

Flood and Water Management Act 2010

Section 19 Flood Investigation Report

**Storm Dennis –
Flood Investigation Area RCT16
(Upper Boat & Nantgarw)**

March 2024

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



RHONDDA CYNON TAF

Blank Page

DOCUMENT VERIFICATION

Client	Director Frontline Services
Project	Flood and Water Management Act 2010, Section 19 Flood Investigation Report
Document Title	Storm Dennis – Flood Investigation Area RCT 16
Document Ref	FRM – S19 – 016
Project No	N/A

Revision Status	Final 1.0	Final 2.0		
Publication Status	Publication Approved	Publication Approved		
Date of Issue	28/01/2022	07/03/2024		
Prepared by	William McLean BEng (Hons) Catrin Evans BSc (Hons)	Catrin Evans BSc (Hons)		
Checked by	Owen Griffiths MSc, BSc (Hons)	Owen Griffiths MSc, BSc (Hons)		
Approved by	Andrew Stone BSc (Hons), IEng, MICS, Assoc, MCIWM, AaPS	Andrew Stone BSc (Hons), IEng, MICS, Assoc, MCIWM, AaPS		

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.

CHANGES TO THE REPORT

Change No	Sections Changed	Description
1	2.1 Previous Flood Incidents	The paragraph related to historical flooding within the investigation area has been updated to reflect a re-review of the available baseline data to inform the narrative. The original statement was incorrect and was broadly stating the flood history. A re-review of the available data has provided further clarification of the data.

Blank Page

CONTENTS

EXECUTIVE SUMMARY	3
ABBREVIATIONS.....	6
TABLES AND FIGURES	7
1 INTRODUCTION.....	9
1.1. Purpose of Investigation.....	9
1.2. Site Location	10
1.3. Drainage System.....	12
1.4. Investigation Evidence	12
1.5. Public Engagement	13
2. FLOODING HISTORY	14
2.1. Previous Flood Incidents	14
2.2. Flood Incident.....	15
2.3. Rainfall Analysis.....	21
3. POSSIBLE CAUSES	22
3.1 Culvert Conditions.....	22
3.2 Ordinary Watercourse Conditions	24
3.3 Main River	25
3.3.1. Main River Levels and Flood Warnings	25
3.3.2. Main River Flood Risk.....	27
3.3.3. Main River Flood Defences.....	30
3.4 Highway Drainage Condition.....	32
3.5 DCWW Apparatus Conditions	34
3.6 Surface Water	35
3.7 Access Structures	37
3.8 System at Capacity	38
3.9 Summary of Possible Causes	40
4 RISK MANAGEMENT AUTHORITY ACTIONS.....	42
4.1 Lead Local Flood Authority	46
4.2 Natural Resources Wales	48

4.3	Water Company	49
4.4	Highway Authority	51
5	USEFUL LINKS/CONTACTS	52

Blank Page

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 the 15th and 16th of February 2020 within the Rhondda Cynon Taf County Borough Council area, focusing the investigation on the flooding that occurred within the impacted areas of Upper Boat and Nantgarw (Flood Investigation Area RCT 16, Figure 1).

This report was undertaken to identify the mechanisms of 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 are planning to undertake actions related to those functions to manage the risk of flooding.

The flooding that affected RCT on the 15 and 16th of February 2020 was a result of an extreme rainfall event, designated by the Met Office as ‘Storm Dennis’. The storm event resulted in the internal flooding of at least 306 properties: including 121 residential properties and 185 non-residential properties. Significant flooding to the highway throughout the investigation area also occurred.

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 in this incident was the overtopping of the main River Taf following persistent and heavy rainfall. River level gauge data from NRW’s Upper Boat monitoring station reveal that the River Taf was over four times its typical level during Storm Dennis, reaching a peak level of 5.49 metres; the highest river level recorded at the station since its opening in 2001.

On review of NRW's FRAW maps, the majority of the impacted properties within RCT16 are identified at low risk of flooding from the main river due to the presence of formal flood defences along sections of both the eastern and western embankments. Despite the majority of formal flood defences within RCT16 providing protection from a 1 in 100 annual probability (Q100) flood event, flood defences at Upper Boat have been identified as providing protection from only a 1 in 20 annual probability (Q20) flood event. This means the area to the north of RCT16 is at medium risk of main river flooding.

Storm Dennis has been estimated as in excess of a 1 in 200 annual probability (Q200) flood event according to NRW, therefore it has been concluded that the flood defences along the River Taf became overwhelmed and were overtopped at several locations, resulting in widespread fluvial flooding to residential and commercial properties.

The investigation also identified ordinary watercourse flooding as a contributing source of flooding to properties at Cardiff Road following the surcharging of a culvert inlet associated to the Nant Garw ordinary watercourse. On review of its hydraulic performance, it was confirmed that the culvert inlet became hydraulically overloaded during the storm event. Surface water accumulation on the highway was also identified as the primary cause of flooding to two residential properties, in addition to contributing to existing fluvial flooding throughout RCT16.

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 investigation area RCT16, NRW has;

- Carried out their own post event investigative analysis work to understand the mechanism of flooding from the River Taf at Upper Boat and Nantgarw;
- Commissioned a Lower Taf Flood Modelling Project, the outcomes of which will include an initial assessment of the viability of potential flood risk management options; and
- Developed a series of recommendations and a detailed action plan to address areas of improvement for future storm events, including the performance of NRW's Flood Warning Service and incident management response.

RCT as the Lead Local Flood Authority, Land Drainage Authority and Highway Authority has been determined as the relevant Risk Management Authority responsible for managing the ordinary watercourse and surface water flooding that occurred during Storm Dennis. In response to the flooding at investigation area RCT16, the LLFA has;

- Carried out survey, jetting and cleansing operations to highway drainage and ordinary watercourse infrastructure;
- Led on the development of a central Control Room to compliment the Council's Contact Centre and CCTV Centre; and to provide a comprehensive and informed response to residents during storm events;
- Exercised its powers, under Section 13 of the Flood and Water Management Act 2010, to engage with NRW and DCWW in relation to their responsibilities as Risk Management Authorities; and
- Working in partnership with NRW, the LLFA have expanded their interim Property Flood Resistance project offering expandable flood gates to those properties deemed at high risk of river flooding, as per NRW's determination.

The event that occurred on 15 and 16th February 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 RCT16, however, further measures have been proposed by all RMAs to improve 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 Taf

RCT16 – Flood Investigation Area RCT 16

RCTCBC – Rhondda Cynon Taf County Borough Council

RMA – Risk Management Authority

SAB – Sustainable Drainage Approval Body

SFRA – Strategic Flood Risk Assessment

SOC – Strategic Outline Business Case

SuDs – Sustainable Drainage Systems

TABLES AND FIGURES

Table 1: Investigative evidence gathered in preparation of the Storm Dennis Section 19 report	12
Table 2: Summary of the source(s), pathway(s) and receptor(s) affected during Storm Dennis within investigation area RCT 16.....	15
Table 3: Flood Warnings issued by NRW for the River Taf at RCT16 during Storm Dennis	26
Table 4: Summary of the culvert capacity assessment results which indicate the current standard of protection of the 'Cross Keys' culvert at Cardiff Road in free flowing and blockage conditions	38
Table 5: Summary of source(s) and possible cause(s) of flooding in investigation area RCT16 during Storm Dennis (15-16 th February 2020)	40
Table 6: Risk Management Authority with relevant functions to manage the risk for different flood types.....	42
Table 7: Recommendations provided by the LLFA to be considered by the relevant Risk Management Authority identified in response to the source(s) of flooding in RCT16 (as per Table 5)	43
Figure 1: Flood Investigation Area RCT16 Location Plan.....	10
Figure 2: Natural Resources Wales' Flood Risk Assessment Water (FRAW) map for rivers and ordinary watercourse and surface water flood risk at investigation area RCT16. Contains Natural Resources Wales information © Natural Resources Wales and database right. All rights reserved. ..	11
Figure 3: Aerial view of Treforest Industrial Estate and Upper Boat following Storm Dennis (Image: National Police Air Service).....	17
Figure 4: Photo showing main river flooding along the A4054 Oxford Road during Storm Dennis (image provided by resident).....	18
Figure 5: Image of the flooding on Cardiff Road near A4054/A468 roundabout during Storm Dennis, looking south. (Image: Tom Martin/Wales News Service)	19
Figure 6: Image of the flooding on Cardiff Road near A4054/A468 roundabout during Storm Dennis, looking north. (Image: PA/Wales Online).....	20
Figure 7: Indicative flow paths observed during Storm Dennis to the south of RCT16	20
Figure 8: The Nant Garw culverted ordinary watercourse which runs beneath the A4054 Cardiff Road	22
Figure 9: Map of ordinary watercourses that feed into investigation area RCT16.....	24
Figure 10: The River Taf River levels at Upper Boat station between the 14 th and 17 th February 2020 (Natural Resources Wales)	26
Figure 11: NRW's FRAW map for River sources at RCT16. Contains Natural Resources Wales information © Natural Resources Wales and database right. All rights reserved.....	28
Figure 12: NRW's National Hazard map for Medium Risk River Flood Depth in RCT16. Contains Natural Resources Wales information © Natural Resources Wales and database right. All rights reserved.	29

Figure 13: NRW's National Hazard map for Low Risk River Flood Depth in RCT16. Contains Natural Resources Wales information © Natural Resources Wales and database right. All rights reserved. ... 30

Figure 14: Natural Resources Wales' map for Main River Flood Defences and areas benefiting at RCT16. Contains Natural Resources Wales information © Natural Resources Wales and database right. All rights reserved 31

Figure 15: Photo of a manhole at Oxford Street captured before (left) and after (right) surveying and cleansing operations during June 2020 32

Figure 16: NRW's Flood Risk Assessment Wales (FRAW) map for Surface Water and Ordinary Watercourse flood sources at RCT16. Contains Natural Resources Wales information © Natural Resources Wales and database right. All rights reserved. 35

1. INTRODUCTION

1.1. PURPOSE OF INVESTIGATION

On the 15th and 16th of February 2020, Rhondda Cynon Taf County Borough Council was impacted by an extreme weather event which was named ‘Storm Dennis’ by the Met Office. Due to the extent of the event’s impact, 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 RCT16 (further referred to as RCT16) which encompasses the Nantgarw region of the county borough in the River Taf catchment.

The reason behind RCT’s investigation is in response to the duties of the local authority regarding 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 the flood event in question.

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 covers the villages of Nantgarw and, Upper Boat which comprises part of the Treforest Industrial Estate, located within the southern region of the borough. The investigation area falls within the electoral wards of Hawthorn, Taff's Well and Tonteg, situated to the south-east of Pontypridd.

RCT16 is located within the River Taf catchment and encompasses both the western and eastern banks of the main river, as illustrated in Figure 1.

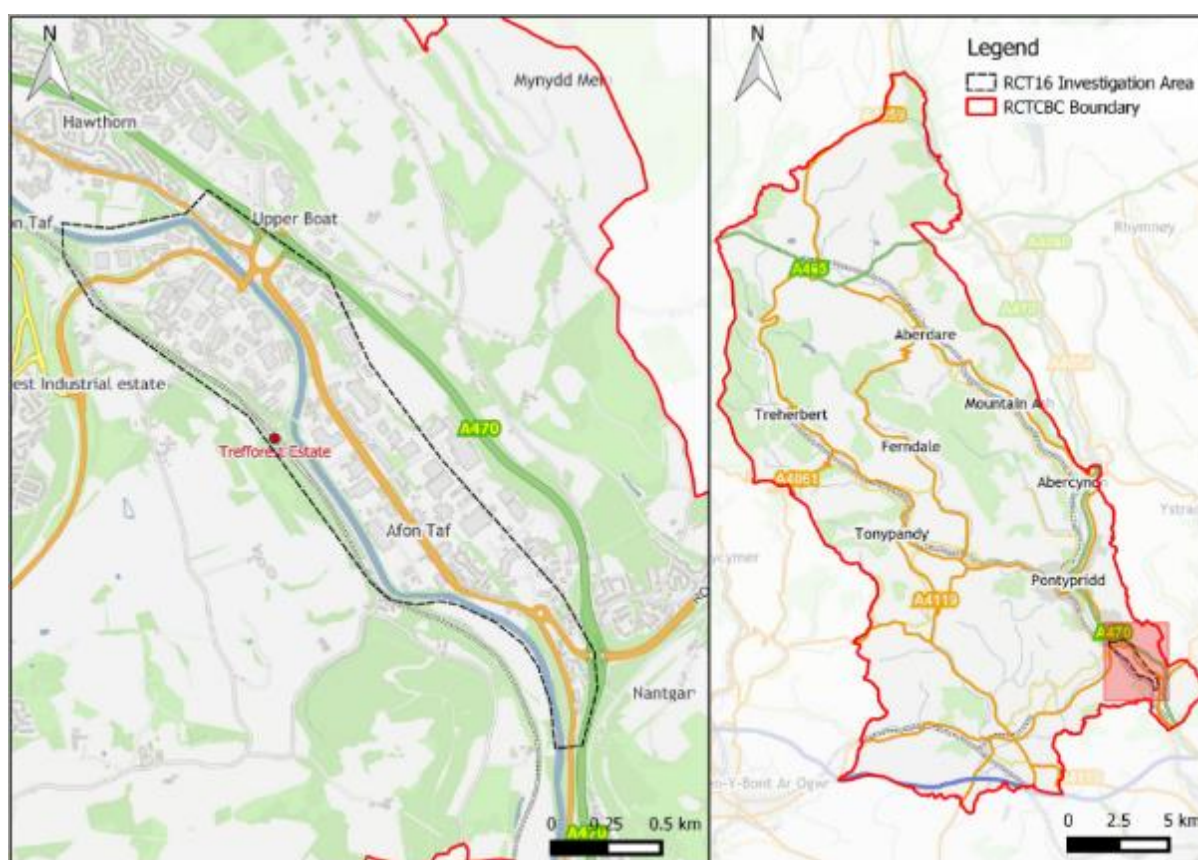


Figure 1: Flood Investigation Area RCT16 Location Plan

According to Welsh Government's CaRR, Nantgarw is ranked 124th for main river flooding and 101st for surface water flooding in Wales.

NRW's Flood Risk Assessment Wales (FRAW) maps indicate that there are areas of low to high flood risk from both fluvial and surface water and ordinary watercourse sources within the investigation area. This is illustrated in Figure 2, which is an excerpt from the FRAW maps.

The highest risk posed to people and properties within RCT16 is associated with the River Taf, with a low risk of fluvial flooding observed across the eastern embankments and a medium to low risk of fluvial flooding present on the western floodplains at Treforest Industrial Estate.

Flood risk from surface water and ordinary watercourse sources is also noted across many parts of the investigation area, although not to the same degree and extent as main river flood risk. RCT's FRMP³ identifies areas of low to high surface water and ordinary watercourse flood risk within RCT16 associated with culvert inlets and potential bank breaches.

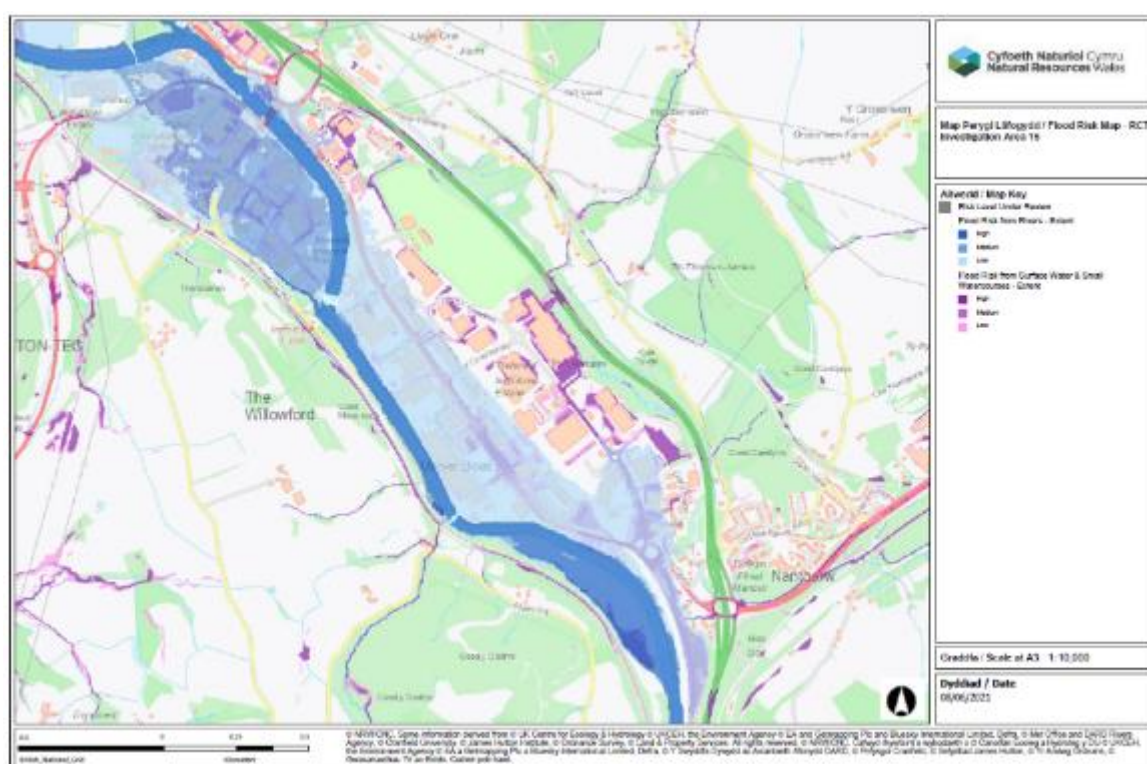


Figure 2: Natural Resources Wales' Flood Risk Assessment Water (FRAW) map for rivers and ordinary watercourse and surface water flood risk at investigation area RCT16. Contains Natural Resources Wales information © Natural Resources Wales and database right. All rights reserved.

There are multiple ordinary watercourses within the investigation area, both open and culverted beneath residential development. These include the Nant Garw, Nant Lonydd and several unnamed watercourses which convey towards the River Taf via the A470 dual carriageway.

³ [RCT'S Flood Risk Management Plan \(rctcbc.gov.uk\)](http://rctcbc.gov.uk)

1.3. DRAINAGE SYSTEM

The surface water drainage systems that serve investigation area RCT16 are 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 below within 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 of February during Storm Dennis, flood risk officers from RCT's Flood Risk Management department were deployed to areas across the borough to investigate reports of internal flooding by residents. Residents engaged with the Flood Risk Management team to help determine the initial impacts caused by the flooding event and to investigate the potential source(s) and pathway(s) of flood water. Due to the volume of calls received by RCT's Out of Hours 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 the 4th and 25th of January 2021 by Redstart, on behalf of RCT. The aim of this exercise was to engage with 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

Historical flood records and residents accounts captured by RCT's Flood Risk Management officers following Storm Dennis indicate that the majority of properties within the investigation area had not experienced internal flooding prior to Storm Dennis. Anecdotal information supplied by two long-term residents of Rhyd-yr-Helyg, as part of the consultant-led public engagement exercise, suggests that properties along Rhyd-yr-Helyg did experience flooding on at least two occasions between 1960 and 1970 however no further incidences of previous flooding to properties was recorded across RCT16 as per the results of the public engagement exercise.

Based on available historical flood records, RCT's Flood Risk Management team have identified 25 reports of flooding between 1998 and 2020 (prior to Storm Dennis), all of which relate to incidences of surface water flooding along the highway network, damaged and/or blocked gullies and surcharging highway drainage infrastructure along A4054 (Cardiff Road) and the surrounding area. No internal flooding to properties was identified on review of the available information.

Two reports of potential surcharging of the Nant Garw ordinary watercourse were also reported between 1998 and 2000, however no properties were identified as being impacted on both occasions.

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’. The rainfall event 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’².

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 121 residential properties and 185 non-residential properties as internally flooded within the investigation area.

A summary of the source(s) and pathway(s) of flooding within RCT16 during Storm Dennis have been outlined in Table 2 and further described throughout this section.

Table 2: Summary of the source(s), pathway(s) and receptor(s) affected during Storm Dennis within investigation area RCT 16

Source(s)	Pathway(s)	Receptor(s)
The River Taf overtopping its eastern and western banks at multiple locations throughout the investigation area.	Main river flood water conveyed into the front and/or back of properties across RCT16 via several highway networks including the A4054 (Cardiff Road / Oxford Street / Main Avenue) and the A473 (Tonteg Road).	The overtopping of the River Taf resulted in internal flooding to at least 280 receptors, including 113 residential and 167 non-residential properties, across the Treforest Industrial Estate, Williams Place, Oxford Street and Rhyd-yr-Helyg. Main river flooding also contributed to the flooding of 6 residential and 18 non-residential properties on Cardiff Road, near the Nant Garw watercourse inlet.
Intense rainfall running off the steep hillsides to the east of RCT16 draining to lower ground via the Nant Garw ordinary watercourse.	Water overflowed from the Nant Garw ordinary watercourse inlet, known as Cross Keys Inlet, onto the A4054 Cardiff Road.	Contributed to the internal flooding of 6 residential properties and 18 non-residential properties along the A4054 Cardiff Road.

<p>A Nant Garw ordinary watercourse inlet adjacent to Cardiff Road became overwhelmed and surcharged during the storm event.</p>		
<p>Intense rainfall and subsequent surface water runoff from the surrounding area.</p>	<p>Surface water runoff was observed along several highway networks including the A4054 (Main Avenue / Oxford Street / Cardiff Road), the A468 (Caerphilly Road), Tyla Gwyn, Quarry Street.</p> <p>Furthermore, surface water contributed to the main river and ordinary watercourse flows throughout the investigation area.</p>	<p>Two residential properties on Quarry Street were flooded primarily due to localised surface water ponding.</p> <p>Surface water flows are also considered to have exacerbated the flooding experienced at many internally flooded properties throughout RCT16 during Storm Dennis.</p>

On review of Table 2, the primary source of flooding throughout the majority of RCT16 was the overtopping of the main river, the River Taf, which flows from north to south through the investigation area. In the southernmost section of the investigation area, a surcharging ordinary watercourse culvert inlet was also identified as a source of flooding. Across the entirety of RCT16, the impacts of main river and ordinary watercourse flooding were exacerbated due to intense rainfall and subsequent surface water flows conveying via the highway network.

During the early hours of Sunday 16th February 2020, RCT received several calls from residents at Nantgarw and Upper Boat reporting the overtopping of the River Taf at multiple locations and the ingress of water into properties. Several flow paths were observed as properties located on the western and eastern floodplains of the River Taf were impacted. Internal flooding to 113 residential and 167 commercial properties across RCT16 were confirmed as directly attributed to the River Taf overtopping its banks. Main river flooding was also confirmed as a contributing source of flooding to a further 6 residential and 18 commercial properties within RCT16.

To the north of RCT16, the overtopping of the River Taf resulted in the conveyance of riverine flood water through several streets within the Upper Boat area on the western embankment, and Treforest Industrial Estate on the eastern embankment.

At Upper Boat, properties immediately adjacent to the main river were most severely impacted by the overtopping, with resident accounts reporting flood depths of up to 1.8 metres at localised low points on Williams Place. Nine residential properties and one commercial premise at Williams Place were internally affected by the River Taf overtopping at this location. Resident accounts also highlighted surcharging highway drainage at Upper Boat Interchange as a contributing source of flooding. The associated surface water flows along the highway have been attributed as the primary cause of flooding to two commercial properties located at low points at Williams Place.

The flooding that occurred at Treforest Industrial Estate did not remain confined to areas adjacent to the main river channel, with commercial properties up to 450 metres inland from the River Taf reporting internal flooding. The main river overtopped both its eastern and western banks, resulting in internal flooding to the majority of commercial premises throughout the industrial estate. Figure 3 depicts an aerial view of the flooding at Treforest Industrial Estate and Upper Boat, to the north of RCT16.



Figure 3: Aerial view of Treforest Industrial Estate and Upper Boat following Storm Dennis (Image: National Police Air Service)

Further south, the overtopping of the River Taf along the eastern embankment resulted in the conveyance of fluvial flood water through Treforest Industrial Estate and onto

the A4054 (Main Avenue). Water travelled south onto the A4054 (Oxford Street) before entering Rhyd-yr-Helyg cul-de-sac.

Based on the available evidence, the River Taf is considered to have overtopped its defences adjacent to the A4054 (Oxford Street) during the night of 16th February 2020 when river levels were at their peak, however the primary pathway of fluvial flood water, as stated by residents, was via the highway network.

Accounts from residents at Oxford Street and Rhyd-Yr-Helyg note a significant amount of water conveyed along the highway network towards their properties during the storm event. This flow path is considered to have originated further upstream following the overtopping of the River Taf at Treforest Industrial Estate and Upper Boat, which then conveyed behind formal flood defences towards Oxford Street and Rhyd-yr-Helyg during the storm event. Photographic evidence provided by residents at Oxford Street show water flowing south along the highway, behind the eastern embankment, during the morning of Sunday 16th February 2020 (Figure 4).



Figure 4: Photo showing main river flooding along the A4054 Oxford Road during Storm Dennis (image provided by resident)

A total of 103 residential properties at Oxford Street and Rhyd-yr-Helyg were internally impacted by the River Taf, with residents reporting flood depths of over 1.8 meters.

A detached residential property on the western floodplain of the River Taf also experienced internal flooding as a result of the River Taf overtopping its banks.

Fluvial flood water reportedly continued to flow south along the A4054 Oxford Street towards Cardiff Road, where a further 6 residential and 18 commercial properties were internally affected.

The impacts of flooding from the main river at Cardiff Road were exacerbated by the surcharging of the 'Cross Keys' culvert inlet (Figure 8) associated to the Nant Garw ordinary watercourse. Exceedance flows from the surcharged inlet conveyed onto Cardiff Road, contributing the flooding of properties in this area. Flood depths along Cardiff Road reportedly reached over a metre in depth, as depicted in Figures 5 and 6.



Figure 5: Image of the flooding on Cardiff Road near A4054/A468 roundabout during Storm Dennis, looking south. (Image: Tom Martin/Wales News Service)



Figure 6: Image of the flooding on Cardiff Road near A4054/A468 roundabout during Storm Dennis, looking north. (Image: PA/Wales Online)

An isolated incident of surface water flooding occurred at Quarry Street, where two residential properties experienced internal flooding during Storm Dennis as a result of localised pluvial flows from the adjacent street, Tyla Gwyn. The observed flow pathways resulting in internal flooding at Cardiff Road are illustrated in Figure 7.



Figure 7: Indicative flow paths observed during Storm Dennis to the south of RCT16

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

There are several named and unnamed watercourses which drain the upper catchment areas surrounding RCT16, however, only the Nant Garw ordinary watercourse to the southeast of the investigation area was identified as a source of flooding during Storm Dennis.

The majority of the Nant Garw ordinary watercourse is open channel, however the watercourse is culverted beneath sections of the A468 (Caerphilly Road), the A470 dual carriageway and the A4054 (Cardiff Road) before it discharges into the River Taf downstream. Following Storm Dennis, a CCTV survey inspection of the culverted ordinary watercourse beneath the A4054 Cardiff Road (Figure 8), known as 'Cross Keys' culvert, was undertaken to ascertain both the operational condition of the network and its structural integrity.



Figure 8: The Nant Garw culverted ordinary watercourse which runs beneath the A4054 Cardiff Road

Comprising of four culvert sections in a double-barrel configuration, the survey revealed that the culvert was in good structural condition, with only one of the four

sections having structural defects present. However, the serviceable condition of the culvert network identified accumulated debris within three of the four culvert sections and both outfall sections were unable to be fully inspected due to the level of the outfall within the main river at the time of the survey, which suggests the culverts are subject to debris settlement and outfall control.

In response to the identified debris, approximately 5 tonnes of material was removed from the inlets by a Council appointed contractor following the inspection.

3.2. ORDINARY WATERCOURSE CONDITIONS

There are several named and unnamed ordinary watercourse that convey towards the River Taf through the investigation area (illustrated in Figure 9).

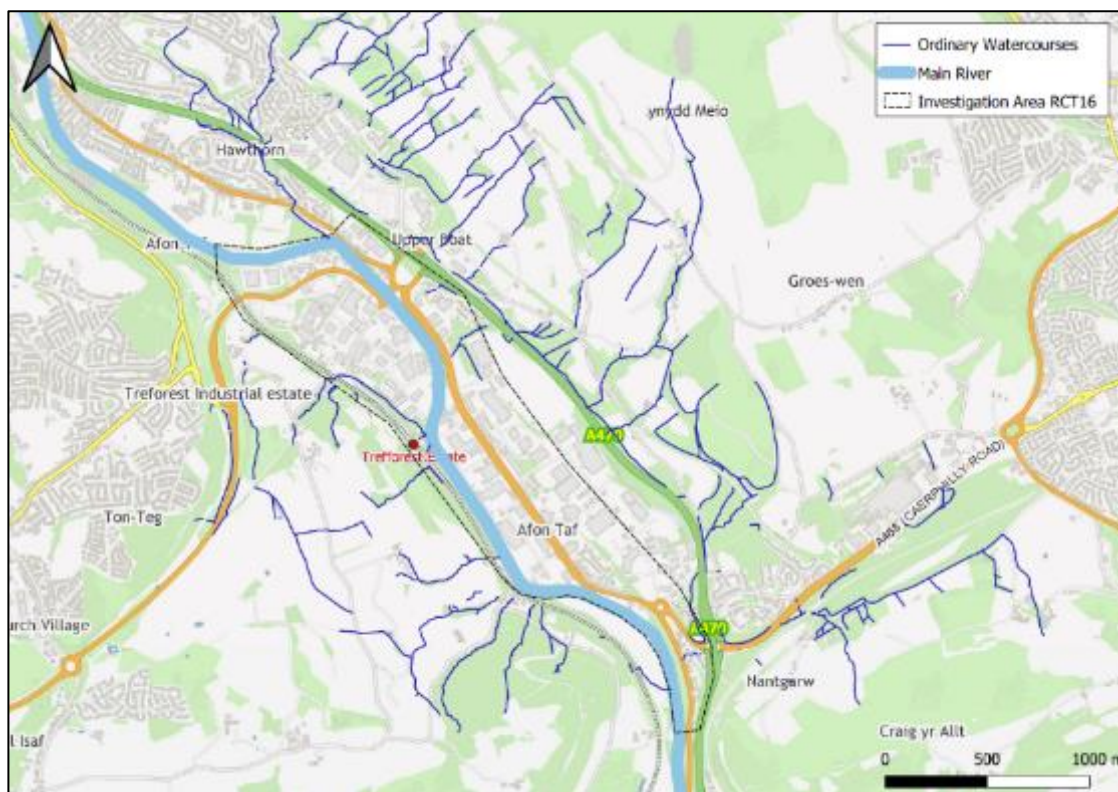


Figure 9: Map of ordinary watercourses that feed into investigation area RCT16

With the exception of the Nant Garw ordinary watercourse in the south of the investigation area, there is no evidence to suggest that the network of ordinary watercourses illustrated in Figure 8 contributed to the flooding experienced during Storm Dennis.

3.3. MAIN RIVER

The designated main River Taf flows from the north east of the investigation area at Upper Boat, through Treforest Industrial Estate and towards Nantgarw, in the southeast of RCT16 (Figure 9). Areas on both the western and eastern embankments of the River Taf were impacted during Storm Dennis

3.3.1. MAIN RIVER LEVELS AND FLOOD WARNINGS

The hydrograph in Figure 10 illustrates the significant rise in the River Taf's levels in response to rainfall between the 14 – 17th February 2020. River level data was captured at NRW's Upper Boat river level gauge, located in the northwest of the investigation area.

NRW issued a 'Flood Alert' (indicating possible flooding) for the entirety of the River Taf at approximately 13:30 on the 15th February; at which point the main river was over 2 metres in depth and continuing to rise at Upper Boat station. At approximately midnight on the 16th February the River Taf began to rise again, reaching a peak river level of 5.49 metres at 06:00 on the 16th February; the highest level recorded for the River Taf at Upper Boat since 2001.

The green bar displayed on the hydrograph shows the typical level of the River Taf at the Upper Boat station, ranging between approximately 0.2 and 1.2 metres. The river level was above this green line for over 48 hours, highlighting the severity of the storm event and its unprecedented nature. At its peak, the River Taf at Upper Boat was over four meters higher than its average level.

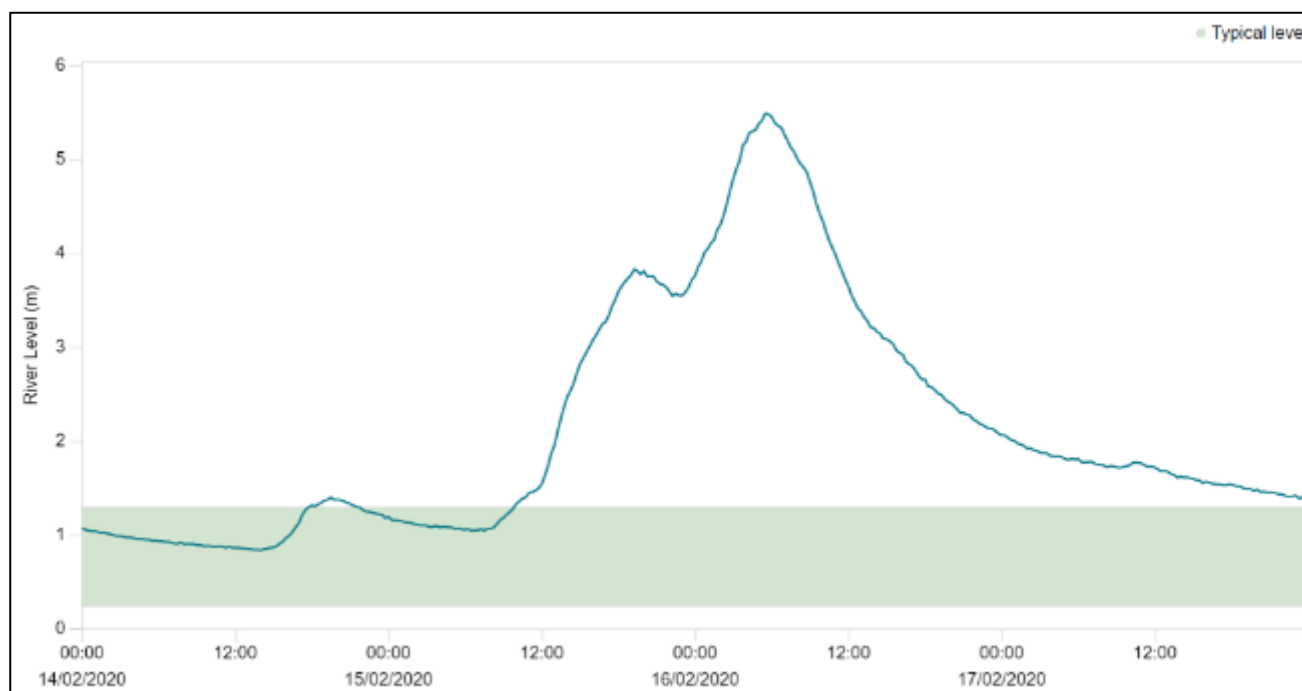


Figure 10: The River Taf River levels at Upper Boat station between the 14th and 17th February 2020 (Natural Resources Wales)

Investigation area RCT16 encompasses two NRW Flood Warning Areas; the River Taf at Upper Boat and the River Taf at Nantgarw. The Flood Warnings issued by NRW, and associated river levels at Upper Boat gauging station (i.e., nearest gauging station to RCT16), for the River Taf at investigation area RCT16 during Storm Dennis are shown in Table 3.

Table 3: Flood Warnings issued by NRW for the River Taf at RCT16 during Storm Dennis

Flood Warning Type	Location	Start Time	River Level (m) at Upper Boat
Flood Alert	River Taf	13:27 15/02/2020	2.24
Flood Warning	River Taf at Upper Boat	02:10 16/02/2020	4.306
Flood Warning	River Taf at Nantgarw	05:19 16/02/2020	5.414

NRW issued a ‘Flood Warning’ alert (indicating flooding is expected) for the River Taf at Upper Boat (north of RCT16) at 02:10 on the 16th February; at which point the main river was over 4.3 metres in depth. A ‘Flood Warning’ alert was also issued for the River Taf at Nantgarw (south of RCT16) at approximately 05:20 on the 16th February; at which point the main river was over 5.4 metres in depth. Based on the available

evidence, main river flooding at RCT16 had already commenced prior to both 'Flood Warning' alerts being issued.

A 'Severe Flood Warning' alert (indicating Community-wide severe flooding and possible risk to life) was not issued by NRW for the River Taf at Upper Boat or Nantgarw during the storm event.

However, a 'Severe Flood Warning' was issued by NRW for the River Taf at Pontypridd (outside of RCT16) at approximately 06:30 on the 16th February. Based on accounts of residents and responders, significant main river flooding to properties had already commenced at several locations along the River Taf, including at investigation area RCT16.

NRW have acknowledged within their 'Flood Incidence Response Review'⁴ 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. At this location (RCT16), this is in reference to the 'Flood Warning' alerts at Upper Boat and Nantgarw, in addition to the 'Severe Flood Warning' alert that was not issued for RCT16.

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 Review⁴.

3.3.2. MAIN RIVER FLOOD RISK

As outlined in Section 2, the overtopping of the River Taf that occurred at RCT16 during Storm Dennis has been identified as the primary cause of flooding to at least 280 receptors within the investigation area.

Figure 13 is an extract from NRW's Flood Risk Assessment Wales (FRAW) mapping exercise which depicts the main river flood risk 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 flooding that occurred within RCT16 during Storm Dennis is largely consistent with the modelled outputs of NRW's FRAW map (Figure 11), with the majority of the

⁴ [February 2020 Floods in Wales: Flood Incident Management Review \(cyfoethnaturiol.cymru\)](https://www.cyfoethnaturiol.cymru/February-2020-Floods-in-Wales-Flood-Incident-Management-Review)

affected properties falling within an area of at least a low to medium main river flood risk.

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; meanwhile, a medium risk of flooding signifies a yearly chance of flooding between 1 in 100 (1%) and 1 in 30 (3.3%). Considering Storm Dennis has been estimated as a 1 in 200 annual probability (Q200) flood event, the area of flooding during Storm Dennis aligns with those depicted by the low flood risk extents (Figure 11).



Figure 11: NRW's FRAW map for River sources at RCT16. Contains Natural Resources Wales information © Natural Resources Wales and database right. All rights reserved.

NRW's Flood Hazard maps (Figures 12 and 13) illustrate the modelled flood depth predictions for a medium (Figure 12) and low (Figure 13) risk flood event.

The figures below highlight the substantial difference in predicted flood extents and impacts between a medium risk storm event and a low risk storm event, with the latter being more representative of the flooding that occurred during Storm Dennis, where flooding to a depth of greater than 0.9 metres was observed across most of RCT16.

Figure 13 also identifies a fluvial flow path from Oxford Street towards Cardiff Road, which supports the notion that main river flooding did not occur immediately adjacent to Cardiff Road in the south of the investigation area but was as a result of fluvial flows conveying southwards along the highway network.

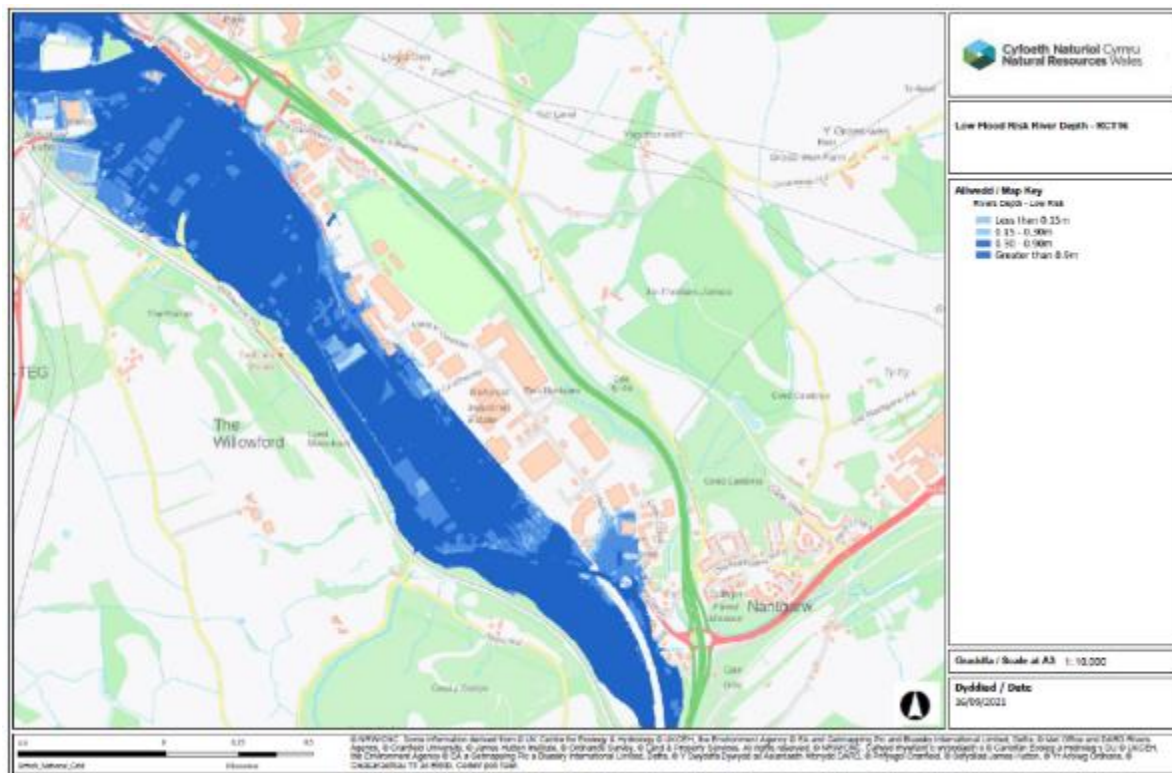


Figure 12: NRW's National Hazard map for Medium Risk River Flood Depth in RCT16. Contains Natural Resources Wales information © Natural Resources Wales and database right. All rights reserved.

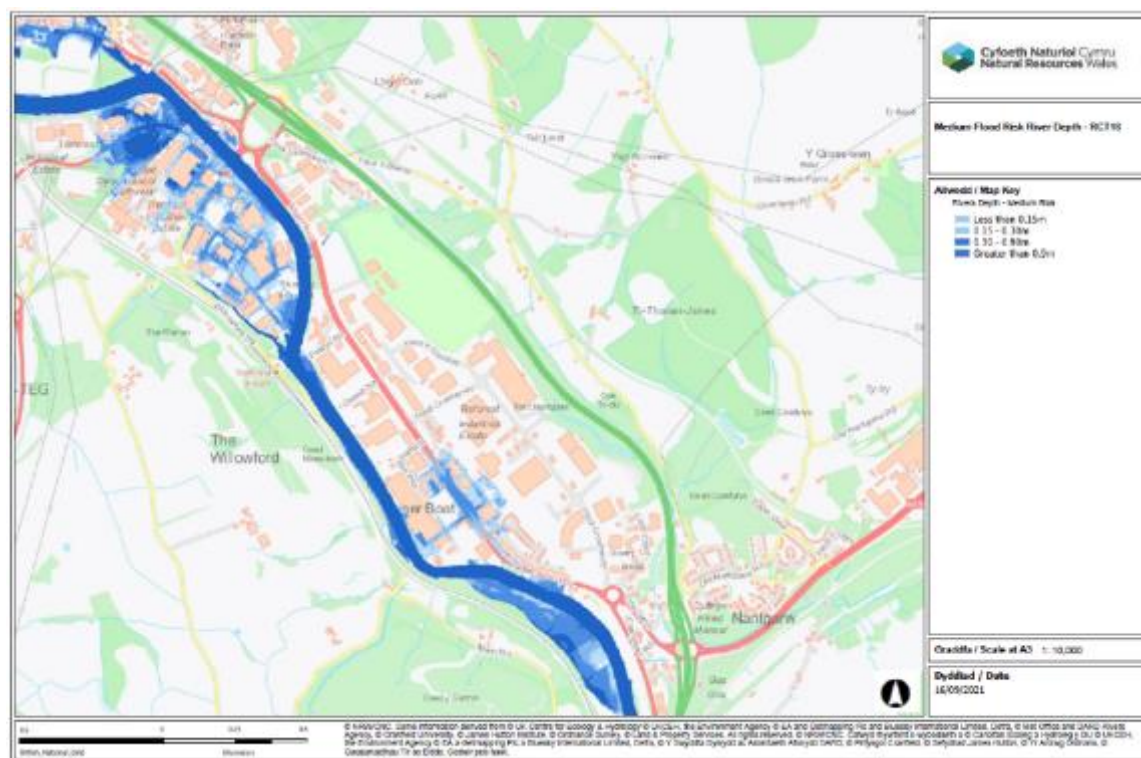


Figure 13: NRW’s National Hazard map for Low Risk River Flood Depth in RCT16. Contains Natural Resources Wales information © Natural Resources Wales and database right. All rights reserved.

3.3.3. MAIN RIVER FLOOD DEFENCES

As illustrated in Figure 14 (demarcated by a bold red line), there are approximately 2.5 kilometres, and 1.25 kilometres, of formally designated flood defence infrastructure along the eastern, and western banks, of the River Taf at RCT16, respectively. This infrastructure is operated and maintained by NRW.

According to NRW, flood defence infrastructure throughout the Treforest Industrial Estate, including at Oxford Street and Rhyd-yr-Helyg, provides a standard of protection up to a 1 in 100 annual probability flood event (Q100) (black hatched area in Figure 16). Flood defence infrastructure at Upper Boat and William’s Place provide a reduced standard of protection of 1 in 20 annual probability (Q20) flood event.

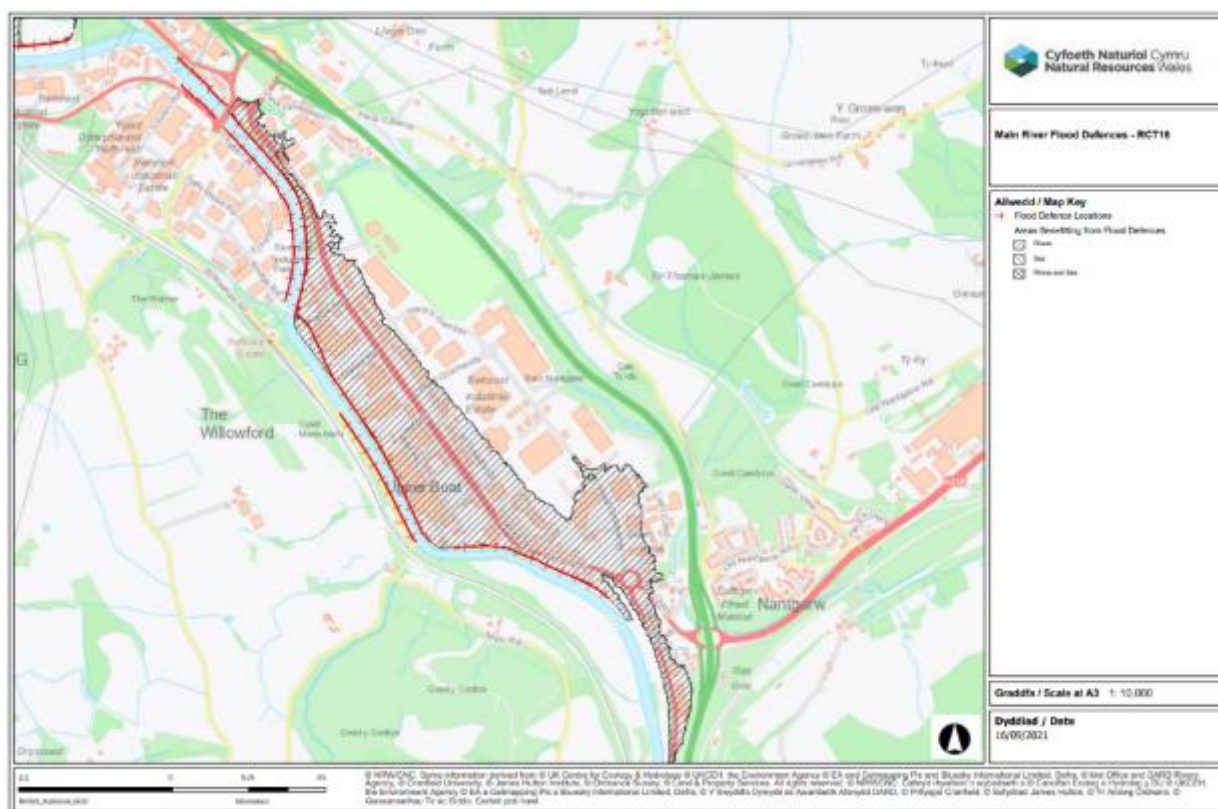


Figure 14: Natural Resources Wales' map for Main River Flood Defences and areas benefiting at RCT16. Contains Natural Resources Wales information © Natural Resources Wales and database right. All rights reserved

The current indicative design standard of protection (SOP) for flood defences on a main river is Q100 flood event plus, for new defences, an allowance for climate change. This is stated within the Welsh Government's National Strategy for Flood and Coastal Erosion Risk Management which encourages main river flood alleviation schemes to provide a SOP up to 1 in 100 annual probability (Q100)⁵. It is thereby inferred that the majority of the existing flood defence infrastructure at RCT16 is in accordance with current indicative standards, with the exception of the defences at Upper Boat, which are below indicative design standards.

Whilst some of the flood defences identified at RCT16 are below the current indicative standard, the unprecedented rise of river levels in the Taf during Storm Dennis resulted in the overtopping of assets up to Q100 SOP. NRW's 'Flood Incidence Response Review'⁴ does in fact outline that no flood defences failed in the lower Taf region and that the flooding was the result of river flows exceeding the design standard of the defences.

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

3.4. HIGHWAY DRAINAGE CONDITION

Several streets that flooded throughout RCT16 during Storm Dennis were impacted by the overtopping of the River Taf. These fluvial flows deposited mud, silt and debris across the investigation area which are assumed to have entered the highway drainage system, leading to blockages and a reduction in the hydraulic capacity of the surface water network.

CCTV inspections undertaken in the months following the storm event confirm this, with surveys completed on Oxford Street and Rhyd-Yr-Helyg identifying large silt and debris deposits within many sections of the highway drainage network. Figure 15 depicts the operational condition of the highway drainage at Oxford Street before and after cleansing operations took place. A total of 25 tonnes of silt and debris was removed by a Council appointed contractor during cleansing operations.



Figure 15: Photo of a manhole at Oxford Street captured before (left) and after (right) surveying and cleansing operations during June 2020

CCTV inspections also identified structural defects within the drainage network on Oxford Street, including collapses within the drainage infrastructure near to the system's main river outlet. A section of the outlet structure was also damaged during Storm Dennis.

Whilst a lack of baseline highway drainage inspection data restricts the determination of whether the identified structural defects were caused during Storm Dennis or present beforehand, the severity of the flood incident at RCT16, caused by the overtopping of the River Taf, indicates that the condition of the highway drainage infrastructure would have had little to no impact on the extent of flooding observed.

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 RCT16 was exceeded as a result of both main river and surface water flows entering the network. The maintenance condition of the highway drainage infrastructure is not considered to have significantly impacted the flooding experienced.

3.5. DCWW APPARATUS CONDITIONS

There is no evidence from this investigation that DCWW apparatus contributed to the flooding that occurred during Storm Dennis within investigation area RCT16.

DCWW reported no issues within RCT16 during Storm Dennis 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.

3.6. SURFACE WATER

Surface water is considered to have been the primary cause of internal flooding to two properties at Quarry Street, however surface water is considered to have exacerbated the main river flooding observed across the investigation area, as well as the ordinary watercourse flooding observed at Cardiff Road.

The pathways for surface water runoff during the storm event were observed along the highway network within RCT16. The exact flow routes have not been confirmed due to lack of anecdotal evidence, however, NRW's national surface water and ordinary watercourse flood maps (Figure 16) provide a reasonable indication of the pathways and areas most at risk of flooding from local sources.

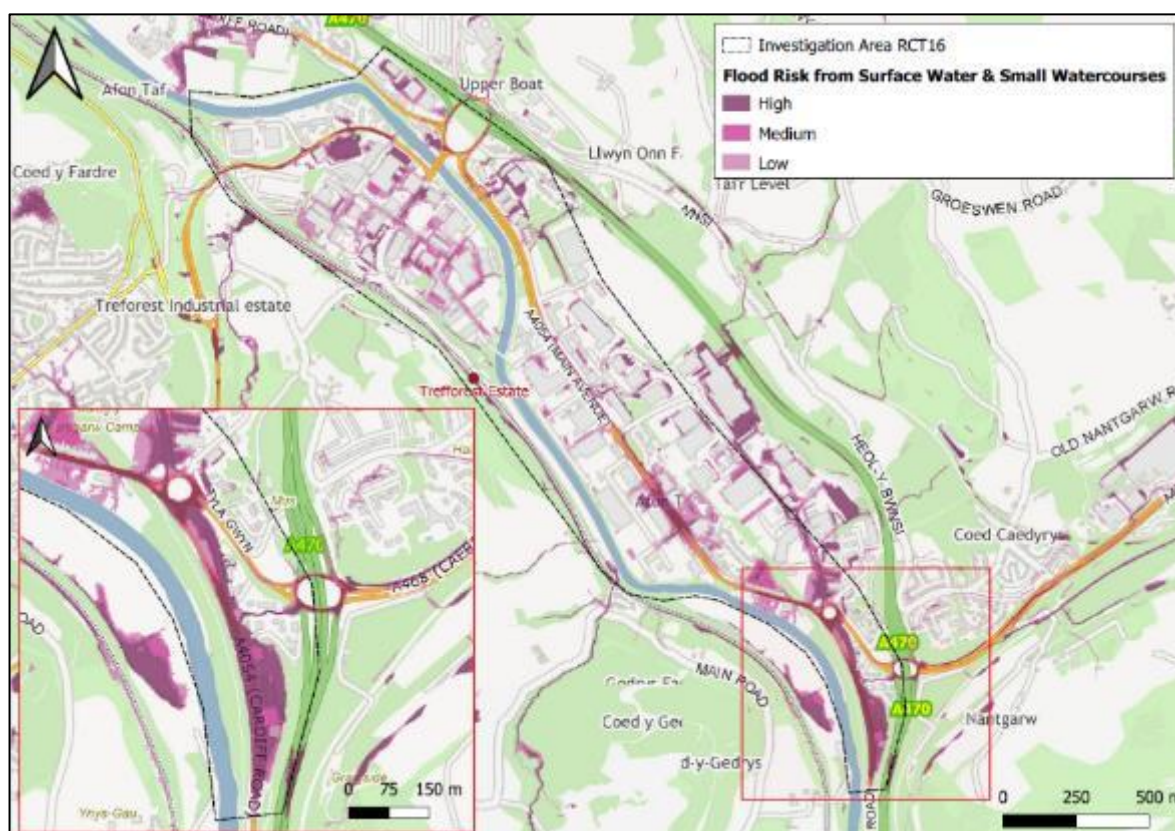


Figure 16: NRW's Flood Risk Assessment Wales (FRAW) map for Surface Water and Ordinary Watercourse flood sources at RCT16. Contains Natural Resources Wales information © Natural Resources Wales and database right. All rights reserved.

Notable areas where surface water flows are considered to have exacerbated the main river flooding include Williams Place, Cardiff Road, and parts of Rhyd-yr-Helyg and Oxford Street, where the FRAW map indicates a high to low risk of pluvial flooding (Figure 16). At Quarry Street, localised surface water flows generated by intense

rainfall and conveying via local topography from Tyla Gwyn and the A4054/A468 roundabout are considered the primary cause of flooding to two residential properties.

Investigation area RCT16 sits on a floodplain, meaning the area is predominantly flat. This suggests that the areas of high to low flood risk are primarily associated to the conveyance of pluvial flows towards localised low points across the investigation area and not a consequence of the dominant valley gradient above RCT16.

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

Whilst the overtopping of the River Taf has been determined as the primary cause of flooding to the majority of properties within RCT16, the capacity of the Nant Garw culvert network at Cardiff Road has also been assessed to ascertain its current standard of protection following the observed surcharging of the culvert inlet during Storm Dennis.

The results of the culvert capacity assessment are summarised in Table 4.

Table 4: Summary of the culvert capacity assessment results which indicate the current standard of protection of the ‘Cross Keys’ culvert at Cardiff Road in free flowing and blockage conditions

Culvert Network	Standard of Protection (SOP) – Free Flowing	Standard of Protection (SOP) – Blockage Condition
Inlet 1 – Cross Keys Culvert	Q10 (10% AEP)	<Q2 (>50% AEP)
Inlet 2 – Cross Keys Culvert	<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 both ‘Inlet 1’ and ‘Inlet 2’, associated to the ‘Cross Key’ culvert (Figure 10), have a standard of protection below current design standards, as defined by CIRIA C786⁶ (minimum standard of protection of Q100 + 40% climate change allowance for new culverts). The hydraulic capacity of the culvert sections is further reduced when accounting for outfall control and its serviceable condition i.e., blockages caused by debris observed during the CCTV inspections.

The primary cause of debris accumulation within the culvert network is believed to be the low positioning of the structure with respect to the main river, leading to significant ‘outlet control’⁶ and the settling of fluvial deposits. During Storm Dennis, it is likely that the unprecedentedly high river levels resulted in the culvert outlet becoming completely submerged, thus resulting in ‘full flow outlet control’ and an increased risk of blockage and/or surcharge.

Whilst settled deposits within the culvert structure are likely to have exacerbated flooding at the ‘Cross Keys’ inlet, the ‘full flow outlet control’⁶ and resultant surcharging are likely to have occurred without the presence of debris in the culvert. Furthermore, the hydraulic control present at the culvert outlet due to its low positioning with respect

⁶ Culvert, screen and outfall manual, CIRIA, C786 (2019)

to the adjacent main river indicates that the settlement of fluvial deposits is inevitable without reconfiguring the culvert gradient. This infers that a cleansing of the culvert inlet would not have prevented the flooding which occurred during Storm Dennis as new material would have subsequently begun accumulating within the culvert barrel soon after due to its low gradient at the outfall.

Upon review of the CCTV inspection data discussed in Section 3.1, as well as the culvert capacity assessments stipulated above, it is considered that the primary cause of surcharge to the 'Cross Keys' culvert inlet during Storm Dennis was due to hydraulic overload, which contributed to the internal flooding of 6 residential and 18 non-residential properties along Cardiff Road.

3.9. SUMMARY OF POSSIBLE CAUSES

The above sections have identified and described the possible causes of flooding within investigation area RCT16 during Storm Dennis which occurred on the 15th and 16th of February 2020. A summary of the identified source(s) and possible cause(s) of flooding (issue) has been outlined below in Table 5.

Table 5: Summary of source(s) and possible cause(s) of flooding in investigation area RCT16 during Storm Dennis (15-16th February 2020)

Ref No	Asset (Source)	Issue	Asset Owner	Type of Flooding
1	River Taf	Unprecedentedly high river levels within the River Taf resulted in the main river overtopping its banks at several locations and flood water conveying into multiple properties, resulting in internal flooding of 304 receptors	Natural Resources Wales	Main River
2	River Taf	Unprecedentedly high river levels within the River Taf resulted in the main river overtopping its banks at several locations and flood water conveying into multiple properties, resulting in internal flooding of 304 receptors.	Private Landowner(s)	Main River
3	Nant Garw Culvert Network at Cardiff Road ('Cross Keys' culvert inlet)	Intense rainfall across the wider RCT16 catchment resulted in the 'Cross Keys' culvert inlet, which conveys the Nant Garw watercourse beneath Cardiff Road, becoming hydraulically overwhelmed. This resulted in the culvert inlet surcharging, contributing to the internal flooding of 24 properties at Cardiff Road.	Rhondda Cynon Taf Highway Authority	Ordinary Watercourse

4	Surface water drainage network across RCT16	Intense rainfall across RCT combined with the overtopping of the River Taf severely overwhelmed highway drainage infrastructure, resulting in the accumulation of surface water on many streets throughout the investigation area.	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 6. 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 and Responsibilities'⁵, and RCT'S 'FRM – Storm Dennis - Overview Report'**Error! Bookmark not defined..**

Table 6: Risk Management Authority with relevant functions to manage the risk for different flood types

Type of Flooding	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 RCT16, the flood risk management functions exercised or proposed to be exercised by relevant RMAs were recorded pursuant to Section 19 of the Flood and Water Management Act 2010, which 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 the response to the flood.”

Through the investigation process, the source(s) and possible cause(s) of flooding in RCT16 during Storm Dennis have been previously identified and summarised within Table 5. The Risk Management Authorities responsible for managing that flooding have been listed in Table 7 below, along with a series of recommendations put forward by the LLFA.

Table 7: Recommendations provided by the LLFA to be considered by the relevant Risk Management Authority identified in response to the source(s) of flooding in RCT16 (as per Table 5)

Ref No	Asset (Source)	Asset Owner	Type of Flooding	Relevant Risk Management Authority	Recommendations
1	River Taf	Natural Resources Wales	Main River	Natural Resources Wales	R1A NRW to “complete detailed investigative analysis work to understand the mechanisms of flooding in areas known to have flooded from main rivers”, including the River Taf at Upper Boat and Nantgarw. Aligns with recommendation ‘Action FD2’ within NRW’s Flood Incident Management Review.
					R1B NRW to investigate the standard of protection provided by flood defences throughout RCT16 and “consider

						<p>improvements to NRW flood alleviation schemes and structures on a prioritised basis”. Aligns with recommendation ‘Action FD3’ within NRW’s Flood Incident Management Review.</p>
					R1C	<p>NRW to work with the landowner(s) to assess and review the risk of flooding from the River Taf at locations known to have overtopped during the event but are currently ‘undefended’, to identify the viability of risk management options.</p>
2	River Taf	Private Landowner	Main River	Natural Resources Wales	R2A	<p>NRW to work with the landowner(s) to assess and review the risk of flooding from the River Taf at locations known to have overtopped during the event but are currently ‘undefended’, to identify the viability of risk management options.</p>
3	Nant Garw Culvert Network at Cardiff Road (‘Cross Keys’ culvert inlet)	Rhondda Cynon Taf Highway Authority	Ordinary Watercourse	Highway Authority, Lead Local Flood Authority and Land Drainage Authority	R3A	<p>The LLFA and LDA to identify drainage asset ownership and responsibility.</p>
					R3B	<p>The LLFA and LDA to investigate the standard of protection and the condition of the culvert structure and network as a whole.</p>
					R3C	<p>The LLFA to jet and cleanse the ordinary watercourse culvert network.</p>

					R3D	The LLFA to develop a Strategic Outline Business Case (SOC) to identify suitable management methods to reduce the risk of flooding from local sources (ordinary watercourse, surface water, groundwater).
4	Surface water drainage network across RCT16	Rhondda Cynon Taf Highway Authority	Surface Water	Highway Authority and Lead Local Flood Authority	R4A	The Highways Authority to jet and cleanse the highway drainage network and action repairs accordingly.
					R4B	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 3 and Ref 4 of Table 7, the LLFA has been determined as the relevant Risk Management Authority in relation to the ordinary watercourse and surface water flooding which occurred in investigation area RCT16 during Storm Dennis.

The LLFA exercised the following functions in response to the flooding at investigation area RCT16:

- 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. **(R3B)**
- An estimated 98 metres of culverted ordinary watercourse and 580 metres of surface water drainage network length within RCT16 has been surveyed following Storm Dennis to ascertain both the operational condition and structural integrity along sections of the network. **(R3B)**
- An estimated 30 tonnes of debris was removed from the culverted watercourse and surface water drainage network within RCT16 during cleansing operations. **(R3C)**
- The LLFA have commissioned Redstart to investigate the standard of protection of the Cross Keys culvert network in RCT16 to determine its hydraulic capacity following the observed surcharging at the inlet during Storm Dennis. **(R3B)**
- The LLFA has exercised its powers, under Section 13 of the FWMA, to request information and co-operation from the relevant risk management authorities (NRW and DCWW) in relation to their responsibilities as RMAs in response to Storm Dennis.
- 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, working in partnership with NRW, have expanded their interim Property Flood Resistance project offering expandable flood gates to those properties deemed at high risk of flooding from the main river, as per NRW's determination.

The LLFA also propose to exercise the following functions in response to the flooding at investigation area RCT16:

- Following the surveying of the Cross Keys culvert network in RCT16, the LLFA propose to input and update all relevant asset data. **(R3A)**
- The LLFA propose to develop a Strategic Outline Business Case (SOC) to better understand the risk of flooding within RCT16 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). **(R3D, R4C)**
- 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.
- 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.
- 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 Lower Taf 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 SFRA also aim to encourage whole catchment measures, including working with natural processes, to alleviate flood risk in those areas of highest risk. **(R3D, R4B)**
- The LLFA will cooperate and collaborate with NRW to ensure a detailed study of the investigation area is completed and that appropriate actions to mitigate the impacts of river flooding are undertaken in accordance with NRW's Flood Incident Management Review.

4.2 NATURAL RESOURCES WALES

In review of Ref 1 and 2 in Table 7, NRW has been identified as the relevant Risk Management Authority in relation to the main river flooding from the River Taf during Storm Dennis.

NRW have exercised the following functions in response to the flooding at investigation area RCT16:

- NRW have carried out post event data collection including an assessment of the properties impacted by main river flooding and a survey of wrack marks, i.e., the marked high-water level.
- NRW specifically outline within their ‘Flood Incident Management Review’⁴ that “more Severe Flood Warnings should have been issued based on the flooding impacts experienced” in the Lower Taf region. Utilising post event data and information, NRW have reviewed the Resultant Thresholds for the River Taf at Nantgarw and Upper Boat Flood Warning Area. This is critical for assessing the performance, timeliness and accuracy of the warning service after a flood. **(R1C)**.
- 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, according to NRW, improve how live flood warning and water level data is shared before and during flood events. **(R1C)**
- NRW have commissioned a Lower Taf Flood Modelling Project which is currently ongoing. **(R1A)**
- Following the flooding events of February 2020, NRW published a review of its incident response to Storm Ciara and Dennis in October 2020⁷. 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 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 **(R1C)**.

⁷ [Natural Resources Wales / Our response to Storm Ciara and Storm Dennis](#)

NRW also propose to exercise the following actions in response to the flooding at investigation area RCT16:

- Following the completion of NRW's Lower Taf Flood Modelling Project, NRW propose to undertake an initial economic assessment of the viability of potential flood risk management options. Greatest consideration should be given to areas at high risk of flooding from rivers on a prioritised basis. **(R1A, R1B)**
- Following the completion of NRW's Lower Taf Flood Modelling Project, NRW propose further threshold work and flood warning area amendments. **(R1A, R1C)**
- NRW will undertake a review of the modelled outputs and adopt changes to their maintenance program within the investigation area if required. **(R1A)**
- NRW to undertake repairs and upgrades to the concrete revetments along the River Taf at RCT16.

4.3. WATER COMPANY

Dŵr Cymru Welsh Water were not identified as a relevant authority in relation to the flooding at investigation area RCT16 during Storm Dennis. DCWW do not propose to undertake any actions in relation to the event within the investigation area.

4.4. HIGHWAY AUTHORITY

During the investigation into the flooding at investigation area RCT16 during Storm Dennis, the Highway was identified as flooding from a combination of sources at different locations, most notably as a result of main river flooding from the River Taf and the surcharging of the Nant Garw ordinary watercourse at 'Cross Keys' culvert inlet.

Ref 3 and 4 of Table 7 identifies the Highway Authority as a relevant Risk Management Authority in relation to the surface water flooding that occurred along the highway across RCT16.

RCT as the Highway Authority have exercised the following functions in response to the flooding within investigation area RCT16:

- 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 fluvial flood water to ensure the safety of the highway post event. **(R4A)**
- The Highway Authority completed repairs to the damaged highway drainage infrastructure at Oxford Street following the storm event. This included repairs to the partially damaged outlet structure. **(R4A)**
- The Highway Authority has undertaken emergency clearance works to the culvert inlet identified as a source of flooding. **(R3C)**

RCT as the Highway Authority propose to undertake the following function in relation to the storm event at RCT16:

- The Highway Authority intend to increase 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.

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>