

Flood and Water Management Act 2010

Section 19 Flood Investigation Report

Storm Dennis – Flood Investigation Area RCT03 (Cwmbach)

April 2022

ANDREW STONE

Head of Flood Risk Management and Strategic Projects
Strategic Projects, Sardis House, Sardis Road, Pontypridd, CF37 1DU

ROGER WATERS

Director
Frontline Services, Sardis House, Sardis Road, Pontypridd, CF37 1DU



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Prepared by	Catrin Evans BSc (Hons)			
Checked by	Owen Griffiths MSc (Hons)			
Approved by	Andrew Stone BSc (Hons), IEng, MICS, Assoc, MCIWM, AaPS			

This report should be read in its entirety

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EXECUTIVE SUMMARY

This report has been produced through the duties placed upon Rhondda Cynon Taf County Borough Council under Section 19 of the Flood and Water Management Act 2010. The Act states, “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”.

This Section 19 investigation provides a factual report of the storm event that occurred on 15 and 16th of February 2020 within the Rhondda Cynon Taf County Borough Council area, focusing investigation on the flooding at Cwmbach in the Cynon valley (Flood Investigation Area RCT03, Figure 1).

This report was undertaken to identify the mechanism for flooding, establish which Risk Management Authorities have relevant flood risk management functions under the Flood and Water Management Act 2010 and ascertain if those Risk Management Authorities had undertaken or were planning to undertake actions related to those functions to manage the risk of flooding.

The flooding that affected RCT on 15 and 16th of February 2020, was a result of an extreme rainfall event, designated by the Met Office as ‘Storm Dennis’. The impact of the event at investigation area RCT03 resulted in internal flooding to a total of 34 properties, 18 of which were commercial properties. These impacts were identified through inspections made by RCT’s Flood Risk Management Team during the days following the storm event, as well as information collated by residents, RCT’s Public Health team, RCT’s Highway and Streetcare Depot, Natural Resources Wales and Dŵr Cymru Welsh Water.

It has been established from the evidence gathered within this report that the primary source of flooding at RCT03 on the 15 and 16th February 2020 was a result of significant overland runoff being generated from the steep hillsides above Cwmbach draining to lower ground via a series of ordinary watercourses, many of which became overwhelmed with water and debris and eventually overtopped, impacting several properties on its course of flow.

On review of the condition and hydraulic performance of the culverted infrastructure identified as sources of flooding to properties, the culverted infrastructure associated

to Cefnpennar Road culvert network was assessed as providing inadequate standards of protection in both free-flowing and blockage conditions. The remaining three culvert networks identified as sources of flooding were identified as having adequate standards of protection in free-flowing conditions. Despite the three culvert networks having sufficient capacity to manage the expected flows, the culverted infrastructure was observed to be in poor condition and its capacities significantly reduced due to blockages caused by mobilised debris from Cwmbach's upper catchment.

RCT as the Lead Local Flood Authority (LLFA) and Land Drainage Authority (LDA) has been determined as the relevant Risk Management Authority responsible for managing the ordinary watercourse and surface water flooding that occurred at RCT03 during Storm Dennis.

In response to the flooding at investigation area RCT03, the LLFA has undertaken 15 actions and have proposed to undertake a further 7. A summary of which include;

- Undertaken clearance works to the culvert inlet structures identified as sources of flooding following the storm event (assisted by the Highway Authority);
- Carried out survey, jetting and cleansing operations to an estimated 2413 metres of ordinary watercourse drainage network length within the investigation area;
- Led on the development of a central Control Room, to compliment the Council's Contact Centre and CCTV Centre, to provide a comprehensive and informed response to residents during storm events; and
- Initiated an interim Property Flood Resistance project offering expandable flood gates to properties deemed at high risk of ordinary watercourse and surface water flooding.

As the relevant Risk Management Authority for ordinary watercourse flooding, RCT as the LLFA will also look to better understand the catchment above investigation area RCT03 through the development of a Strategic Outline Business Case to provide recommendations for suitable management mechanisms to mitigate the wider risk of ordinary watercourse, surface water and groundwater flooding in the community.

NRW has been determined as the relevant Risk Management Authority responsible for managing the main river flooding that occurred during Storm Dennis. In response to the flooding at RCT03, NRW has;

- Commissioned a Cynon Flood Modelling Study, the outcomes of which will include an initial assessment of the viability of potential flood risk management options;

- Carried out a waterway clearance of the Cwmbach Ditch which was identified as a source of flooding to one residential property within RCT03 during Storm Dennis; and
- Developed a series of recommendations and a detailed action plan to address the areas of improvement for future storm events, including the performance of NRW's Flood Warning Service Review and incident management response.

The event that occurred on 15 and 16th February 2020 was extreme, and it is unlikely flooding from a similar event could be prevented entirely. It is concluded that Risk Management Authorities satisfactorily carried out their flood risk management functions in response to the flood event, however, further functions have been proposed by Risk Management Authorities to better address preparedness and response to future flood events.

ABBREVIATIONS

CaRR – Communities at Risk Register

DCWW – Welsh Water

FRMP – Flood Risk Management Plan

FWMA – Flood and Water Management Act 2010

LDA – Land Drainage Authority

LFRMS – Local Flood Risk Management Strategy

LLFA – Lead Local Flood Authority

NRW – Natural Resources Wales

Q – Return Period (1 in X chance of an event occurring in any given year)

RCT - Rhondda Cynon Taff CBC

RCT03 – Flood Investigation Area RCT 03

RMA – Risk Management Authority

SAB – Sustainable Drainage Approval Body

SFRA – Strategic Flood Risk Assessment

SOC – Strategic Outline Business Case

SuDs – Sustainable Drainage Systems

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1 INTRODUCTION

1.1. PURPOSE OF INVESTIGATION

On the 15 and 16th February 2020, RCT was impacted by an extreme weather event which was designated by the Met Office as ‘Storm Dennis’. Due to the extent and impact of the event, the LLFA opted to undertake a formal investigation.

The storm resulted in widespread residential and commercial flooding within the Rhondda Cynon Taf County Borough Council area. This report will focus on Flood Investigation Area RCT 03 which covers the village of Cwmbach in the Cynon valley.

The reason behind RCT’s investigation is in response to the duties of the local authority in regards to Section 19; of the Flood and Water Management Act 2010, which 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 the response to the flood.”
2. “When 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 authority”¹

The purpose of the investigation is to determine which RMAs have relevant flood risk management functions and which functions have been exercised in response to a flood.

Specific details of Storm Dennis, such as rainfall analysis are covered within a separate overview report that covers the wider RCT area. The report is titled ‘Storm Dennis February 2020 – Overview Report’ and will be referred to as ‘FRM – Storm Dennis – Overview Report’².

¹ Flood and Water Management Act 2010 – Section 19 - <https://www.legislation.gov.uk/ukpga/2010/29/section/19>

² [Flood Investigation Reports | Rhondda Cynon Taf County Borough Council \(rctcbc.gov.uk\)](https://www.rctcbc.gov.uk/flood-investigation-reports)

1.2. SITE LOCATION

The area investigated within this report falls within the electoral ward and community area of Cwmbach which is located in the east of Rhondda Cynon Taf CBC, to the north of Mountain Ash, in the River Cynon catchment (Figure 1).

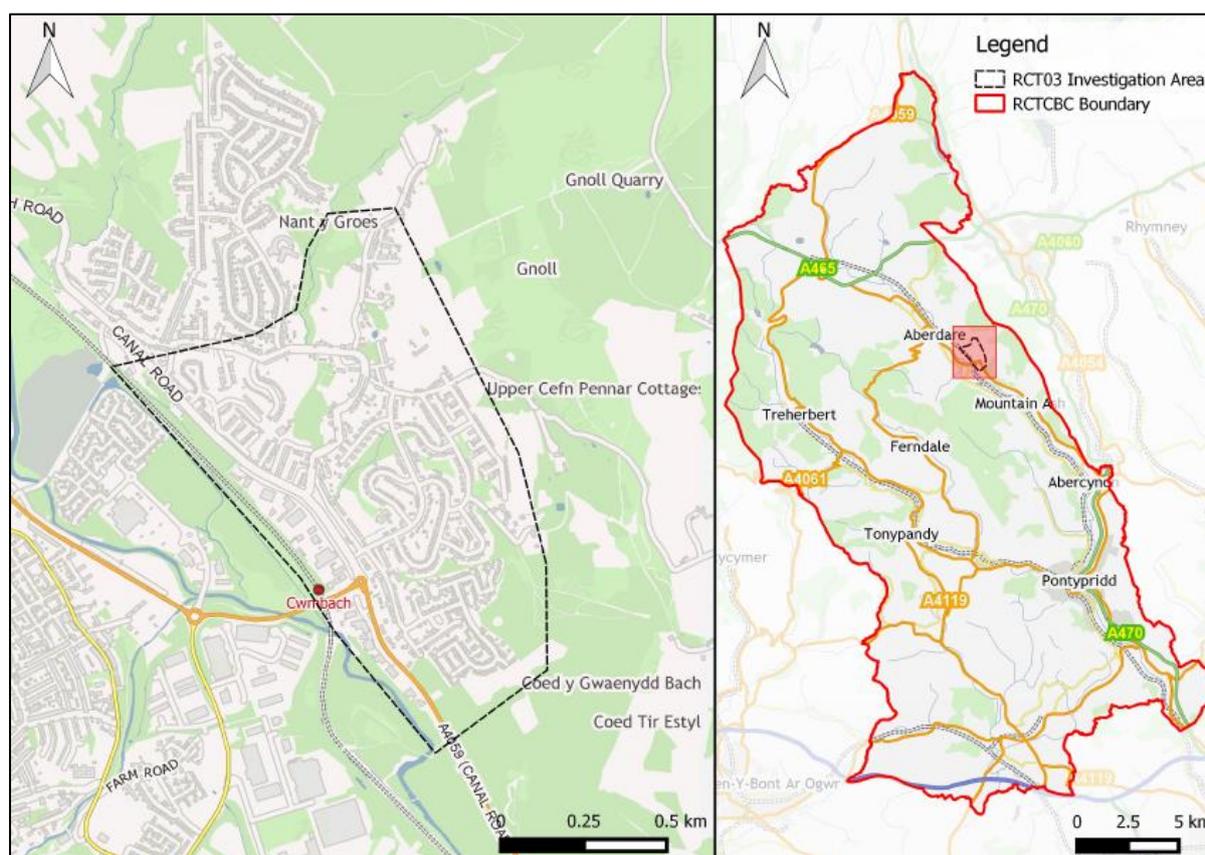


Figure 1: Flood Investigation Area RCT03 Location Plan

Cwmbach is predominantly a rural environment, owing to the steep topography and the higher elevations in the east. Residential dwellings are confined within the valley of the River Cynon which flows northwest to southeast adjacent to the investigation area. A small industrial estate is located adjacent to Aberdare Canal which flows parallel to the River Cynon, in the west of RCT03.

The highlands in the east are drained by several ordinary watercourses that drain into the Aberdare Canal, notably the Nant y Groes, which are culverted through residential development. The watercourses are small, with very steep slopes varying approximately 400mAOD (Above Ordnance Datum) on the east to 112mAOD on the west which equates to a drop of 299m over 2km.

Flood risk is generally associated with ordinary watercourses within Cwmbach, notably from culvert inlets and bank breaches. A high flood risk is presented in Figure 2 associated with the Nant y Groes watercourse, particularly from the culvert inlet adjacent to Cwmbach Road and downstream at Canal Road.

NRW's Flood Risk Assessment Wales (FRAW) maps also note a low risk of main river flooding along the eastern floodplains of the River Cynon and Aberdare Canal. This area lies to the south of RCT03 within the Cwmbach Industrial Estate. A high to medium risk of main river flooding is noted along the western floodplains however this area falls outside of the investigation area (Figure 2).

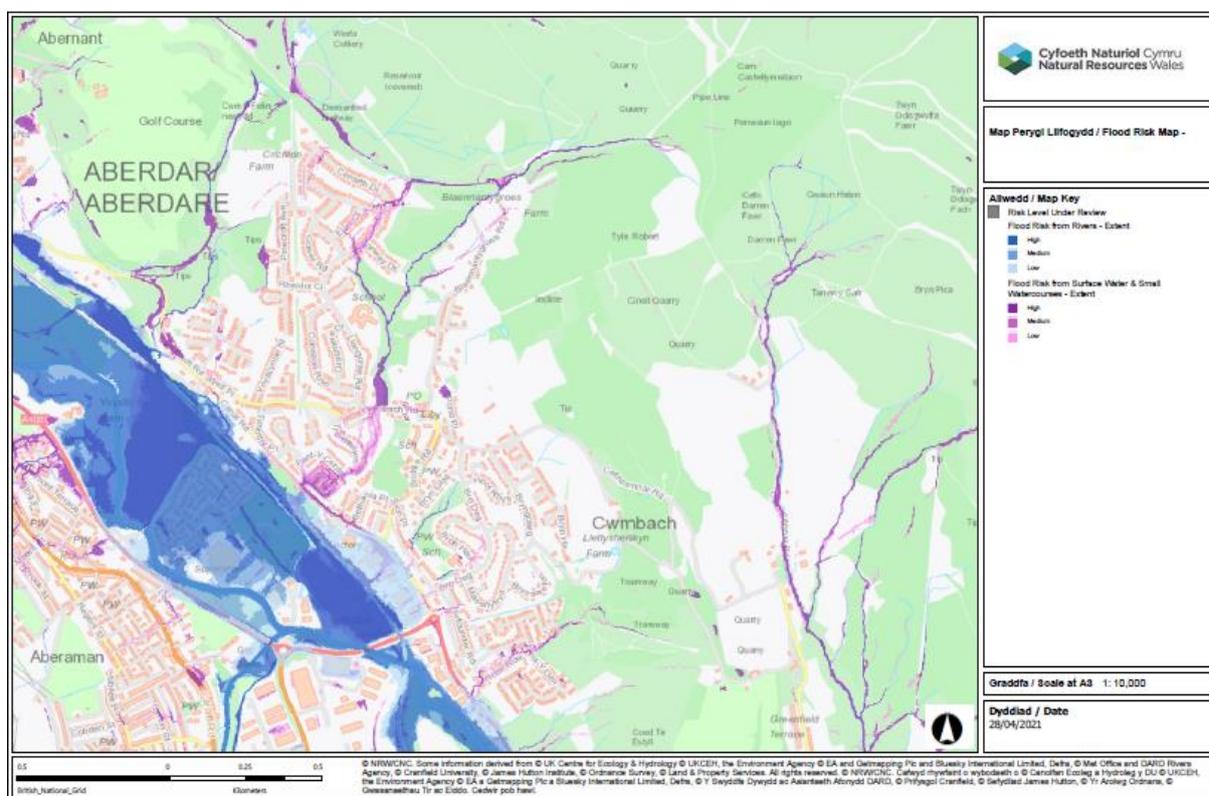


Figure 2: Natural Resources Wales' Flood Risk Assessment Wales (FRAW) map for rivers and ordinary watercourse and surface water flood risk at investigation area RCT03. Contains Natural Resources Wales information © Natural Resources Wales and database right. All rights reserved.

1.3. DRAINAGE SYSTEM

The surface water drainage system that serves RCT03 is that of the highway drainage network designed to manage the surface water within the highway and public surface water sewer and combined sewer networks operated by Dŵr Cymru Welsh Water.

1.4. INVESTIGATION EVIDENCE

To support the investigation, a range of qualitative and quantitative evidence has been gathered from numerous sources, the summary of which is listed in Table 1.

Table 1: Investigative evidence gathered in preparation of the Storm Dennis Section 19 report

Source	Data
Residents	Photos, videos, statements, email correspondence, public engagement survey responses
Responders' statements	Local responders' statements
CCTV Surveys	Internal surveys of the local drainage networks
Met Office Data	Weather Warning information (see FRM – Storm Dennis – Overview Report)
Rain Gauges	RCT and NRW operated gauge information (see FRM – Storm Dennis – Overview Report)
Natural Resources Wales	River Level and Flood Warning data
RCT Flood Risk Management Plan	Site specific information and data for each electoral ward in RCT
Communities at Risk Register	Flood risk ranking and scores for all flood types based on community data in Wales
Flood Investigation Report (Redstart's FIR)	A summary of the source-pathway-receptors, culvert capacity assessment and hydraulic modelling work undertaken by Redstart. The Flood Investigation Report was commissioned by RCT prior to writing the Section 19 report.

Evidence sourced from the 'Flood Investigation Report', commissioned by RCT, will be further referred to as 'Redstart's FIR' throughout this report.

1.5. PUBLIC ENGAGEMENT

Following the initial flooding event that occurred on the 15 and 16th February during Storm Dennis, flood risk officers from the RCT Flood Risk Management department were deployed to areas across the borough to investigate reports of internal flooding by residents. Residents were engaged with by the Flood Risk Management team to determine the initial impacts caused by the flooding event and to investigate the potential source(s) and pathway(s) of flood water during the event. Due to the volume

of calls received by RCT's Out of Hour department, visits were prioritised to those areas experiencing significant internal flooding to residential properties.

To support the flood investigations, a public engagement exercise was undertaken between 4th and 25th January 2021 by Redstart on behalf of RCT. The aim of this was to engage with the local residents who were affected by the flood event to capture details on how they were impacted, the source and movement of flood water within the area, how receptors were impacted as well as drawing on local knowledge to query how local conditions could have exacerbated the event. This data is useful to help the LLFA better understand and validate our assessment of the flood event to support the investigation under Section 19 of the FWMA.

2. FLOODING HISTORY

2.1. PREVIOUS FLOOD INCIDENTS

Previous incidences of flooding to properties within the wider investigation area have occurred over the past twenty years, often in relation to the network of ordinary watercourses and culverted infrastructure which convey a substantial volume of water through the village of Cwmbach. Despite this, no storm event has resulted in flooding so extreme as the flooding that occurred during Storm Dennis.

Information relating to historical flood incidences prior to Storm Dennis is limited however, in recent years the frequency and impact of property flooding has increased with the most notable flood events being Storm Bronagh on 20-21st September 2018 and Storm Callum on 12-13th October 2018.

According to RCT's Flood Risk Management team, surface water flooding along Canal Road and Cwmbach Industrial Estate has been observed to occur during extreme storm events. During Storm Bronagh and Callum in 2018, severe flooding to the Cwmbach Industrial Estate occurred. This is because the industrial estate is located at the lowest point of Cwmbach, meaning all overland runoff is conveyed towards Canal Road, impacting several commercial properties in this area.

2.2. FLOOD INCIDENT

The flooding that occurred on the 15th and 16th February 2020 was a result of an extreme rainfall event, designated by the Met Office as ‘Storm Dennis’, which affected the majority of RCT and caused widespread flooding to communities.

Specific details of Storm Dennis, such as rainfall and river level analysis are covered within a separate overview report that covers the wider RCT area, referenced ‘FRM – Storm Dennis – Overview Report²’.

The post event inspections undertaken on the days following the storm event by RCT’s Flood Risk Management Team and RCT’s Public Health, Protection and Community team identified 16 residential properties and 18 commercial properties as internally flooded.

A summary of the source(s) and pathway(s) of flooding within investigation area RCT03 during Storm Dennis have been outlined in the Table 2 and further described throughout this section. For the purpose of this investigation, the flood incident at investigation area RCT03 will be described in three parts: the incident at ‘Eastern Cwmbach’ sub-catchment, ‘Central Cwmbach’ sub-catchment and the incident at ‘Western Cwmbach’ sub-catchment. The sub-catchment areas are illustrated below Table 2, within Figure 3.

Table 2: Summary of the source(s), pathway(s) and receptor(s) affected during Storm Dennis within investigation area RCT03

Source	Pathway	Receptor
Eastern Cwmbach Sub-Catchment		
Collapsed culvert network within the rear garden of a property at Maeshyfyd	Water discharged from the collapsed culvert and flowed towards the rear of properties at Bro Deg which are situated immediately downstream of the collapse. Overland flow continued its pathway downstream along Bro Deg towards the lower reaches of Cwmbach and pooled at Canal Road.	Water entered the rear of several properties at Bro Deg and caused internal flooding to three residential properties. Surface water flows also contributed to the flooding of 17 commercial properties at Canal Road.
Surcharged manhole at Bryngolwg	Surcharging flows from the manhole caused surface water to flow down	Contributed to the internal flooding of 4

	Maeshyfyd and onwards to impact the rear of Tirfounder Road before reaching the lower reaches of Cwmbach and pooling across Canal Road.	residential properties at Maeshyfyd, Tirfounder Road and the flooding of several commercial units at Canal Road.
A culvert inlet located to the rear of Tirfounder Road surcharged during the storm event.	Exceedance flows from the surcharged inlet flowed south towards the junction to Canal Road and flowed west and east along Canal Road.	Contributed to the internal flooding of 17 commercial properties along the A4059 Canal Road and Cwmbach Industrial Estate.
An ordinary watercourse manhole at Canal Road surcharged during the storm event.	Surcharging flows from the ordinary watercourse manhole flowed west and east along Canal Road.	Contributed to the internal flooding of 17 commercial properties along the A4059 Canal Road and Cwmbach Industrial Estate.
Intense rainfall running off the hillsides to the east of Cwmbach draining to lower ground along the steep streets within the sub-catchment.	<p>Routing of runoff from the eastern hillsides towards the rear of Brynhir, Bryngolwg, Glas-y-Gors, Llys-y-Coed and Heol-y-Deri.</p> <p>Surface water runoff from the eastern hillsides above Cwmbach was channelled via the highway network (Brynawelon, Bryngolwg, Maeshyfyd) towards the lower reaches of Cwmbach and pooling on Canal Road.</p>	<p>Internal flooding to one residential property at Llys-y-Coed which sits below steep hillside.</p> <p>Overland flows conveying via the highway network also contributed to the internal flooding of 3 residential properties at Maeshyfyd, 1 residential property at Tirfounder Road, 1 residential property at Canal Road and several commercial units along Canal Road.</p>
The River Cynon overtopped its banks to the rear of commercial properties at Canal Road.	Properties to the south of the roundabout along the A4059 (Canal Street) were impacted by main river flooding from the rear.	Internal flooding to at least 4 commercial properties to the south of the roundabout at Canal Street.

	DCWW identified surcharging manholes in the vicinity which were discharging from the outfall of a nearby combined sewer outflow due to becoming overwhelmed during the event.	Flooding also impacted the railway track at this location.
Central Cwmbach Sub-Catchment		
Collapsed culvert network at Cefnpennar Road	<p>Surface water runoff discharged from a hole in the culvert and flowed downstream via the highway towards Bro Deg to the east and Cwmbach Road to the west.</p> <p>Flows conveyed towards the lower reaches of Cwmbach and accumulated along Canal Road.</p>	Contributed surface water flows towards properties further down the catchment in Cwmbach, including Tre Telynog and Canal Road, in addition to Bro Deg and Bronhaul within the 'Eastern Cwmbach' sub-catchment.
A culvert inlet located to the rear of Sion Terrace surcharged during the storm event.	Exceedance flows from the surcharged inlet flowed east along Sion Terrace and south towards Canal Road and Cwmbach Industrial Estate.	Contributed to the flooding of 13 commercial properties within Cwmbach Industrial Estate.
An ordinary watercourse manhole within the Cwmbach Industrial Estate surcharged during the storm event.	Surcharging flows from the ordinary watercourse manhole contributed additional surface water ponding within Cwmbach Industrial Estate.	Contributed to the flooding of 13 commercial properties within Cwmbach Industrial Estate.
Intense rainfall running off the hillsides to the north and east of Cwmbach draining to lower ground along the steep streets within the sub-catchment.	<p>Routing of runoff from the eastern and northern hillsides towards several streets including Cefnpennar Road, Cwmbach Road and Waterloo Road.</p> <p>Significant surface water runoff was observed along Cefnpennar Road in the north of Cwmbach and channelled via the highway towards lower ground before accumulating at low points within the lower reaches of the catchment, including Tre Telynog, Rhiw Ceris and Canal Road, resulting in the highway</p>	<p>Internal flooding to 1 residential property at Cwmbach Road and 1 commercial property at Waterloo Road which sit directly adjacent to areas of hillside.</p> <p>Surface water flows towards the lower reaches of Cwmbach also resulted in external flooding to</p>

	drainage in the area becoming overwhelmed.	the front and rear of several residential properties at Tre Telynog, in addition to internal flooding of 3 residential ground floor flats. 1 residential property at Pant-y-Cerdin was confirmed as internally flooded. Surface water flows also contributed to the internal flooding of 13 commercial units within the industrial estate at Canal Road (north of the roundabout).
Western Cwmbach Sub-Catchment		
The Aberdare Canal / Cwmbach ditch (a designated main river) overtopped to the rear of Scales Row, Canal Road	The ordinary watercourse which flows the rear of properties at Scales Row overtopped and flowed into the rear garden and basement of a residential property.	Internal flooding to the basement of one property at Scales Row, Canal Road, to the north of the Cwmbach Industrial Estate

On review of Table 2, the principal source of flooding at investigation area RCT03 originated from intense rainfall running off the steep hillsides to the northeast of Cwmbach draining to lower ground. This runoff was routed towards the investigation area via several ordinary watercourses, many of which became overwhelmed during Storm Dennis and caused flooding associated to blocked culvert inlets and sheeting runoff directly from the hillsides.

Figure 3 depicts the topographic watershed for the Cynon River valley (bold pink line) based on LIDAR data, with rainfall falling to the east of the watershed draining to the Cynon River catchment. The catchment above investigation area RCT03 can be subdivided into further sub-catchments to illustrate the area of land that would expect to drain towards the investigation area (hatched areas in Figure 3). The flood incident at RCT03 will be further described in three parts: the incident at Eastern Cwmbach

(green hatched area, Figure 3), the incident at Central Cwmbach (red hatched area, Figure 3), and the incident at Western Cwmbach (blue hatched area, Figure 3).

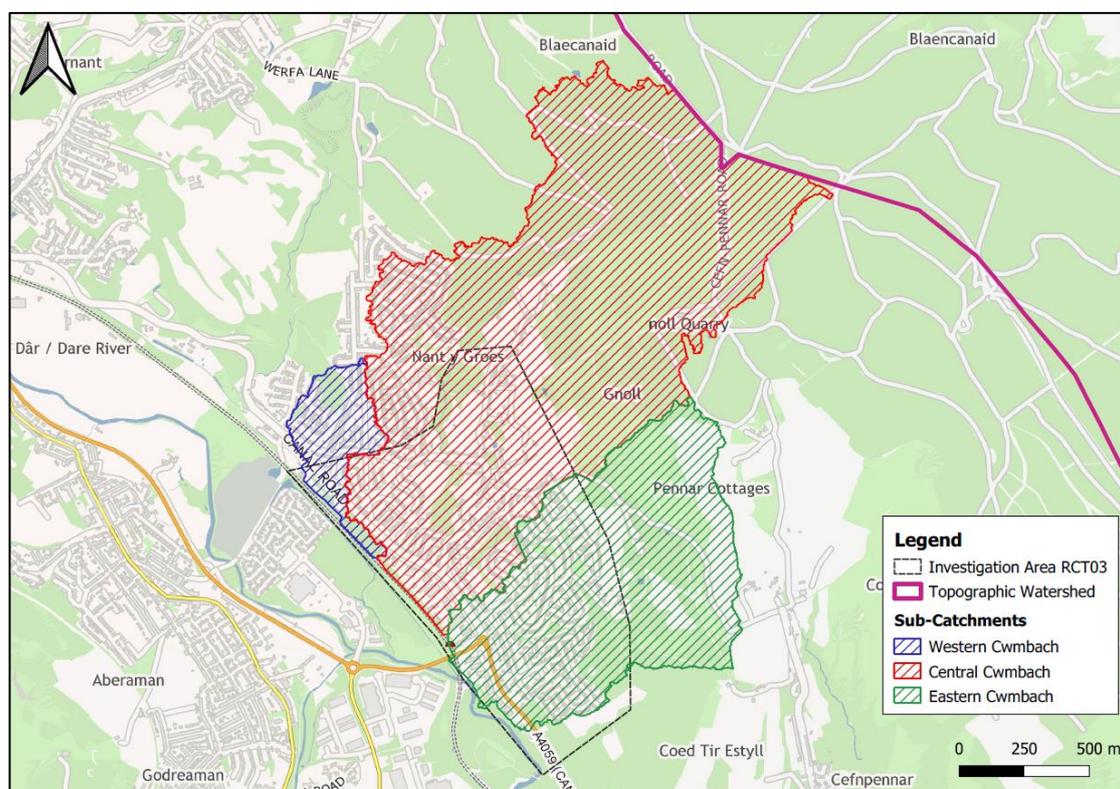


Figure 3: Rainfall Topographic Watershed and Sub-catchments above investigation area RCT03

2.2.1. EASTERN CWMBACH SUB-CATCHMENT

This sub-catchment includes the central and eastern areas of Cwmbach containing the Bryn Hir, Bryngolwg and Bro Deg streets, extending southwards towards the lower section of the A4059 (Canal Road) below the roundabout. This area is drained by a network of unnamed ordinary watercourses which discharge into the River Cynon below the A4059 (Canal Road).

Figure 4 depicts the observed pathways of flooding within the 'Eastern Cwmbach' sub-catchment during Storm Dennis. The infrastructure known to have surcharged and contributed to the flooding are also illustrated in Figure 4.

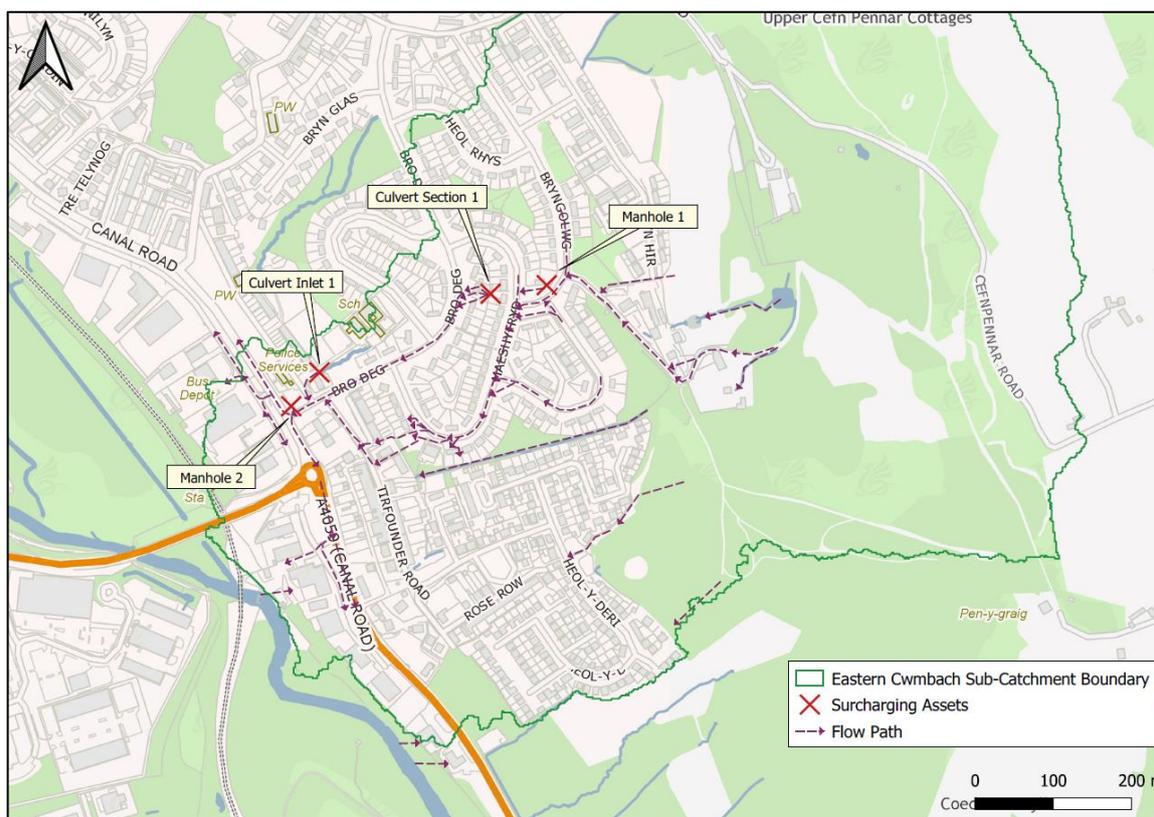


Figure 4: Observed flow paths and surcharged assets within the 'Eastern Cwmbach' sub-catchment during Storm Dennis (15-16th February 2020)

On the 9th February 2020, during Storm Ciara, it was reported by residents at Maeshyfyrd and Bro Deg that a culvert in the rear garden of a residential property at Maeshyfyrd had collapsed, resulting in water flowing overland towards properties situated below at Bro Deg. Internal flooding to properties was not recorded during this event.

Upon an inspection undertaken by RCT's Flood Risk Management and Highway and Streetcare Depot on 10th February 2020, it was identified that the ground within the rear garden of the property at Maeshyfyrd had collapsed, exposing a section of damaged culvert network (Figure 5). The location of the collapsed culvert network is shown in Figure 4, labelled 'Culvert Section 1'.



Figure 5: Collapsed culvert in the rear garden of Maeshyfyrd identified by RCT's Flood Risk Management team on 10/02/2020

During Storm Dennis, on the 15th February 2020, it was reported by residents that the collapsed culvert was causing a significant volume of water to flow overland towards the rear gardens of three properties on Bro Deg situated immediately downstream of the collapsed culvert (Figure 6), and onwards to flow down the steep streets towards the lower reaches of Cwmbach.

Upon inspection undertaken by RCT's Flood Risk Management team and Highway and Streetcare Depot on the evening of 15th February 2020, it was confirmed that the collapse in the culvert network was the source of internal flooding to three residential properties at Bro Deg. As a result of the identified collapse, and to alleviate the property flooding, the Highway and Streetcare Depot channelled the flow of water around the properties and onto the highway using sandbags.

The flow of water was observed to travel downhill on Bro Deg towards the lower reaches of Cwmbach (Figure 7), contributing to the surface water flooding at this location.



Figure 6: Rear garden of a residential property at Bro Deg during Storm Dennis (immediately downstream of the collapsed culvert) (image provided by resident)



Figure 7: Looking upwards at Bro Deg (shows water emanating from properties impacted by the collapsed culvert network at Maeshyryd during Storm Dennis) (image provided by resident)

During the site inspection there was also evidence that the culvert network upstream of the collapse at Maeshyryd had surcharged at Bryngolwg during the storm event (labelled 'Manhole 1', Figure 4). Flow from 'Manhole 1' was observed to flow down the steep highway at Maeshyryd and accumulate at the low point near Cwmbach Nursery

School. On its course of flow, three residential properties along Maeshyfyd were internally flooded. Surface water conveyed over the highway verge and continued downhill towards the rear of Tirfounder Road and onwards to Canal Road (Figure 8). Internal flooding to one residential property at Tirfounder Road from water ingress to the rear was confirmed during site inspections.



Figure 8: Surface water flows travelling down Maeshyfyd and channelled towards the rear of Tirfounder Road during Storm Dennis (images provided by resident)

Upon further investigation and engagement with residents it was also observed that sheeting runoff directly off the eastern hillsides contributed additional surface water flows towards the lower reaches of Cwmbach. Overland flows were observed along several streets including Bryn Haul, Bryngolwg, Brynawelon, Maeshyfyd and Bro Deg, accumulating at the lower reaches along Canal Road.

To the east of the sub-catchment, one residential property at Llys-y-Coed, which sits directly adjacent to the steep eastern hillsides, was confirmed as internally flooded. Residents at Heol-y-Deri in the easternmost part of the sub-catchment reported “water

coming from the mountain” indicating substantial overland flows were originating from the eastern hillsides and impacting the rear of properties adjacent to the hillside during Storm Dennis.

Evidence of saturated ground, overland flows and ponding surface water was observed during post-event inspections of the hillside immediately to the rear of Glas-y-Gors and Heol-y-Deri (Figure 9). These flows are considered to have been a primary source of surface water within the lower reaches of Cwmbach, where a further residential property at Canal Road was reportedly impacted internally.



Figure 9: Surface water runoff and saturated ground on land to the rear of Heol-y-Deri (image captured by RCT Flood Risk Management officers post storm event on 24/02/2020)

In the lower reaches of the ‘Eastern Cwmbach’ sub-catchment, along Canal Road, 17 commercial units were reported as flooding internally during Storm Dennis, primarily due to the significant surface water flows travelling down the steep streets within both the Eastern and Central sub-catchments and accumulating across Canal Road and Cwmbach Industrial Estate.

‘Culvert Inlet 1’, located to the rear of Tirfounder Road, in addition to ‘Manhole 2’ which is situated downstream of ‘Culvert Inlet 1’, were both observed as surcharging during the storm event. Flow paths from both assets contributed additional flows towards Canal Road and Cwmbach Industrial Estate.

The impacted commercial units to the south of the roundabout on the A4059 (Canal Road) were reported as flooding internally by a combination of surface water runoff from the front and main river flooding to the rear sourced by the River Cynon, which flows to the rear of the commercial premises, overtopping its banks. Post event inspections identified surcharging manholes to the rear of the commercial properties which were discharging from the outfall of a nearby combined sewer outflow due to becoming overwhelmed during the storm event.

Residents also reported the River Cynon overtopping its banks further upstream of Canal Road, near Tirfounder Fields, however this area falls outside the investigation area.

2.2.2. CENTRAL CWMBACH SUB-CATCHMENT

The 'Central Cwmbach' sub-catchment covers the main northern area of the Cwmbach catchment, extending from the RCT boundary in the northeast to the south of Canal Road. This area is drained by a network of ordinary watercourses, with the Nant Groes ordinary watercourse being the most notable.

Figure 10 depicts the observed pathways of flooding within the 'Central Cwmbach' sub-catchment during Storm Dennis. The infrastructure known to have surcharged and contributed to the flooding are also illustrated in Figure 10.



Figure 10: Observed flow paths and surcharged assets within the 'Central Cwmbach' sub-catchment during Storm Dennis (15-16th February 2020)

Several calls were received from residents within the 'Central Cwmbach' sub-catchment referencing a large hole in the highway at Cefnpennar Road which was resulting in significant surface water runoff flowing down the steep road towards the lower streets of Cwmbach.

Upon an inspection of the issue, the hole in the highway was identified as a collapsed ordinary watercourse culvert along the highway approximately 25 metres downstream of a culvert inlet situated at the junction to Springfield Close from Cefnpennar Road (Figure 11). The location of the collapsed culvert network is shown in Figure 10, labelled 'Culvert Section 2'.



Figure 11: Collapsed culvert network ('Culvert Section 2') to the north of Cefnpennar Road identified during post event inspections (image captured by RCT's Flood Risk Management team on 18th February 2020)

The upstream culvert inlet, labelled 'Culvert Inlet 2' in Figure 10, was also observed as surcharging during the storm event after becoming blocked with debris. Figure 12 depicts the surcharging flows from 'Culvert Inlet 2' on 16th February 2020 which conveyed towards the lower reaches of Cwmbach.

Significant damage to the highway to the north of Cefnpennar Road and evidence of stonewash and debris was identified across the road towards Bro Deg, indicative of the overland flows conveying down Cefnpennar Road towards Bro Deg, Bryn Glas and Maeshyfyd in the 'Eastern Cwmbach' sub-catchment in addition to flows towards Cwmbach Road, Rhiw Ceris, Pant-y-Cerdin and Canal Road within the 'Central Cwmbach' sub-catchment.



Figure 12: 'Culvert Inlet 2' at Cefnpennar Road surcharging and flooding onto the highway during Storm Dennis

Overland runoff originating from the steep hillsides to the north and east of the sub-catchment was also identified by residents and inspecting officers as a source of flooding to properties situated directly adjacent to areas of hillside in addition to contributing additional surface water flows towards the low points within the sub-catchment.

One commercial property at Waterloo Street was confirmed as being internally flooded during the storm event. Flows at this location are considered to have travelled downhill along Blaennantygroes Road towards Cwmbach Road. A further residential property was also confirmed as flooding internally at Cwmbach Road from water ingress to the rear of the property. Both properties sit below areas of hillside, allowing sheeting runoff from the hillsides to impact both properties.

As previously described in Section 2.2.1., surface water channelled via the steep streets in Cwmbach naturally accumulates at the low point at the Cwmbach Industrial Estate along Canal Road. Surface water ponding and surcharging surface water drainage infrastructure, inclusive of road gullies and 'Manhole 3' within the Industrial Estate, was observed during the storm event, resulting in 13 commercial units becoming internally flooded north of the roundabout.

'Culvert Inlet 3' situated to the rear of Sion Terrace was also observed as surcharging during the storm event, contributing additional flows towards Canal Road. Figure 13 depicts the condition of the culvert inlet following Storm Ciara which occurred a week

before Storm Dennis. The image shows sandbags placed near the inlet, indicating that 'Culvert Inlet 3' had surcharged ahead of Storm Dennis. Flow path from 'Culvert Inlet 3' passes through a derelict property situated below the inlet and flows east towards Tirfounder Road and onwards towards Canal Road. No flooding to residential properties has been directly attributed to the surcharge of 'Culvert Inlet 3'.



Figure 13: Image of 'Culvert Inlet 3' captured by RCT's Highway and Streetcare Depot following Storm Ciara on 7 – 8th February 2020

Residential properties in the lower streets of the 'Central Cwmbach' sub-catchment at Rhiw Ceris, Pant-y-Cerdin and Tre Telynog also suffered external flooding due to surface water accumulating at localised low points. Reports of surcharging and overwhelmed surface water drainage infrastructure were received by several residents within the lower reaches of Cwmbach, indicating surface water accumulation to be the primary cause of flooding during Storm Dennis. One residential property at Pant-y-Cerdin and 3 incidents of internal flooding to ground floor flats at Tre Telynog was confirmed during post event inspections.

2.2.3. WESTERN CWMBACH SUB-CATCHMENT

This sub-catchment includes a small section at the northwest of Cwmbach and extends into RCT03 along Canal Road. The Nant y Geugarn ordinary watercourse flows in an easterly direction to the south of the sub-catchment.

Figure 14 depicts the observed pathways of flooding within the 'Western Cwmbach' sub-catchment during Storm Dennis.

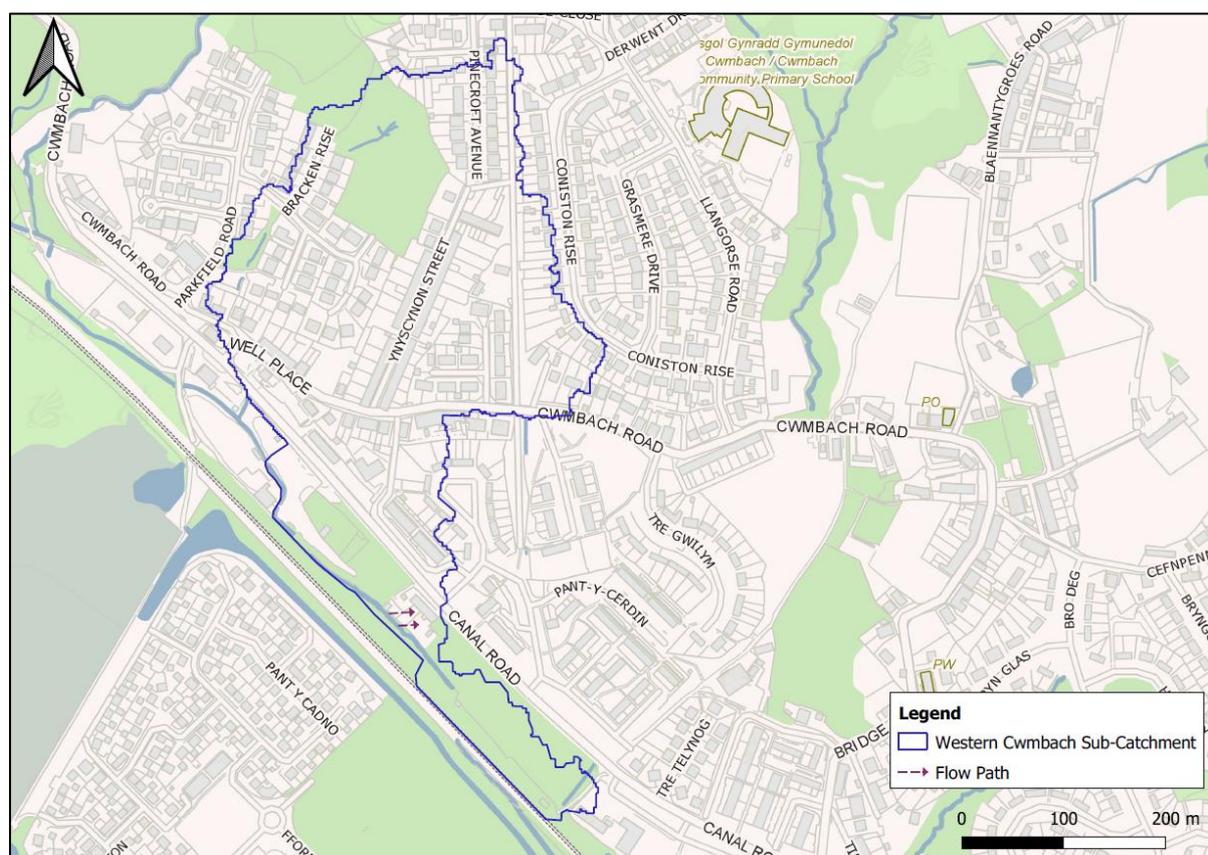


Figure 14: Observed flow paths within the 'Western Cwmbach' sub-catchment during Storm Dennis (15-16th February 2020)

During the public engagement exercise it was reported by a resident at Scales Row, Canal Road, that the Nant y Geugarn ordinary watercourse overtopped its banks during the storm event, resulting in 4 to 5 feet of external flooding within the rear gardens of 3 properties. One residential property confirmed internal flooding to the basement of their property as a result of the watercourse overtopping.

2.3. RAINFALL ANALYSIS

See RCT's 'Overview Report' of Storm Dennis, reference 'FRM – Storm Dennis – Overview Report'², for a detailed analysis of the rainfall and ordinary watercourse response.

3. POSSIBLE CAUSES

3.1. CULVERT CONDITIONS

Within investigation area RCT03 there are several unnamed watercourses which drain the hillsides above the village of Cwmbach and discharge into the River Cynon. Many of these watercourses are culverted beneath Cwmbach's urban settlement.

Several culvert inlets were inspected by RCT's Flood Risk Management team and Council's Highway and Streetcare Depot following the flood event to assess their condition and help determine whether they served as a contributing factor to the flooding at Cwmbach. CCTV survey inspections of the culvert networks were undertaken to ascertain both the operational condition of the network, and its structural integrity along sections of the network.

It should be noted that all surveys reported in this section were undertaken post flood event. It's not possible to say what debris identified in the survey was mobilised and deposited as a result of the storm event and what had been deposited by previous events (last inspections were completed in 2018-2019 following Storm Callum). As such, the following should be considered to be reflective of the asset condition at the end of the storm event and may not necessarily be reflective of the condition of the assets prior to the onset of the storm event.

For the purpose of this investigation, the culvert conditions within investigation area RCT03 will be described in two parts: the 'Eastern Cwmbach' sub-catchment and the 'Central Cwmbach' sub-catchment.

3.1.1. EASTERN CWMBACH SUB-CATCHMENT

Figure 15 and 16 outlines the two culvert networks surveyed within the 'Eastern Cwmbach' sub-catchment and highlights the culvert sections and manholes known to have surcharged during the storm event. Figure 15 highlights the sections/assets associated to the 'Bryngolwg – Bro Deg' culvert network known to have surcharged, whilst Figure 16 highlights the infrastructure known to have surcharged along the 'Tirfounder Road – Canal Road' culvert network during Storm Dennis.

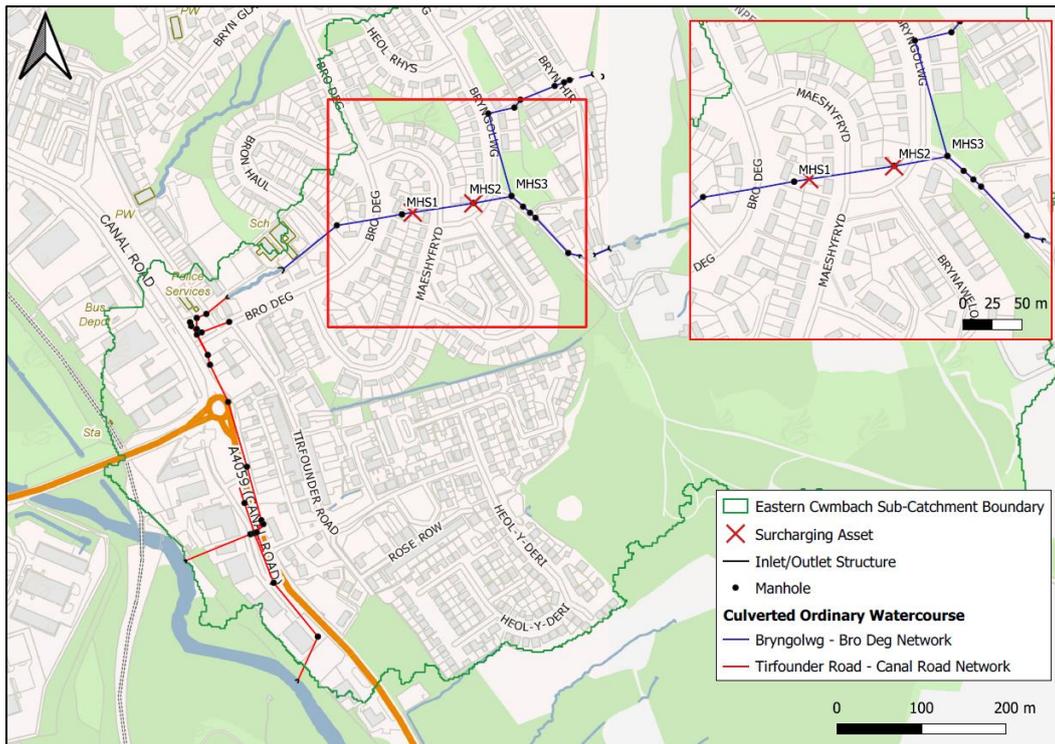


Figure 15: Surveyed culverted ordinary watercourse networks within the 'Eastern Cwmbach' sub-catchment. The infrastructure identified as surcharging during Storm Dennis along the 'Bryngolwg – Bro Deg' network is highlighted.

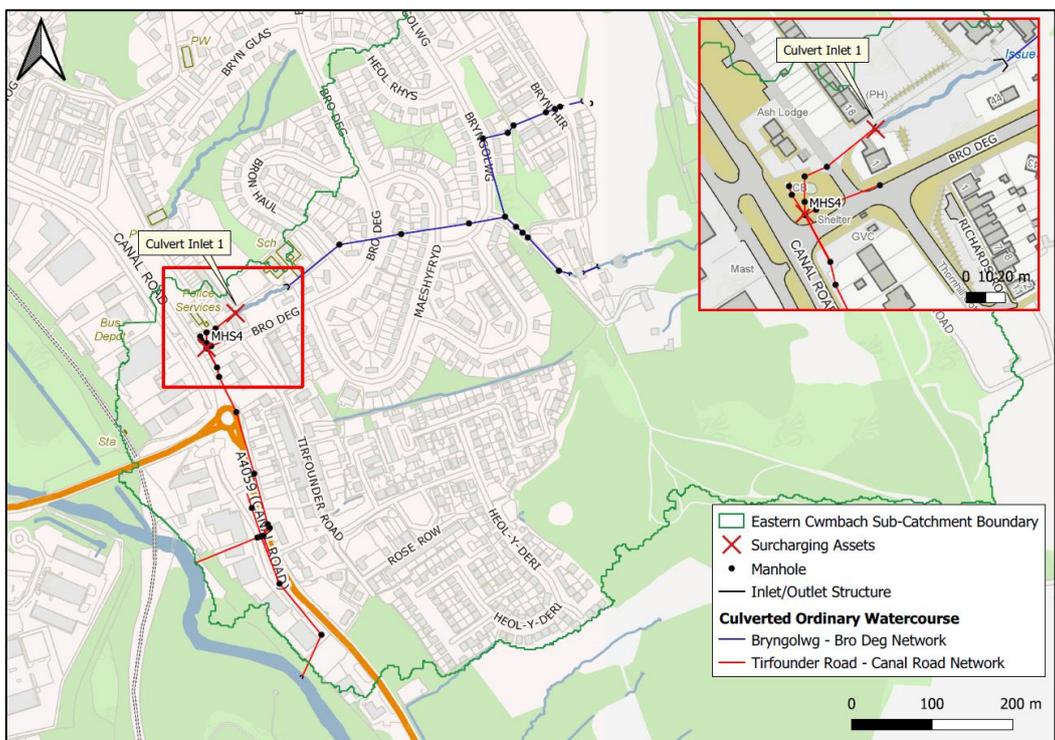


Figure 16: Surveyed culverted ordinary watercourse networks within the 'Eastern Cwmbach' sub-catchment. The infrastructure identified as surcharging during Storm Dennis along the 'Tirfounder Road – Canal Road' network is highlighted.

The 'Bryngolwg – Bro Deg' culvert network was partially surveyed (between MHS1 and MSH3, Figure 15) post Storm Dennis in March 2020 following the identified collapsed culvert at 'Culvert Network 1' (Figure 4) which resulted in internal flooding to 3 residential properties at Bro Deg and contributed surface water flows towards Canal Road and Cwmbach Industrial Estate.

The culvert network between MHS1 and MHS3 was surveyed to be in poor structural and operational condition with large holes, root mass and collapsed pipework observed, particularly between MHS1 and MHS2. Figure 17 shows the condition of the internal culvert barrel at the point of collapse approximately 14 metres upstream of MHS1.

The poor condition of the culvert network between MHS1 and MHS3, and the subsequent collapse of the culvert structure has been determined as the primary cause of flooding at this location in addition to causing 'MHS2' ('Manhole 1', Figure 4) to surcharge.



Figure 17: CCTV image of the collapsed 'Bryngolwg - Bro Deg' culvert network 13.78 metres upstream of MHS1 (CCTV survey undertaken 02/03/2020)

The 'Bryngolwg – Bro Deg' culvert network was surveyed again in September 2020 to assess the condition of the entire length of culvert network. Significant debris was identified at the outlet and downstream watercourse which is considered to have contributed to the surcharge of 'Culvert Inlet 1', associated to the 'Tirfounder Road – Canal Road' culvert network (Figure 16). The condition of the unnamed ordinary watercourse is described in Section 3.2.

'Culvert Inlet 1' was also observed to be in poor structural condition following the storm event. Figure 18 shows evidence of damages to the culvert's debris screen assumed to have been caused by debris during the storm event.



Figure 18: Image of 'Culvert Inlet 1' at Tirfounder Road following the storm event

The 'Tirfounder Road – Canal Road' culvert network was surveyed in September 2020 and identified multiple Grade 5 operational defects within the majority of the network. The survey operation was abandoned at several locations due to settled deposits and debris in the network restricting camera access, particularly along the network length at Canal Road where it was reported that several manholes surcharged during the storm event and continued to surcharge in the days following.

Figure 19 identifies 'MHS 4' ('Manhole 2', Figure 4), associated to the 'Tirfounder Road – Canal Road' network, as heavily silted with silt and stone during surveying operations. Significant volumes of silt and stone was identified at several manholes and catchment pits along the culverted network. A significant cleansing operation was carried out to remove approximately 5 tonnes of debris from the culvert network.



Figure 19: Mud and silt identified at MHS4 (Manhole 2, Figure 4) during CCTV survey operations prior to cleansing (left) and the debris removed from the MHS4 (right)

Debris was observed along the length of both the 'Bryngolwg – Bro Deg' and 'Tirfounder Road – Canal Road' culvert networks, indicative of the high sediment loading being transported from the ordinary watercourses upstream of the Cwmbach catchment. The poor operational condition of the culvert networks within the 'Eastern Cwmbach' sub-catchment is considered to have contributed to the surcharging of 'Culvert Inlet 1' and 'Manhole 2' during the storm event.

3.1.2. CENTRAL CWMBACH SUB-CATCHMENT

Figure 20 outlines the four culvert networks surveyed within the ‘Central Cwmbach’ sub-catchment and highlights the culvert sections and infrastructure known to have surcharged during the storm event.

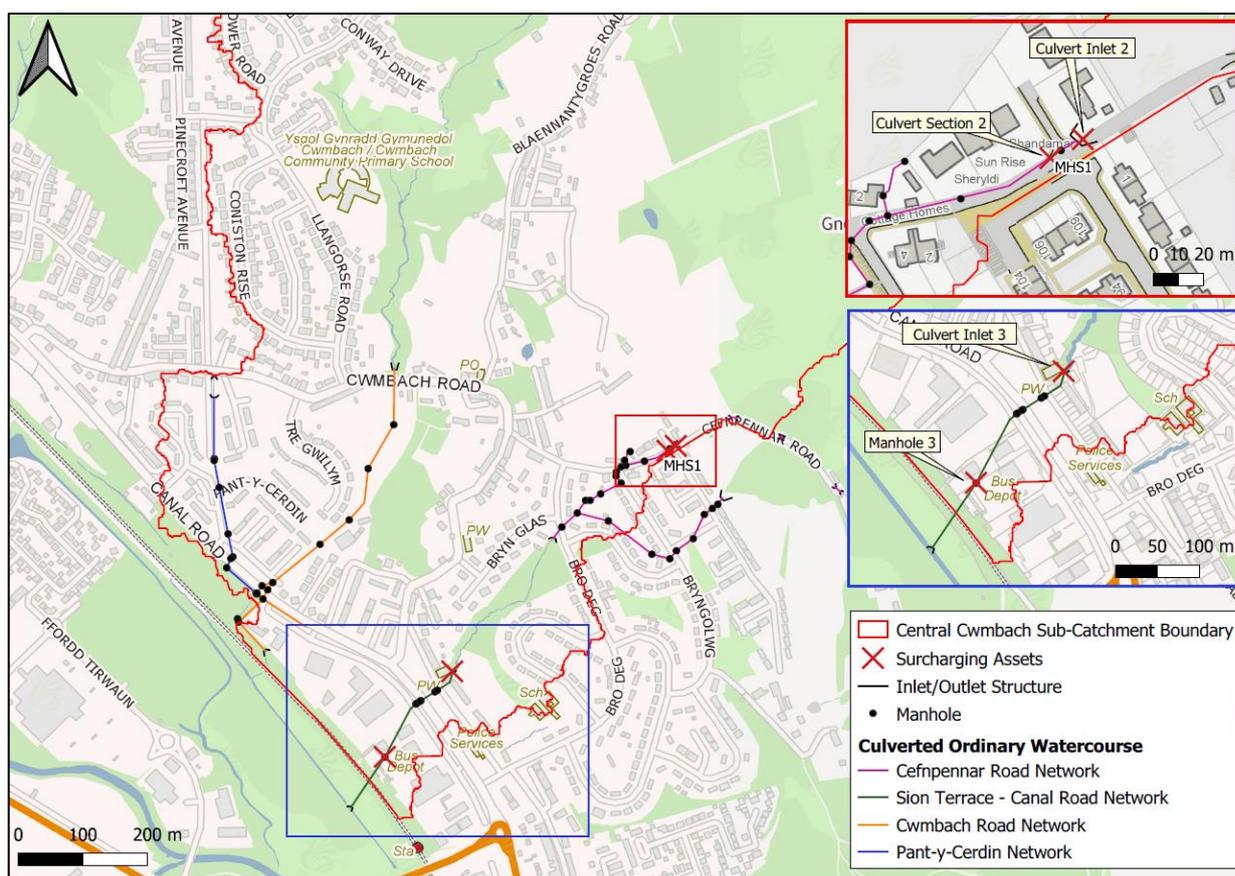


Figure 20: Surveyed culverted ordinary watercourse networks within the ‘Central Cwmbach’ sub-catchment. The infrastructure identified as surcharging during Storm Dennis along the ‘Cefnpennar Road’ and ‘Sion Terrace – Canal Road’ networks are highlighted.

Following the identification of a collapse along the ‘Cefnpennar Road’ culvert network during Storm Dennis, the culvert network and inlet structures were surveyed by a Council appointed contractor to assess its condition.

‘Culvert Inlet 2’ was identified to be in poor condition during post event inspections. Figure 21 depicts the damaged debris screen which was caused by mobilised debris washing down the watercourse channel during the storm. Figure 22 depicts the volume of accumulated debris identified within ‘Culvert Inlet 2’ which is considered to have reduced the culvert’s ability to manage the flow of water entering the network, contributing to its surcharge.



Figure 21: Damaged debris screen at 'Culvert Inlet 2' following Storm Dennis



Figure 22: Internal condition of 'Culvert Inlet 2' following Storm Dennis

Grade 4 and 5 operational defects were identified at several sections of the 'Cefnpennar Road' culvert network, indicative of the high sediment loading from the upper catchment during the storm event. The culvert inlets upstream of 'Culvert Inlet 2', located adjacent to the highway to the north of Cefnpennar Road, and take flow directly from the hillside, were identified during post event inspections as heavily filled with silt and stone which required cleansing (Figure 23). This debris is considered to have contributed to the surcharge of 'Culvert Inlet 2', in addition to conveying into the 'Cefnpennar Road' culvert network, reducing its hydraulic capacity and contributing to the collapse downstream of 'MHS1' (labelled 'Culvert Section 2' in Figure 20).

In response to the identified culvert collapse at Cefnpennar Road, emergency repairs were carried out to repair the culvert section, followed by further culvert lining works undertaken by a Council appointed contractor in August 2021 to repair the structural damages within the network length.



Figure 23: Silt and stone removed from the culvert inlets located upstream of the collapse at 'Culvert Section 2' along Cefnpennar Road (captured by RCT's FRM team on 18/02/2020)



Figure 24: Downstream view of the culvert collapse which resulted in water flowing down Cefnpennar Road towards the lower reaches of Cwmbach (captured by RCT's FRM team on 18/02/2020)

The 'Sion Terrace – Canal Road' culvert network was surveyed to also be in poor operational condition, with a high volume of silt and debris identified throughout the culvert barrel, particularly along Canal Road.

Upon CCTV survey inspections, a high volume of debris and silt was observed to be blocking access to 'Culvert Inlet 3'. The area surrounding the inlet was also very

overgrown which restricted access to inspect the inlet, however, based on Figure 13 which is an image of 'Culvert Inlet 3' captured a week prior to the storm event, the culvert structure is identified to be in poor condition. This condition of the aged infrastructure, in addition to the debris identified to be obstructing the inlet and open watercourse is considered to have contributed to its surcharging, resulting in ordinary watercourse flows conveying towards Canal Road and Cwmbach Industrial Estate.

A high volume of silt and settled debris was identified within the culvert network running beneath Cwmbach Industrial Estate. This was assessed as reducing the cross-sectional area of the network by more than 50%. The poor operational condition of the network is considered to have contributed to the surcharging of 'Manhole 3' during the storm event. Figure 25 depicts the volume of silt identified within 'Manhole 3' during surveying and cleansing operations. This debris is assumed to have entered the network from the upper catchment during the storm event.



Figure 25: Significant volume of silt identified within 'Manhole 3' during CCTV survey operations (captured in June 2020)

The 'Pant-y-Cerddin' and 'Cefnpennar Road' culvert networks were also surveyed post event to assess their condition for any evidence of surcharge. The surveys identified both networks to be in poor structural and operational condition, with heavy siltation present at culvert structures associated with the networks, however, based on the available evidence presented within this report, no flooding was observed to have occurred along both culvert networks.

Based on the available evidence, this investigation has concluded that the condition of several culvert networks within investigation area RCT03 have been assessed as

being in poor condition, with several Grade 4 and 5 structural and operational defects identified. Despite this, the internal condition of the culvert networks is not considered to be the primary cause of flooding to properties within the investigation area during Storm Dennis. The primary cause of flooding has been determined as the significant volume of water entering the watercourses from the hillsides and the associated mobilisation of debris downstream which caused several culvert inlets to become blocked, resulting in the observed flow pathways that occurred during Storm Dennis.

3.2. OPEN WATERCOURSE CONDITIONS

Several sections of natural ditches and open watercourses which drain the steep hillsides above RCT03 are identified to flow through the investigation area and discharge into the Aberdare Canal / Cwmbach Ditch and River Cynon to the south of RCT03 (Figure 26).

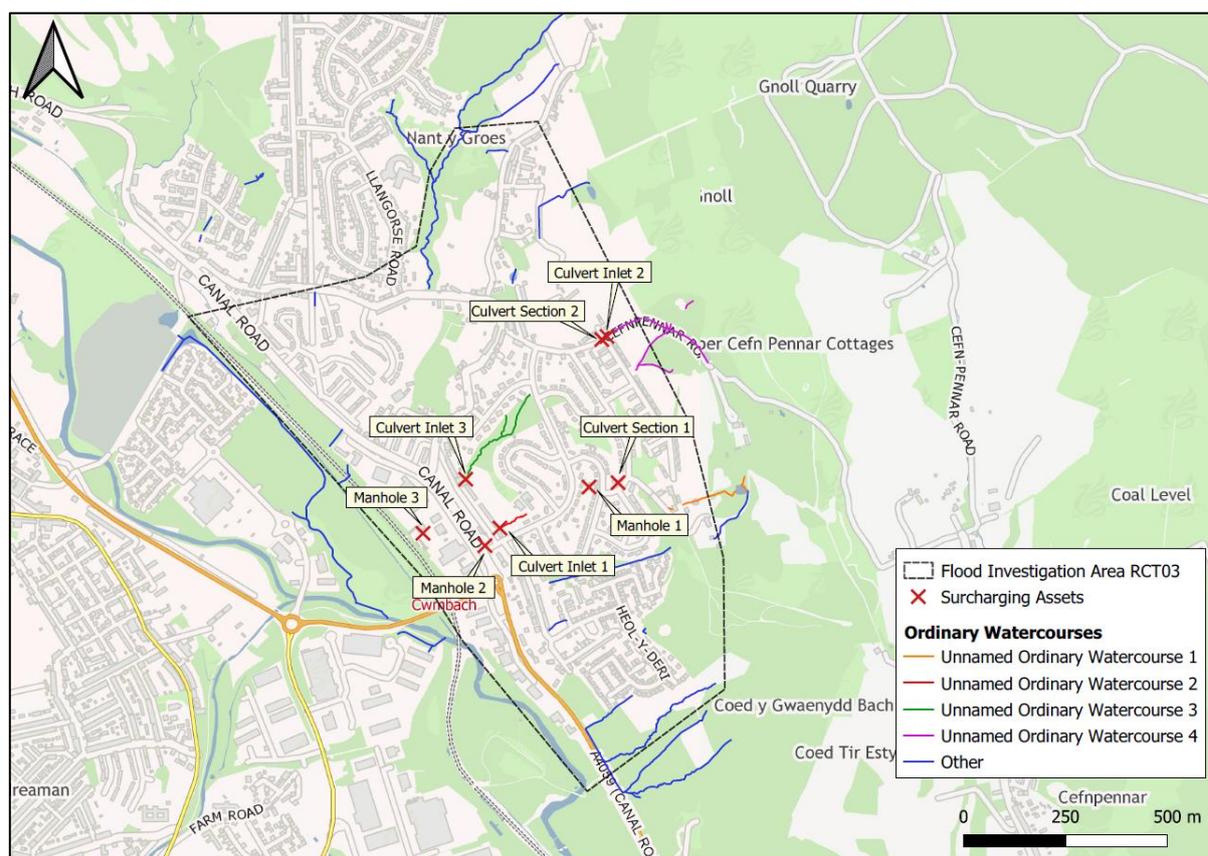


Figure 26: Map of Ordinary Watercourses which feed into investigation area RCT03.

Following the storm event, RCT Flood Risk Management officers carried out a site walk-over assessment, where possible, of the ordinary watercourses upstream of the culverted infrastructure identified as sources of flooding (highlighted in Figure 26) to assess the condition of the watercourses for any signs of overtopping, evidence of scour and any land movement of the hillsides.

Information pertaining to the condition of the sections of unnamed ordinary watercourse were also assessed during CCTV operations undertaken following the storm event.

3.2.1. UNNAMED ORDINARY WATERCOURSE 1

The unnamed ordinary watercourse upstream of 'Bryngolwg – Bro Deg' culvert network was assessed during post event inspections following the identified culvert collapse at 'Culvert Section 1' and surcharge of 'Manhole 1'. The assessment identified evidence of embankment scour along sections of the upstream watercourse in addition to debris, inclusive of woody debris, deposited within the downstream channel (Figure 27). Evidence of out-of-bank flows from the watercourse was also observed along sections of Bryngolwg, directly below the watercourse, whereby debris had been deposited along the highway during post event inspections.

The poor condition of 'unnamed ordinary watercourse 1' is considered to have restricted the capacity of the watercourse to manage the flows coming from the hillside, contributing to the exceedance ordinary watercourse and surface water flows conveying towards the lower reaches of Cwmbach.

The debris identified within the watercourse is also considered to have contributed to the volume of debris identified within the downstream 'Bryngolwg – Bro Deg' culvert network, however the primary cause of surcharge at 'Manhole 1' and the collapse of 'Culvert Section 1', has been attributed to the poor structural condition of the culvert network.



Figure 27: Debris identified within 'Unnamed Ordinary Watercourse 1' during CCTV survey inspections post storm event

3.2.2. UNNAMED ORDINARY WATERCOURSE 2

'Culvert Inlet 1' takes inflow from a small section of unnamed ordinary watercourse (labelled 'unnamed ordinary watercourse 2', Figure 26) to the rear of Tirfounder Road.

The open watercourse upstream of 'Culvert Inlet 1' was identified to be in very poor condition during post event inspections. Figure 28 depicts the materials and debris identified within the watercourse, which consisted of woody debris in addition to large objects indicative of fly tipping. This debris is considered to have contributed to the blockage and associated reduction in capacity of 'Culvert Inlet 1' to manage the flow of water, resulting in its surcharge.



Figure 28: Woody debris and other material within the section of ordinary watercourse upstream of 'Culvert Inlet 1' at Tirfounder Road (captured during post event CCTV survey operations)

3.2.3. UNNAMED ORDINARY WATERCOURSE 3

'Culvert Inlet 3' takes inflow from 'unnamed ordinary watercourse 3' to the rear of Sion Terrace (Figure 26).

The open watercourse upstream of 'Culvert Inlet 3' was identified to be in poor condition during post event inspections. Figure 29 illustrates areas of heavy embankment scour and areas of debris deposition consisting of large stones which are considered to have been mobilised downstream during the storm event by the fast-flowing water. The evidence does suggest that the identified scouring and deposition of material contributed to the blockage and subsequent surcharge of 'Culvert Inlet 2' during the storm event.

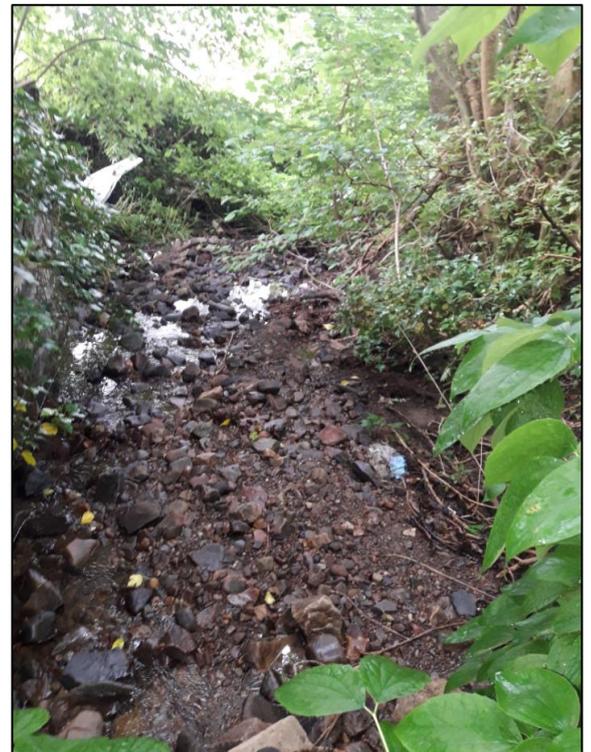


Figure 29: Condition of 'Unnamed Ordinary Watercourse 3' showing significant embankment scour (left) and debris deposition within the channel (right) during post event inspections

3.2.4. UNNAMED ORDINARY WATERCOURSE 4

The section of open watercourse upstream of 'Culvert Inlet 2' at Cefnpennar Road consists of a heavily modified channel which runs adjacent to the highway and is partially culverted in sections (see Figure 30).



Figure 30: 'Unnamed Ordinary Watercourse 4' upstream of 'Culvert Inlet 2' which runs adjacent to Cefnpennar Road

During post event inspections, the upstream channel was observed to be filled with stone and silt (Figure 23), considered to have been washed down the hillside above Cefnpennar Road during the storm event. Sheeting runoff is also considered to have over capacitated the watercourse, leading to out-of-bank flows along the highway, in addition to contributing to the surcharge at 'Culvert Inlet 2'.

The delivery of sediment and stone towards the investigation area via the unnamed ordinary watercourse is considered to have contributed to the surcharging of several culvert inlets and sections of culverted infrastructure, in addition to the blockages observed to the highway drainage infrastructure within the lower reaches of Cwmbach as a result of overland flows carrying material.

3.3. MAIN RIVER

The designated main River, Cynon flows west to east to the west of Cwmbach (Figure 31) and flows through the southwest corner of the investigation area, to the rear of the A4059 (Canal Road). Aberdare Canal / Cwmbach Ditch is also identified as a designated main river and flows adjacent to the southern boundary of the investigation area before discharging into the River Cynon below the roundabout.

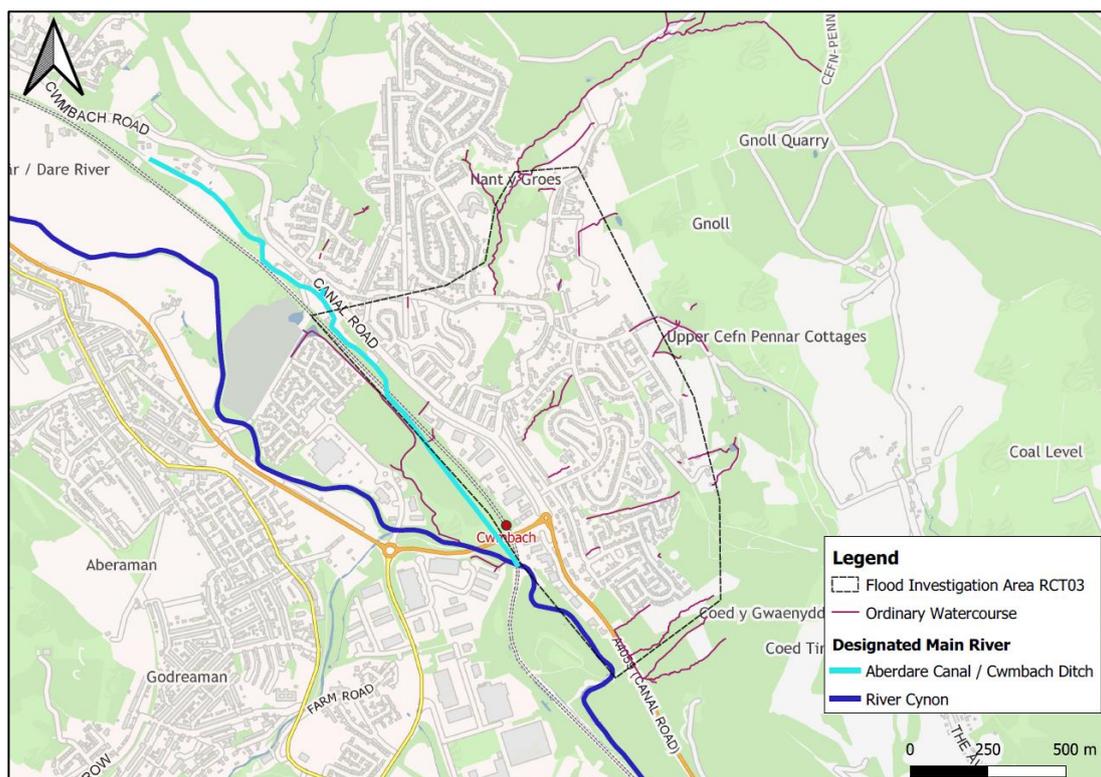


Figure 31: Map depicting the designated main rivers and ordinary watercourses which flow through RCT03

3.3.1. MAIN RIVER LEVELS AND FLOOD WARNINGS

The hydrograph in Figure 32 illustrates the rapid rise in levels of the River Cynon in response to rainfall, captured at NRW's Aberdare monitoring station which is located approximately 2 kilometres upstream of investigation area RCT03. The River Cynon at Aberdare reached its highest peak recorded at 03:00am 16th February 2020, reaching 2.13 metres.

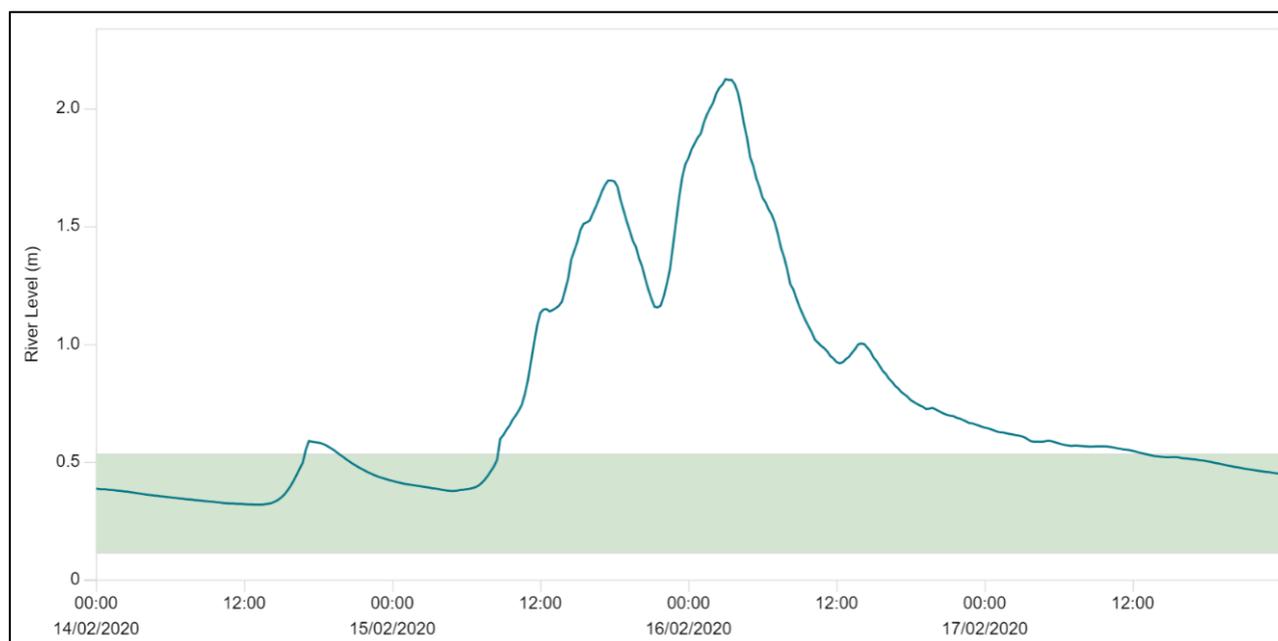


Figure 32: The River Cynon level at Aberdare station between the 14th and 17th February 2020 (Natural Resources Wales)

The green bar displayed on the hydrograph shows the typical level of the River Cynon at Aberdare station, ranging between 0.1 and 0.55 metres. At its peak, the River Cynon at Aberdare was almost three times higher than its average level, stressing the extreme and unprecedented levels that RCT's rivers rose to during the storm's peak intensity. As a result of the significant rise in river levels following heavy and persistent rainfall, the River Cynon overtopped its banks to the rear of the industrial estate situated below the roundabout along the A4059 (Canal Road), contributing to the flooding of four commercial properties and railway line. Aberdare Canal / Cwmbach Ditch was also confirmed to have overtopped its banks to the rear of properties at Scales Row, causing internal flooding to the basement of one residential property.

Investigation area RCT03 falls within NRW's Aberaman Flood Warning Area.

A 'Flood Alert' (indicating flooding is possible) for the River Cynon was issued by NRW at 12:51 on 15th February 2020 however, no 'Flood Warning' alerts (indicating flooding is expected) were issued for the River Cynon at Aberaman during Storm Dennis.

NRW have acknowledged within their 'Flood Incidence Response Review'³ that the operation of the Flood Warning Service "came under significant pressure during February and at times became overwhelmed" resulting in flood warnings being issued late (after the onset of flooding) or not issued at all.

³ [February 2020 Floods in Wales: Flood Incident Management Review \(cyfoethnaturiol.cymru\)](https://www.naturalresources.wales/cyfoethnaturiol.cymru)

Improvements to their flood forecasting and warning services are being internally investigated by NRW and where feasible implemented to deliver the recommendations outlined within their Flood Incident Response Review³.

3.3.2. MAIN RIVER FLOOD RISK

Figure 33 is an excerpt from NRW's Flood Risk Assessment Wales (FRAW) mapping exercise which depicts the main river flood extents for the 'Defended' scenario, i.e., with the presence of flood defence infrastructure. The darker shading identifies areas at higher risk of flooding (more frequent/less extreme rainfall events) and lighter shading showing the lower risk areas (less frequent/more extreme rainfall events).

The commercial properties impacted by flooding at Canal Road are situated directly adjacent to an area of high to low flood risk as depicted in Figure 33. The properties fronting the Aberdare Canal / Cwmbach Ditch are identified at high risk of main river flooding.

A high risk of flooding means that an area has a chance of flooding of greater than 1 in 30 (3.3%) each year; a medium risk of flooding signifies a yearly chance of flooding between 1 in 100 (1%) and 1 in 30 (3.3%); meanwhile a low risk of flooding means that an area has a chance of flooding of between 1 in 1000 (0.1%) and 1 in 100 (1%) each year. Considering Storm Dennis was estimated as in excess of a 1 in 200 annual probability (Q200) flood event, the area of flooding during Storm Dennis aligns with those depicted by the high and medium extents.

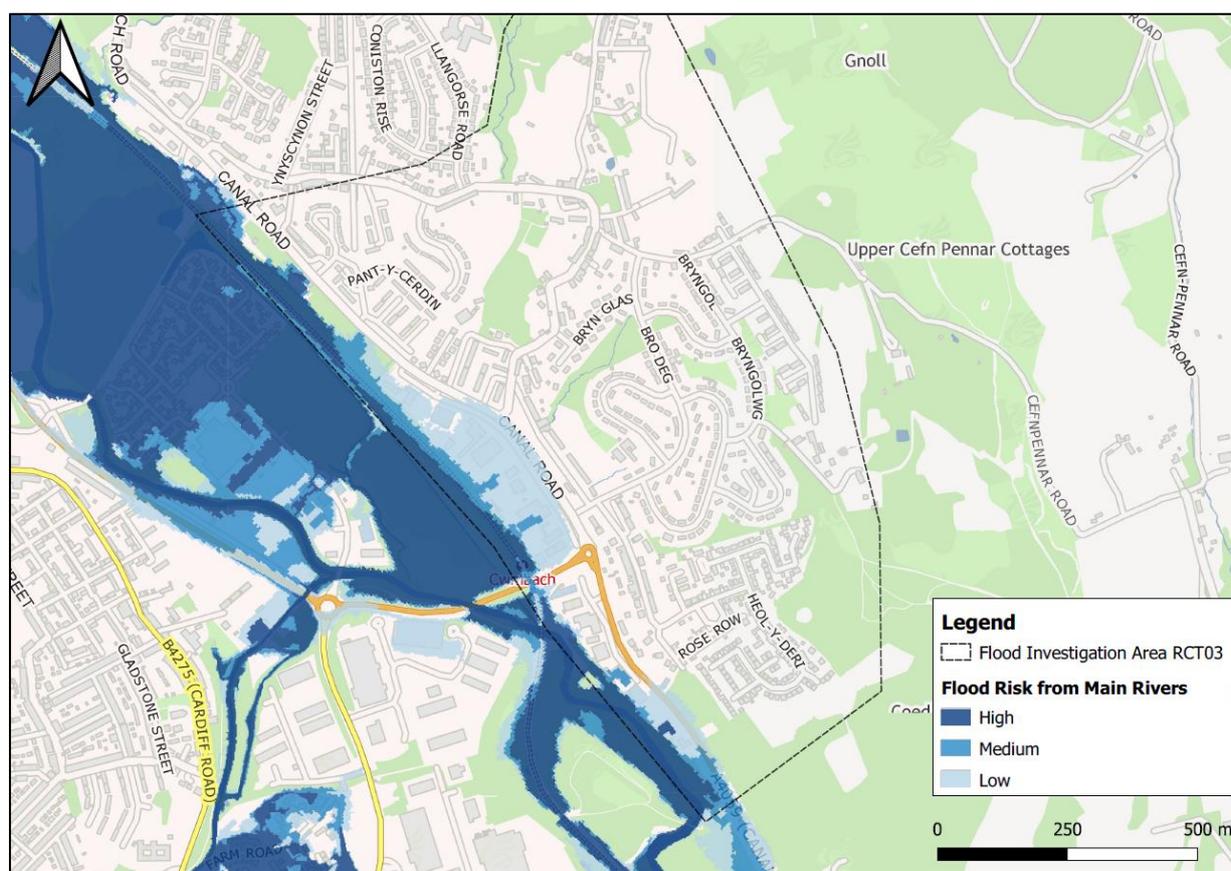


Figure 33: Natural Resources Wales' Flood Risk Assessment Wales (FRAW) map for River sources at RCT03. Contains Natural Resources Wales information © Natural Resources Wales and database right. All rights reserved.

In addition to reports that the River Cynon overtopped its banks below the roundabout at the A4059 (Canal Road), it was also reported that manholes to the rear of the commercial properties were surcharging during the storm event. Based on the relative high levels recorded within the River Cynon during the storm event, it is considered likely that the outfall conditions of the culverted ordinary watercourse, surface water and sewer structures became restricted. This is considered to have contributed to the observed surcharging of the culverted ordinary watercourse network within the industrial estate (south of the roundabout) however, there is limited evidence to outline this interaction.

A low risk of flooding from main rivers is noted elsewhere within the investigation area, specifically across Canal Road and the Cwmbach Industrial Estate, however no incidents of internal flooding sourced by Aberdare Canal / Cwmbach Ditch or the River Cynon were reported within RCT03.

3.3.3. MAIN RIVER FLOOD DEFENCES

The commercial properties impacted by the River Cynon at Canal Road and the residential property impacted by the overtopping of the Aberdare Canal / Cwmbach Ditch are currently 'Undefined', i.e., there are no formally designated flood defence infrastructure under the operation and maintenance of NRW in place along the designated main rivers at Cwmbach.

3.4. HIGHWAY DRAINAGE CONDITIONS

Surface water runoff along the highway was reported by residents at various locations within the investigation area during Storm Dennis, however, there is no evidence to suggest that the condition of the highway drainage within RCT03 significantly contributed to the flooding of properties. The highway drainage infrastructure was overwhelmed by intense rainfall and subsequent surface water flows, in addition to ordinary watercourse flooding associated to culvert infrastructure surcharging, which led to the accumulation of standing water entering properties within the lower reaches of Cwmbach.

Overland flows from areas of hillside and runoff originating from surcharged culvert infrastructure across RCT03 resulted in deposition of mud, silt and debris across several streets which is assumed to have entered the highway drainage network via gullies. In these instances, it is likely that highway drainage assets will have had a limited capacity to intercept flows within the investigation area. Evidence of deposited debris along Bro Deg (Figure 34) and Cefnpennar Road (Figure 35) is indicative of the flow paths during the storm event.



Figure 34: Debris deposited along Bro Deg by the surcharging ordinary watercourse and surface water flows during the storm event (image provided by resident)



Figure 35: Debris deposited along Cefnpennar Road by surcharging watercourse and surface water flows during the storm event (image provided by resident)

The reduction in hydraulic capacity as a result of the mobilised debris is considered to have contributed to the surface water flooding observed at Pant-y-Cerdin, Tre Telynog, Maeshyfyd and Canal Road. The large quantities of sediment and debris washed onto the streets is also indicative of the high sediment loading from the ordinary watercourses described in Section 3.2.

Highway drainage is not designed to manage overland flows from private areas, parks or open space, nor is it designed to accommodate fluvial flows that may arise during storm events. In this instance, the capacity of the highway drainage in RCT03 was exceeded as a result of ordinary watercourse and surface water flows entering the network after conveying from the top of the catchment. The maintenance condition of the highway drainage infrastructure is not considered to have significantly impacted the flooding experienced during Storm Dennis.

3.5. DCWW APPARATUS

Three reports of flooding within investigation area RCT03 were reported to DCWW during Storm Dennis, namely from residents at Canal Road, Maeshyfyd and Tre Telynog.

DCWW were informed by RCT of surcharging manholes on Canal Road on the 15th February 2020. DCWW attended site the same day and confirmed that the surcharging manholes were connected to the outfall from a combined sewer overflow (CSO) which would have been operating during the storm event. DCWW's operative also reported that both surface water and combined sewer manholes and highway gullies were also surcharging due to the amount of flow in the catchment.

Culvert issues at the top of the Cwmbach catchment in addition to some surface water misconnections were noted by both RCT and DCWW officers as having contributed to the significant flooding that occurred along Canal Road however, DCWW acknowledge that their combined sewer network became hydraulically overloaded during Storm Dennis and contributed to the surface water flooding of commercial properties at Cwmbach Industrial Estate.

On the 16th February 2020 DCWW attended reports of internal flooding at Tre Telynog. Two ground floor flats were identified as flooding internally from the front of their properties. High flows were identified within the combined sewer network running to the rear of the properties which is considered to have become hydraulically overloaded during the storm event and causing external flooding at this location. According to DCWW, the surcharging of their network at Tre Telynog is not considered to have been the primary cause of internal flooding as there are drainage holes in the rear retaining wall which allowed pooling water to drain away from the building.

Based on residents' comments as part of RCT's public engagement exercise, internal flooding to three properties at Tre Telynog as a result of surface water flows originating from the upper Cwmbach catchment, overwhelmed the surface water drainage network at the fronts of their properties, resulting in water ingress into three ground floor flats. The topography of the front gardens was identified by residents as directing water towards the front of some properties, leading to a compartmentalisation of the floodwater.

Upon an investigation into DCWW's telemetry in the area following the flood event it was confirmed that their assets were working and operating with no issues raised or reported.

3.6. SURFACE WATER

Surface water flooding as a result of ordinary watercourse flooding associated to blocked, damaged and overwhelmed culvert infrastructure, in addition to overland flows originating from areas of hillside, has been determined as a contributing source of flooding to several residential and commercial properties within the lower reaches of Cwmbach, particularly along Canal Road and Tre Telynog, where water naturally accumulates. This is highlighted in Figure 36 which depicts the surface water and ordinary watercourse flood extents based on NRW's FRAW mapping exercise.

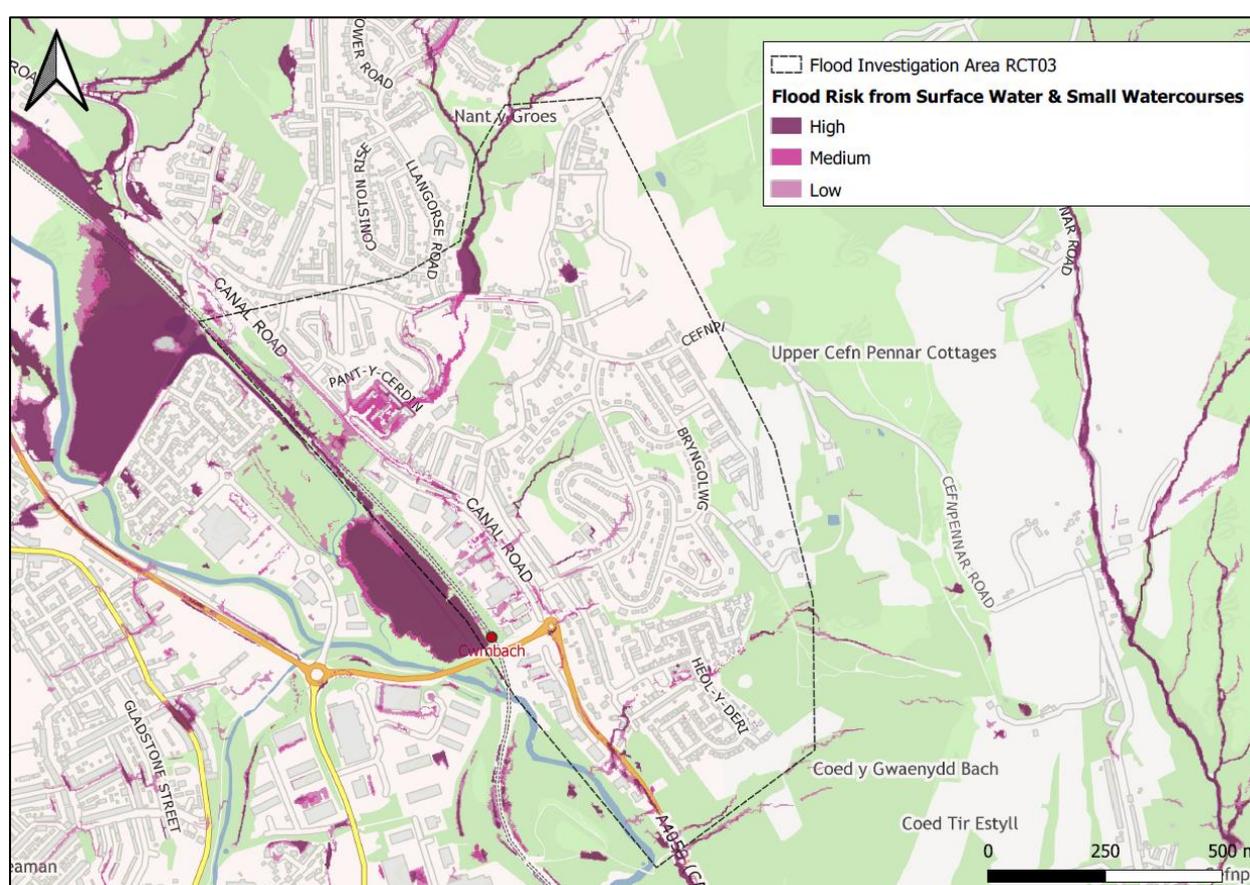


Figure 36: Natural Resources Wales' FRAW map for surface water and ordinary watercourse sources within investigation area RCT03. Contains Natural Resources Wales information © Natural Resources Wales and database right. All rights reserved.

The pathways for surface water runoff during the storm event was observed primarily along the highway network, but also as overland flows originating from areas of hillside within the investigation area. Indicative surface water flow paths observed during the storm event have previously been illustrated in Figures 4 and 10.

The volume of water conveying to these low points within RCT03 during Storm Dennis would have been unable to drain away via the surface water drainage systems, resulting in surface water accumulation on the highway which entered several properties. Blockages to the highway drainage infrastructure caused by mobilised debris is also considered to have exacerbated the surface water flooding observed across RCT03.

3.7. ACCESS STRUCTURES

No access structures were identified during the asset investigations within the area, as such 'access structures' have not been considered within this report.

3.8. SYSTEM AT CAPACITY

Culvert networks within the investigation area (Figures 15, 16 and 20) were surveyed post event to ascertain the internal condition of the networks, the results of which fed into a review of the hydraulic performance of the network to ascertain its current standard of protection using Causeway Flow modelling. The results of the culvert inlet capacity assessments are summarized in the Table below (refer to Figures 15, 16 and 20 for culvert labels).

Table 3: Summary of culvert capacity assessment results which indicate the current standard of protection of the culverted networks in free flowing and blockage conditions

Culvert Network	Standard of Protection (SOP) – Free Flowing	Standard of Protection (SOP) – Blockage Conditions
Bryngolwg – Bro Deg	>Q1000 (0.1% AEP)	<Q2 (50% AEP)
Cefnpennar Road	Q30 (3.33% AEP)	<Q2 (50% AEP)
Tirfounder Road	Q100 (1% AEP)	<Q100 (<1% AEP)
Sion Terrace	Q100 (1% AEP)	Q100 (1% AEP)

The results from the culvert capacity assessments and hydraulic modelling undertaken as part of Redstart’s FIR, infer that the ‘Bryngolwg – Bro Deg’ culvert network has a SOP greater than the current design standards for new culverts as defined by CIRIA C786. Its SOP in blockage conditions however is significantly reduced to below Q2.

The ‘Cefnpennar Road’ culvert network is identified as being under capacity, with a SOP of Q30 which is further reduced to below Q2 with the presence of blockage. ‘Culvert Inlet 2’ associated to the ‘Cefnpennar Road’ culvert network is considered to have been hydraulically overwhelmed during Storm Dennis.

On review of the poor structural and operational condition of both the ‘Bryngolwg – Bro Deg’ and ‘Cefnpennar Road’ culvert networks during post event inspections and CCTV survey operations, it is considered likely that the networks’ hydraulic capacities were further reduced, resulting in significant surcharge of ordinary watercourse flows from the sections of culvert network which were identified as partially collapsed.

Both the ‘Tirfounder Road’ and ‘Sion Terrace’ culvert networks have been assessed as having adequate capacity in free-flowing conditions. The capacity of the ‘Tirfounder Road’ culvert network is reduced to below capacity in ‘medium’ (67%) blockage

conditions⁴, whilst the capacity of the 'Sion Terrace' culvert network is still able to manage the flow in blockage conditions. On review of the poor condition of both inlets post storm event however, it is considered that the networks' hydraulic capacities were further restricted. Furthermore, the significant volume of debris identified within the open sections of watercourse, in addition to the internal culvert networks, has been attributed as the primary cause of surcharge to 'Culvert Inlet 1' and 'Manhole 2' (associated to 'Tirfounder Road' culvert network), and 'Culvert Inlet 3' and 'Manhole 3' (associated to 'Sion Terrace' culvert network).

⁴ Natural Resources Wales Guidance Note (Ref No GN43)

3.9. SUMMARY OF POSSIBLE CAUSES

The above sections have identified and described the possible causes of flooding within investigation area RCT03 during Storm Dennis which occurred on the 15 and 16th February 2020. A summary of the identified source(s) and possible cause(s) of flooding (issue) has been outlined below in Table 4.

Table 4: Summary of the source(s) and possible cause(s) of flooding in RCT03 during Storm Dennis

Ref No	Asset (Source)	Issue	Asset Owner	Type of Flooding
1	Overland flow from the eastern and northern hillsides above Cwmbach	Intense rainfall generating significant surface water runoff to flow overland from the hillsides to the north and east of RCT03 towards properties, directly impacting 3 properties situated adjacent to areas of hillside, and onwards to convey along the highway network, contributing to the surface water flooding within the lower reaches of Cwmbach.	Private Landowners	Surface Water
2	'Culvert Section 1' associated to the Bryngolwg – Bro Deg culvert network	A section of the 'Bryngolwg – Bro Deg' culvert network collapsed during the storm event resulting in flows surcharging from the damaged network and onwards to impact 3 properties at Bro Deg.	Private Landowner	Ordinary Watercourse
3	'Manhole 1' surcharge at Bryngolwg	'Manhole 1' was observed as surcharging during the storm event and contributing to the flooding of 4 properties at Maeshyfyrd and Tirfounder Road, in addition to contributing surface water to the lower reaches of Cwmbach. This has been	RCT	Ordinary Watercourse & Surface Water

		attributed to the poor structural and operational condition of the network downstream of 'Manhole 1'.		
4	'Culvert Inlet 1' associated to Tirfounder Road – Canal Road culvert network	The culvert inlet became blocked with debris during the storm event which led to surcharging at the inlet causing water to overtop the structure and flow towards Canal Road.	RCT Highway Authority	Ordinary Watercourse
5	'Manhole 2' associated to Tirfounder Road – Canal Road culvert network	A manhole situated below 'Culvert Inlet 1' was observed as surcharging during the storm event. This has been attributed to debris accumulation within the culvert network reducing the hydraulic capacity of the network.	RCT	Ordinary Watercourse & Surface Water
6	'Culvert Inlet 2' associated to the Cefnpennar Road culvert network	'Culvert Inlet 2' was identified as surcharging during the storm event after becoming both blocked with debris and hydraulically overloaded, causing water to overtop the structure and flow down Cefnpennar Road towards the lower reaches of RCT03.	RCT Highway Authority	Ordinary Watercourse
7	'Culvert Section 2' associated to the Cefnpennar Road culvert network	A section of the 'Cefnpennar Road' culvert network collapsed within the highway during the storm event, resulting in flows surcharging from the damaged network and onwards towards the lower reaches of Cwmbach.	RCT Highway Authority	Ordinary Watercourse
8	'Culvert Inlet 3' associated to the Sion Terrace culvert network	'Culvert Inlet 2' was identified as surcharging during the storm event after becoming hydraulically overloaded.	RCT Highway Authority	Ordinary Watercourse

		Debris mobilisation is also considered to have obstructed the flow and contributed to the surcharging at this structure.		
9	'Manhole 3' associated to the Sion Terrace culvert network	'Manhole 3' was observed as surcharging within Cwmbach Industrial Estate and contributing to flooding of 13 commercial properties. This has been attributed to debris accumulation within the culvert network leading to surcharge.	Private Landowner	Ordinary Watercourse & Surface Water
10	Surface water drainage network across RCT03	<p>Surface water runoff was channelled down the steep roads within the investigation area towards the lower reaches of Cwmbach and accumulating at the low points.</p> <p>The highway drainage network within RCT03 was over capacitated and was unable to convey the substantial surface water exceedance flows during Storm Dennis. Overland flow transporting silt and debris also contributed to the blockage of highway drainage infrastructure, limiting the capacity of the network further and contributing to the internal flooding of several residential and commercial properties.</p>	RCT Highway Authority	Surface Water
11	River Cynon	Levels on the River Cynon exceeded river bank levels to the rear of commercial properties along A4059 (Canal Road) south of the	Coal Authority	Main River

		roundabout, contributing to the flooding of 4 commercial properties via ingress from the rear.		
12	Aberdare Canal / Cwmbach Ditch	<p>Aberdare Canal / Cwmbach Ditch is a designated main river.</p> <p>Levels within Aberdare Canal / Cwmbach Ditch exceeded river bank levels to the rear of properties at Scales Row, resulting in internal flooding to the basement of one residential property via ingress from the rear.</p>	Private Landowner	Main River

4. RISK MANAGEMENT AUTHORITY ACTIONS

A Welsh Risk Management Authority is defined in Section 6 of the Flood and Water Management Act 2010 as NRW; a LLFA, a district council for an area where there is no unitary authority, or a highway authority wholly in Wales; an internal drainage board for an internal drainage district that is wholly or mainly in Wales; a water company that exercises functions in relation to an area in Wales. As the LLFA, RCT has the responsibility to coordinate the management of flood risk and the interaction of Risk Management Authorities across Rhondda Cynon Taf.

An overview of the relevant Risk Management Authority in relation to flood type is provided in Table 5. For further details of the roles and responsibilities of individual Risk Management Authorities in managing flooding, refer to Welsh Government's National Strategy for Flood and Coastal Erosion Risk Management, Section 4 'Roles and Responsibilities'⁵, and RCT's 'FRM – Storm Dennis - Overview Report'².

Table 5: Risk Management Authority with relevant functions to manage the risk for different flood types

Type of Flooding	Relevant Risk Management Authority
Flooding from Main River, reservoirs and the sea (including coastal erosion).	Natural Resources Wales
Flooding from ordinary watercourses, surface water and groundwater	Lead Local Flood Authority
Flooding from water and sewage systems	Water Companies (Dŵr Cymru Welsh Water)
Flooding from the highway	Highway Authority
Flooding from the highway (motorways and major trunk roads)	Welsh Government Trunk Road Agency

Risk Management Authorities have direct flood risk management functions under the Flood and Water Management Act 2010, as well as the Water Resources Act 1991, Land Drainage Act 1991 and the Highways Act 1980. Through analysis of the flooding that impacted RCT03, the flood risk management functions exercised, or proposed to be exercised, by relevant RMAs was recorded pursuant to Section 19 of the Flood and Water Management Act 2010, which states;

⁵ [National Strategy for Flood and Coastal Erosion Risk Management in Wales \(English\) \(gov.wales\)](https://gov.wales/national-strategy-for-flood-and-coastal-erosion-risk-management-in-wales)

“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 the response to the flood.”

Through the investigation process, the source(s) and possible cause(s) of flooding in investigation area RCT03 as a result of Storm Dennis has been previously identified and summarised within Table 4. The Risk Management Authorities responsible for managing that flooding have been listed within Table 6 below, along with a series of recommendations presented by the LLFA.

Table 6: Recommendations provided by the LLFA to be considered by the relevant Risk Management Authority identified in response to the source(s) of flooding in RCT03 (Table 4)

Ref No	Asset (Source)	Asset Owner	Type of Flooding	Relevant Risk Management Authority	Recommendations	
1	Overland flow from the eastern and northern hillsides above Cwmbach	Private Landowners	Surface Water	Lead Local Flood Authority and Land Drainage Authority	R1A	The LLFA and LDA to identify asset ownership and responsibility.
					R1B	The LLFA and LDA to exercise their permissive powers under Section 64 of the Land Drainage Act to inspect and investigate the ordinary watercourse conditions and surface water drainage arrangements.
					R1C	The LLFA and LDA to engage and work with the

						<p>riparian landowner to regulate the ordinary watercourse infrastructure to ensure the infrastructure is free flowing and unobstructed.</p>
					R1D	<p>The LLFA to develop a SOC to identify suitable management methods to reduce the risk of ordinary watercourse and surface water flooding in Cwmbach.</p>
2	<p>‘Culvert Section 1’ associated to the Bryngolwg – Bro Deg culvert network</p>	Private Landowner	Ordinary Watercourse	Lead Local Flood Authority and Land Drainage Authority	R2A	<p>The LLFA and LDA to identify asset ownership and responsibility.</p>
					R2B	<p>The LLFA and LDA to investigate the standard of protection and the condition of the culvert structure and network as a whole.</p>
					R2C	<p>The LLFA and LDA to carry out repairs to the section of damaged culvert network.</p>
					R2D	<p>The LLFA and LDA to engage</p>

						and work with the riparian landowner to regulate the ordinary watercourse infrastructure to ensure the infrastructure is free flowing and unobstructed.
						R2E The LLFA to develop a SOC to identify suitable management methods to reduce the risk of ordinary watercourse and surface water flooding in Cwmbach.
3	'Manhole 1' surcharge at Bryngolwg	RCT	Ordinary Watercourse & Surface Water	Lead Local Flood Authority and Land Drainage Authority	R3A	The LLFA and LDA to identify asset ownership and responsibility.
					R3B	The LLFA and LDA to investigate the standard of protection and the condition of the culvert structure and network as a whole.
					R3C	Jet and cleanse the ordinary watercourse network.
					R3D	The LLFA to develop a SOC to identify suitable

						management methods to reduce the risk of ordinary watercourse and surface water flooding in Cwmbach.
4	'Culvert Inlet 1' associated to Tirfounder Road – Canal Road culvert network	RCT Highway Authority	Ordinary Watercourse	Lead Local Flood Authority, Land Drainage Authority & Highway Authority	R4A	The LLFA and LDA to identify asset ownership and responsibility.
					R4B	The LLFA and LDA to investigate the standard of protection and the condition of the culvert structure and network as a whole.
					R4C	Jet and cleanse the ordinary watercourse network.
					R4D	The LLFA to upgrade the culvert inlet structure and improve the condition of the upstream ordinary watercourse channel following the damages and identified debris caused during Storm Dennis.
					R4E	The LLFA to install remote telemetry monitoring at

						<p>Culvert Inlet 1 to monitor the risk of blockage.</p>
						<p>R4F The LLFA to develop a SOC to identify suitable management methods to reduce the risk of ordinary watercourse and surface water flooding in Cwmbach.</p>
5	'Manhole 2' associated to Tirfounder Road – Canal Road culvert network	RCT	Ordinary Watercourse & Surface Water	Lead Local Flood Authority and Land Drainage Authority	R5A	The LLFA and LDA to identify asset ownership and responsibility.
					R5B	The LLFA and LDA to investigate the standard of protection and the condition of the culvert structure and network as a whole.
					R5C	Jet and cleanse the ordinary watercourse network.
					R5D	The LLFA to develop a SOC to identify suitable management methods to reduce the risk of ordinary watercourse and surface water flooding in Cwmbach.

6	'Culvert Inlet 2' associated to the Cefnpennar Road culvert network	RCT Highway Authority	Ordinary Watercourse	Lead Local Flood Authority, Land Drainage Authority & Highway Authority	R6A	The LLFA and LDA to identify asset ownership and responsibility.
					R6B	The LLFA and LDA to investigate the standard of protection and the condition of the culvert structure and network as a whole.
					R6C	Jet and cleanse the ordinary watercourse network.
					R6D	The LLFA to upgrade the culvert inlet structure and improve the condition of the upstream ordinary watercourse channel following the damages and identified debris caused during Storm Dennis.
					R6E	The LLFA to develop a SOC to identify suitable management methods to reduce the risk of ordinary watercourse and surface water flooding in Cwmbach.

7	'Culvert Section 2' associated to the Cefnpennar Road culvert network	RCT Highway Authority	Ordinary Watercourse	Lead Local Flood Authority, Land Drainage Authority & Highway Authority	R7A	The LLFA and LDA to identify asset ownership and responsibility.
					R7B	The LLFA and LDA to investigate the standard of protection and the condition of the culvert structure and network as a whole.
					R7C	The LLFA, LDA and Highway Authority to carry out repairs to the section of damaged culvert network.
					R7D	The LLFA to develop a SOC to identify suitable management methods to reduce the risk of ordinary watercourse and surface water flooding in Cwmbach.
8	'Culvert Inlet 3' associated to the Sion Terrace culvert network	RCT Highway Authority	Ordinary Watercourse	Lead Local Flood Authority, Land Drainage Authority & Highway Authority	R8A	The LLFA and LDA to identify asset ownership and responsibility.
					R8B	The LLFA and LDA to investigate the standard of protection and the condition of the culvert structure

						and network as a whole.
					R8C	Jet and cleanse the ordinary watercourse network.
					R8D	The LLFA to review the risk of scour potential within the ordinary watercourse channel and to identify suitable management methods to improve the condition of the channel and to reduce the risk of scour potential.
					R8E	The LLFA to facilitate a Flood Alleviation Scheme to manage the exceedance flow path from 'Culvert Inlet 3'.
					R8F	The LLFA to develop a SOC to identify suitable management methods to reduce the risk of ordinary watercourse and surface water flooding in Cwmbach.
9	'Manhole 3' associated	Private Landowner	Ordinary Watercourse	Lead Local Flood Authority	R9A	The LLFA and LDA to identify

	to the Sion Terrace culvert network		& Surface Water	and Land Drainage Authority		asset ownership and responsibility.
					R9B	The LLFA and LDA to investigate the standard of protection and the condition of the culvert structure and network as a whole.
					R9C	Jet and cleanse the ordinary watercourse network.
					R9D	The LLFA to develop a SOC to identify suitable management methods to reduce the risk of ordinary watercourse and surface water flooding in Cwmbach.
10	Surface water drainage network across RCT03	RCT Highway Authority	Surface Water	RCT Highway Authority	R10A	The Highways Authority to jet and cleanse the highway drainage network and action repairs accordingly.
					R10B	The LLFA, Highway Authority and DCWW to evaluate surface water management options to alleviate pluvial flooding at

						locations across the investigation area.
11	River Cynon	Coal Authority	Main River	Natural Resources Wales	R11A	NRW to “complete detailed investigative analysis work to understand the mechanisms of flooding in the areas known to have flooding from main rivers”, including the River Cynon at Cwmbach. Aligns with recommendation ‘Action FD2’ within NRW’s Flood Incident Management Review.
					R11B	NRW to work with landowners to assess and review the risk of flooding from the River Cynon at Cwmbach to identify the viability of risk management options.
					R11C	NRW to review its flood warning service provision, especially for extreme events. This will form part

						of NRW's Flood Warning Service Review Implementation Programme and aligns with the recommendations set out in their 'Flood Incidence Management Review'.
12	Aberdare Canal / Cwmbach Ditch	Private Landowner	Main River	Natural Resources Wales	R12A	NRW to "complete detailed investigative analysis work to understand the mechanisms of flooding in the areas known to have flooding from main rivers", including the Aberdare Canal / Cwmbach Ditch at Cwmbach. Aligns with recommendation 'Action FD2' within NRW's Flood Incident Management Review.
					R12B	NRW to work with landowners to assess and review the risk of flooding from the River Cynon at Cwmbach to identify the

						viability of risk management options.
					R12C	NRW to review its flood warning service provision, especially for extreme events. This will form part of NRW's Flood Warning Service Review Implementation Programme and aligns with the recommendations set out in their 'Flood Incidence Management Review'.

4.1. LEAD LOCAL FLOOD AUTHORITY

In review of Ref 1 – 9 in Table 6, the LLFA has been determined as the relevant Risk Management Authority in relation to the ordinary watercourse and surface water flooding which occurred at investigation area RCT03 during Storm Dennis.

The LLFA exercised the following functions in response to the flooding at investigation area RCT03;

- Officers investigated the initial flooding and have produced this report in line with Section 19 of the Flood and Water Management Act 2010.
- Officers contacted residents affected by flooding to offer support and advice to assist in the recovery following the event.
- A public engagement exercise carried out by Redstart, on behalf of RCT as the LLFA, was undertaken in order to gain further local insight and anecdotal evidence to support the flood investigation.
- The LLFA and LDA have exercised their permissive powers under Section 64 of the Land Drainage Act 1991 to investigate the culvert structures and network condition and its impact on the flooding within the investigation area. **(R1B, R2B, R3B, R4B, R5B, R6B, R7B, R8B, R9B)**
- An estimated 2413 metres of culverted ordinary watercourse network length and 624 metres of surface water drainage network length within RCT03 has been surveyed following the event to ascertain both the operational condition of the network, and its structural integrity along section of the network. **(R2B, R3B, R4B, R5B, R6B, R8B, R9B)**
- An estimated 125 tonnes of material and debris was removed from the culvert networks within RCT03 during jetting and cleansing operations. **(R3C, R4C, R5C, R6C, R7C, R8C, R9C)**
- The LLFA and LDA have undertaken clearance works to the culvert network systems which fall under the responsibility of the Authority **(R3C, R4C, R5C, R6C, R8C)**. In addition to this, the LLFA and LDA have carried out clearance works to the culvert inlet structures which fall under private land ownership utilising powers under Section 14A of the Land Drainage Act. **(R9C)**
- The LLFA commissioned Redstart to investigate the standard of protection of the existing culvert networks in Cwmbach to determine their hydraulic capacity following the identification of several structural and operational defects within sections of the network. **(R2B, R3B, R4B, R5B, R6B, R7B, R8B, R9B)**

- The LLFA has set up a central Control Room, to compliment the Council's Contact Centre and CCTV centre which is based at the Council's officers, to provide a comprehensive and informed response to the residents of RCT as appropriate during storm events.
- The LLFA have initiated an interim Property Flood Resistance project offering expandable flood gates to those properties deemed at high risk of flooding from local sources.
- The LLFA and LDA have initiated engagement with riparian landowners to ensure the ordinary watercourse infrastructure is free flowing and unobstructed. **(R1C, R2D)**
- The LLFA have installed remote telemetry monitoring devices at key culvert structures to enable operators to ensure the drainage systems in Cwmbach are operating effectively. **(R4E)**
- In response to Ref 2 and 7, the LLFA, working alongside the Highway Authority, have completed emergency repair works to both the private and publicly owned sections of culvert network that collapsed during Storm Dennis. **(R2C, R7C)**
- The LLFA have completed upgrade works to improve the structural condition of the culvert inlets and ordinary watercourse drainage channel along Cefnpennar Road upstream of 'Culvert Inlet 2'. The LLFA have also completed relining works to improve the structural integrity of sections of the internal culvert network from inlet to outfall. **(R6D, R7C)**
- The LLFA, in collaboration with the Highway Authority, have completed a flood routing scheme along Canal Road to manage exceedance flows from a range of sources and reduce the risk of surface water flooding to properties within the lower reaches of Cwmbach. The scheme involved the installation of debris catch pits, in addition to utilising green infrastructure to manage overland flows, including raingardens and tree pits. **(R8E)**

The LLFA propose to exercise the following functions in response to the flooding at investigation area RCT03;

- Following the surveying of culvert network in RCT01, the LLFA propose to input and update all relevant asset data.
- The LLFA and LDA intend to clarify drainage asset owners and management responsibilities to make them aware of their personal risk. To ensure landowners manage the risk in compliance with the relevant legislation, a team of Flood Enforcement Officers including legal support is to be appointed. **(R2A, R9A)**

- The LLFA and LDA will work with landowners and property owners to manage their personal flood risk through local measures, such as property resilience and resistance measures.
- In response to the poor condition of the ordinary watercourses upstream of 'Culvert Inlet 1 and 3', the LLFA and LFA have applied for Welsh Government funding to utilise their permissive power under Section 64 of the Land Drainage Act 1991 to undertake rehabilitation works of the scoured sections of open ordinary watercourse. **(R4D, R8D)**
- The LLFA and LDA will continue to engage with riparian landowners and regulate the ordinary watercourse infrastructure to ensure the infrastructure is free flowing and unobstructed. **(R1C, R2D)**
- The LLFA will develop a Strategic Outline Business Case to better understand the risk of flooding using a whole catchment approach to provide recommendations for suitable management mechanisms to reduce the wider risk of flooding to people and properties from local sources (Ordinary Watercourse, Surface Water and Groundwater). **(R1D, R2E, R3D, R4F, R5D, R6E, R7D, R8F, R9D)**
- As part of RCT's comprehensive review of the County Borough's most at risk communities, the LLFA are proposing to undertake a formal SFRA of the Cwmbach catchment area to better understand the overall risk from ordinary watercourse and surface water flooding in order to target investment to areas of highest risk. The SFRAs also aim to encourage whole catchment measures, including working with natural processes, to alleviate flood risk in those areas of highest risk.

4.2. NATURAL RESOURCES WALES

In review of Ref 11 and 12 in Table 6, NRW has been identified as the relevant Risk Management Authority in relation to the main river flooding from the River Cynon and Aberdare Canal / Cwmbach Ditch during Storm Dennis.

NRW has exercised the following functions in response to the flooding at investigation area RCT03;

- Utilising post event data and information, NRW have reviewed the Resultant Thresholds reviewed for the River Cynon at Aberaman Flood Warning Area (FWA). This is critical for assessing the performance, timeliness and accuracy of the warning service after a flood. **(R11C, R12C)**
- NRW has introduced improved digital services to provide comprehensive flood risk, river level and rainfall information to households, businesses and communities across Wales. The improved service was launched in September 2020 on the NRW website and will improve how live flood warning and water level data is shared before and during flood events. **(R11C, R12C)**
- Following the flooding events of February 2020, NRW published a review of its incident response to Storm Ciara and Dennis in October 2020⁶. This review contains several recommendations for improvements to their ways of working and services which NRW are in the process of implementing through an internal delivery programme.
- NRW have commissioned a Cynon Flood Modelling Study which is programmed for completion by the end of March 2022. **(R11A)**
- NRW have carried out a waterway clearance of the Cwmbach Ditch which was identified as a source of flooding to one residential property within RCT03 during Storm Dennis.
- NRW have undertaken a T98 inspection of main river channel at Cwmbach following the storm event. **(R11A, R12A)**
- NRW have developed a detailed Implementation Programme to address the areas of improvement work required to deliver the recommendations of the Flood Warning Service Review carried out by NRW in 2018. Several of the recommendations directly link to the recommendations set out by NRW within their Flood Incident Management Review. **(R11C, R12C)**

⁶ [Natural Resources Wales / Our response to Storm Ciara and Storm Dennis](#)

NRW propose to exercise the following functions in response to the flooding at investigation area RCT03;

- Following the completion of NRW's Cynon Flood Modelling Study, NRW propose to undertake an initial economic assessment of viability of potential flood risk management options. Consideration should be given to areas at high risk of flooding from rivers on a prioritised basis. **(R11A, R11B, R12A, R12B)**
- Following the completion of NRW's Cynon Flood Modelling Study, NRW propose further threshold work and flood warning area amendments. **(R11A, R11C, R12C)**
- NRW will undertake a review of the modelled outputs and adopt changes to their maintenance program within the investigation area if required. **(R11A, R12A)**

4.3. WATER COMPANY

Following the results into the investigation of flooding at Cwmbach, DCWW were not identified as a relevant Risk Management Authority in relation to the flooding at investigation area RCT03 on the 15th and 16th February 2020. Despite this, calls were received by DCWW in relation to the flooding at RCT03.

DCWW have exercised the following functions in response to the flooding at investigation area RCT03;

- DCWW carried out their own investigation in response to the incidents of flooding that were reported by residents directly to DCWW.
- DCWW contacted residents affected by flooding to offer support and advice to assist in the recovery following Storm Dennis.
- DCWW investigated the performance of their network within RCT03 to ensure their assets were operating with no issues.

DCWW propose to exercise the following functions in response to the flooding at RCT03;

- Storm Dennis has highlighted the high risk of flooding present within the Cwmbach catchment. In response to this, DCWW will review their hydraulic model of the sewer network within Cwmbach and will review their planned maintenance work in the area to ensure they are monitoring enough of the network to mitigate potential pinch points.
- DCWW will continue to liaise and share information with the LLFA to help understand and develop a holistic approach to flooding in the area. **(R10B)**

4.4. HIGHWAY AUTHORITY

During the investigation into the flooding at investigation area RCT03 during Storm Dennis, the Highway was identified as flooding as a result of ordinary watercourse and surface water flooding associated to blocked and overwhelmed culverted watercourse infrastructure.

Ref 10 of Table 6 identified the Highway Authority as a relevant Risk Management Authority in relation to the surface water flooding that occurred along the highway in the lower reaches of RCT03.

RCT as the Highway Authority have exercised the following functions in response to the flooding at investigation area RCT03;

- The Highway Authority assisted with the emergency response during the event by supplying equipment and sandbags, some to individual properties and using sandbags to redirect flood water away from properties.
- The Highway Authority exercised their functions under Section 100 of the Highways Act 1980, to arrange for all gullies and open drains in the highway to be inspected and cleansed following the influx of flood water to ensure the safety of the highway post event. **(R10A)**
- The Highway Authority has undertaken emergency clearance and repair works to the culverted infrastructure identified as sources of flooding. **(R2C, R3C, R4C, R5C, R6C, R7C, R8C, R9C)**
- The Highway Authority have increased their resource capacity by establishing a dedicated 'Pluvial Drainage Team' to focus entirely on the refurbishment and maintenance of RCT's existing and enhanced highway drainage infrastructure.

RCT as the Highway Authority propose to undertake the following function in relation to the event at investigation area RCT03:

- The Highway Authority to work with the LLFA and DCWW to evaluate surface water management options to alleviate pluvial flooding at locations across the investigation area. **(R10B)**

USEFUL LINKS/CONTACTS

Blue Pages – property Resilience - <http://bluepages.org.uk/>

Flood Re – Flooded Property Insurance Scheme - <https://www.floodre.co.uk/>

Natural Resources Wales – Check Flood Warnings - <https://naturalresources.wales/flooding/check-flood-warnings/?lang=en>

Natural Resources Wales - Long Term Flood Risk - <https://naturalresources.wales/evidence-and-data/maps/long-term-flood-risk/?lang=en>

Rhondda Cynon Taf CBC - Local Flood Risk Management Plan - <https://www.rctcbc.gov.uk/EN/Resident/ParkingRoadsandTravel/Roadspavementsandpaths/FloodAlleviation/Floodriskregulations2009.aspx>

Rhondda Cynon Taf CBC - Local Flood Risk Management Strategy - <https://www.rctcbc.gov.uk/EN/Resident/ParkingRoadsandTravel/Roadspavementsandpaths/FloodAlleviation/LocalFloodRiskManagementStrategy.aspx>

Rhondda Cynon Taf CBC – Sustainable Drainage – <https://www.rctcbc.gov.uk/EN/Resident/ParkingRoadsandTravel/Roadspavementsandpaths/SustainableDrainage/SustainableDrainage.aspx>

Welsh Government - National Strategy for Flood and Coastal Erosion Risk Management - <https://gov.wales/sites/default/files/publications/2019-03/national-strategy-for-flood-and-coastal-erosion-risk-management-in-wales.pdf>

Welsh Water – How to Contact Us – <https://www.welshwater.com/en/Contact-Us.aspx>