Torfaen County Borough Council
Flood and Water Management Act 2010
Section 19 Flood Investigation Report- Cwmbran

Date report of flooding received

22/05/2014

Date completed

9/09/2014

Date referred to relevant RMA

9/09/2014

Contents

Executive Summary

This report has been produced through the duties placed upon Torfaen County Borough Council (TCBC) 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*."

This Section 19 report provides a factual report of the storm event that occurred on 22 May 2014 in the Cwmbran area, it will form part of future considerations to be considered with regard to Torfaen's Flood Risk Management Strategy, **but does not** identify, other than in broad terms any proposed specific actions or works.

The flooding that impacted Torfaen County Borough Council on 22nd May 2014, in the Cwmbran area was as a result of a localised extreme weather event that has been assessed as greater than a 1 in 100 year event with Met Office data giving a peak intensity of at least of 78mm/H. The impact of the event caused internal flooding to 198 properties, which were identified through the assessments made by the Flood Risk Officer and collated against residents requests for assistance and external agencies such as; South Wales Fire and Rescue Service, Natural Resources Wales, Bron Afon and Dŵr Cymru Welsh Water.

These properties were located in the following Ward areas

Area of Cwmbran	Number of properties flooded
Greenmeadow/Fairwater	71
Pontnewydd	35
Llantarnam	25
Two Locks	18
St Dials	12
Thornhill	8
Coed Eva	8
Henllys	8
Croesyceiliog	6
Upper Cwmbran	3
Old Cwmbran	3
Ty Canol	1
Total	198

A post event survey showed that 198 properties were internally flooded and have been categorised into the following areas:

- 108 internally flooded properties from culvert overloads
- 26 properties were affected internally by the public sewerage system. (Discussions with Dŵr Cymru Welsh Water indicate that to date, only 20 residents have contacted the Company related to this event which they are investigating.)
- 64 flooded properties from overland surface flows such as roof drainage, garden run-off, and highway run-off.
- There were two supermarkets that suffered structural damage due to the heavy rainfall that caused collapse of flat roofs due to the significant weight of water that collected upon them.

Therefore, it appears, the area where the flooding occurred was impacted by a rainfall event that far exceeded these recorded levels. This is supported by the observations of TCBC staff, other members of emergency services and local residents in that area at the time, along with photographic records within the report. The significant number of properties affected in Cwmbran and the fact that the drainage systems in New Inn and Cwmbran are of a similar age and design, meant the rainfall conditions must have been far worse in Cwmbran for such flooding to have arisen. It has been established from examination of photographic records, verbal accounts and post event surveys that the flooding resulted from a combination of:

- Hydraulic overload of the foul, storm, combined drains, and the highway drainage system on or near the overland flood route.
- Six specific culverts along the course of the Dowlais Brook and five others becoming unable to transport the excess flows created by the event
- The rapid deposition of debris onto security and trash screens at these locations.
- The rapid onset and magnitude of flood flows that the event produced precluding residents or the Risk Management Authorities (RMA's) to react to prevent flooding to properties.

This event initiated a multi-agency response and TCBC records show that its agreed policies with regard to culvert cleansing and road drainage maintenance were in accordance with our schedules.

Since the event TCBC has carried out a comprehensive survey of overland flood flows and has met with the Risk Management Authorities concerned and made them aware of our findings. As part of its responsibility, the Council has initiated meetings with Dŵr Cymru Welsh Water, Natural Resources Wales and Network Rail to identify areas of concern related to the flooding incident. Whilst not included within this report these meetings have been successful in the Council has ensured appropriate works have been undertaken by Network Rail related to culvert cleansing and Dŵr Cymru Welsh Water have committed to carrying out further study work on the South West Cwmbran Sewer.

This event is deemed to be an extreme event with a probability of reoccurrence within the next twelve months of below 1%, as such this will be a prime consideration in the need for any future interventions. The event exceeded all existing design criteria for the various drainage systems.

TCBC are however, very aware that any type of flooding causes great distress to individuals and communities and will work to address these concerns to better inform them of their flood risk and how, together with the Council they can work to reduce this risk.
Officers will now consider a range of responses which may include:

- The use of community engagement and awareness programmes as set out in the Flood Strategy will be essential in developing the resilience of the communities throughout Cwmbran.
- Where deemed appropriate and in line with its Strategy, there may be works carried out by the Authority that would involve small scale projects aimed at redirecting surface flows and the creation of directed flood paths.
- Consideration of maintenance regimes.

It must be understood that TCBC cannot prevent flooding, but have a duty where appropriate and cost effective, to reduce the risk of flooding in the County Borough. This Section 19 report details the facts of the event together the Councils' response which satisfies its role as a Lead Local Flood Authority and its associated duties.

1. Introduction

1.1 LLFA Investigation

1.2 Purpose of Investigation

May 22nd saw an extreme weather event impact TCBC. The area of South West Cwmbran was the most severely affected by the flooding. The reason behind TCBC's investigation is in response to the duties of the local authority in regards to Section 19; of the Flood and Water Management Act 2010. 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:

1. "Which risk management authorities have relevant flood risk management functions and, 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 publish the results of its investigation, and notify any relevant risk management authority"

1.3 Site Location

The area of Cwmbran; mainly Fairwater, Pontnewydd, Llantarnam and Two Locks showed the highest number of internally flooded properties (Table 1). The Dowlais Brook had 6 overloaded culverts from Penmaes Road to Gifford Close, and one on the Cwmbran Brook near Court Road, one at Rede Road and Coed Eva Mill Lane and one each at Upper Cwmbran Road and Henllys Village Lane, (a total of 11 sites). The flooding that took place was centred on the Fairhill area and reduced away from this point. The area is heavily urbanised, and is situated on a steep valley side running eastward to the Afon Lwyd main river. This provides an opportune environment for overland flows of surface water.

Area of Cwmbran	Number of properties
Greenmeadow/Fairwater	71
Pontnewydd	35
Llantarnam	25
Two Locks	18
St Dials	12
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Upper Cwmbran	3
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Table 1: Identifies the areas of Cwmbran affected internally by flooding

1.4 Drainage System

The majority of local domestic drainage systems were constructed by Cwmbran Development Corporation, private housing developers and Housing Act requirements, and were designed to a maximum capacity of a 1 in 30 year return period. The highway drainage systems were also constructed by these parties and would have been designed to cope with no more than a 1 in 10 year return period event as set out by current design guide at that time. The culverts affected were designed to a 1 in 100 year event with the newly constructed culverts, after 2006, having a design specification of 1 in 100 + 20% on derived flood flows for this return period to compensate for the predicted change in the climate (Image 1).

The drainage networks found throughout New Inn and Cwmbran are of very similar age and design in terms of drainage, highway and culvert networks. The growth of Cwmbran has been documented by a CDC commissioned book. The contents highlight the various stages of development. The later developments such as Greenmeadow/Fairwater were approved for construction in 1969 with final developments completed by 1985. The majority of new estates were already completed within the New Inn areas by this time. Greenmeadow/Fairwater was the most severely affected area of Cwmbran during the flooding. It has been estimated as the epicentre for the highest level of rainfall due to the impact of the flooding compared to the lack of impact within New Inn.

Current design guides that have been approved by Welsh Government and adopted by TCBC since 2006 (Design Standard for Roads and Bridges Volume 4, supplemented by Road Note 35) currently state that combined surface water and groundwater drains, longitudinal sealed carrier drains, are designed to accommodate a one-year storm in-bore without surcharge. The design must be checked against a five-year storm intensity to ensure that surcharge levels do not exceed the levels of chamber covers. There is a further statement that suggest that local engineers take into account the local surroundings, topography, geology, etc. and deem it prudent to design outfall drainage to a design storm return period of say ten years i.e. having an annual probability of 10%. Culvert designs have been set at 1 in 100 return period for urbanised areas with the addition that climate change be factored into the design by adding 20% to the capacity. Surface water sewers adopted either by TCBC of Dŵr Cymru Welsh Water, or those adopted by them have been designed in accordance with Sewers for Adoption – A Design and Construction Guide for Developers. The document states that surface water sewers adopted will need to be designed using the Wallingford procedure, and set against storm frequencies:

- Sites with average ground slopes greater than 1 per cent 1 in 1
- Sites with average ground slopes 1 per cent or less 1 in 2
- Sites where consequences of flooding are severe 1 in 5

Further to the hydrological modelling (Wallingford) set against the pre set storm return periods, an initiative to protect against flooding has been set where an adequate protection is achieved. The systems should then be designed not to flood in a 1 in 30 year return period storm; this is also mirrored by Ofwat for below ground assets.

The drainage systems have been tested since the 22nd May in relation to weather warnings where 4 severe weather warnings have been issued; 3 Yellow and 1 Amber all of which passed through the area without incident. There have not been any new works within Cwmbran since the event on the 22nd. The drainage networks throughout TCBC managed the severe weather events that passed over, including the low pressure system that had the remnants of ex-hurricane Bertha. Cwmbran remained unaffected.

Image 1: A 1.5m Diameter culvert designed for the 1 in 100 event return period approved by the National Rivers Authority in 1992/3.

2. Flooding History

2.1. Previous Flood Incidents

Over the last 30 years Cwmbran has experienced several flooding events, the most severe of which was the 1986/7 event; during which flooding was experienced in multiple locations throughout Cwmbran. As empirical data is not available for that event, a comparison with that of the storm of 22nd May 2014 has not been possible to carry out. It must be noted however that the flooding that was experienced in 1986/7 resulted in a limited number of properties suffering internally from flooding, compared to the more widespread damage of the flooding on the 22nd May 2014.

2.2. Flood Incident

The flooding that occurred on the 22nd May 2014 was a result of an intense rainfall event that caused the overloading of culverts, public and private foul water and surface water drains, and the available highway drainage system. A post event survey showed that 198 properties becoming internally flooded. Multiple culvert overloads resulted in 108 internally flooded properties. Initial investigation determined that 26 properties were affected internally by the public sewerage system. Discussions with Dŵr Cymru Welsh Water indicate that to date, only 20 residents have contacted the Company related to this event which they are investigating. Flooding from surface water flows resulted in 64 flooded properties. There were two supermarkets that suffered structural damage due to the heavy rainfall that caused collapse of flat roofs due to the significant weight of water that collected upon them.

2.3. Rainfall Analysis

The Met Office issued a Yellow warning for Thursday 22nd May. Yellow warnings refer to "be aware." The warning was issued for all of Wales and an estimated 15mm per hour of rainfall was expected in localised downpours, the heaviest of which was expected to bring 40mm/hr. Specific locations could not be given due to the erratic nature of the weather system generating the localised downpours.

Rainfall was recorded at the New Inn weather station 4.1Km northwest of the assumed centre of the event (Fairwater School) at a peak intensity of 71.9mm per hour at 14:52 on the day in question (Graph 1). Based on data supplied by the Met Office for the Fairwater area and over a 25 minute duration a maximum rainfall intensity of 78mm/H has been provided, giving an event return period of greater than a 1 in 100 but less than a 1 in 1000 year, (an abstract of this data is reproduced as Table 2)

Table 2

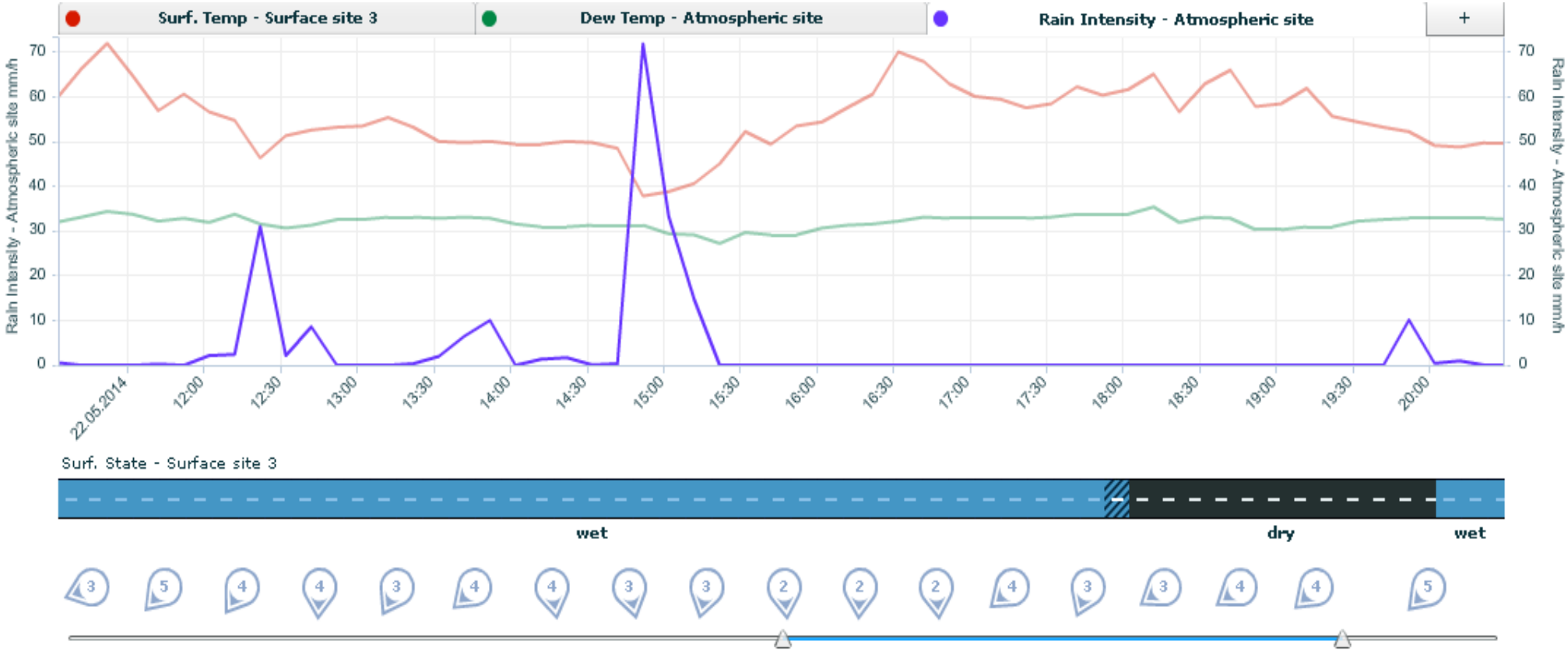
Fairwater Cwmbran Nat Grid Ref 3273E 1949N										
Rates of Rainfall in MM/H for a range of durations and return periods for a specified location in the United Kingdom for areas less than 5 hectares										
		Return Period (years)								
Duration		0.5	1	2	5	10	20	25	50	100	1000
24.0 MINS		16.5	22.3	28.8	36	42.5	50	52	61	71	119
25.0 MINS		16.1	21.8	28.1	35.2	41.6	49	51	60	70	116
26.0 MINS		15.8	21.3	27.5	34.4	40.6	48	50	59	68	114

Table 2: Storm return periods projected against duration times used to identify the likely event experienced on 22nd May, information provided by the metrological Office.

Following the event TCBC requested a storm analysis to be carried out by the Met Office. This was undertaken using 2km resolution radar data combined with the statistical analysis of averages of rainfall, within the surrounding area where Met Office rainfall stations are present (none in Torfaen). The results identified limited sporadic data regarding the event due to the localised storm cell that passed over on the 22nd. There was reference to locations within Cwmbran receiving a peak intensity of 78 mm/hr. Since this initial assessment TCBC requested a further detailed analysis of the storm track and cell development to be undertaken to further analyse the impacts of the rainfall event. This work has not yet been completed.

As there are no rainfall gauges located within the area where the flooding event occurred, total rainfall at the nearest available locations have been used to indicate the severity of the storm. Monthly Met Office and Natural Resources Wales data have been averaged from the nearest stations in the region and compared against the nearest rain gauge available to TCBC based 4.1 km from the focal point of flooding. This shows that no less than two weeks rain fell on the 22 May 2014 with half of this total falling in the 1hour nearest the flooding event.

2.4. Vaisala rainfall Intensity Graph



Graph 1: Rain gauge readings taken at Jerusalem Lane via Vaisala system

2.5. Rainfall Radar

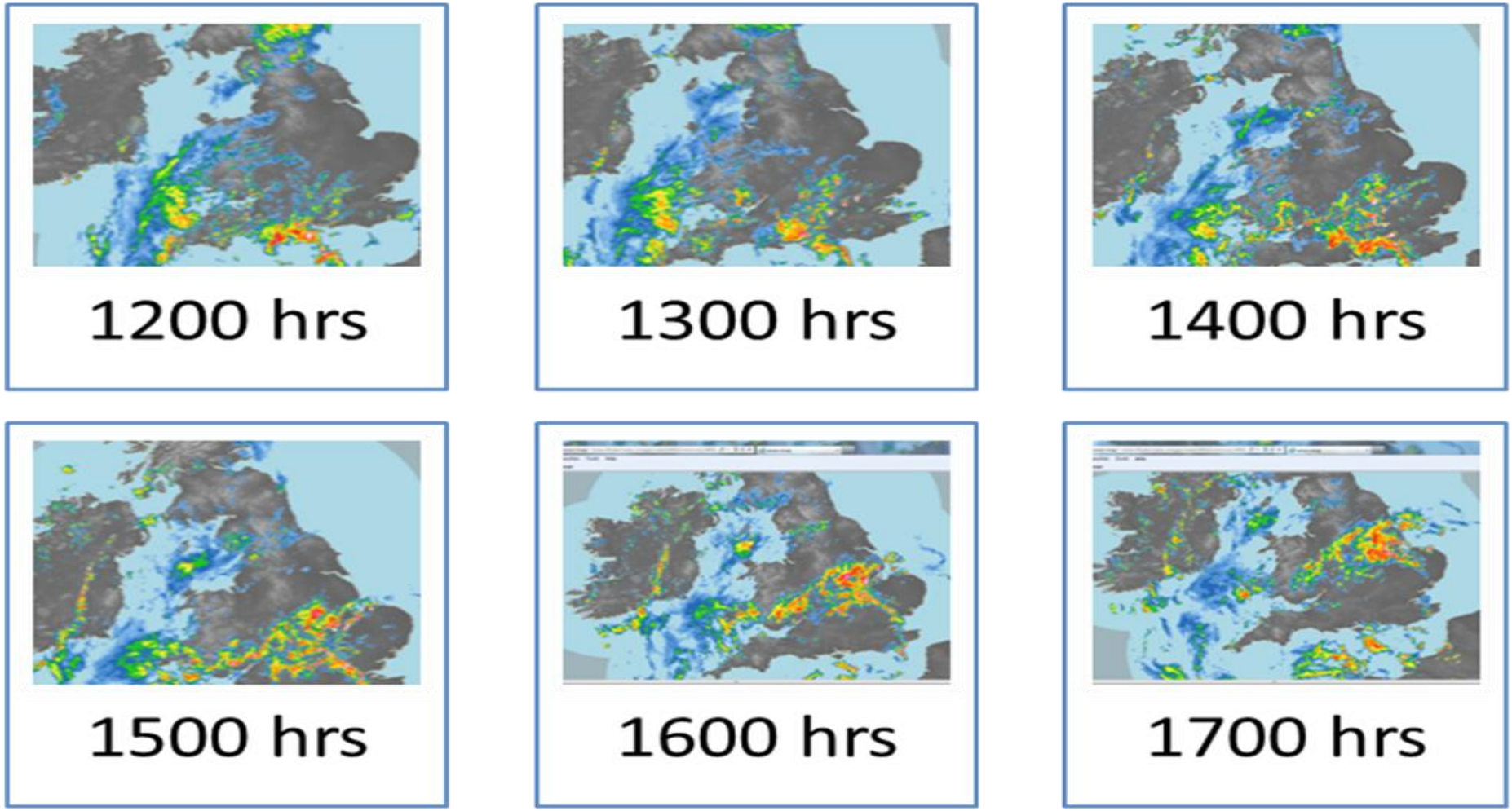


Image 2: The rainfall radar images above have been provided by the Met Office and show the intensity of the downpour.

3. Possible Causes

3.1. Culvert Conditions

Each culvert has been assigned a unique culvert number for administration purposes and each culvert has been assigned an engineering Priority, which has three risk grades:

1. Highest Risk, (has caused flooding in the past)
2. Medium Risk (has not caused flooding in the past but could flood properties if blocked)
3. Low Risk (has not caused flooding in the past but is unlikely to flood properties if blocked)

It was noted that 11 culverts that experienced hydraulic overload and partial blockage resulted in 108 flooded properties. TCBC is responsible for the maintenance of 9 of these culverts where 1 is owned by Network Rail and 1 is in private ownership.

Prior to the incident the regular inspection and maintenance schedule was being implemented in the usual manner. Typically the schedule runs cyclically utilising a three stage priority system. The culvert crew are responsible for maintaining the inlets and outlets throughout the County Borough. This involved the clearance of debris, obstructions, litter and sediment. Table 3 outlines the schedule of the crew throughout May on the culverts that presented a source point for flooding on the 22nd. Many of the culverts that suffered partial blockages

Culvert Number	Location	Priority	Dates Visited
78	Upper Cwmbran Road, Queens Inn	3	01/05/14
94	Near junction of Fairhill	2	01/05/14 - 12/05/14
95	Windsor Road	1	01/05/14 - 07/05/14 - 13/05/14
96	Waun Road	1	01/05/14 - 07/05/14 - 13/05/14
110	Coed lee, Coed Eva Mill	2	01/05/14 - 13/05/14
112	Hollybush Close	1	01/05/14 - 08/05/14 - 13/05/14
113	Rede Road	1	01/05/14 - 08/05/14 - 20/05/14
134	Penmaes Road	2	01/05/14 - 20/04/14
130	Junction of Henllys Lane	2	01/05/14 - 20/04/14

Table 3: Torfaen County Borough Council's maintenance schedule for culverts that experienced hydraulic overload on 22nd May 2014.

It should be noted that the culvert near Court Road is maintained by Network Rail, and the culvert at Gifford Close lies within private land.

Also the agreed polices regarding road drainage maintenance was accordance with the TCBC's schedule

3.2. Open Watercourse Conditions

Dowlais Brook has been identified as having the majority of culverts that overloaded. It is probable that overland flow from this watercourse is responsible for 71 properties suffering internal flooding. Under land drainage law it is the responsibility of the riparian owner to maintain the waterways so as not to cause a nuisance to a neighbour, further detailed in section 4.6. Riparian Owners. TCBC carry out operations to reduce the risk of flooding from the culvert entrances as part of their land drainage operations. No major problems were noted on any of the culvert entrances and any debris observed at the entrances (and 10m upstream) or on the trash/security screens was removed in prior inspections.

In terms of the open watercourse, TCBC also operate ad-hoc maintenance of the watercourses in terms of removing any debris and fly tipped material reported to, or noted by, the Authority. Any changes and amendments planned for a section of watercourse must first be passed through the LLFA, to ensure the watercourse does not present any negative impacts to the ecology, water quality or flood risk. TCBC also operate the requirements of the Land Drainage Act ensuring any development that discharges into an open watercourse has been structured and designed not to present an increased risk of flooding. This is carried out through industry standard rainfall design standards and mitigation measures.

Image 3: Culvert No 96 after the flooding.

Image 4: Culvert No 95 after the flooding event

Image 5: Culvert No 134 after the flooding event

Image 6: Culvert no 94 after the flooding

Image 7: Clean up crew on site at culvert 94 after the flooding

Image 8: Material removed from Culvert 94 totalled 35tonnes.

Image 9: The main river section of Dowlais Brook after the flooding event (above the inlet near Gifford Close).

Image 10: The main river section of Dowlais Brook during the flooding event (taken from Gifford Close Bank).

Image 11: Banks of Dowlais Brook above the inlet near Gifford Close (Privately owned and overseen by NRW).

Image 12: Two Locks Road garage area next to Dowlais Brook.

Image 13: Car park adjoining the main river section of Dowlais Brook Two Locks Road during the event.

Image 14: Car park adjoining the Dowlais Brook, Two Locks Road after the event.

Image 15: Hollybush Close flood route after the rainfall event surcharging from Culvert 112

3.3. Access Structures/ Inspection Chambers

No relevant land drainage access structures/inspection chambers were implicated during this event. The flooding was a result of surface water flows overloading the capacity of the Public Sewer system, domestic drains, highway drains and at its peak, the watercourses as they became overburdened and surcharged releasing the hydraulic pressure that had built up through the volume of water involved during the event, rather than any failure in design or lack of maintenance.

3.4. System at Capacity

Any remedial actions for this event would have to:
1. Accept that the storm event was at or above the systems design standards and any risk mitigation would be based on the cost benefit set against the risk of reoccurrence.
2. Any remedial actions would have to be fully considered to ensure that current risk mitigation measures are not compromised.
3. Any actions form part of the Torfaen County Borough Council Flood Strategy.

4. Rights and Responsibilities of Risk Management Authorities

4.1. Lead Local Flood Authority

Since 2007 flood risk management has been brought to the forefront of risk management, through the evidence produced within the Pitt Review. Since the Review several recommendations were taken forward, the risk posed by climate change being one of them. The Review highlighted the need for the government to provide emphasis on the adaptation and mitigation techniques.

On an international level the Floods Directive (Directive 2007/60/EC of the European Parliament and of the European Council on the assessment and management of flood risks) was designed to provide a universal management strategy for flood risk. The directive was transposed into UK law by the Flood Risk Regulations 2009. The regulations placed several requirements on local authorities identified as having a risk to flooding:

- Preliminary flood risk assessment maps and reports by 22 December 2011(on the basis of which ‘Flood Risk Areas’ should be identified in accordance with Government guidance);
- Flood hazard maps and flood risk maps by 22 December 2013;
- Flood risk management plans by 22 December 2015;
- All assessments, maps and plans to be reviewed and updated every 6 years.

Further to the development of the Flood Risk Regulations the Flood and Water Management Act 2010 was produced to provide clarity regarding the powers and responsibilities of flood risk management authorities. The aims of both the flood risk regulations and flood and water management act have been designed to reduce the risk of future flooding; through the use of a UK and European standard of flood risk. The aspects of which focus upon national strategies (Welsh Government), river basin strategies (Natural Resources Wales) and local strategies (Lead Local Flood Authority) when applied to Wales.

The role of TCBC as the Lead Local Flood Authority (LLFA) to investigate this event falls into section 19 of the Flood and Water Management Act 2010. The LLFA is responsible for compiling the evidence to what, when, why and how the event took place to better understand the impacts. The LLFA will be utilising the results to place responsibility for the incident onto the appropriate RMA, It will be up to the responsible RMA to progress with any flood risk alleviation schemes that are deemed sustainable and cost beneficial for the future impacts of climate change.

Each RMA has a duty under the flood and water management act 2010 to take flood risk measures where appropriate. Under TCBC's Flood Strategy, the LLFA have a duty to investigate and where appropriate seek to reduce the risk of flooding. Any measures that may impact ordinary watercourses and surface/groundwater flooding issues will have to be communicated to TCBC or NRW before the RMA proceeds.

The Idea of climate change is a key principal in the management of future flood risk and so the latest stage of the regulations to produce Flood Risk Management Plans focuses on a variety of associated hazards (1 in 100 to 1 in 1000 year return periods). The risks are being identified through the latest release of 1D/2D flow model extents at varying levels of intensities. The associated plans are within the early stages and are on track to satisfy the requirements of the regulations at the end of 2015.

The projected change in climate has been predicted through the work of the IPCC Fifth assessment Report (2013), which has been further developed locally by the United Kingdoms Climate Impacts Programme modelling software (UKCIP09). The change has been generalised by hotter drier summers, warmer wetter winters, and more frequent extreme weather events. The developments of the IPCC, UKCIP09 projections have not changed the view of climate change they have simply created the most up to date assessment on a global scale.

Despite the evidence presented by the work of the IPCC working groups, there is still an animosity regarding the actuality and consequences of climate change. This is a stigma that causes a great deal of difficulty when managing any risk associated to a changing future. The work of UKCIP09 projections provide three levels of certainty high medium and low which reflect the changes in climate expected for the UK. The results agree at all levels that the climate is expected to bring hotter drier summers, warmer wetter winters and more frequent extreme weather events.

Developing a mitigation strategy for climate change is a long term process in which an understanding of the likelihood and Impact must first be achieved. The Flood Risk Management Plans will aim to develop these strategies with short and long term plans. The flood risk management plans won't remove the risk of flooding, neither will engineering solutions. Resilience to flooding will need to be developed through the joint working between TCBC, RMA's and local communities to ensure a holistic sustainable approach that incorporates the predicted change in climate.

4.2. Natural Resources Wales

Natural Resources Wales has an operational responsibility for flooding from main rivers, the sea and coastal erosion and an oversight responsibility in relation to all flood and coastal erosion risk management in Wales. Included within this event was a localised length of 200 metres of Dowlais Brook within NRW control as it is deemed Main River. During the event the area became flooded due to the hydraulic loading of a culvert (Image 1). The area backed up and attenuated 3 meters above the 1.5m culvert. The attenuated flows raised the level of the brook substantially and overtopped the banks flooding the adjacent businesses, streets and open areas/car park along the watercourse from the culverted area. The volume of water attenuated at this site took over 1 hour to recede to normal flows. At no point did the culvert become overloaded with debris; meaning the culvert was flowing at full bore for more than an hour with and increased pressure head which would have increased the flow of water. Discussions will include issues such as the existing maintenance regimes for this culvert and any actions necessary following this event to reduce the impacts of flood risk to property.

4.3. Water Company

Dŵr Cymru Welsh Water is the responsible water company that provides both potable and waste water services to the whole County Borough. It is a Risk Management Authority as such the company is responsible for the control and movement of fresh and foul water systems. Initial investigation determined that 26 properties were affected internally by the public sewerage system. Discussions with Dŵr Cymru Welsh Water indicate that to date, only 20 residents have contacted the Company related to this event which they are investigating. It is believed that any flooding would have originated through hydraulic overload on combined systems (surface water and foul).

4.4. Network Rail

Network Rail has an operational responsibility for flooding from land ownership. During this event a section of the Cwmbran Brook overtopped. The section of the Brook lies within Network Rail ownership as the brook passes under its infrastructure through a culvert. The company has a responsibility as a land owner to undertake regular maintenance of all assets that pose a risk to flooding.

4.5. Highway Authority

Operatives of TCBC Neighbourhood Services Department took on the responsive role during and after the event. The Department working on the information provided from the met office took its usual action and monitored the situation at mid-day on the 22nd May. Based on this information the Highways Network team made the decision to begin preparations with on call staff ensuring further staff were available to respond to the possibility of flooding events. This included two culvert crews (North and South) as well as ensuring the availability of the gully sucker and an emergency team to deploy sand bags.

The deployment of the teams came after the initial reports around 14:30pm. From this time the TCBC call centre received over 100 enquires from residents throughout Cwmbran. A further 145 were received the day following the event, a 5 fold increase in the normal number of calls. There were no contact made to TCBC through any medium reporting flooding to property, highway or otherwise throughout New Inn or any other part of the County Borough, despite the volume of rainfall recorded at New Inn. This implies the volume of rainfall within Cwmbran must have been greater.

Regardless of the high volume of calls the majority of work could not be carried out until after the rainfall event had passed to ensure the safety of the teams on site. Many of the culverts that had become partially blocked and overloaded were flowing with a force that was assessed as a significant risk to life and limb. Any debris removal therefore had to wait until flows had subsided. This happened within 120 minutes of the peak of the storm and cleansing operations were commenced as soon as it was deemed safe after the initial downpour.

The teams did however begin closing sections of flooded highways to reduce the risk to the public and to contain the situation. The gully sucking crew was deployed until midnight cleaning gullies and drains throughout Cwmbran. The culvert crews were deployed through the day and over the weekend period ensuring the complete clearance of the culverts. The clearance was a prolonged operation due to the sheer volume of material brought down over the grills and guards. The total quantity of material removed has been weighed and totalled at 76.36tons. One culvert in particular (94) received a large amount of debris which totalled 35tons brought down over the grill.

External resources were utilised as part of the clean up operation to assist in the removal of the large amount of debris transported during the event.

4.6. Riparian Landowners

Riparian Landowners are legally responsible under common law for the maintenance of the land generally up to the centreline of any watercourse adjacent to their property. This includes the maintenance of the bed, banks and any boundary features e.g. vegetated strips such as hedging, with routine clearance of debris and/or blockages. This does not mean that the owner has to remove all debris from the watercourse, but it does require the owner to maintain as far as it does not pose a risk or nuisance to a neighbour. Any works to modify the watercourse by the landowner must first be passed through the relevant Risk Management Authority, Lead Local Flood Authority (LLFA) or Natural Resources Wales (NRW).

4.7. Residents and Property Owners

Residents and property owners are responsible for the protection of their own properties against flooding. The drainage systems used for highways have not been designed for the defence of properties but for the proper function of highways. Residents have the right to defend their property as long as they do not subsequently increase the risk of flooding to other properties. The ordinary watercourses overseen by TCBC are typically owned by others which relates to Section 4.6. The open watercourses and culverts throughout TCBC are maintained where they are owned by TCBC or other risk management authorities through service level agreements. TCBC operates a maintenance schedule to reduce the risk of flooding but this will not remove the risk. Residents need to be aware of the potential for surface water flooding, and this can be done through being prepared. There are several companies that provide Property Level Protection (PLP) from initial surveys to determine the risk as well as the provision of equipment that is designed to prevent flood water entering the property (subject to costing).

5. Permissive Powers of Risk Management Authorities

Risk Management Authorities have direct permissive powers under the Flood and Water Management Act 2010, as well as the Land Drainage Act 1991. The LLFA can utilise such powers as section 14A General Powers: Flood risk management work, taken from the Land Drainage Act, and amended through the Flood and Water Management Act 2010 Schedule 2.

The use of this section can have a varied approach from public awareness campaigns to increase the knowledge base, to engineering works designed to mitigate the impact of flooding. The approaches taken will follow TCBC's local flood risk management strategies four overreaching aims:

- Reducing the impacts on individuals, communities businesses and the environment;
- Raising awareness of and engaging people in the response to flood risk;
- Providing an effective and sustained response to flood events; and
- Prioritising investment in communities most at risk.

6. Flood Alleviation Schemes

If deemed appropriate and within the parameters of the Local Flood Risk Management Strategy, flood alleviation schemes will take the form of small scale redirection works. These include where possible offline storage areas aimed at alleviating the pressure on the drainage systems and ordinary watercourses by diverting surface water away from high risk areas. This should reduce the risk of the drainage systems becoming overloaded during similar rainfall events. The works will also look to develop existing flood channels to utilise and enlarge these structures providing a route for flood water.

Several historical alleviation schemes are in place throughout the Cwmbran area, which include overflow channels along footways. These features were designed to direct the flow of an overtopped culvert and redirect it back into the watercourse. During this event these measures proved effective in the way that they channelled the flow back to the watercourse. However the sheer volume of water released into the system was enough to hydraulically overwhelm the escape routes and maintain a flow along the footways. In one case the flow was strong enough to pass across an open footbridge (Image 16) and continue onwards up an inclined path (Image 17) and down into several streets below.

The scale of the event is a major factor in what level of mitigation schemes are going to be carried out. During this event engineered overland flood routes were hydraulically overwhelmed in minutes, and many of the highway systems acted as storage for large volumes of flood water and still over 198 properties became internally flooded. This scale of event emphasise the fact that engineering solutions will not remove the risk. Future engineering projects to reduce the risk would likely prove impractical and lack cost benefits for the area.

Image 16: Open footbridge that allowed the flow of water to travel across.

Image 17: Inclined path uphill from the open footbridge.

7. Conclusion

The flooding that took place on 22nd May 2014 was a localised extreme weather event, and has been estimated between a 1 in 100 and a 1 in 1000 year event which occurred within a 1 hour duration. This type of weather system is extremely unpredictable and by its nature very rare, which explains only a yellow warning being given by the Met Office. The "Be aware" notice brought with it warnings of rainfall in the range of 15mm – 40mm per hour. This was clearly exceeded during the event with the recorded levels at New Inn, the nearest rainfall station, which has been corroborated by the Met Office. The impact of this event led to 198 properties to become internally flooded. This figure would have been significantly higher if the weather had persisted.

The weather conditions witnessed on the 22nd were a very unusual weather event that has not been witnessed within TCBC in living memory of many residents and officers. Long standing members of the Neighbourhood Services Department commented that they had never witnessed an event like the one of the 22nd throughout their career. Following the event there has been 4 severe weather warnings issued by the met office, 3 Yellow warnings and 1 Amber for rainfall. This includes the ex-hurricane Bertha that passed over bringing localised downpours. During the events no issues of flooding were recorded throughout the County Borough. There have been no alterations made to Cwmbran's drainage, highway or culvert network meaning the network was working in the same way as it was on the 22nd May.

As the LLFA, TCBC will be investigating the possibility for sustainable methods of risk reduction over the next 9 to 12 months. The use of community engagement and awareness programmes as set out in the Flood Strategy will be essential in developing the resilience of the communities throughout Cwmbran. The aim of the communication will be to increase the knowledge base of why flooding occurs and what residents can do to protect themselves in the long term. TCBC has already published information relating to severe weather, flooding and emergencies on its website. Where deemed appropriate and in line with its Strategy, there may be works carried out by the Authority that would involve small scale projects aimed at redirecting surface flows and the creation of directed flood paths.

8. Recommendations

- Public awareness programmes to inform residents that it is statutory for them to defend their own properties, and the possibility of providing examples of property level protection schemes (flood gates, walls, step ups, drains, orientation of driveways, etc.)
- Awareness programme to inform Council members of the risk of flooding (Response, Recovery, Mitigation, preparedness), and what the procedures are when dealing with insurance issues, householder's responsibilities, council's responsibilities, etc.
- Riparian owners informed of their duties to maintain the watercourse which is generally up to the centreline of the watercourse adjacent to their property.
- For new development the encouragement for SuDS designs, as well as green environments within communities to better develop natural drainage.
- Investigation into areas that already suffer extreme localised weather events and the mitigation techniques deployed. Best practice adoption.

Useful Links/Contacts

- Design Manual for Road and Bridges http://www.dft.gov.uk/ha/standards/dmrb/ (Volume 4)
- Emergency Advice form TCBC: http://www.torfaen.gov.uk/en/CommunityLiving/EmergencyManagement/EmergencyPlanning-gaspipelines/Emergency-Advice.aspx
- Flooding Advice from TCBC: http://www.torfaen.gov.uk/en/CommunityLiving/EmergencyManagement/EmergencyPlanning-flooding/Flooding.aspx
- IPCC Fifth Assessment Report: http://www.ipcc.ch/report/ar5/
- Local flood risk management strategy is available on request from TCBC in Bilingual and large print.
- National flood risk Management strategy: http://wales.gov.uk/topics/environmentcountryside/epq/flooding/nationalstrategy/strategy/?lang=en
- Severe Weather Advice from TCBC: http://www.torfaen.gov.uk/en/CommunityLiving/EmergencyManagement/Emergencies-severeweatherwarnings/Severe-Weather.aspx
- UKCIP: http://www.ukcip.org.uk/

- http://archive.defra.gov.uk/environment/flooding/manage/propertylevel/
- Property Level Protection: http://www.nationalfloodforum.org.uk/property-level-protection-community-tool/
- Road note 35: http://www.thenbs.com/PublicationIndex/DocumentSummary.aspx?PubID=538&DocID=254785
- Sewers for Adoption: http://sfa.wrcplc.co.uk/sewers-for-adoption-6th-edition.aspx
- Videos of the Fairhill Subway Flooding: http://www.cwmbranlife.co.uk/cwmbran-stream-bursts-its-banks/ (01/07/2014)

Abbreviations

DWR	-	Welsh Water/DWR Cymru
FRMP	-	Flood Risk Management Plans
GHG	-	Green House Gases
IPCC	-	International Panel on Climate Change
LFRMS	-	Local Flood Risk Management Strategy
LLFA	-	Lead Local Flood Authority
NRW	-	Natural Resources Wales
RMA	-	Risk Management Authority
SAB	-	SuDS Approval Body
SuDS	-	Sustainable Urban Drainage Systems
TCBC	-	Torfaen County Borough Council
UKCIP	-	United Kingdom Climate Impact Programme
WG	-	Welsh Government