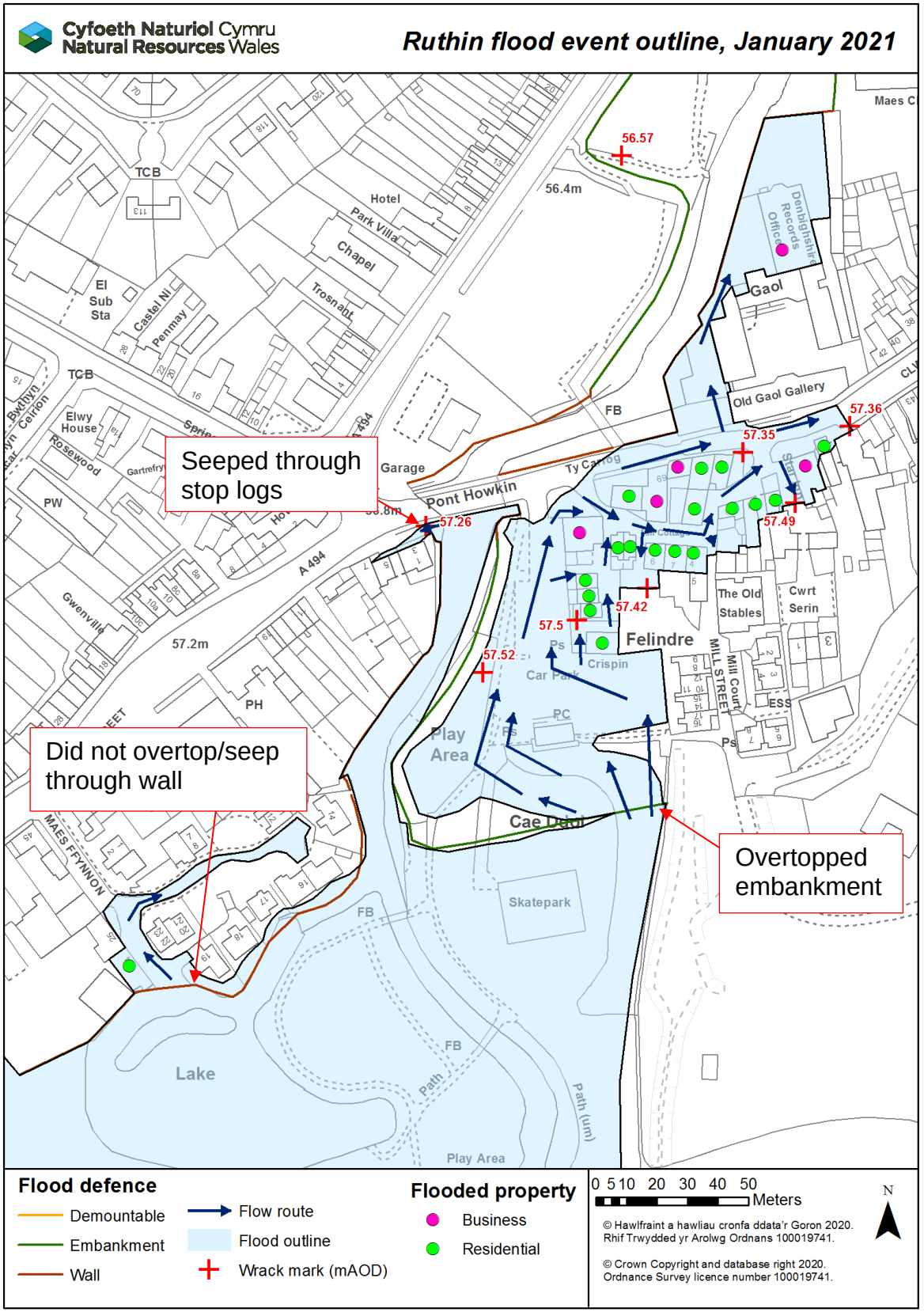

Figure 13: Outline and Route

6 Details of Warnings and Alerts issued

The **Clwyd Catchment** Flood Alert covers areas around the river Clwyd from Clocaenog to Rhuddlan (see Figure 14).

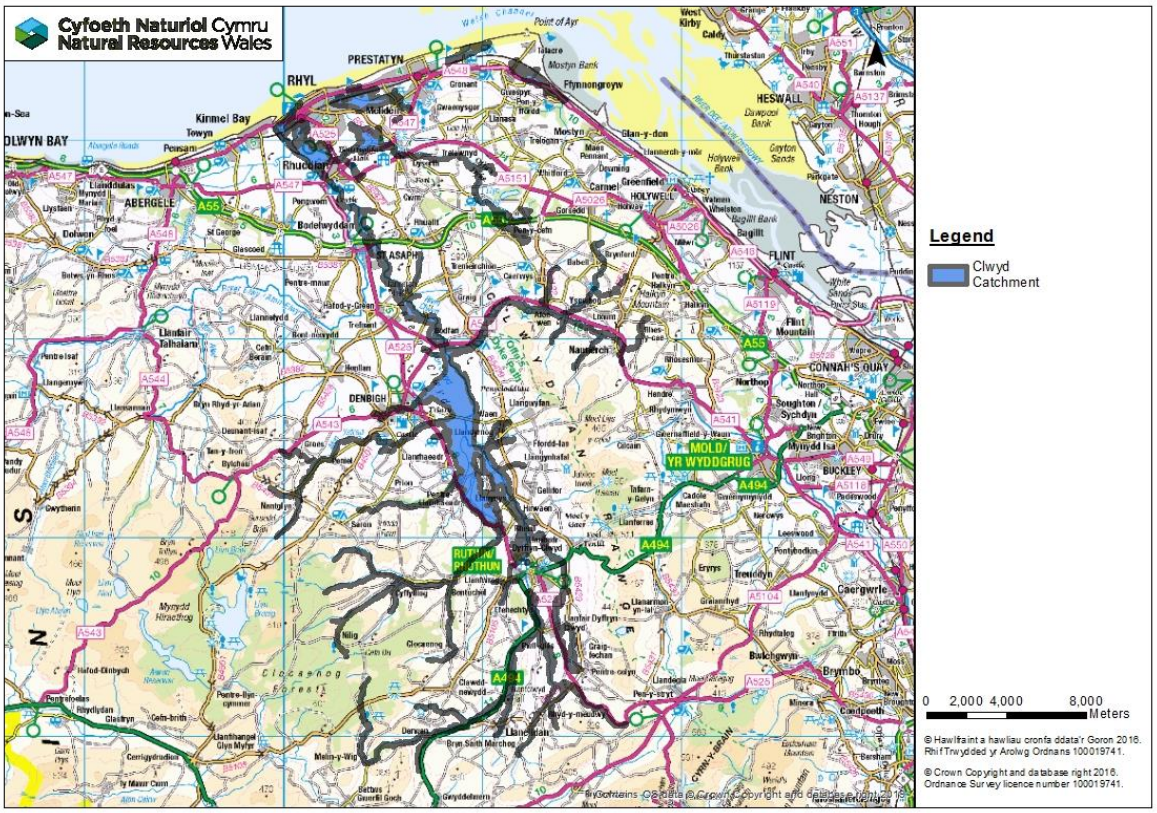

Figure 14: Map showing the Clwyd Catchment Flood Alert Area

A Catchment Flood Alert means that flooding of low-lying land and roads is possible, and for people to be prepared. Flooding of property is not expected to occur at this level of warning.

The Catchment Flood Alert is based on a pre-determined level at Ruthin Weir river level station, located at SJ1218259218.

There are also three site-specific Flood Warning Areas covering various parts of Ruthin. These are;

- **River Clwyd at Lon Fawr, Ruthin** (see Figure 15), which covers areas around the River Clwyd from Castle Park Farm at Lon Fawr, towards Pont Howkin, including Cae Ddol, parts of Maes Ffynnon, Mill Street, Crispin Yard, Mwrog Street and the Park Place Hotel.
- **River Clwyd at Ruthin Town** (see Figure 16), which covers parts of Ruthin from Pont Howkin towards the football fields, including Mwrog Street, Ty'n y Parc, Parc y Dre and Cae Seren.
- **River Clwyd at Glasdir, Ruthin** (see Figure 17), which covers the Glasdir housing estate in Ruthin.

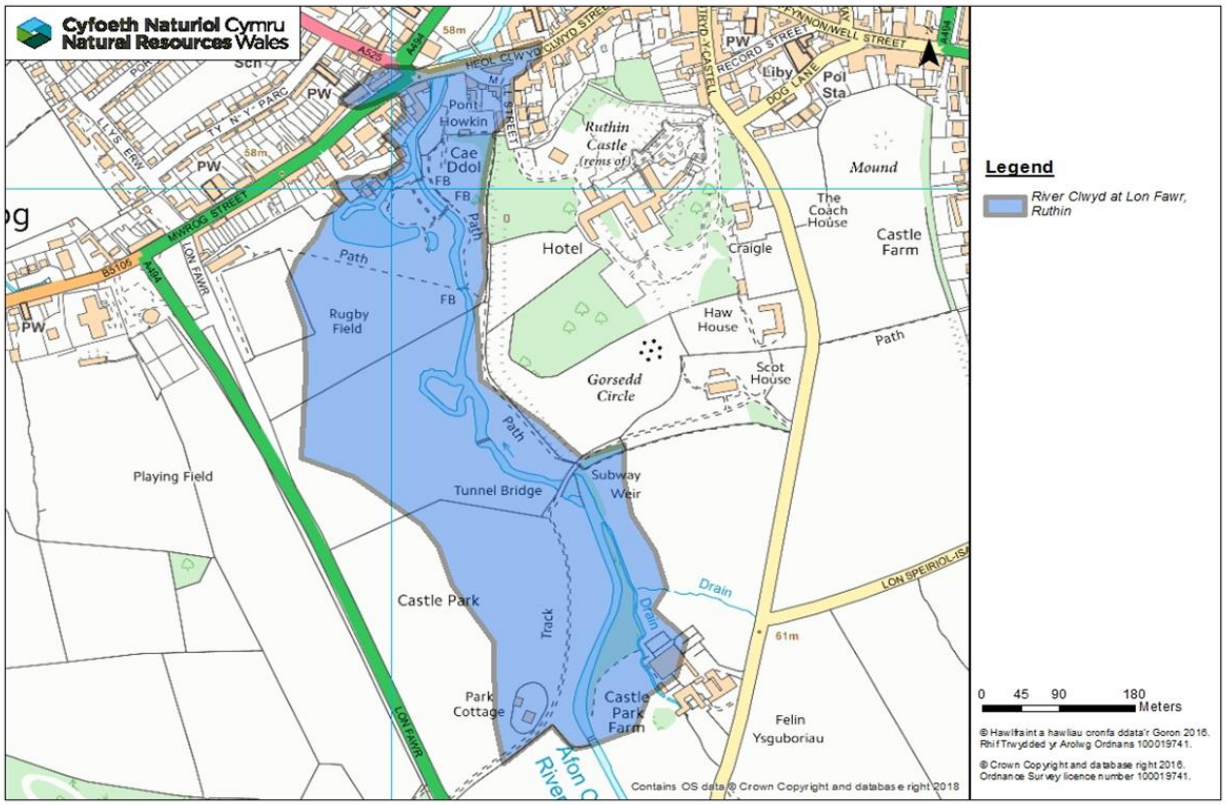

Figure 15: **Map showing the River Clwyd at Lon Fawr, Ruthin Flood Warning Area**

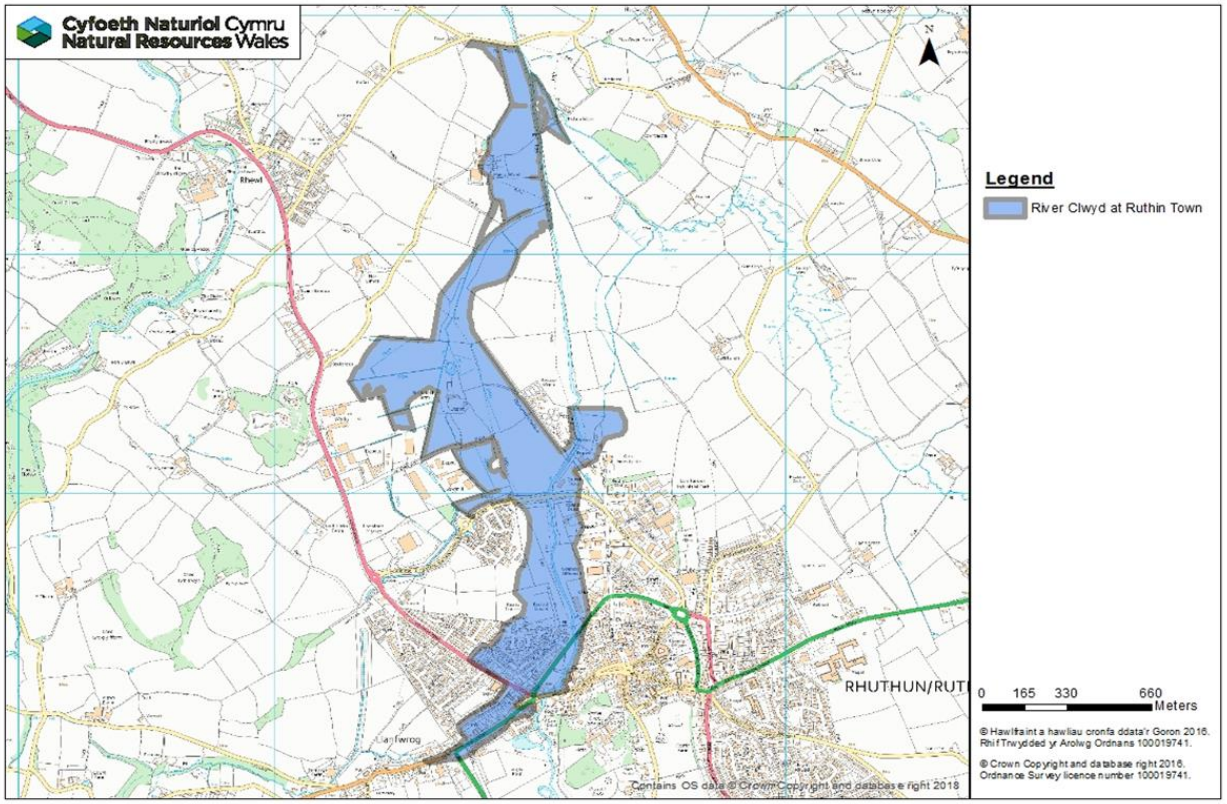

Figure 16: Map showing the River Clwyd at Ruthin Town Flood Warning Area

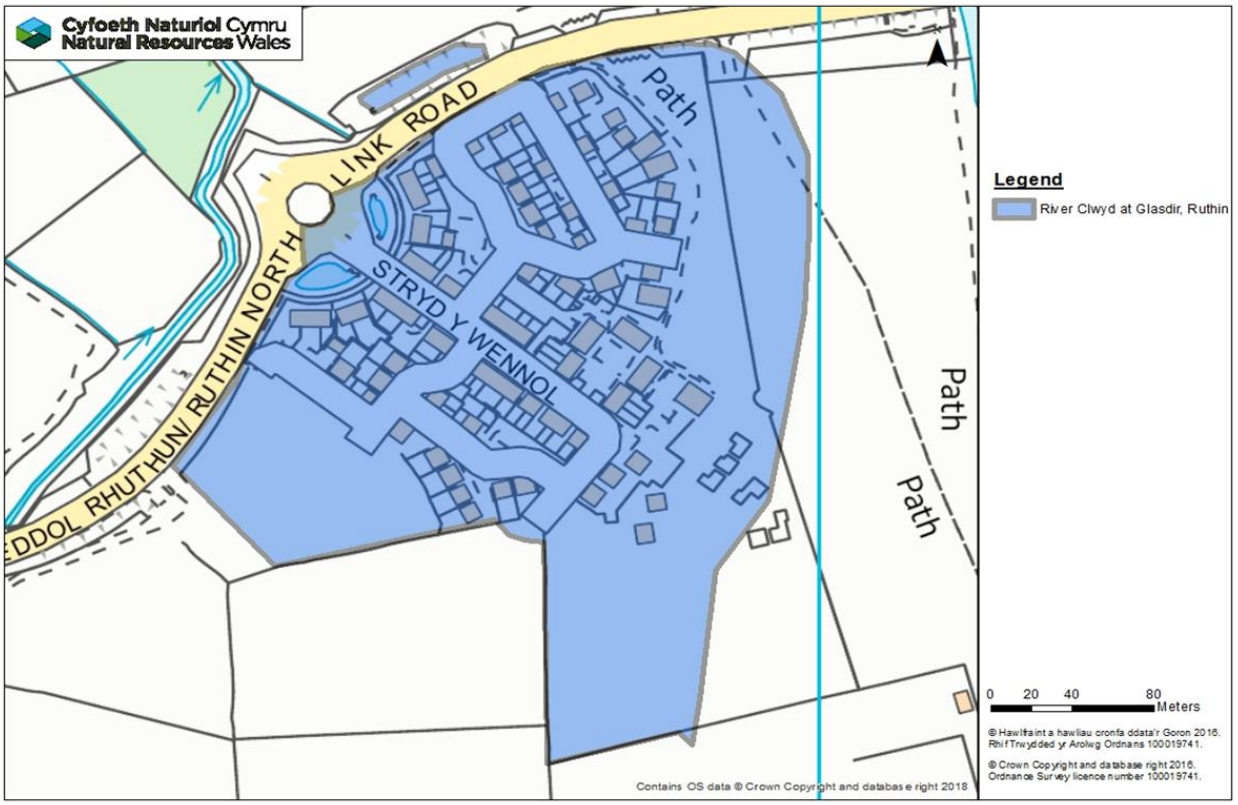

Figure 17: Map showing the River Clwyd at Glasdir, Ruthin Flood Warning Area

The three site-specific Flood Warning Areas comprise of Flood Alert, Flood Warning and Severe Flood Warning messages.

A Flood Alert means that flooding of land and roads is possible, and defences are expected to be impounded but not overtop. Flooding of property is not expected at this level of warning.

A Flood Warning means that flooding of property is expected and for people to take action to protect themselves and their property.

These Flood Alert and Flood Warning messages are issued based on pre-determined levels at Pont Howkin river level station, located at SJ1207258143.

The River Clwyd at Glasdir, Ruthin Flood Alert and Flood Warning messages can also be issued based on pre-determined levels at Lon Goch river level station, located at SJ1136258553.

Severe Flood Warnings are issued based on onsite conditions and observations and involve duty officers agreeing whether the criteria of significant risk to life and/or significant disruption to communities has been met.

The following table outlines the flood warning messages that were issued and removed for the River Clwyd during Storm Christoph;

Date	Time	Flood Alert/Warning Area	Message Issued
20/01/2021	03:38:00	Clwyd catchment	Flood Alert Issued
20/01/2021	13:04:16	River Clwyd at Glasdir Ruthin	Flood Alert Issued
20/01/2021	13:31:12	River Clwyd at Glasdir Ruthin	Flood Warning Issued
20/01/2021	15:24:57	River Clwyd at Lon Fawr, Ruthin	Flood Alert Issued
20/01/2021	15:50:16	River Clwyd at Ruthin Town	Flood Alert Issued
20/01/2021	18:40:14	River Clwyd at Lon Fawr, Ruthin	Flood Warning Issued
20/01/2021	19:17:15	River Clwyd at Ruthin Town	Flood Warning Issued
21/01/2021	06:38:51	River Clwyd at Glasdir Ruthin	Flood Warning Removed
21/01/2021	06:54:42	River Clwyd at Ruthin Town	Flood Warning Removed
21/01/2021	07:01:03	River Clwyd at Lon Fawr, Ruthin	Flood Warning Removed
22/01/2021	11:52:51	Clwyd catchment	Flood Alert Removed

7 Response

The immediate response to the event was from North Wales Fire and Rescue Service together with the North Wales Police. The fire service evacuated at least two residents from their homes via an inflatable boat and were pumping water from the Mill and Clwyd streets back into the Clwyd downstream of Pont Howkin.

Due to the significant nature of flooding across North East Wales, limited availability of resources (already deployed elsewhere) and the speed of the event NRW did not have any resource available to attend.

Residents in Mill and Clwyd streets and along Park Road used sandbags to protect their properties, with sand provided by a local building supplier.

NRW received two calls (at 6:42 pm and 7:34 pm) from residents in Ruthin reporting that the Afon Clwyd has burst its banks in Ruthin and that floodwater was close to entering their properties.

It was reported by residents in Mill and Clwyd streets that the notification they received from NRW regarding the issuing of a flood warning for Clwyd at Lon Fawr was after initial internal flooding had occurred or did not provide enough notice before flooding occurred.

8 Conclusion

On the 20 January 2021, after heavy rainfall fell on an already saturated Clwyd catchment, the Afon Clwyd overtopped the Cae Ddol flood defence in Ruthin. This floodwater that overtopped the defence, was unable to drain back into the Clwyd and as a result, 22 properties were flooded internally along Mill and Clwyd Street. There is evidence that other lengths of the defence scheme through Ruthin were close to overtopping aswell, impacting on the design freeboard, which demonstrates the flood event experienced was significant.

The significant nature of the event and the extent of defences overtopped indicates that the flooding was caused by an exceedance event, in that the flood event was bigger than the defences were designed to protect against.

One property was also flooded on the Maes Ffynnon estate due to water surcharging up through the ground due to the elevated river levels adjacent to it.

Had the flood defences not been in place potentially around 200 properties could have been affected by flooding.

9 Next Steps

In the short term NRW have completed the following:

1. Temporarily raised the Cae Ddol embankment through the use of sandbags to increase the standard of protection for the properties on Mill and Clwyd streets.

2. Undertaken a full topographic survey of the Ruthin flood alleviation scheme.

3. Undertaken an asset condition walk through to check on any post flood defects.

In the longer term:

4. Review performance of the Ruthin flood alleviation scheme using the new survey data to update the existing flood hydrological model for Ruthin. This will also allow a look at the impacts of climate change.

5. Use the new survey information of defence crest levels to check current flood warning thresholds / trigger levels.

6. If required, following the modelling, NRW should undertake an initial assessment to identify ways to further reduce the risk of flooding through Ruthin and/or improve the standard of protection of flooding from the Clwyd.

7. NRW and DCC to work together to improve community engagement to include things like Community Flood Plan, Flood Partnership etc.

8. NRW to investigate the possibility of producing a Flood Forecasting model which would allow a greater lead time for predicting flooding.

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Appendix A Hydrological Post Event Analysis

Post flood event analysis
Ruthin
January 2021

Version History

Document Version	Date Published	Summary of Changes
1	10/02/2021	First draft
2	23/02/2021	Correction to Section 2, Ruthin Weir reached its second highest level. Addition of Table 2 and comments added to Table 1

1. Background

This report provides a summary of peak river levels, flows and rainfall experienced in the Clwyd catchment at Ruthin during Storm Christoph (18 to 21 January 2021). Three flood warnings were issued for the Ruthin area in response to the rising river levels and parts of the town experienced flooding, the reasons for which are currently being investigated.

Natural Resources Wales monitor rainfall and river levels at several locations in the Ruthin area. The locations of the raingauges and river gauging stations used in this analysis are shown in *Figure 1*.

Datasets have not yet been quality assured and may be subject to change. Care should be taken when comparing recent peak river levels with historic data. For example, the refurbishment of Ruthin Weir gauging station in 2009 means river levels before and after this date may not be comparable.

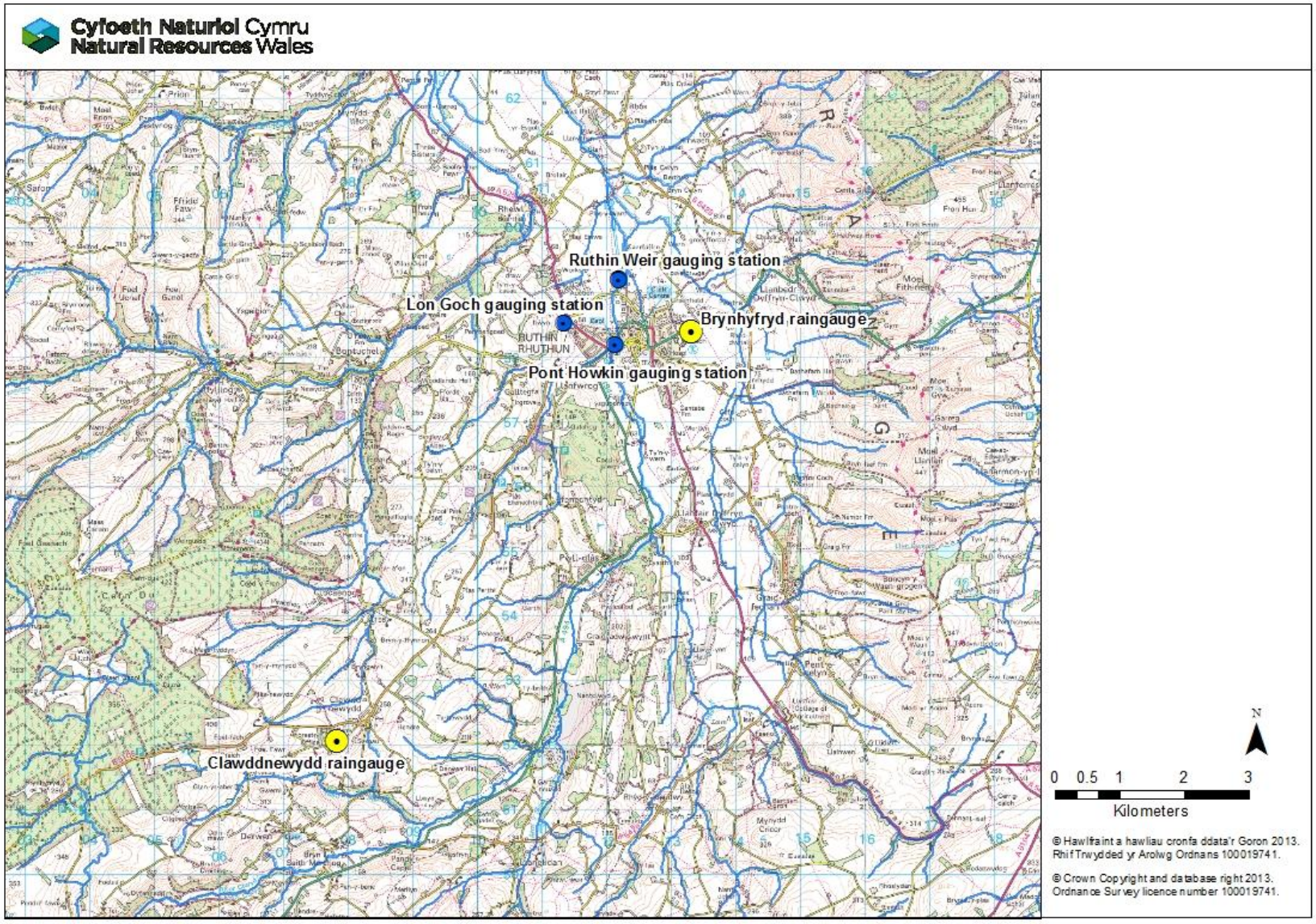

Figure 1. *Location of raingauges and river gauging stations used to inform this report.*

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2. River level & flow data

The peak river levels and flows experienced on the 20 and 21 January 2021 are summarised in *Table 1 and 2* (below), along with their rankings against the long-term historic record.

On the Afon Clwyd, Ruthin Weir gauging station reached its second highest level since the start of the record in 1971. However, a station rebuild in 2009 means stage data isn't comparable before and after. The flow recorded was the 4th highest on record but there is considerable variability in extrapolation of historic high flow ratings and so accuracy of peak flow data comes with some uncertainty. The variability in the historic high flow ratings and the station rebuild in 2009 accounts for the mis-match between the stage and flow rankings. At Ruthin Weir there is also an upstream access bridge which is known to restrict flood flows due to its low soffit. Hydrometric data recorded at Ruthin Weir has not been formally quality assured by the Wales H&T team since March 2020 leading to further uncertainty in its quality over the past year.

Pont Howkin gauging station is a level only site which was installed following the significant flood event in the area in 2012. The level reached at Pont Howkin during Storm Christoph is the highest reached since installation although this is a relatively short record.

Lon Goch gauging station is located on a flood alleviation channel. There is flow data available at this site although due to concerns about gravel build up only level data is presented in the table below and should be used with caution. Hydrometric data recorded at Lon Goch has not been formally quality assured since February 2020 leading to further uncertainty in its quality over the past year. The level reached at Lon Goch during Storm Christoph was the highest since installation in 2003.

Gauging Station	River	Date/Time of peak	Peak stage (m)	Rank	Record Start	Comments
Ruthin Weir	Clwyd	20/01/2021 18:30	1.154	2	1971	Highest recorded peak 1.167m on 27/11/2012
Pont Howkin	Clwyd	20/01/2021 19:30	2.519	1	2014	Second highest peak 2.180m on 16/02/2020
Lon Goch	Clwyd bypass channel	20/01/2021 15:00	1.123	1	2003	Second highest peak 0.949m on 09/02/2020

Table 1. *River levels and flows recorded over 20th and 21th January 2021 and their rankings in the long-term record*

Gauging Station	River	Date/Time of peak	Peak Flow (m^3/s)	Rank	Record Start	Comments
Ruthin Weir	Clwyd	20/01/2021 18:30	23.84	4	1971	Highest recorded peak 26.03m^3/s on 25/06/2007

Table 2. *Peak river flow recorded during 20th and 21st January 2021 and their rankings in the long-term record. No flow data available for Pont Howkin and significant uncertainty in the flow data from Lon Goch so both sites are excluded from this table.*

Note there is uncertainty in accuracy of peak flows for extreme events given uncertainty in rating accuracy at high flows and/or extent of bypassing of the gauges.

3. Rainfall data

Rainfall data from two raingauges have been used in this analysis. Clawddnewydd raingauge is located upstream of Ruthin in the Clwyd catchment. Brynhyfryd raingauge is in Ruthin. Rainfall data has not yet been formally quality assured by the Wales Hydrometry and Telemetry team but an initial check shows that the two raingauges used were in broad agreement with their adjacent check gauges.

Table 3 below shows the daily totals recorded at both gauges compared to the 81-10 long term average (LTA). All daily totals are water day i.e the total for the 18 January is from 09:00 on 18 January until 09:00 on 19 January. The table shows that Brynhyfryd raingauge located in Ruthin recorded more rainfall in the four days from 18 to 21 January than its average rainfall throughout the whole of January.

Raingauge	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			
Brynhyfryd	10.8	22.6	38.2	4.8	76.4	75.09	101%
Clawddnewydd	12.6	26.0	25.6	9.4	73.6	114.03	65%

Table 3*. Rainfall summary rainfall totals during Storm Christoph.*

Rainfall return periods were calculated for a range of durations using the Flood Estimation Handbook (FEH) Depth Duration Frequency tool on the FEH Webservice. The maximum return period recorded at each gauge is shown in *Table 4* below.

It should be noted that rainfall return periods often don't reflect the scale of flooding that has occurred. Pre-cursor conditions such as soil saturation, starting river level and floodplain inundation play a big part in determining how rivers respond to rainfall. These factors are not specifically accounted for in rainfall return period analysis. Furthermore, the raingauge network is only able to provide data where raingauges are situated and isn't necessarily representative of catchment rainfall.

Raingauge	Critical Rainfall (mm)	Duration (hours)	Start date and time of critical rainfall	Return Period (years)
Brynhyfryd	76.4	66	18/01/2021 18:30	10
Clawddnewydd	73.2	66	18/01/2021 20:15	5

***Table 4**. Ruthin area summary rainfall totals over a range of durations during Storm Christoph*

The maximum return period recorded at Brynhyfryd raingauge was 1 in 10 years over a duration of 66 hours between 18:30 on 18 January until 12:30 on 21 January. Figure 2 below shows the rainfall recorded every 15 minutes at Brynhydfyd raingauge compared to the flow measured at Ruthin Weir Gauging station. The peak at Ruthin Weir can be seen at 18:30 on 20/01/2021. Rainfall return periods for shorter durations were less significant. At Brynhyfryd all rainfall with a duration below 24 hours had a return period less than 1 in 5 years.

At Clawddnewydd raingauge the highest return period of 1 in 5 years was also for the 66 hour duration. All other durations had a return period of less than 1 in 5 years.

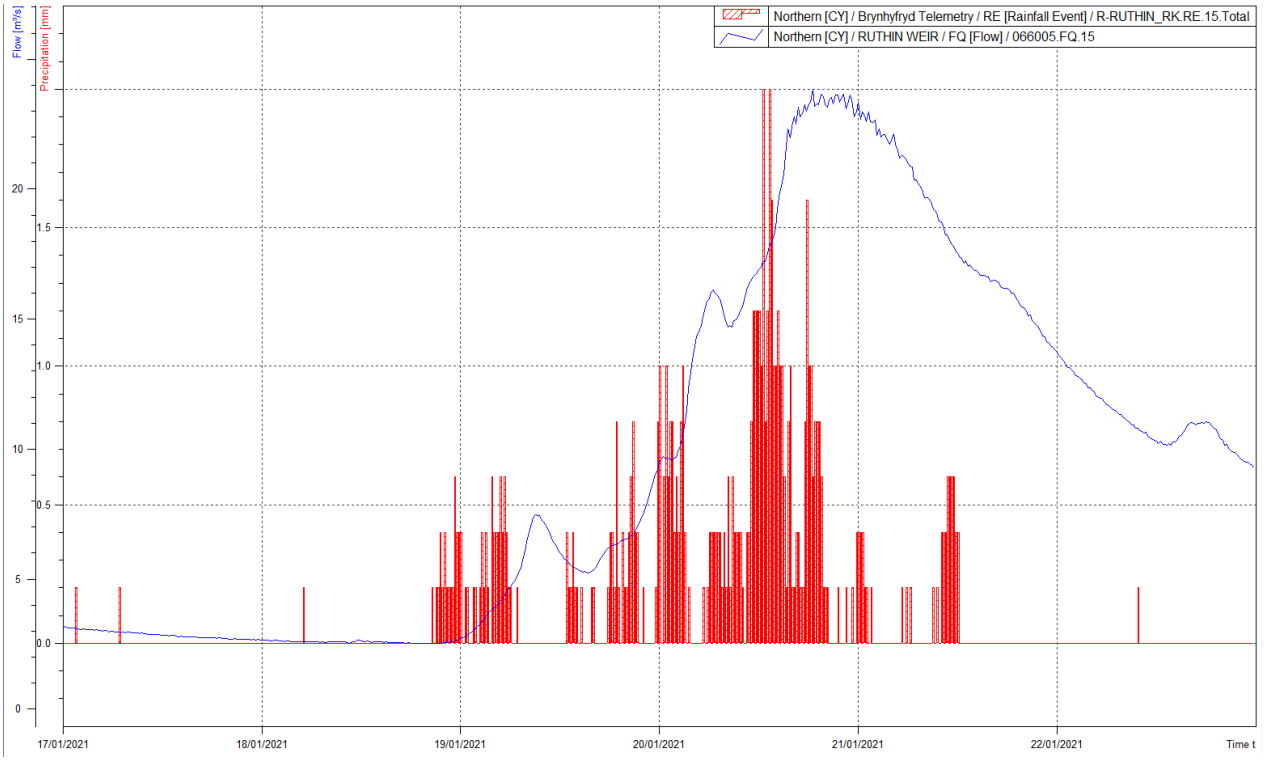

Figure 2. *Hydrograph showing rainfall at Brynhyfryd raingauge compared to flow at Ruthin Weir gauging station during Storm Christoph.*

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Appendix B Waterco event summary report

Ruthin Flood Event 20th January 2021

Following reports of heavy rainfall and overtopping of the River Clwyd flood defence embankments at Cae Ddol, Waterco carried out a walkover of the Ruthin area to understand the impact Storm Cristoph on the town.

The following flood event summary presents the casual factors and impacts of Storm Cristoph, based on observations noted during the event.

Shaun Wasik and Chris Lewis walked various known 'hotspots' in the town between 19:15 and 22:00 on 20/01/21.

The map below references each site attended, with site photos appended to the summary note.

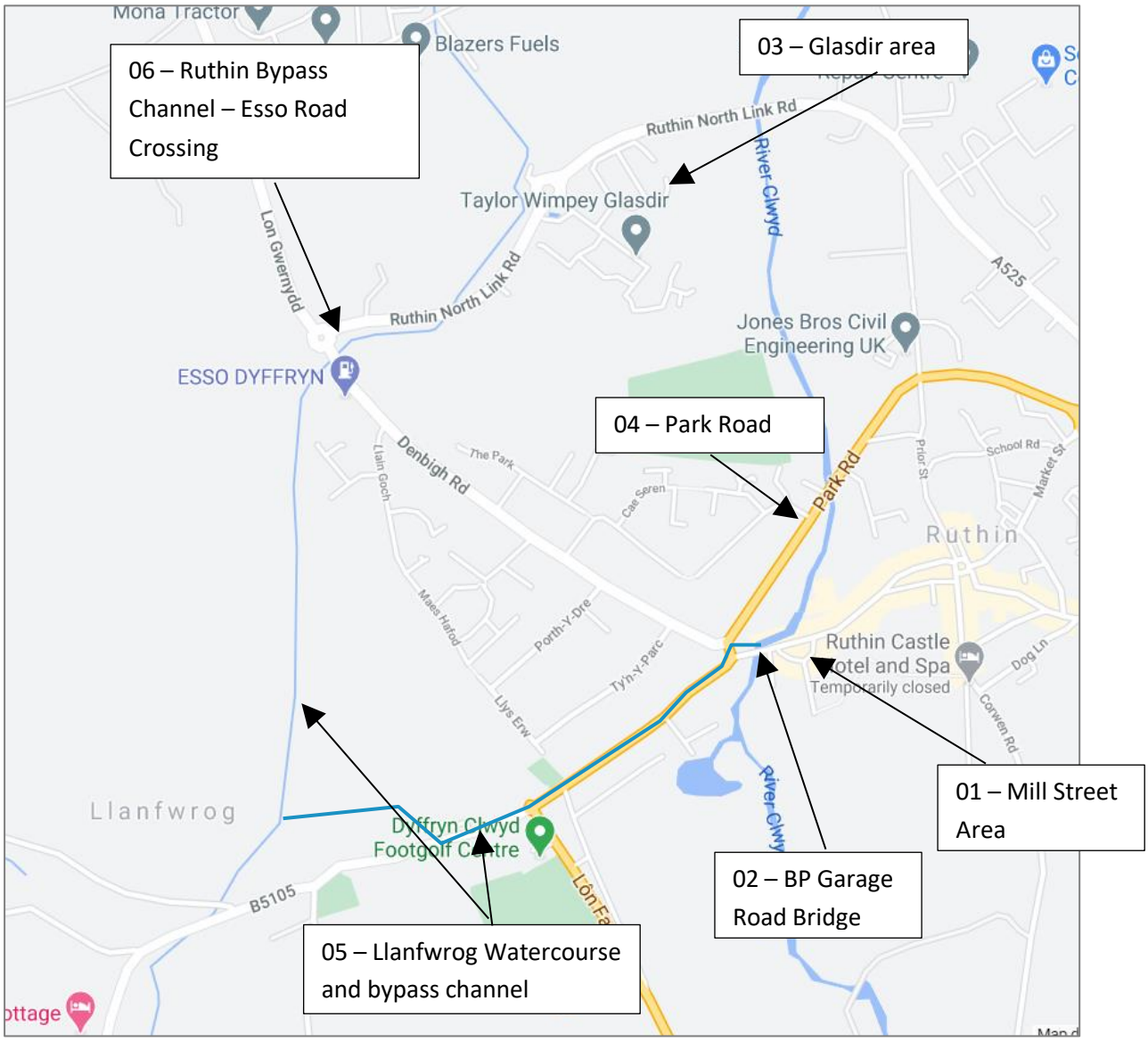


Figure 1 - Map of Ruthin taken from Google Maps

01 – Mill Street Area

Approximately 12 houses and 3no. businesses are reported to have flooded internally. It is reported that the River Clwyd overtopped the local flood defences in Cae Ddol park, upstream of the BP Garage road bridge. Flood water is reported to have flowed around the back of the Mill Street area, reaching a maximum depth of 400mm.

During the site visit, we observed the flood water extent to be from approximately 10m short of the local chip shop, Finns, to the eastern side of the BP Garage road bridge. Due to the depth of the flood water, we were unable to inspect further than the extent of the flood extent.

The water level was observed to have dropped by approximately 100mm between 20:00 and 21:15.

First responders were observed to be attempting to reach stranded residents via an inflatable boat. First responders were also observed to be pumping water from the Park Road area, into the watercourse downstream of the BP Garage road bridge. This raised concerns as there appears to be a low spot in the Park Road defences (see 04 – Park Road for further details). We did not observe anyone inspecting the downstream impacts of pumping the flood water away from the Mill Street area.

02 – BP Garage Road Bridge

The road bridge allows the River Clwyd to pass under the road (Clwyd Street), with the Llanfwrog watercourse discharging into the River Clwyd immediately downstream of the bridge. The road bridge appeared to be at full capacity with water up to the soffit. To the east and west of the road bridge demountable stop logs (wood) were deployed. Water was observed to be flowing/seeping slowly between each stop log. The result to the western demountable was that water was slowly flowing towards a shop and at least one property, with a low door threshold. The owners were attempting to block the water at their doors, but it was unclear if internal flooding had occurred.

We were unable to inspect the eastern demountable but it can be assumed that the impact was much the same.

The BP Garage appeared unaffected during our visit and remained open for business.

03 – Glasdir Area

The Clwyd had breached its banks adjacent to the Glasdir estate and the surround fields (existing floodplain) were holding flood water. The flood defences (namely the highway culverts and housing estate flood wall) were operating as intended. The water level at the culverts appeared to be approximately 100mm below the top of soffit and the water level appeared to be some 1m below the Glasdir flood defence wall top.

The surface water storage areas associated with Glasdir appeared to have capacity to hold approximately 50% additional flood water.

Glasdir appeared to be at no risk of flooding.

04 – Park Road

The residents along Park Road appeared extremely concerned about imminent flooding. Anecdotal reports suggest they were provided with free sandbags from a local contractor. We did not observe any property level protection (PLP), and the homeowners appeared to assume that sandbags would be sufficient.

We attended the area twice and no flooding was observed. Flood water stayed within the former Gaol bunded area.

A potential low spot in the flood defences was observed at the fire station road crossing. The parapet threshold appears to be some 300mm lower than the top of the earth bunds. The water level in the bunded area was approximately 500mm lower than the top of the bunds.

The road crossing at the fire station appeared to be at full capacity, with an imminent risk of overtopping. This could have caused flooding to the fire station and the properties along Park Road and into Parc-y-Dre and Cae Seren.

05 – Llanfwrog Watercourse

We walked the watercourse from the outfall at BP Garage (location 02) upstream to the Flood alleviation scheme at Llanfwrog Church.

The outfall at the BP Garage appeared to be discharging at full bore. The first upstream manhole in the highway (next to the Park Place public house) had be fenced off by residents. It was assumed that this action had been taken in advance of the manhole cover potentially blowing. We visited the manhole twice and observed minimal surcharging onto the road.

Approximately 200m upstream of the outfall, highway gullies were observed to be surcharging and flooding towards Maes Ffynnon. It is assumed that the gullies discharge into the culvert. The cul-de-sac appeared flooded, but no properties appeared to be affected internally.

Further upstream between Llanfwrog Church and the Community Centre, there is an open section of watercourse approximately 500m long. The water level at this point appeared to approximately 300mm, with plenty of capacity for additional flows. Based on the downstream water level and the level at the open section of watercourse, it was assumed that a backwater affect from the River Clwyd was causing the manhole next to the Park Place pub to surcharge.

The watercourse is culverted upstream of the open channel section for approximately 100m. Upstream of this point the watercourse is an open channel through agricultural fields between Llanfwrog Church and Parc-y-Dre. We inspected this this section of watercourse. Although the water level was high, it remained in channel upstream to the flood alleviation bypass.

No overtopping was observed from either the bypass channel or Llanfwrog watercourse. No flood water was observed in the fields at the back of Parc-y-Dre.

06 – Ruthin Bypass Channel – Esso Road Crossing

No flooding was observed at this location. This was confirmed following discussions with residents.

Recommendations

1) Educate vulnerable communities about the pros and cons of sandbags and advise those who consider themselves at risk of flooding to consider PLP measures.

2) Review the threshold of the fire station road bridge along Park Road. It appears to be a low spot in the flood defences.

3) Assess the risk associated with pumping floodwater away from the Mill Street Area. The process may be passing the risk downstream to Park Road.

4) Consider more impermeable demountables at the BP Garage Road Bridge.

Appendix A Photographs

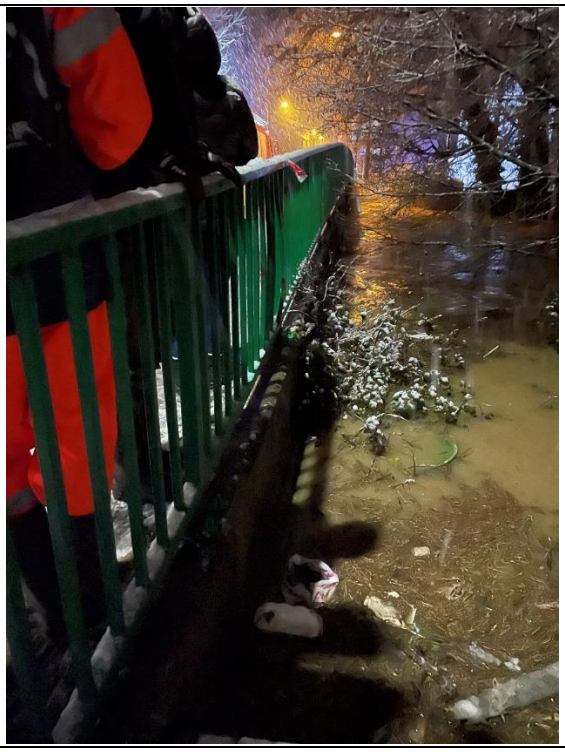
01 – Mill Street Area

View from the chip shop towards Mill Lane

View from opposite the chip shop towards Mill Lane

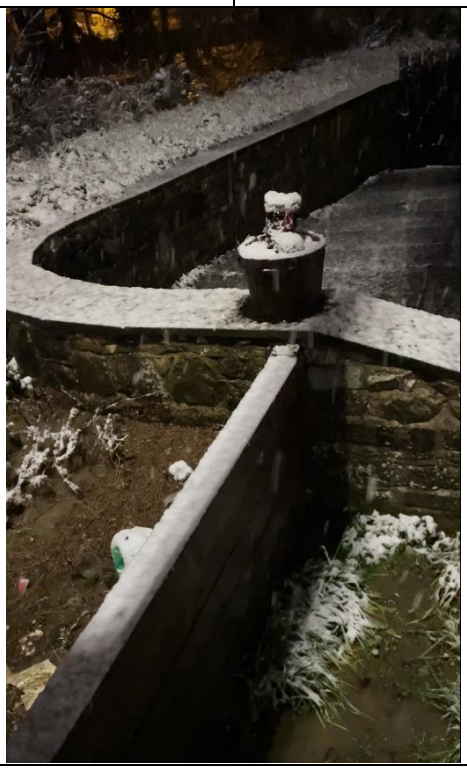
View towards Gaol

02 – BP Garage Road Bridge



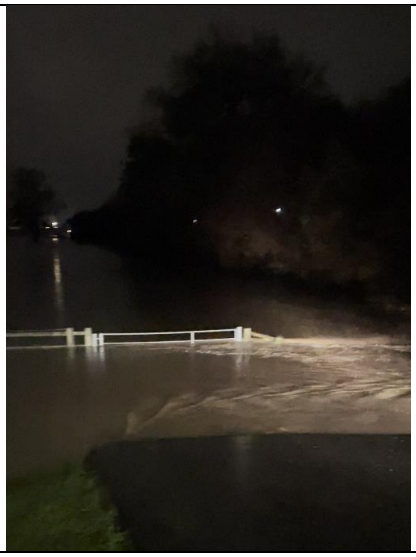
Upstream view across road bridge from western demountable

View from western demountable towards affected property and shop



View of western demountable defence

03 – Glasdir Area



View south from highway culverts toward floodplain

View from highway towards Glasdir

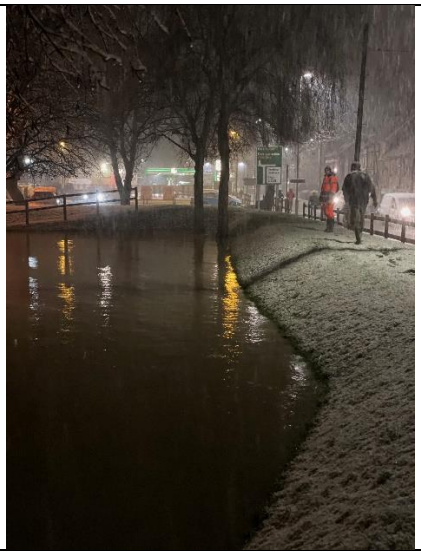
View from Glasdir towards highway culverts

View from Glasdir towards highway culverts

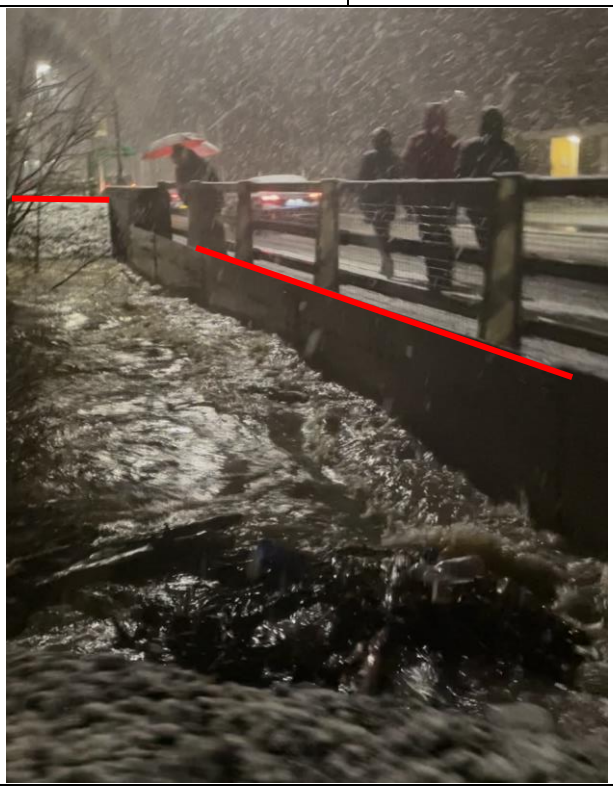
Glasdir surface water storage area

04 – Park Road

View upstream from fire station road crossing

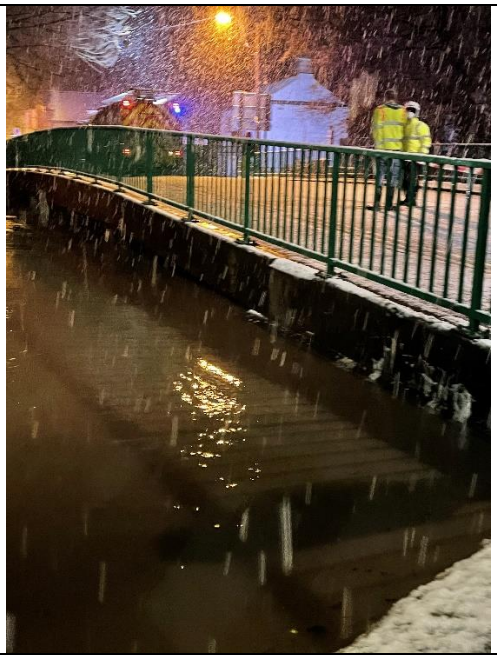


View showing available capacity within the bunded storage area



View of the fire station road crossing and bunded area.
Note the difference in level (shown in red) between the top of bund and bridge threshold

05 – Llanfwrog Watercourse



View above outfall towards road bridge

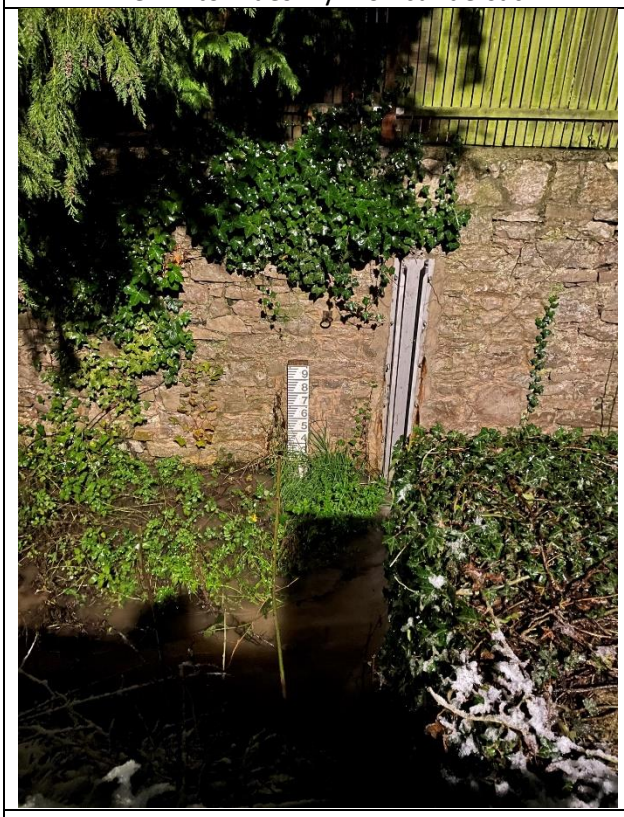
Outfall view – BT garage to left, road bridge to right

Surcharging manhole adjacent to Park Place pub

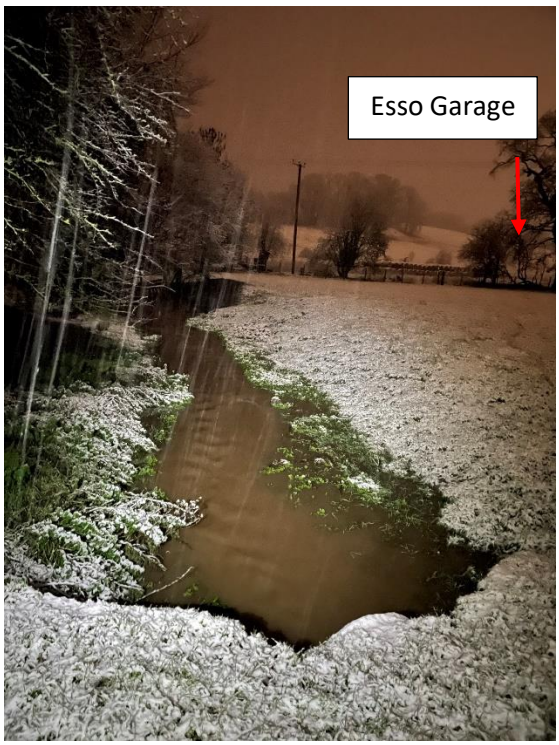
Entrance to Maes Ffynnon cul-de-sac

View into Maes Ffynnon cul-de-sac

Llanfwrog culvert inlet



Llanfwrog open channel water level



Open channel watercourse adjacent to Llanfwrog Church

View towards Glasdir from Llanfwrog Church

06 – Ruthin Bypass Channel – Esso Road Crossing

Due to low light, weather and access problems, we were unable to access take photographs of the Esso culvert inlet.