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Caiff Aelodau nad ydyn nhw'n aelodau o'r pwyllgor ac aelodau o'r cyhoedd gyfrannu yn y cyfarfod ar faterion y cyfarfod er bydd y cais yn ôl doethineb y Cadeirydd. Gofynnwn i chi roi gwybod i Wasanaethau Democrataidd erbyn Dydd Iau, 24 Chwefror 2022 trwy ddefnyddio'r manylion cyswllt uchod, gan gynnwys rhoi gwybod a fyddwch chi'n siarad Cymraeg neu Saesneg.

**AGENDA**

**Tudalennau**

**5. ADRODDIADAU YMCHWILIO I LIFOGYDD ADRAN 19**

Derbyn adroddiadau Ymchwilio i Lifogydd Adran 19 y Cyngor o dan Ddeddf Rheoli Llifogydd a Dŵr 2010.

**Atodiad L - Treorci**

**3 - 72**

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# **Flood and Water Management Act 2010**

## **Section 19 Flood Investigation Report**

### **Storm Dennis – Flood Investigation Area RCT26 (Treorchy)**

February 2022

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This report should be read in its entirety

This report has been prepared in accordance with the requirements of section 19 Flood and Water Management Act 2010. The Council assumes no responsibility or liability from any person in connection with its contents or findings.

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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 16<sup>th</sup> of February 2020 within the Rhondda Cynon Taf County Borough Council area, focusing investigation on the flooding at Treorchy in the Rhondda Fawr valley (Flood Investigation Area RCT 26, 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 have 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 16<sup>th</sup> 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 RCT26 resulted in internal flooding to 44 properties, including four commercial properties and flooding to the highway. 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, 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 RCT26 on the 15 and 16<sup>th</sup> February 2020 was a result of significant overland runoff being generated from the steep hillsides above Treorchy 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 four culvert inlets identified as sources of flooding to properties, it was confirmed that the three culvert inlets associated to the ‘Nant Tyle-du’ network do not provide adequate standards of

protection in both free-flowing and blockage conditions. Despite blockages caused by debris being determined as the primary cause of surcharge to the three inlets, it is considered, based on the culvert capacity assessments, that 'Culvert Inlet 1, 2 and 3' would have become hydraulically overloaded during the storm event.

A capacity assessment for 'Culvert Inlet 4', associated to the Nant Coly watercourse, could not be undertaken however it is considered based on the poor condition of the structure that the inlet became hydraulically overloaded during Storm Dennis.

RCTCBC as the Lead Local Flood Authority and Land Drainage Authority has been determined as the relevant Risk Management Authority responsible for managing the ordinary watercourse and surface water flooding that occurred in Treorchy during Storm Dennis.

In response to the flooding in RCT26 during Storm Dennis, the LLFA has undertaken 15 actions and have proposed to undertake a further 3. 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 1673 meters of culverted ordinary watercourse 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;
- Initiated an interim Property Flood Resistance project offering expandable flood gates to properties deemed at high risk of ordinary watercourse and surface water flooding; and
- Installed remote telemetry monitoring devices at key culvert structures to enable operators to ensure the drainage systems within RCT26 are operating effectively.

As the relevant Risk Management Authority for ordinary watercourse flooding, RCTCBC as the Lead Local Flood Authority will also look to better understand the catchment above investigation area RCT26 through the development of an 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. In advance of the works associated to Phase 1 of the OBC, the LLFA have completed a Business Justification Case and Detailed Design.

The event that occurred on 15 and 16<sup>th</sup> 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 at RCT26, however, further measures have been proposed by RMAs to better address preparedness and response to future surface water flood events.

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## 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

**LFRRMS** – 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

**RCT26** – Flood Investigation Area RCT 26

**RMA** – Risk Management Authority

**SAB** – Sustainable Drainage Approval Body

**SFRA** – Strategic Flood Risk Assessment

**SOC** – Strategic Outline Business Case

**OBC** – Outline Business Case

**SuDs** – Sustainable Drainage Systems

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# 1 INTRODUCTION

## 1.1. PURPOSE OF INVESTIGATION

On the 15 and 16<sup>th</sup> 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 26 (further referred to as RCT26) which covers the town of Treorchy in the Rhondda Fawr valley.

The reason behind RCT's investigation is in response to the duties of the local authority in regard 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"<sup>1</sup>

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'<sup>2</sup>.

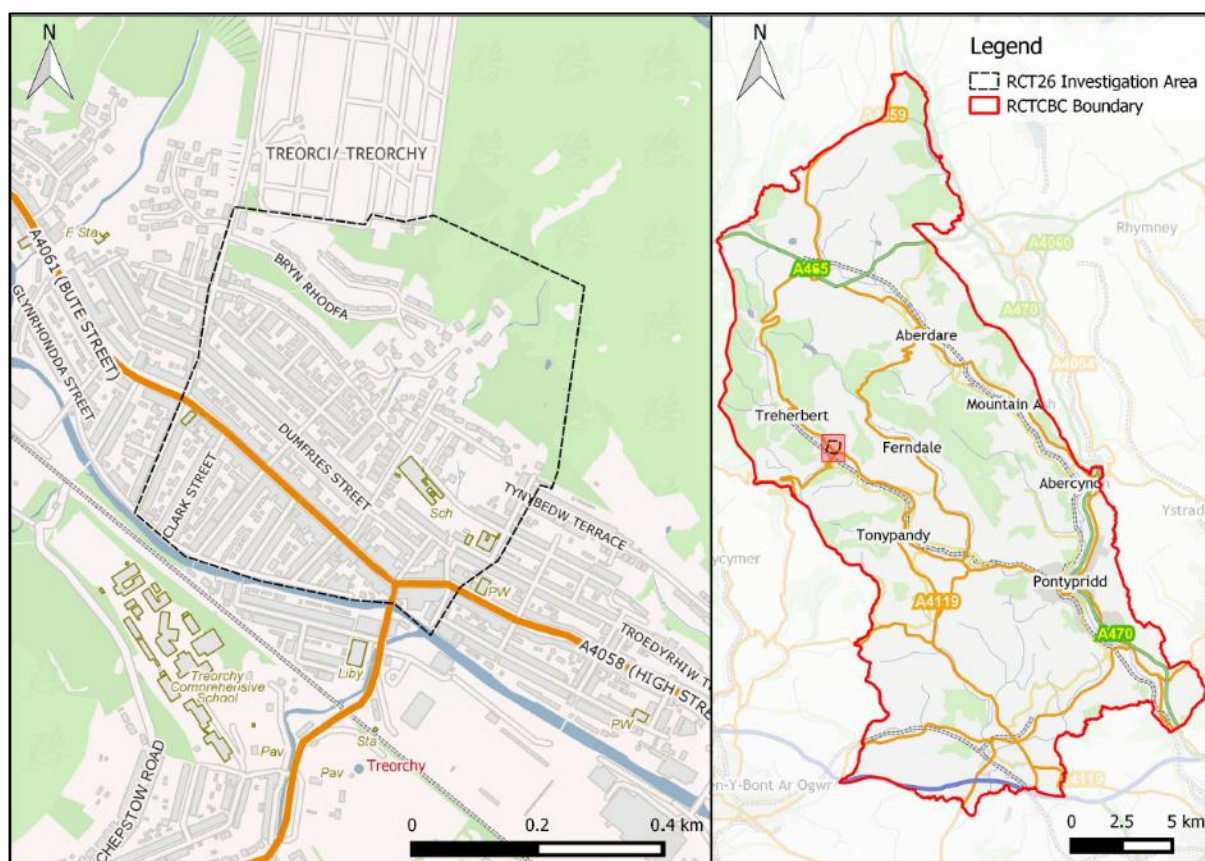
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<sup>1</sup> Flood and Water Management Act 2010 – Section 19 - <https://www.legislation.gov.uk/ukpga/2010/29/section/19>

<sup>2</sup> [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 covers the town and community of Treorchy, located in the north-western sector of Rhondda Cynon Taf CBC in the Rhondda Fawr valley, to the south of Treherbert (Figure 1)



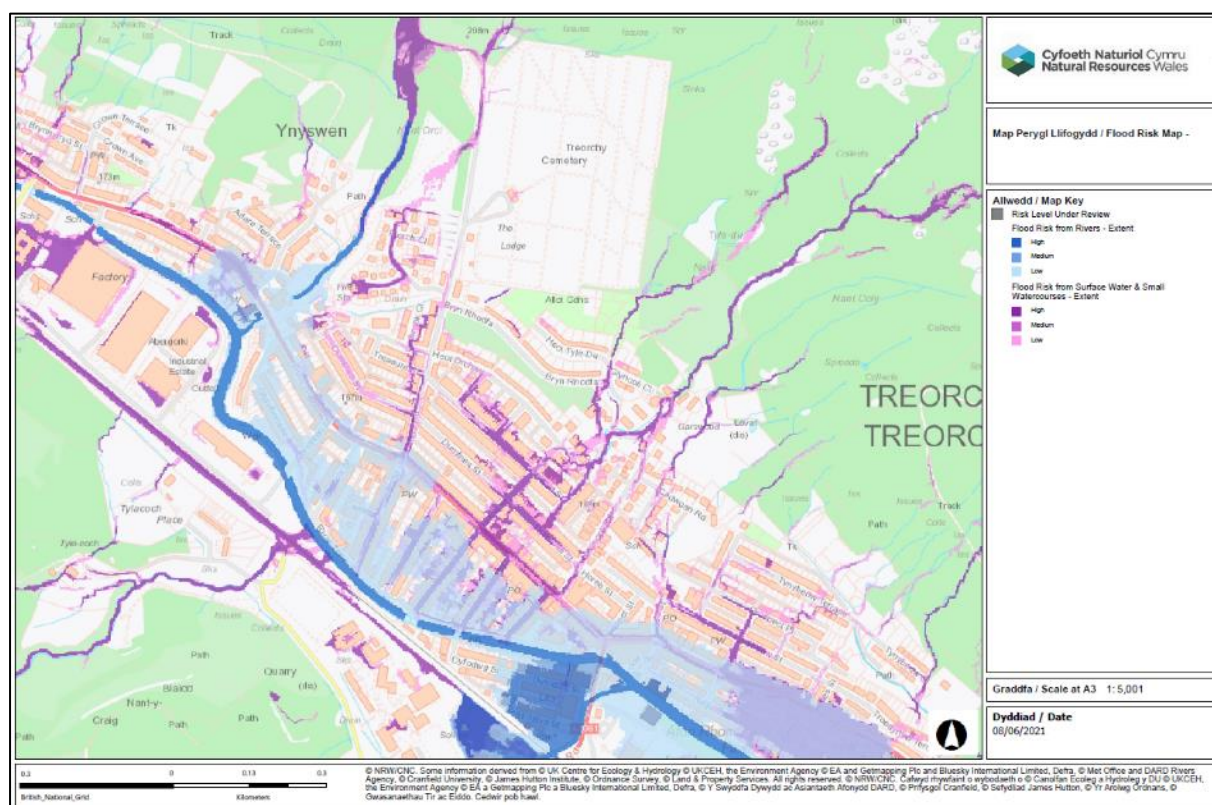
**Figure 1:** Flood Investigation Area RCT26 Location Plan

Treorchy is located within the River Rhondda catchment which flows north to south below the investigation area. The highlands to the east of the Rhondda Fawr River are drained by the Nant Orci watercourse which covers much of the north-eastern sector of Treorchy, along with several minor unnamed watercourses. The Nant Orci falls outside the investigation area to the west of Treorchy Cemetery (Figure 1).

Several ordinary watercourses also drain the hillsides to the east of Treorchy Cemetery. Notably the Nant Tyle-du and Nant Coly watercourses are partially culverted beneath residential development in the east of investigation area RCT27.

Treorchy is predominantly a rural environment because of the steep topography in both the west and east. As a result, residential development is confined to the base of the Rhondda Fawr River and consequently the eastern banks of the Rhondda Fawr River are identified as having low risk of Main River flooding (illustrated in Figure 2).

The steep slopes above Treorchy also contribute to the town's significant ordinary watercourse and surface water flood risk. The community of Treorchy has been ranked as the third most at risk community in Wales for surface water and ordinary watercourse flooding according to the Communities at Risk Register (CaRR). Figure 2, extracted from Natural Resources Wales' Flood Risk Assessment Wales (FRAW) mapping, shows a low to high risk of surface water and ordinary watercourse flooding within the investigation area, related to culvert inlets and bank breaches, particularly associated to the Nant Tyle-du and Nant Coly watercourses.



**Figure 2:** Natural Resources Wales' Flood Risk Assessment Wales (FRAW) map for rivers and ordinary watercourse and surface water flood risk at investigation area RCT26. 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 investigation area RCT26 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
<b>Residents</b>	Photos, videos, statements, email correspondence, public engagement survey responses
<b>Responders' statements</b>	Local responders' statements
<b>CCTV Surveys</b>	Internal surveys of the local drainage networks
<b>Met Office Data</b>	Weather Warning information (see FRM – Storm Dennis – Overview Report)
<b>Rain Gauges</b>	RCT and NRW operated gauge information (see FRM – Storm Dennis – Overview Report)
<b>Natural Resources Wales</b>	River Level and Flood Warning data
<b>RCT Flood Risk Management Plan</b>	Site specific information and data for each electoral ward in RCT
<b>Communities at Risk Register</b>	Flood risk ranking and scores for all flood types based on community data in Wales
<b>Flood Investigation Report (Redstart's FIR)</b>	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.

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## 1.5. PUBLIC ENGAGEMENT

Following the initial flooding event that occurred on the 15 and 16<sup>th</sup> 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 4<sup>th</sup> and 25<sup>th</sup> 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.

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## 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 town of Treorchy. 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 20-21<sup>st</sup> September 2018 and Storm Callum on 12-13<sup>th</sup> October 2018.

During RCT's public engagement exercise, residents at Dumfries Street, an area which was severely impacted during February 2020, reported one previous incident of internal flooding to properties in October 2000 associated to the culvert inlet(s) upstream at Column Street. During this incident it was reported that the majority of the street had been affected by flooding, although its impact was less severe than during Storm Dennis.

## 2.2. FLOOD INCIDENT

The flooding that occurred on the 15<sup>th</sup> and 16<sup>th</sup> 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 Report’<sup>2</sup>.

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 38 residential properties and 4 commercial properties as internally flooded.

A summary of the source(s) and pathway(s) of flooding within investigation area RCT26 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 RCT26 will be described in two parts: the incident at ‘Nant Tyle-du’ sub-catchment and the incident at ‘Nant Coly’ 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 RCT26

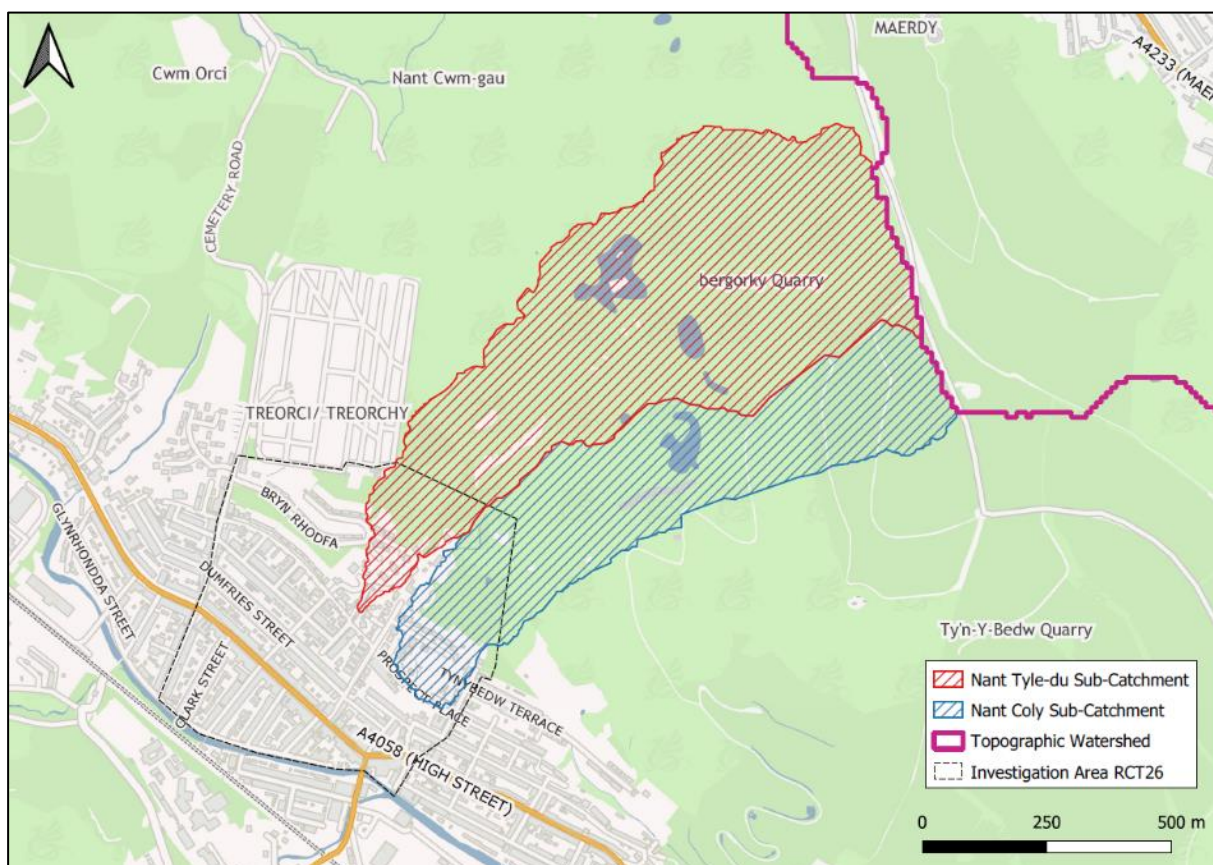
Source	Pathway	Receptor
<b>Nant Tyle-du Sub-Catchment</b>		
Intense rainfall running off the hillsides to the north of Treorchy draining to lower ground via the Nant Tyle-Du Ordinary Watercourse.	Surcharging flows overtopped the inlet structure and conveyed south down Heol Tyle-du towards Bryn Rhodfa.	The primary flow path along Bryn Rhodfa caused internal flooding to 4 residential properties along Heol Orchwy.
A culvert inlet situated at Heol Tyle-du surcharged during the storm event.	At the low point along Bryn Rhodfa, water cascaded down the hillside towards the rear of properties at Heol Orchwy.	The secondary flow path towards Column Street contributed to the flooding of 33 residential properties and 4 commercial properties in the lower reaches of Treorchy (Dumfries Street, Luton Street, A4061 Bute Street / High Street).
	Surcharging flows from the culvert inlet also contributed to the flow path towards Column Street via a small connecting lane.	

<p>A culvert inlet northeast of Glyncoli Close surcharged during the event after becoming blocked due to an obstruction at the inlet.</p>	<p>Surcharging flows from the culvert inlet flowed south towards Glyncoli Close</p>	<p>The flow path towards Glyncoli Close caused internal flooding to 1 residential property at Glyncoli Close.</p> <p>The Flow path further contributed to the flooding of 33 residential properties and 4 commercial properties in the lower reaches of Treorchy (Dumfries Street, Luton Street, A4061 Bute Street / High Street).</p>
<p>A culvert inlet downstream of Glyncoli Close surcharged during the storm event due to hydraulic overload and blockage.</p>	<p>Surcharging flows from the culvert inlet conveyed south down Column Street towards the rear of properties at Dumfries Street.</p> <p>Water conveyed via a small archway between two properties at Dumfries Street and travelled west and east towards Luton Street and Glyncoli Road, impacting several properties along both sides of Dumfries Street.</p> <p>Water continued to flow towards the base of the valley before pooling along the A0461 (Bute Street / High Street).</p>	<p>The surcharging inlet primarily contributed to the flooding of 29 residential properties at Dumfries Street, 3 residential properties at Luton Street and a further 1 residential property along the A4061 Bute Street.</p> <p>1 commercial property at Luton Street and 3 commercial properties along the A4061 High Street were also internally flooded.</p>
<p>Intense rainfall and overland flow from the surcharged culverts resulting in surface water accumulation along several streets.</p>	<p>Surface water ponding along Dumfries Street and the A4061 (Bute Street / High Street).</p>	<p>Contributed to the flooding of 33 residential properties and 4 commercial properties in the lower reaches of Treorchy (Dumfries Street, Luton Street, A4061 Bute Street / High Street).</p>

Nant Coly Sub-Catchment		
Intense rainfall running off the hillsides to the northeast of Treorchy draining to lower ground via the Nant Coly Ordinary Watercourse.	Surcharging flows from the culvert inlet caused a flow pathway through the garden of one private property and onwards to a nearby park space where the water dispersed.	Internal flooding to 1 residential property at Crosswood Street.
A culvert inlet to the north of Crosswood Street surcharged during the storm event after becoming hydraulically overwhelmed.		

On review of Table 2, the principal source of flooding in this incident originated from intense rainfall generating significant surface water runoff from the steep hillsides to the north and east of Treorchy draining to lower ground. This runoff was routed towards the investigation area via several ordinary watercourses, many of which became overwhelmed and/or blocked during Storm Dennis which resulted in property flooding.

Figure 3 depicts the topographic watershed of the Rhondda Fawr and Fach valleys (bold pink line), with rainfall to the south west of the watershed draining to the Rhondda Fawr catchment. The catchment above investigation area RCT26 can be sub-divided into further sub-catchment to illustrate the area of land that would expect to drain towards the investigation area (hatched areas in Figure 3). The flood incident at investigation area RCT26 will be further described in two parts: the incident at 'Nant Tyle-du' sub-catchment (red hatched area, Figure 3) and the incident at 'Nant Coly' sub-catchment (blue hatched area, Figure 3).

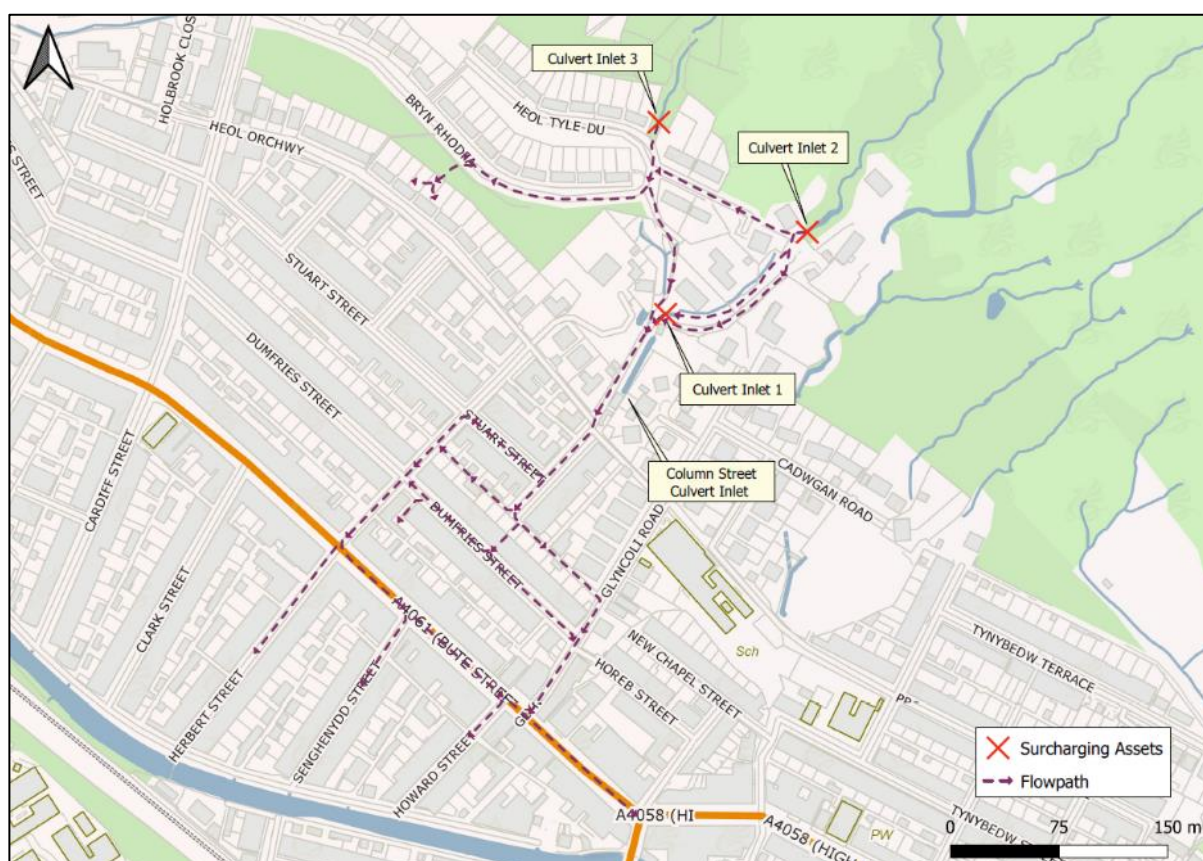


**Figure 3:** Rainfall Topographic Watershed and sub-catchments above investigation area RCT26

### 2.2.1. NANT TYLE-DU SUB-CATCHMENT

The steep hillsides to the northeast of investigation area RCT26 form the 'Nant Tyle-du' catchment. This area is drained by a network of ordinary watercourses which drain into the Nant Tyle-du ordinary watercourse.

Figure 4 depicts the observed pathways of flooding within the 'Nant Tyle-du' 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 within 'Nant Tyle-du' sub-catchment during Storm Dennis (16<sup>th</sup> February 2020)

Several calls were received from residents at Column Street and Dumfries Street on the 16<sup>th</sup> February 2020 to report water ingress into multiple residential properties associated to culvert blockages upstream of Column Street. Upon a site inspection undertaken by RCT's Flood Risk Management team on the 17<sup>th</sup> February 2020, three culvert inlets associated to the Nant Tye-du ordinary watercourse and its tributaries were identified as sources of flooding during the storm event. The location of the culvert inlets are illustrated in Figure 4.

'Culvert Inlet 1' was reported by residents as the primary source of flooding to properties at Dumfries Street, Luton Street and the A4061 (Bute Street / High Street). The inlet is situated approximately 60 metres north of the 'Column Street Culvert Inlet'. The culvert was reported by residents as being "unable to manage the flow of water entering the culvert" during the early hours of the storm event and as a result surcharged. Debris consisting of large stones and silt was also noted by residents to have blocked the inlet debris screen.

Exceedance flows from 'Culvert Inlet 1' overtopped the inlet structure and conveyed south west down Column Street (depicted in Figure 5) towards the rear of properties at Dumfries Street. Water entered Dumfries Street via a small archway between two properties, allowing water to impact the fronts of several properties along both sides of Dumfries Street. Water travelled west along Dumfries Street towards Luton Street, and east towards Glyncoli Road, before continuing its pathway towards the lower reaches of Treorchy where surface water pooled along the A4061 (Bute Street / High Street) (Figure 6).

Approximately 33 residential properties and 4 commercial properties along Dumfries Street, Luton Street and the A4061 (Bute Street / High Street) were internally flooded as a result of this flow path.



**Figure 5:** Evidence of 'Culvert Inlet 1' surcharging during the storm event and conveying southwards towards Column and Dumfries Streets (left) (image provided by resident), and 'Culvert Inlet 1' post storm event (right) (captured by RCT's Flood Risk Management team on 20<sup>th</sup> February 2020)



**Figure 6:** Surface water ponding along the A4061 High Street during Storm Dennis on 16<sup>th</sup> February 2020 (image provided by resident)

Upstream of 'Culvert Inlet 1', 'Culvert Inlet 2', located north east of Glyncoli Close, was reported to have surcharged during the storm event, causing water to travel through external private property towards Glyncoli Close and flooding 1 residential property (flow path depicted in Figure 7).



**Figure 7:** Flow path from 'Culvert Inlet 2' conveying towards Glyncoli Close

Accounts provided by residents stated that the flow of water was diverted by residents during the storm event to allow the water to convey southwards down a small lane towards 'Culvert Inlet 1'. On its path, water was partially redirected back into the downstream open watercourse, whilst the remaining flow conveyed towards the lower reaches of Treorchy, contributing to the flooding at Dumfries Street, Luton Street and the A4061 (Bute Street / High Street).

Video footage provided by residents during RCT's site inspection showed evidence of debris, inclusive of tyres, blocking 'Culvert Inlet 2'. Tyres were also noted to have been amongst the debris removed from 'Culvert Inlet 1' during the storm event.

The site inspection also identified evidence of a third surcharged culvert inlet located at Heol Tyle-Du (labelled 'Culvert Inlet 3' in Figure 4). This inlet conveys flows from the Nant Tyle-du ordinary watercourse towards the 'Column Street Culvert Inlet'. 'Culvert Inlet 3' was observed as surcharging by residents during the event, resulting in water conveying down Heol Tyle Du towards Bryn Rhodfa. At a low point along Bryn Rhodfa, water overtopped the kerb line before cascading down the hillside towards the rear of properties at Heol Orchwy. Four residential properties along Heol Orchwy were confirmed as internally flooded as a result of this flow path.

Exceedance flows from 'Culvert Inlet 3' are also considered to have conveyed towards Column Street, contributing to the flow path which affected properties in the lower reaches of Treorchy.

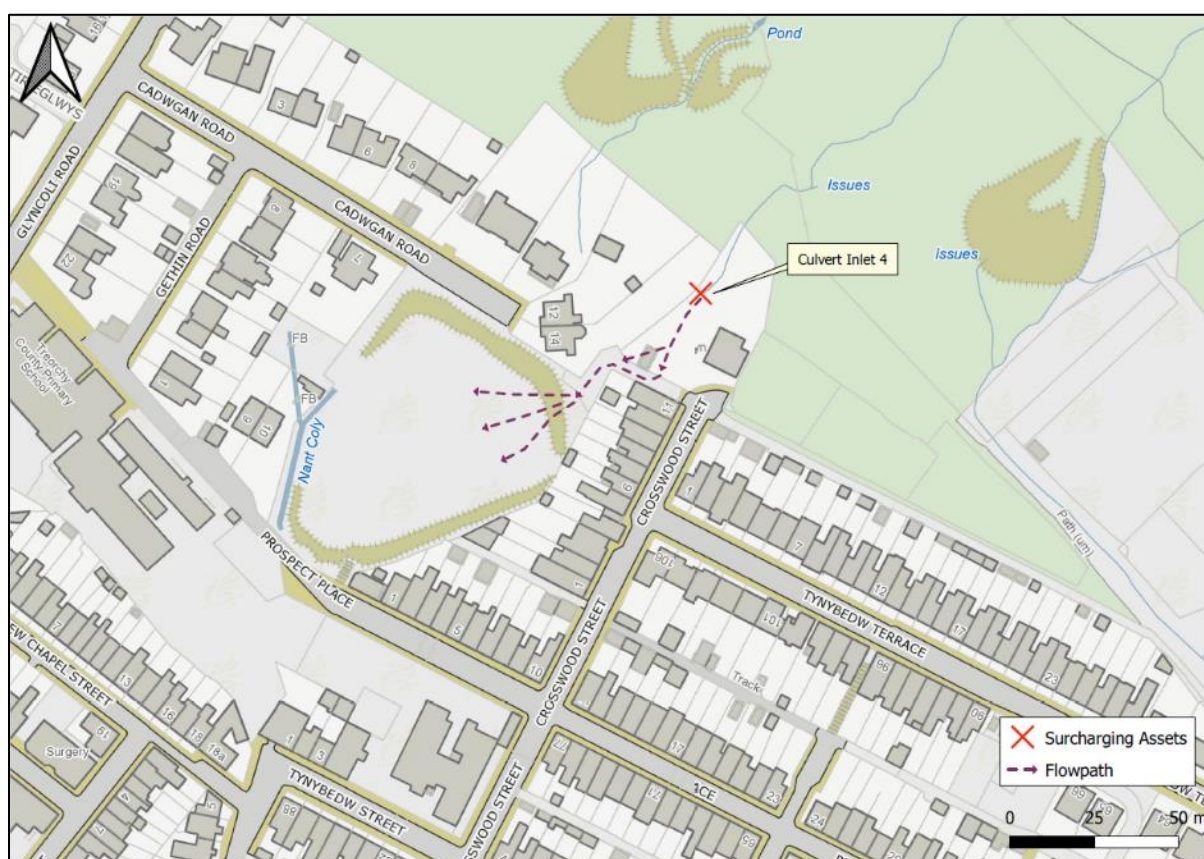


**Figure 8:** Surcharging flows down Heol Tyle Du from 'Culvert Inlet 3' during Storm Dennis (image provided by resident)

### 2.2.2. NANT COLY SUB-CATCHMENT

The steep hillsides to the eastern most land above investigation area RCT26 form the 'Nant Coly' catchment. This area is drained by a network of ordinary watercourses which drain into the Nant Coly ordinary watercourse.

Figure 9 depicts the observed pathways of flooding within the 'Nant Coly' sub-catchment during Storm Dennis. The infrastructure known to have surcharged and contributed to the flooding is illustrated in Figure 9.



**Figure 9:** Observed flow paths within the 'Nant Coly' sub-catchment during Storm Dennis (16<sup>th</sup> February 2020)

Calls were received by residents at Crosswood Street to report water emanating from a culvert inlet situated north of Crosswood Street. Upon wider inspection of the area and discussions with residents, undertaken by RCT's Flood Risk Management team on 21<sup>st</sup> February 2020, one culvert inlet, labelled 'Culvert Inlet 4' in Figure 9, showed evidence of surcharge.

Residents stated that the flow of water entering the culvert during the storm event was unprecedented, indicating that the inlet became hydraulically overloaded during Storm Dennis. Photographic evidence provided by residents show ponding water surrounding the culvert inlet during the morning of 16<sup>th</sup> February 2020 (Figure 10 left), in addition to evidence of the surcharging flows conveying through private property towards an open park space below Cadwgan Road, where water reportedly dispersed overland (Figure 10 right).

One residential property at Crosswood Street was internally impacted by the flows originating from 'Culvert Inlet 4' during Storm Dennis.



**Figure 10:** Evidence of 'Culvert Inlet 4' surcharging during Storm Dennis (left) and evidence of surcharging flows travelling through the garden of a private property towards the park space downstream (right) (images provided by resident)

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### **2.3. RAINFALL ANALYSIS**

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

## 3 POSSIBLE CAUSES

### 3.1. CULVERT CONDITIONS

Within investigation area RCT26 there are several unnamed watercourses which drain the hillsides above the town of Treorchy and discharge into the Rhondda Fawr River. Many of these watercourses are culverted beneath Treorchy's urban settlement.

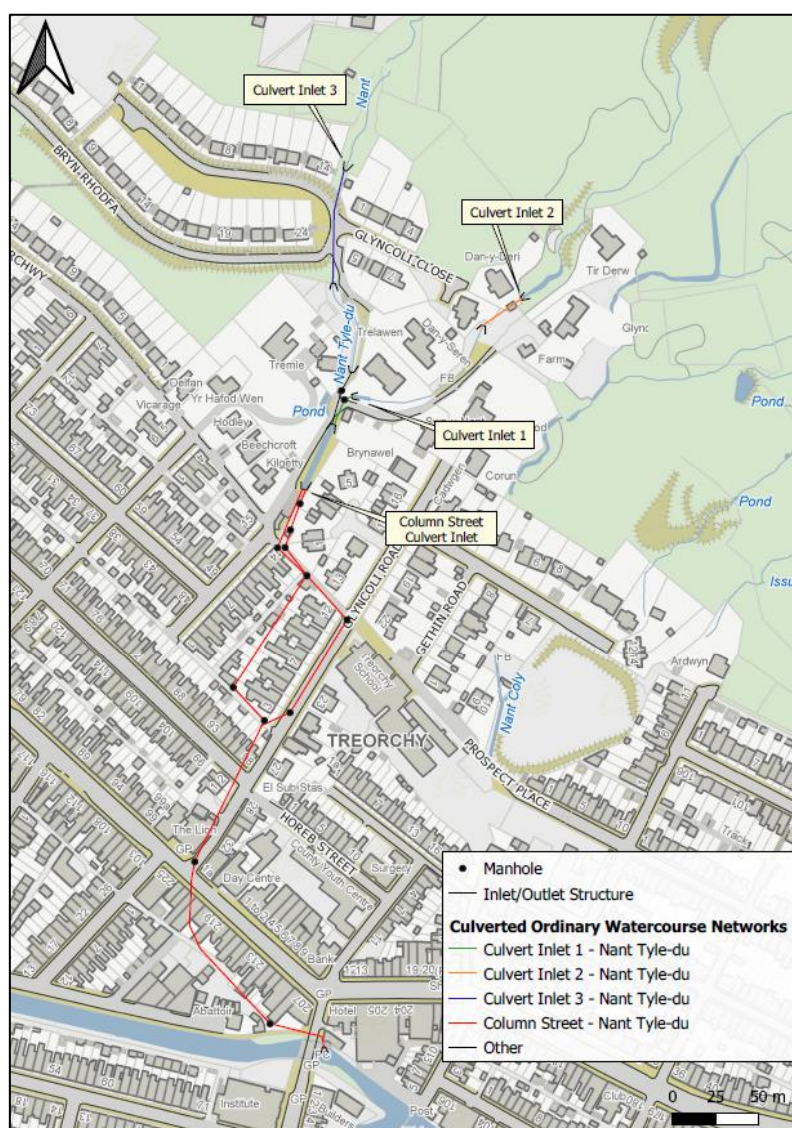
Several culvert inlets were inspected by RCT's Flood Risk Management team and Council's Highway and Streetcare Depot following the flood event to assess their condition and help determine whether they served as a contributing factor to the flooding at Treorchy. CCTV survey inspections of the culvert 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. As such, the following should be considered to be reflective of the asset condition at the end of the storm event and may not be 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 RCT26 will be described in two parts: the 'Nant Tyle-du' sub-catchment and the 'Nant Coly' sub-catchment.

#### 3.1.1. NANT TYLE-DU SUB-CATCHMENT

Figure 11 outlines the four networks surveyed within the 'Nant Tyle-du' sub-catchment and highlights the culvert inlets known to have surcharged. All four culvert networks are associated to the Nant Tyle-du ordinary watercourse and its tributaries.



**Figure 11:** Surveyed culverted ordinary watercourse networks within the 'Nant Tyle-du' sub-catchment

### 3.1.1.1. CULVERT INLET 1 – NANT TYLE-DU NETWORK

'Culvert Inlet 1' was identified as a primary source of flooding to properties at Dumfries Street, Luton Street and the A4061 (Bute Street / High Street). The culvert inlet is a steep box culvert inlet and is identified as a privately owned asset.

The 'Culvert 1 – Nant Tyle-du' network was surveyed to be in acceptable condition downstream of the inlet however, significant debris was noted to have accumulated within the inlet chamber during cleansing operations (Figure 12, right). The ordinary watercourse entering the culvert network is set much higher than the inlet itself,

allowing smaller debris to pass through the debris screen and build up at the start of the pipe (Figure 12, left).



**Figure 12:** Image of 'Culvert Inlet 1' captured post event during CCTV surveying operations (30/07/2020) (left) and evidence of debris accumulation within the culvert chamber (right)

The CCTV survey also noted damages caused to the inlets trash screen, indicating that the inlet suffered significant debris accumulation during the storm event. It was noted by residents and emergency responders that the culvert became blocked with debris during the storm event. It was also noted by residents that tyres were amongst the debris removed from the culvert.

Evidence of the volume and type of debris removed from 'Culvert Inlet 1' post event is depicted in Figure 13.

The condition of the inlet structure itself is considered to have contributed to the surcharging at 'Culvert Inlet 1' by allowing some debris to enter the network however, the volume of debris entering the network from the hillside above RCT26 is considered the primary cause of surcharge.



**Figure 13:** Evidence of debris removed from 'Culvert Inlet 1' post event (captured by Council appointed contractor during CCTV surveying operations on 30/07/2020)

### 3.1.1.2. CULVERT INLET 2 – NANT TYLE-DU NETWORK

'Culvert Inlet 2' was identified as a source of flooding to one property at Glyncoli Close, in addition to contributing to the flooding in the lower reaches of RCT26 during Storm Dennis. 'Culvert Inlet 2' consists of a 450mm concrete pipe and is identified as a privately owned asset.

'Culvert Inlet 2' was identified by first responders as being blocked with silt and debris mobilised by the fast-flowing water entering the network during the storm event. Photographs and video footage provided by residents during post event inspections carried out by RCT's Flood Risk Management team on 17<sup>th</sup> February 2020 show evidence of tyres being manually pulled out of the culvert inlet to manage the flow of water (Figure 14). This material was reportedly washed down from the upstream ordinary watercourse section (described in Section 3.2).



**Figure 14:** Evidence of debris, inclusive of tyres, causing a blockage to 'Culvert Inlet 2' during Storm Dennis (left) and evidence of the three tyres removed from the inlet by a resident (right) (images provided by resident)

'Culvert Inlet 2 – Nant Tyle-du' network was surveyed by a Council appointed contractor in August 2020. The culvert network was found to be in poor structural condition with multiple operational defects observed. Its poor condition is considered to have contributed to the surcharging of 'Culvert Inlet 2', however, the blockage to the inlet structure has been determined as the most significant contributor to the surcharging and associated flood flow path along Glyncoli Close and downhill towards Column Street during Storm Dennis.

#### **3.1.1.3. CULVERT INLET 3 – NANT TYLE-DU NETWORK**

'Culvert Inlet 3', situated north of Heol Tyle-du, was identified as the source of flooding to four residential properties at Heol Orchwy, in addition to contributing flows towards the lower reaches of Treorchy. The inlet comprises of a 450mm concrete pipe and is identified as a Council owned asset.

Upon an inspection of 'Culvert Inlet 3' carried out by RCT's Highways and Streetcare Depot post storm event, the inlet was identified as blocked with debris mobilised from

the hillsides above RCT26 during the storm event. This debris is considered to have reduced the inlet's hydraulic capacity to manage the flow of water, resulting in surcharge. The inlet was initially cleared by local residents (Figure 15) and subsequently, inspected and cleared of debris by the Highway and Streetcare Depot.



**Figure 15:** Photo of 'Culvert Inlet 3' following initial debris clearance by local residents on 16<sup>th</sup> February 2020.

Internal CCTV surveys of the culvert network recorded the culvert as being in poor structural and operation condition with several fractures and broken sections of pipe in addition to loss in cross-sectional area caused by settled deposits. As a result, approximately 2 tonnes of debris was removed from the network during cleansing operations.

The poor condition of the 'Culvert Inlet 3 – Heol Tyle-du' network is considered to have contributed to the flooding however, blockages to the inlet structure which reduced the inlet's hydraulic capacity to manage the flow of water has been determined as the most significant contributor to the observed surcharging during Storm Dennis.

#### 3.1.1.4. COLUMN STREET – NANT TYLE-DU NETWORK

Downstream of 'Culvert Inlets 1, 2 & 3', associated to the Nant Tyle-du ordinary watercourse, the condition of the 'Column Street Culvert Inlet' was also assessed following the storm event.

During the storm event, the 'Column Street Culvert Inlet' and upstream section of open watercourse was observed as being almost at full capacity (Figure 16). Partial debris accumulation behind the upper debris screen within the open channel were observed by residents however, it was noted that the culvert inlet was still able to manage the flow of water during the storm event (Figure 16).



**Figure 16:** Column Street open channel and culvert inlet showing high flows (image provided by resident. Captured at 11am on 16th February 2020)

Internal surveys of the culvert network downstream of 'Column Street Culvert Inlet' have highlighted several sections of the culvert drainage system that are in poor condition. The poor condition of the culvert network is not considered to have

contributed to the flooding at RCT26 as no flooding was observed from the 'Column Street – Heol Tyle-du' culvert network during the storm event.

It is considered that the blockages and resultant surcharge at 'Culvert Inlets 1, 2 & 3', alleviated the volume of water that would have otherwise conveyed towards the 'Column Street Culvert Network' and thereby reduced the risk of this inlet surcharging.

### 3.1.2. NANT COLY SUB-CATCHMENT

Figure 17 depicts the 'Culvert Inlet 4' culverted ordinary watercourse network associated to the Nant Coly ordinary watercourse within the 'Nant Coly' sub-catchment.



**Figure 17:** Surveyed culverted ordinary watercourse network within the 'Nant Coly' sub-catchment

'Culvert Inlet 4' was identified as the source of flooding to one residential property at Crosswood Street. The inlet was inspected by RCT's Flood Risk Management team in the days following the storm event and was found to be in poor condition (Figure 18).

The network downstream of 'Culvert Inlet 4' was unable to be surveyed due to the inlet's poor condition restricting camera access. Furthermore, the area around the inlet structure had been washed away meaning there was no access point on the safety grid to securely carry out the CCTV survey.



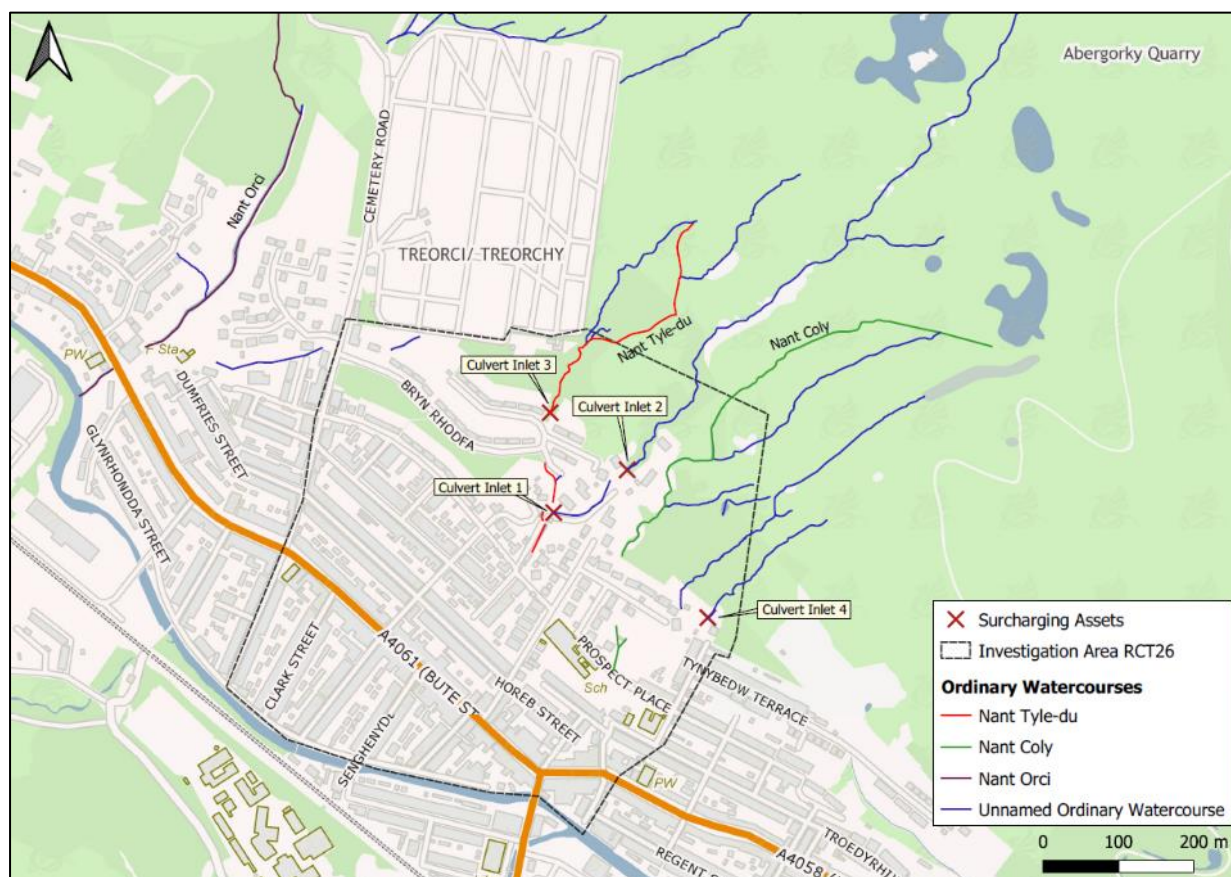
**Figure 18:** Photo of 'Culvert Inlet 4' captured by RCT's Flood Risk Management team post storm event on 21<sup>st</sup> February 2020

The network downstream was surveyed to be in mostly good condition, indicating that the condition of the 'Culvert Inlet 4 – Nant Coly' culvert network was not an influencing factor in the surcharge of 'Culvert Inlet 4' during the storm event.

Based on the available evidence, this investigation has concluded that the condition of several culvert networks within investigation area RCT26 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. ORDINARY WATERCOURSE CONDITIONS

Several sections of natural ditches and open watercourses which drain the steep catchment above Treorchy are identified to flow through the investigation area, as illustrated in Figure 19. The most notable watercourses include the Nant Tyle-du and the Nant Coly. The Nant Orci drains the hillsides to the northwest of RCT26 and flows outside of the investigation area boundary.



**Figure 19:** Map of Ordinary Watercourses which flow through investigation area RCT26

Following the storm event, RCT Flood Risk Management officers carried out a site walk-over assessment of the ordinary watercourses upstream of the culvert inlets identified as sources of flooding (highlighted in Figure 19) to assess the condition of the watercourse for any signs of overtopping, evidence of scour and any land movement of the hillsides.

### 3.2.1. NANT TYLE-DU ORDINARY WATERCOURSE AND TRIBUTARIES

'Culvert Inlet 1 and 2' drain the north eastern hillsides via an unnamed tributary which discharges into the Nant Tyle-du ordinary watercourse at Column Street. The unnamed ordinary watercourse upstream of 'Culvert Inlet 2' was inspected by RCT Flood Risk Management officers on 17<sup>th</sup> February 2020 following reports that debris, inclusive of tyres, was washed down from the upper catchment and caused a blockage at 'Culvert Inlet 2'. Similar debris, inclusive of tyres, was also identified as a cause of blockage to 'Culvert Inlet 1' downstream.

On review of the unnamed open watercourse conditions upstream of 'Culvert Inlet 2', an obstruction was identified within the channel. Evidence of the obstruction, which consisted of a man-made tyre damn across the width of the channel, is shown in Figure 20. This material is considered to have been mobilised downstream during the storm event, contributing to the surcharge of 'Culvert Inlet 2' and 'Culvert Inlet 1' by reducing both inlets' hydraulic capacities to manage the flow of the watercourse.



**Figure 20:** Image of tyre damn acting as an obstruction to the watercourse upstream of 'Culvert Inlet 2' (captured by RCT's Flood Risk Management team on 17th February 2020)

In response to the identified obstruction, the Land Drainage Authority reviewed its records associated to consents under Section 23 of the Land Drainage Act 1991 and identified that the modified structure did not have consent. An enforcement warning was issued to the riparian landowner under Section 24 of the Land Drainage Act 1991 that resulted in the owner removing the obstruction within the channel.

Upstream of the identified obstruction, the unnamed ordinary watercourse channel showed evidence of debris mobilisation within the upper catchment above RCT26 (Figure 21). On review of the type of debris that contributed to the blockages at 'Culvert Inlets 1 and 2', the identified stonewash material depicted in Figures 21 is considered to have been washed down the catchment towards both culvert inlets during the storm event and contributing to its surcharge.



**Figure 21:** Photo of the unnamed ordinary watercourse upstream of 'Culvert Inlet 2' within the upper catchment (captured by RCT's Flood Risk Management team on 17<sup>th</sup> February 2020)

On review of the section of open channel above 'Culvert Inlet 1', the watercourse was observed as showing signs of debris mobilisation in addition to minor scouring of the surrounding embankment areas, indicative of the fast-flowing water conveying towards 'Culvert Inlet 1' during the storm event. The deposited debris largely consisted of large stones (Figures 22).

Although it is not possible to conclude that this material was wholly transported downstream during the storm event, the material pulled out of 'Culvert Inlet 1' and deposited by the side of the structure during emergency cleansing operations (Figure

13) consisted of similar stonewash material inclusive of large stones. It is considered that this material was transported from the upper reaches of Treorchy via the unnamed watercourse and contributed to the surcharging of both 'Culvert Inlet 1 and 2'.



**Figure 22:** Unnamed open watercourse upstream of 'Culvert Inlet 1' showing evidence of large stones within the channel and surrounding embankment area (captured by RCT's Flood Risk Management team on 20<sup>th</sup> February 2020). Looking downstream towards 'Culvert Inlet 1' (left) and looking upstream towards the outfall of 'Culvert Inlet 2' (right).

The Nant Tyle-du ordinary watercourse enters the town of Treorchy via 'Culvert Inlet 3' at Heol Tyle-du. On review of the condition of the Nant Tyle-du ordinary watercourse, significant accumulation of natural scour material was evident behind the upper debris screens upstream of 'Culvert Inlet 3' (Figure 23). Figure 23 highlights the extreme flows within the Nant Tyle-du during the storm event which were able to convey a significant volume of scour material downstream towards 'Culvert Inlet 3'.



**Figure 23:** Photo of significant debris accumulation behind the upstream debris screens above 'Culvert Inlet 3' in the Nant Tyle-du watercourse (captured by a Council appointed contractor on 03/08/2020 during CCTV survey operations)

### **3.2.2. NANT COLY ORDINARY WATERCOURSE AND TRIBUTARIES**

'Culvert Inlet 4' drains the north eastern hillsides via an unnamed tributary which discharges into the Nant Coly ordinary watercourse at Prospect Place. The unnamed ordinary watercourse upstream of 'Culvert Inlet 4', which was identified as a source of flooding during Storm Dennis, was inspected by RCT Flood Risk Management officers on 21<sup>st</sup> February 2020.

The unnamed ordinary watercourse channel was observed as largely undefined with dense vegetation restricting on-site inspections (Figure 24). The inspecting officer noted minimal evidence of scour and debris deposition within the channel, and debris was not noted at 'Culvert Inlet 4' during post event inspections, indicating that the geomorphic condition of the upstream channel had little impact on the surcharging of 'Culvert Inlet 4'.



**Figure 24:** Photo of the unnamed ordinary watercourse upstream of 'Culvert Inlet 4' (captured by RCT's Flood Risk Management team on 21<sup>st</sup> February 2020)

Following evidence from the Storm Dennis flooding event, it is clear that morphological processes can be a key contributor to flood risk. As a result, a geomorphological review of the upper catchment above Treorchy was carried out in early November 2020 by JBA Consulting, on behalf of RCT, which identified evidence of “localised slope failure” and “depositional features within the incised river channels, indicating temporary storage of sediment” which would be activated during extreme storm events and transported downstream<sup>3</sup>.

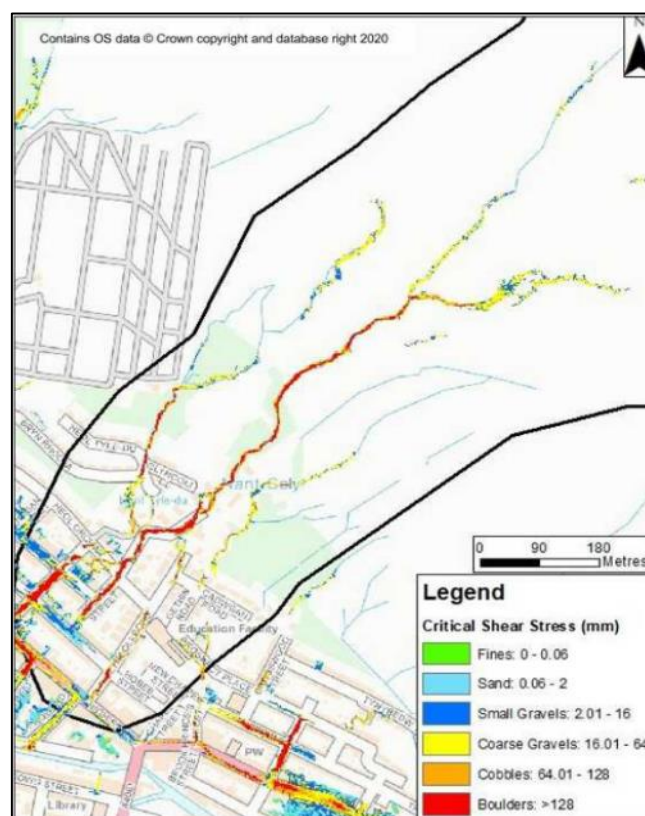
Observations made during the geomorphic assessment indicates a high availability of loose sediment in the upper hillslopes above Treorchy which can become “entrained and delivered to the watercourse network via overland flows”. The delivery of sediment and stone towards the investigation area during Storm Dennis has primarily been attributed to “natural erosional processes associated with an extreme flood event” which is exacerbated by the steep slope profiles of the ordinary watercourses flowing towards Treorchy which produce faster velocities and increased sheer stresses.

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<sup>3</sup> Fluvial Geomorphology Assessment: Treorchy, JBA Consulting, December 2020

Hydraulic modelling was undertaken by JBA to calculate the shear stresses produced during a 1 in 100 annual probability event (Q100) (Figure 25). The model results show that during a Q100 flood event, akin to extreme storm events such as Storm Dennis, significant velocities in the ordinary watercourse channels generate shear stresses capable of entraining sediment up to cobble and boulder size through most of the channel lengths. This is particularly apparent along the Nant Tyle-du and its tributaries, where debris and sediment mobilisation has been attributed as the primary cause of surcharge at 'Culverts 1, 2 and 3'.

Shear stresses along the Nant Coly and its tributaries are less severe which also supports the conclusion that morphological processes had less impact on the surcharge of 'Culvert Inlet 4'. The surcharging at this inlet has been attributed to the watercourse and culvert inlet becoming hydraulically overwhelmed during the storm event.



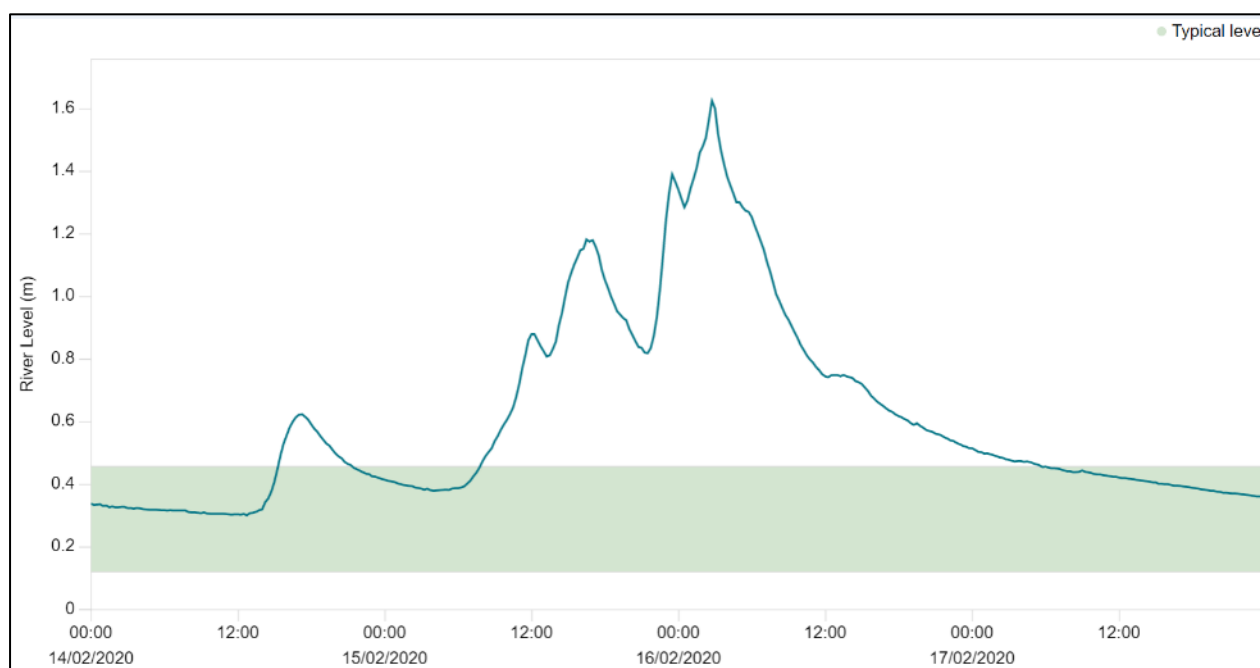
**Figure 25:** Critical shear street results in the Q100 flood event produced by JBA's hydraulic modelling

The material in the upper reaches of Treorchy is believed to have contributed to the surcharging of several culverts during Storm Dennis, in addition to the blockages observed to the highway drainage infrastructure within the lower reaches of Treorchy as a result of overland flows carrying material.

### 3.3. MAIN RIVER

The designated main river Rhondda Fawr flows through the town of Treorchy (Figure 1), to the south of the investigation area.

The hydrograph in Figure 26 illustrates the rapid rise in levels of the River Rhondda Fawr in response to rainfall, captured NRW's Tynewydd station, located approximately 3 km upstream of RCT26. The River Rhondda Fawr at Tynewydd reached its highest peak recorded at 02:45 on 16<sup>th</sup> February 2020, reaching 1.62 metres.



**Figure 26:** The Rhondda Fawr River levels at Tynewydd 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 Rhondda Fawr at Tynewydd station, ranging between 0.1 and 0.5 meters. At its peak, the River Rhondda Fawr was over twice its average level, stressing the extreme and unprecedented levels that RCT's rivers rose to during the storm's peak intensity.

There is no evidence from this investigation to suggest that the main River Rhondda Fawr significantly contributed to the recorded flooding of properties at RCT26 during Storm Dennis.

### 3.4. HIGHWAY DRAINAGE CONDITIONS

Anecdotal reports note surface water was observed to convey down several streets within the investigation area during Storm Dennis. Notably, much of the observed surface water originated from ordinary watercourse flooding associated to culvert inlets surcharging.

Overland flows from areas of hillside and runoff originating from surcharged culvert inlets across RCT26 resulted in deposition of mud, silt and debris across several streets which is assumed to have entered the highway drainage network via gullies. Evidence of deposited debris along Column Street is indicative of the flow path during the storm event (Figure 27).



**Figure 27:** Road damage and debris deposited along Column Street by the surcharging ordinary watercourse flows during the storm event (image provided by resident)

Figure 28 shows the deposits of silt and debris left behind along Dumfries Street once the flood water had drained away. In these instances, it is likely that highway drainage assets will have had a limited capacity to intercept flows within the investigation area. This reduction in hydraulic capacity is considered to have contributed to the surface water flooding observed at Dumfries Street and the A4061 (Bute Street / High Street)

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.



**Figure 28:** Photo of deposits of silt and debris left behind at Dumfries Street following the flooding during Storm Dennis (image provided by resident)

Highway drainage is not designed to manage overland flows from private areas, parks or open space. In this instance, the capacity of the highway drainage was exceeded by the substantial ordinary watercourse and surface water flows entering the drainage network across RCT26. Given the severity of the storm, the maintenance condition of the highway surface water drainage system is not considered to have significantly impacted on the flooding experienced within Treorchy.

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### **3.5. DCWW APPARATUS**

Between the 16<sup>th</sup> and 20<sup>th</sup> February 2020, one incident of internal flooding at Heol Orchwy was reported to DCWW. Upon an inspection of the property on the 16<sup>th</sup> February 2020, DCWW concluded that the cause of internal flooding at Heol Orchwy originating from 'Culvert Inlet 3' due to a blockage at the inlet structure which caused water to surcharge along Bryn Rhodfa and cascade towards Heol Orchwy, resulting in internal flooding to four residential properties.

No further reports of internal flooding were reported to DCWW during the storm event at investigation area RCT26 and it is not believed that any DCWW infrastructure was damaged during the storm event. Whilst DCWW have concluded that their assets performed well during Storm Dennis, the majority of drainage infrastructure within the investigation area is comprised of combined sewer networks which are likely to have become overwhelmed during the storm event for the reasons outlined in Section 3.4.

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### **3.6. SURFACE WATER**

Surface water runoff as a result of ordinary watercourse flooding associated to blocked and overwhelmed culvert inlets has been determined as a contributing source of flooding to properties within the lower reaches of Treorchy, particularly along the A4016 (Bute Street / High Street), where water naturally accumulates.

The volume of water conveying to these low points within RCT26 during Storm Dennis would have been unable to drain away via 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 at Dumfries and Luton Streets.

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### **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 11 and 17) 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 summarised in the Table below (refer to Figure 11 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 within RCT26

<b>Culvert Network</b>	<b>Standard of Protection (SOP) – Free Flowing</b>	<b>Standard of Protection (SOP) – Blockage Conditions</b>
<b>Culvert Inlet 1 (Nant Tyle-du)</b>	Q5 (20% AEP)	Q2 (50% AEP)
<b>Culvert Inlet 2 (Nant Tyle-du)</b>	Q2 (50% AEP)	<Q2 (50% AEP)
<b>Culvert Inlet 3 (Nant Tyle-du)</b>	Q5 (20% AEP)	Q2 (50% AEP)
<b>Column Street Inlet (Nant Tyle-du)</b>	Q2 (50% AEP)	<Q2 (50% AEP)

The results from the culvert capacity assessments and hydraulic modelling undertaken as part of Redstart's FIR, infer that all four culvert inlets, associated to the Nant Tyle-du ordinary watercourse and its tributaries, are under capacity.

'Culvert Inlet 1 and 3' has a SOP of Q5, which is further reduced to below Q2 with the presence of blockage. 'Culvert Inlet 2' and 'Column Street Inlet' has a SOP of Q2 which is further reduced to below Q2 with the presence of blockage.

On review of the culvert capacity assessments, it is inferred that all four culvert inlets became hydraulically overloaded during the storm event, however 'Culvert Inlet 1, 2 and 3' were recorded as surcharged due to blockages to the inlet structures caused by debris which significantly reduced the culvert networks' capacity. This has been determined as the primary cause of flooding at 'Culvert Inlet 1, 2 and 3'.

Despite the blockages to the inlet structures being identified as the primary cause of flooding at 'Culvert Inlet 1, 2 and 3', the capacity of the inlets is well below current design standards for new culverts and therefore it is considered likely that all three

inlets would have become hydraulically overloaded in free-flowing conditions during the storm event.

Although the capacity of the 'Column Street Inlet' has been assessed as not adequate for the expected flows, no flooding was observed from this inlet during the storm event. The surcharging of the Heol Tyle-du culvert network upstream of 'Column Street Inlet' is considered to have alleviated the risk of surcharge at this inlet.

A culvert capacity assessment could not be undertaken for 'Culvert Inlet 4' due to the poor condition of the aged infrastructure. The inlet was observed as surcharging due to hydraulic overload therefore it is considered that the inlet does not provide adequate SOP as stipulated by CIRIA C786.

### 3.9. SUMMARY OF POSSIBLE CAUSES

The above sections have identified and described the possible causes of flooding within the town of Treorchy during Storm Dennis which occurred on the 15 and 16<sup>th</sup> 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 investigation area RCT26 during Storm Dennis

Ref No	Asset (Source)	Issue	Asset Owner	Type of Flooding
1	Culvert Inlet 1 (Nant Tyle-du)	The culvert inlet surcharged during the storm event after becoming blocked with debris mobilised from the ordinary watercourse upstream which caused water to overtop at the inlet and flow south towards the lower reaches of Treorchy.	Private Landowner	Ordinary Watercourse
2	Culvert Inlet 2 (Nant Tyle-du)	The culvert inlet surcharged during the storm event after becoming blocked with debris mobilised from the ordinary watercourse upstream which caused water to flow towards Glynoli Close as well as contributing to the flow path towards the lower reaches of Treorchy.	Private Landowner	Ordinary Watercourse
3	Culvert Inlet 3 (Nant Tyle-du)	The culvert inlet surcharged during the storm event after becoming blocked with debris during the storm event which caused water to overtop at the inlet and flow towards Bryn Rhodfa and Heol Orchwy, as well as contributing to the flow path towards the lower reaches of Treorchy.	Rhondda Cynon Taf Highway Authority	Ordinary Watercourse
4	Culvert Inlet 4 (Nant Coly)	The culvert inlet to the north of Crosswood Street surcharged after becoming hydraulically overwhelmed during the storm	Private Landowner	Ordinary Watercourse

		event, causing water to flow overland towards an open park area north of Prospect Place.		
5	Surface water drainage network across RCT26	<p>Ponding surface water was reported by residents across several streets, including Dumfries Street and the A4061 (Bute Street / High Street).</p> <p>The highway drainage network within RCT26, particularly in the lower reaches, was over capacitated and 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.</p>	Rhondda Cynon Taf Highway Authority	Surface Water

## 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 the Welsh Government's National Strategy for Flood and Coastal Erosion Risk Management, Section 4 'Roles & Responsibilities'<sup>4</sup>, and RCT's 'FRM – Storm Dennis - Overview Report'<sup>2</sup>.

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

Type of Flooding	Risk Management Authority
<b>Flooding from Main River, reservoirs and the sea (including coastal erosion).</b>	Natural Resources Wales
<b>Flooding from ordinary watercourses, surface water and groundwater</b>	Lead Local Flood Authority
<b>Flooding from water and sewage systems</b>	Water Companies (Dŵr Cymru Welsh Water)
<b>Flooding from the highway</b>	Highway Authority
<b>Flooding from the highway (motorways and major trunk roads)</b>	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 the investigation of the flooding that impacted RCT26, the flood risk management functions exercised or proposed to exercise by relevant RMAs was recorded pursuant to Section 19 of the Flood and Water Management Act 2010, which states:

<sup>4</sup> [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 RCT26 during Storm Dennis have been previously identified and summarised within Table 4. The Risk Management Authority(ies) responsible for managing that flooding has been determined as the Lead Local Flood Authority and Land Drainage Authority (Table 6). Table 6 also presents a series of recommendations put forward 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 investigation area RCT26 (as per Table

4)

Ref No	Asset (Source)	Asset Owner	Type of Flooding	Relevant Risk Management Authority	Recommendations	
1	Culvert Inlet 1 (Nant Tyle-du)	Private Landowner	Ordinary Watercourse	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 investigate the standard of protection and the condition of the culvert structure and network as a whole.
					R1C	Jet and cleanse the ordinary watercourse network.
					R1D	The LLFA and LDA to engage with the riparian landowner to regulate the

2	Culvert Inlet 2 (Nant Tyle- du)	Private Landowner	Ordinary Watercourse	Lead Local Flood Authority and Land Drainage Authority		ordinary watercourse infrastructure to ensure the infrastructure is free flowing and unobstructed.
					R1E	The LLFA to develop a OBC to identify suitable management methods to reduce the risk of ordinary watercourse and surface water flooding in Treorchy.
					R2A	The LLFA and LDA to identify asset ownership and responsibility.
					R2B	The LLFA and LDA to investigate the standard of protection and the condition of the culvert structure and network as a whole.
					R2C	Jet and cleanse the ordinary watercourse network.
					R2D	The LLFA and LDA to engage 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 OBC to identify suitable management methods to reduce the risk of ordinary watercourse and surface water flooding in Treorchy.
3	Culvert Inlet 3 (Nant Tyle-du)	RCT Highway Authority	Ordinary Watercourse	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 and LDA to review the risk of scour potential within the ordinary watercourse channel and work
					R3E	The LLFA and LDA to work with riparian landowners to identify suitable management methods to reduce the risk of scour within the ordinary watercourse.

					R3F	The LLFA to develop a OBC to identify suitable management methods to reduce the risk of ordinary watercourse and surface water flooding in Treorchy.
					R3G	The LLFA to install remote telemetry monitoring at Culvert Inlet 3 to monitor the risk of blockage.
4	Culvert Inlet 4 (Nant Coly)	Private Landowner	Ordinary Watercourse	Lead Local Flood Authority and Land Drainage 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 and LDA to engage with the riparian landowner to regulate the ordinary watercourse infrastructure to ensure the infrastructure is free flowing and unobstructed.

					R4E	The LLFA to develop a OBC to identify suitable management methods to reduce the risk of ordinary watercourse and surface water flooding in Treorchy.
5	Surface water drainage network across RCT26	RCTCBC Highway Authority	Surface Water	Highway Authority and Lead Local Flood Authority	R5A	The Highways Authority to jet and cleanse the highway drainage network and action repairs accordingly.
					R5B	The LLFA and Highway Authority to evaluate surface water management options to alleviate pluvial flooding at locations across the investigation area.

#### 4.1. LEAD LOCAL FLOOD AUTHORITY

In review of Ref 1-5 Table 6, the LLFA and LDA have been determined as the relevant Risk Management Authorities in relation to the flooding which occurred at investigation area RCT26 during Storm Dennis.

The LLFA exercised the following functions in response to the flooding at investigation area RCT26;

- 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 conditions and its impact on the flooding within the investigation area. **(R1B, R2B, R3B, R4B)**
- An estimated 1673 meters of culvert network length within RCT26 has been surveyed following the event to ascertain both the operation condition of the network, and its structural integrity along sections of the network. **(R1B, R2B, R3B, R4B)**
- An estimated 20 tonnes of material and debris was removed from the culvert networks within RCT26 during jetting and cleansing operations. **(R1C, R2C, R3C, R4C)**
- The LLFA and LDA have undertaken clearance works to the culvert network systems which fall under the responsibility of the Authority **(R3C)**. 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. **(R1C, R2C, R4C)**
- The LLFA commissioned Redstart to investigate the standard of protection of the existing culvert networks in Treorchy to determine their hydraulic capacity following the identification of several structural and operational defects within sections of the network. **(R1B, R2B, R3B)**

- 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 offices, 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. **(R1D, R2D, R4D)**
- The LLFA have installed remote telemetry monitoring devices at key culvert structures, including 'Culvert Inlet 3' and 'Column Street Culvert Inlet', to enable operators to ensure the drainage systems in Treorchy are operating effectively. **(R3G)**
- The LLFA have commissioned JBA Consulting to undertake a formal SFRA of the Upper Rhondda catchment area to better understand the overall risk from ordinary watercourse and surface water flooding and make recommendations for suitable measures to alleviate the 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. As part of this, JBA were also commissioned to carry out a geomorphic assessment of the upper catchment above Treorchy to determine the risk of culvert blockages due to geomorphic instability of the hillside. **(R1E, R2E, R3F, R4E)**
- The LLFA are currently developing an 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). **(R1E, R2E, R3F, R4E, R5B)**
- The LLFA have completed a Business Justification Case and Detailed Design relating to the advanced works associated to Phase 1 of the wider OBC for Treorchy. **(R1E, R2E, R3F, R4E, R5B)**

The LLFA propose to exercise the following functions in response to the flooding at investigation area RCT26;

- Following the surveying of culvert networks in RCT26, the LLFA propose to input and update all relevant asset data. **(R1A, R2A, R3A, R4A)**

- The LLFA and LDA intend to clarify drainage asset owners and management responsibilities to make them aware of riparian responsibility. 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. **(R1A, R2A, R3A, R4A)**
- 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. **(R1D, R2D, R4D)**

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## **4.2. NATURAL RESOURCES WALES**

Natural Resources Wales were not identified as a relevant authority in relation to the flooding at investigation area RCT26 on the 15<sup>th</sup> and 16<sup>th</sup> February 2020. Furthermore, the authority does not propose to undertake any functions in relation to the event.

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### **4.3. WATER COMPANY**

DCWW were not identified as a relevant authority in relation to flooding at investigation area RCT26 during Storm Dennis. Despite this, calls were received by DCWW in relation to the flooding at Treorchy.

DCWW have exercised the following functions in response to the flooding at investigation area RCT26;

- DCWW carried out their own investigation in response to incidents of flooding that were reported to 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 Treorchy during the storm event to ensure their assets were operating with no issues.

DCWW do not propose to undertake any further functions in relation to the event at investigation area RCT26.

#### 4.4. HIGHWAY AUTHORITY

During the investigation into the flooding at investigation area RCT26 during Storm Dennis, the Highway was identified as flooding as a result of ordinary watercourse flooding associated to blocked and overwhelmed culvert inlets.

Ref 5 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 RCT26.

RCT as the Highway Authority have exercised the following functions in response to the flooding at investigation area RCT26;

- 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. **(R5A)**
- The Highway Authority has undertaken emergency clearance works to the culvert inlets identified as sources of flooding. **(R1C, R3C)**
- 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

RCT as the Highway Authority propose to undertake the following function in relation to the event at investigation area RCT26;

- The Highway Authority to work with the LLFA to evaluate surface water management options to alleviate pluvial flooding at locations across the investigation area. **(R5B)**

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## 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>

Tudalen wag