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February 2020 Floods in Wales: Flood Incident Management Review

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About Natural Resources Wales

Natural Resources Wales' purpose is to pursue sustainable management of natural resources. This means looking after air, land, water, wildlife, plants and soil to improve Wales' well-being, and provide a better future for everyone.

Executive summary

Wales experienced the fifth wettest month on record during February 2020 and the wettest February ever recorded. This led to widespread flooding during Storm Ciara (8 – 9 February 2020), Storm Dennis (15 – 17 February 2020) and Storm Jorge (28 February to 1 March 2020). These storms led to the flooding of 3,130 properties across Wales, making this period the most significant series of flooding incidents to hit Wales since the floods of December 1979, which impacted many of the same communities. 22% of Natural Resource Wales's (NRW's) river gauges recorded their highest water levels ever recorded during Storm Dennis.

The storms of February 2020 were no doubt exceptional events that stretched all emergency responders. NRW staff worked hard throughout this period, using their skills and experience to professionally respond to the unfolding events. Our staff worked to track forecasts, issue warnings, ensure flood and hydrometry assets were operating properly, fix repairs, post up-to-date information on our web-site, handle media interviews and queries and support other incident responder organisations. They worked in the days, weeks and months after the events to inspect assets, make repairs and make immediate improvements to our service. There are many examples of good practice in the review feedback; decisions and actions taken by NRW staff played a key role in managing the situation and lessening the impact of the storms.

Nonetheless, NRW's services and the roles it undertakes during a significant flood event were severely tested during this period and in some cases our services stretched beyond capacity. This is an independently reviewed report of the flood incident response delivered by NRW. This review report focuses on the internal issues and lessons identified regarding resources, systems, tools, ways of working, procedures and guidance, but it does not look at the performance of any individuals. It does not look at the performance of other organisations, or how Wales as a whole responded to the events. There are separate, ongoing flood investigation reviews undertaken by each affected local authority with NRW's support where appropriate. A separate review has also been carried out concerning how NRW manages the Welsh Government Woodland Estate in response to the impact of the February storms. A separate, factual report capturing the facts and statistics of the flood events has also been produced to complement this review report.

As well as acknowledging the many positive elements of the operational response, this review identifies 10 key areas with actions for improvement. These are consolidated into an action plan, included as part of this review document. This plan proposes likely business leads, indicative costs and timescales to deliver these recommendations.

Flood Defences

The performance of NRW's flood defences has been considered. There is an extensive network of defences in Wales; these defences are essential to the nation's ability to cope

with floods and form part of Wales's vital national infrastructure. Some 19,000 properties were protected during Storm Dennis alone, but 3,130 properties were flooded during February 2020. Flooding is complex and can occur from a range of sources, including local watercourses (not managed by NRW), sewerage and road drainage. With those separate flooding mechanisms is a governance structure of different Risk Management Authorities who are required to collaborate to tackle combined flood risk issues. This complexity can be difficult for members of the public to understand and at times leads to a public perception of lack of accountability as to who is responsible for what. This can also be a source of confusion or frustration to those affected by flooding. Whilst there are many areas where there is evidence of good collaborative working, all relevant authorities need to find ways to further improve how they work together to serve our communities.

The network of defences across Wales helps protect 73,000 properties from flooding, yet some flood defences across Wales were overtopped by the extreme flows experienced. Some defences were damaged, but no NRW defences failed in any of these instances. However, clearly some defences were not able to contain the sheer quantity of water. Analysis work is being undertaken in these locations and, where possible, improvements will be made. In many cases though, technical reasons mean it may be very challenging and even impossible to improve defences further and any available options may have significant social, economic and environmental costs. For example, in many of Wales's urban communities, there may not be space to increase the size of existing defences, and higher defences can have a negative intrusive impact locally as well as channelling water downstream and increasing the flood risk of those communities. In some cases, river flows are such that no physical defence is possible.

Managing such huge quantities of water is extremely challenging, especially given the climate change predictions for more extreme weather in the future. We need to complement defences with other measures, such as holding back water higher up in the catchment, making space for water in valleys, and in some cases accepting that, especially during events of this scale, there will be flooding. We also need to make properties more flood-proof, invest in warning systems, community support and advice so that communities can take their own actions to lessen the impacts of flooding.

None of these choices are easy and there is no one single solution to the problem. We also need to manage expectations that all flooding can be prevented. The new Welsh Government National Strategy for Flood and Coastal Erosion Risk Management (set to be published later in 2020) sets out the strategic direction for Wales, but within this context, there are still difficult choices to make. All sectors, from Government, the organisations responsible for managing flood risk along with NRW and the communities at risk, need to be part of the decision making. Householders and individuals also need to take a share of responsibility.

Flood Forecasting and Warning

NRW's Flood Warning Service is reliant on a series of interlinked systems and procedures, coupled with the considerable skills and experience of our duty officers. Whilst our performance in this area was good in many aspects, it was severely stretched at peak times and this review identifies a range of issues and areas for improvement.

The most significant issues relate to the accuracy and timeliness of some of the warnings issued. Whilst a record 243 Flood Alerts, 181 Flood Warnings and 6 Severe Flood Warnings were issued in February, 12 flood warnings were not issued when they should have been, and 6 were issued late. This is below the standard of service we want to provide and the

standard expected by our customers. Improvements to help prevent this occurring again need to be investigated and where feasible implemented.

The shortcomings explained further in the report were due to a complicated series of issues but fundamentally are a consequence of the extreme severity of these flood events and the capacity of the service to become overwhelmed for short and intense periods. Some immediate improvements have been made to help lessen this risk in similar future events, but further action is needed. This includes a fundamental consideration of the level of service that is achievable. Where we lack capacity, ways to address this shortfall need to be sought, either by changing what is expected of duty roles during significant events or by increasing the level of support at such times.

Specific areas have been identified where we can make improvements in our Flood Warning Service. These include: reducing uncertainty in short term rainfall forecasts at a local catchment scale, reducing demands on duty officers who are asked to attend multiple advisory telecons with partners, improving the effectiveness of trigger points within procedures, improving the decision making in relation to risk escalation, and improving the public and partner's understanding of flood forecasts and risk summaries, including in the Flood Guidance Statements.

The procedure for issuing Severe Flood Warnings is an area that requires more consideration. Only four were issued during Storm Dennis despite some of the biggest flood impacts in a generation. A wider debate is needed surrounding the risk appetite from the organisation and partners for issuing these warnings earlier, even if the severe impacts are not certain. A key factor is that issuing a Severe Flood Warning has significant knock-on implications, for example, initiating evacuations, so is not something that should be done lightly. At the same time, this cannot be a reason for not issuing a Severe Flood Warning if there are severe impacts expected, including risk to life.

There needs to be further consideration surrounding how communities receive and react to flood warnings so that they are best prepared to take the right actions when warnings are issued. We also need to consider whether communities understand the significance of the different levels of warnings and how flooding can quickly escalate.

Operational Response

NRW's response on the ground included both proactive and reactive activities. We operated our assets and structures effectively, but we lacked capacity to react to unforeseen events on the ground or to gather observations at all key locations and feed back to incident rooms to support the issuing of flood warnings. The most significant issue occurred in Llanfair Talhaiarn where there were difficulties clearing a trash screen in the village, and operatives received a significant amount of verbal abuse. Elsewhere the closing of flood gates, installation of demountable barriers and clearance of structures ensured many areas were protected.

Incident Management

The wider aspects of incident management have been considered in this review, mainly around how NRW worked with others during the events and how its overarching incident procedures performed. Overall the procedures performed well although there are lessons which have been identified relating to the clarity of roles and responsibilities, how NRW and other organisations mobilised at a strategic level and how incidents are co-ordinated between partners.

Some feedback has questioned whether NRW mobilised early enough, particularly for Storm Ciara and Storm Dennis and consideration should be given to how events like these are escalated within the organisation and with partners. Whilst NRW has a wide array of incident procedures, whether NRW should have a clearer “Major Incident” mode of operation has also been raised. This could help provide clarity on the implementation of contingency procedures, and how and when to bring in additional support and instigate a stronger level of incident response when NRW is experiencing significant pressures on its capacity during events of this scale.

It needs to be emphasised that NRW is not a ‘blue light’ emergency service with significant incident response resources at its disposal. Although NRW is rightly a category one responder organisation under the Civil Contingencies Act (2004) and has approximately 2,000 staff, many of its incident roles are specialist and not suitable for all staff members. However, NRW needs to improve ways to mobilise more staff and utilise more of its available resources, especially in events of this scale. NRW needs to further develop a whole organisation response to flood events, utilising the resources available and ensuring that absolute priority is given to the incident from all parts of the organisation.

Operational Capacity

A significant area of feedback from staff related to the limitations in capacity on several duty rotas, meaning that several staff members worked excessively long hours and also had to pick up wider duties outside of their roles. This is supported by a number of findings from this review that many aspects of NRW’s response were stretched and, in some cases, overwhelmed during these incidents. NRW needs to consider the future operation of its out of hours response capabilities and the operating model it wishes to work under. Being able to recruit and retain staff on rotas is a significant issue, and whilst some measures have already been taken to improve our resilience, more needs to be done.

Aspects such as suitability and availability of vehicles and other equipment such as waterlogged mobile phones are also highlighted as areas that restricted NRW’s capability in some instances. These are being addressed as a priority.

Communications

NRW received vast amounts of correspondence, enquiries and media requests both during and following the storm events and subsequent floods. These were handled well but stretched our capacity. Several lessons and improvements have been identified from these experiences. The number of media spokespeople (especially bilingual) available during and after events, NRW’s role in post-event engagement and developing more proactive messages in advance of future events (as far as possible) have been identified as areas to improve.

We had record numbers of hits on our website and significant social media presence, but our website performed poorly for three and a half hours during the weekend of Storm Dennis, including some periods when it was unavailable. This prevented members of the public and partners from obtaining key information on flood warnings, river levels and what to do during and after a flood. Improvements have been made to the website’s resilience, but this was a critical issue that needs to be prevented from happening in the future.

Recovery

As the flood events moved from an incident response phase into recovery, workstreams for several important recovery activities were established. These included staff recovery, emergency repairs, data collection, post-event debriefs and a range of tasks working with other Risk Management Authorities to begin assessing the impacts of the flooding and developing plans for future action. These activities put an additional workload on many of the same staff who were already heavily involved in the events themselves. As there is for response phases, there needs to be a whole organisation response to recovery as well.

The recovery phase is a key part of how NRW emerges from the significant strains that the storms placed on the organisation. Following Storm Dennis, a Recovery Manager was appointed to provide coordination and oversight of this work, although the organisation currently has limited guidance and procedures for these important elements of work. A better post-event recovery plan is required to give this phase more structure, governance and support.

Conclusions

The rainfall and river data shows that the storms in February 2020 were exceptional and stretched all incident responder organisations. NRW staff worked professionally and diligently throughout the period, for example in issuing unprecedented numbers of warnings and responding to events on the ground. There are many examples where good practice was evident, and the actions of NRW staff made a difference to communities affected. This review inevitably concentrates on the lessons learnt and where improvements should be considered, but it is important this is taken in the context of the good work that also happened, and the scale and severity of the prevailing weather conditions at the time.

This review highlights a number of improvements required by the organisation and it is vital not just to accept the learning, but also to implement the actions and truly embed the improvements within the organisation and its culture. It needs to be recognised that it will not be possible to fully predict with certainty the consequences of such significant events as seen in February 2020. Consequently, we are unlikely to ever fully manage and mitigate against all such events, and the need for adaptation to climate change needs to be understood by all sectors of society. We can reduce some of the risks through managing the likelihood of and impacts from flood events, but we cannot control the weather and prevent all impacts. These messages need to be understood by all stakeholders.

The issues and actions for NRW from this review are summarised in a table at the end of this report. These actions cover elements that NRW can address, either in the short or long term. Given the size and scale of the changes required, it is recommended that these improvements are managed as a programme of work with a Senior Responsible Owner at Executive Team or Chief Executive level, with regular reporting to Executive Team and Board.

While many “quick win” improvements have been made since February, there is still significant work to do. Extra resource will be required to deliver these improvements. For example, the Flood Warning Service Review implementation programme will take an estimated minimum of 7 additional FTEs and five years to deliver in full (though of course, many elements will be delivered sooner). It is hard to estimate the whole requirements and timeframes accurately at this stage; it may require 30 FTEs to deliver the improvements outlined for the next 12 months. It is roughly estimated that 60-70 staff (additional over

current baseline) will be needed over the long term to then sustain the overall service at the levels described by the actions and improvements in this report.

These staff numbers represent additional permanent staff to undertake and sustain new improvement work related to flood forecasting and warning, asset management and planning, flood risk mapping and modelling, asset maintenance and operational incident response, hydrometry and telemetry work, plus support work in areas such as ICT and finance. These new staff would also be added to our incident rotas for out of hours response, thereby bolstering our resilience for this work. This would be in addition to increasing the numbers of staff from across the organisation who can be available for incident response, to strengthen our whole organisational response to incidents. It should be noted that many of the incident roles are specialist roles that cannot be done by non-specialist staff, so it is not just a question of increasing the numbers, it is addressing the skills required as well.

Additional revenue budget has been allocated by the Welsh Government in the 2020/21 financial year which is being utilised to source some of the staff requirements in the short term. This additional funding is welcome but looking forward the expectation is events of this scale will be more frequent, so we need to invest more to ensure we are better equipped to cope with the impacts of climate change. The need is greater in size and longer in duration than the allocation, and more resource is needed on a permanent basis.

Overall, the main issues that need addressing can be summarised as:

- Shortfalls in the flood warning service provision, evident in such significant and extreme events.
- Capacity limitations, especially out of core hours, to effectively warn for and respond to significant flood events.
- The need to develop a whole organisation response to flood events so we are resilient and prepared for major incidents.
- Improvements needed in our actions in the lead up to events and the recovery from them.
- Across all these elements, there are choices to make about the level of service that is practical, realistic and feasible, and the associated implication for investment that will be required.

To truly learn the lessons from the February 2020 flood events, there needs to be a fundamental consideration of the choices that we as a society as a whole, and governments and other decision-makers in particular, have on how the risks are managed. The new National Strategy for Flood and Coastal Erosion Risk Management from Welsh Government sets out the direction for Wales, the strategic aims and objectives, and the main actions (measures) to achieve the objectives. It also sets out the full range of options available to help manage risks, including (amongst others) catchment management approaches and measures not to put further communities at risk, through strong planning and development control practice. Within this context, there are still choices to be made about the 'level of service', and this concept is used throughout this review document. It is used in two senses. Firstly, there are choices that Wales as a society (from communities through to government) makes about what level of flood risk management service it wants to see and is prepared to support. This applies to whether it wants, and is prepared to support, any or all of the wide variety of measures that can be used to manage flood risk. How much effort and budget should go into flood warnings, flood awareness, flood defences, planning control, creating storage areas in catchments to hold back water, creating resilient properties – and all the

other possible interventions? This applies across all organisations that have a role, from the national to local level, and also down to the actions householders and individuals can take themselves.

Additionally, the 'level of service' is used specifically in relation to the services that NRW provides. Inherent in the notion of flood risk management is that it is a risk management process, and the activities undertaken to manage the risk can be pitched at different levels. There is a clear link between the service level that can be provided and the resources and capacity available. More can be done to manage the risks further, but this will require more resources to do so. Equally, we could do less and accept that the resultant flood risks are greater.

An important conclusion of this review is that the scale of resources at our disposal did not match the size of the task at hand for an event of this size and significance. The expectations of delivery from all stakeholders also increase all the time. As a consequence, the level of service we were able to provide was not the same as the level of service many expected from us. It was assumed by many that NRW is geared and resourced to manage risks at a level to deal with the scale of events as we experienced in February. But the evidence of the events was that, despite the dedication and efforts of all staff involved, we were not able to fully deliver the level of service that was needed or expected and fell some way short in some areas. Plus, such events are likely to be more frequent in the future. We have to be realistic about that gap and look at the choices as to what we do about it. We can improve some elements of our existing service with current resources, but we need a common understanding of the level of service Wales wants and is prepared to support.

This review has looked at NRW's performance only, but there are wider considerations that go beyond one organisation's role. For example, there are many organisations involved in managing flood risk in Wales and it can be confusing and frustrating for customers. How can we work more effectively together and deliver the best, joined up approach for customers? Flood defences are built to industry standards of protection, but still, they overtopped in places. Can we and should we build higher still, and what are the implications of that? How do we best deal with such huge quantities of water?

These are significant underlying aspects to consider which require further discussion with partners and stakeholders and are bigger than any single organisation. These are included within the conclusions of this report as 'actions to be discussed with partners' and intended to inform the wider debate that is needed as we implement and take forward Welsh Government's policy and strategy framework; including the upcoming new National Flood and Coastal Erosion Risk Management Strategy. These conversations will be taken forward by senior NRW managers to the appropriate forums. For example, the Flood and Coastal Erosion Committee, as the statutory committee with a role to advise Welsh Government Ministers, is a likely route for such discussions, and this will be explored. Similarly, this Committee would be well placed to consider the Wales-wide implications of the floods and the conclusions from the various reviews being undertaken by the different authorities.

We must also recognise that there are enormous challenges to face. Climate science says that we can expect more intense and more frequent extreme weather events in the future. We cannot stop the rain, and managing such huge quantities of water, as well as the rapid nature of many of our rivers and the subsequent quick flooding, is exceptionally challenging. We need to adapt to the changing climate, which means making big decisions about how and where we live and work, as well as how we reduce carbon emissions. We need to learn to live with water better than before, and water management has to be at the heart of many of the decisions we make about spatial planning and development – where we put or

continue to keep people and property, communities and businesses. We have made great progress in the last decade, but planners need to recognise flood risk more, and be prepared to take a longer-term view, rejecting developments if necessary.

These and other questions need to be part of the bigger debate about how we collectively manage flood risk across Wales in the future and respond to the challenges of climate change. The actions for NRW in this review report need to sit alongside that wider context and debate with Welsh Government and other partners.

This recovery and improvement work comes at a time when Wales is experiencing the Covid-19 pandemic which has had significant effects on people, businesses, services and the wider economy of Wales. It is important the opportunities in recovery from the pandemic, and the Green Recovery in response to the Climate Emergency are taken, and flood risk management is regarded as a key pillar within that wider context. Flooding, and water management more widely, is a key element of the wellbeing and sustainability of communities and future generations.

NRW will play its part at both ends of the scale. We will continue to do our utmost to deliver the best level of flood risk management service we can with the resources we have now, but also recognising and being realistic about the limitations. We will also play our part in shaping Wales' response to the significant climate emergency challenges of the future. But we cannot solve flooding or address the issues on our own, we all need to work collectively, across organisations and across communities, to rise to the challenges.

Introduction

This report summarises the key issues and lessons identified from the flood events experienced in Wales during February 2020. It is an internal performance review of NRW's management of the flood incidents, and the actions undertaken before, during and after the events. This review has been commissioned internally by NRW and is not intended to cover wider aspects of the management of the flood events of February 2020. A separate factual report has been produced which provides more detail on the events themselves, how they unfolded and the impacts they had on Wales.

During February 2020, Wales experienced four noteworthy rainfall events, on the back of a very wet winter period. Three of these storms fell under the naming convention introduced by the Met Office and its European counterparts:

- Storm Ciara – 8 – 9 February 2020
- Storm Dennis – 15 – 17 February 2020
- Unnamed Storm – 21 – 24 February 2020
- Storm Jorge – 28 February – 1 March 2020

Data provided by Local Authorities shows 3,130 properties flooded during February 2020. Storm Dennis in particular was one of the most significant flood events in Wales since the flooding in South East Wales in December 1979. These events stretched NRW's operational capacity and systems significantly and in some areas, it is clear services became overwhelmed. Our staff, and in particular our out-of-hours duty staff were placed in very challenging positions at times during the event, and they felt a strong sense of commitment and ownership of the impacts experienced by communities across Wales. Despite this, the professionalism, dedication and commitment from staff has been evident throughout the review work.

“This has been the worst winter I’ve experienced” – Senior Flood Risk Manager

“It started raining in the last week of September and didn’t stop until March” – Operations Manager

“The work we do makes a difference, these events have been hard because it’s hit “our” communities” – Senior Flood Risk Manager

There is a strong desire to deliver improvements and learn lessons from the February flood events. Of course, it is crucial not just to identify lessons but also to implement recommended improvements that deliver real change. This review report has analysed a wide range of feedback and has identified specific concerns, issues and recommendations across the different aspects of NRW's incident management and response work. A detailed action plan considering indicative costs and timescales is included within this report.

Amongst the issues identified, some matters can be addressed quickly, and some which will take longer to resolve as well as other more challenging aspects that, in some cases, may never be possible to resolve. These elements require further discussion with Government and stakeholders relating to the level of service NRW is able to operate and provide as a Category 1 Responder under the Civil Contingencies Act. Important discussions are required regarding capacity and NRW's ability to deliver what is expected of it, by both policy-makers, funders and customers.

Scope and methodology

Approach

We have reviewed our key systems, tools, procedures, guidance documents and ways of working, what went well and what did not.

The review has built upon the post-incident debriefs held in the days and weeks following the February floods, plus questionnaires completed by duty officers. Staff were asked which elements they felt worked well, those that did not perform well, and also areas for improvement.

Over 1,000 individual pieces of feedback from the debriefs and questionnaires have been considered. Figure 1 illustrates the proportion of submissions per duty rota, which highlights the wide range of views captured. These individual pieces of feedback have been analysed, filtered and grouped to develop themes for the review to consider. Figure 2 below illustrates these main themes.

To build further on the local debriefs and post-event questionnaires, discussions and interviews have been held with key groups and individuals across NRW. In addition to this, multiple staff sessions have been run to both update staff on progress and gather further feedback.

We have continued to work with our communities and partners through the flooding events and the ongoing recovery period. We have listened to their views and issues and have taken them into account when undertaking this review and formulating recommendations.

This process led to identifying recommendations, and from these, a detailed action plan has been produced. This plan also considers the indicative costs and timescales for the actions.

The sections that follow form the main part of this report and are organised by theme, with each theme being a key area of consideration identified through the review process (described above). Several aspects of the review are cross cutting across several themes and the structure of the report has been influenced by this. The review has also looked at the performance of flood defence assets and the Flood Warning Service from detection and forecasting through to the dissemination of warnings. Further detailed analysis of the flood events themselves and the factual record as to what happened have been captured as part of a separate evidence report.

Each section contains text to explain the issues, then, where appropriate, actions as to how these issues should be addressed. In some cases, there are significant underlying aspects to consider, they require further discussion with partners and stakeholders, and are bigger than any single organisation. These are captured as 'actions to that need to be discussed with partners' and intended to inform the wider debate that is needed, these conversations will be taken forward by senior NRW managers to the appropriate forums.

Limitations

This is a review of our performance as an organisation. It is not a review of the performance of any individuals. It is a review of NRW's internal performance only and does not cover the wider performance of the emergency response sector or other partner organisations which may be subject to other reviews or lessons learnt processes. It does, however, look at our interaction with them and where that can be improved. This review can support other reviews, should that be needed.

A separate review has been undertaken to consider the issues and lessons that need to be learnt in relation to how NRW manages its forest estate following the February 2020 flood events.

Organisational Roles and Responsibilities

Flooding is often complex and can be a result of a range of different flooding mechanisms or a combination of several sources. Risk Management Authorities (RMAs) in Wales have different statutory roles and responsibilities for leading FRM work to address these different sources of flooding:

- NRW has powers to manage flooding from main rivers (typically the larger rivers in Wales), the sea and reservoirs they operate.
- Lead Local Flood Authorities, the 22 Local Authorities in Wales, have powers to manage flooding from ordinary watercourses (smaller watercourses), surface water and groundwater. They also carry out coastal protection works in response to coastal erosion.
- Water companies in Wales manage flooding from water and sewerage systems.
- Highways Authorities in Wales manage the drainage of highways.

Following any significant flooding, recovery and review work is undertaken by RMAs. Specifically, Local Authorities in Wales have a duty under the Flood and Water Management Act 2010¹ to produce flood investigation reports under Section 19 of the Act. Where each Local Authority deems it appropriate to do so, these will assess detailed causes of localised flooding and work with other RMAs including NRW to develop any required action plans.

¹ Flood and Water Management Act 2010, c.29. Available at: <http://www.legislation.gov.uk/ukpga/2010/29/section/19> (Accessed: 31 July 2020).

Flood defences

Flood defences form an important part of how flood risk is managed. Wales has a network of flood defences and structures which reduce the risk of flooding to people, properties, infrastructure, transport, businesses, and land. These defences are vital to the nation's ability to cope with floods and form part of the nation's vital national infrastructure.

NRW inspects and maintains over 500 km of flood defences in Wales, estimated to protect over 73,000 properties from flooding from main rivers and tidal inundation from the sea. The defences and assets managed by Local Authorities add to the levels of defence.

During the February 2020 flood events, it is estimated that more than 19,000 homes and businesses benefitted from protection by NRW main river defences during Storm Dennis alone. However, critically, 3,130 properties flooded in Wales during February, causing devastation to homes, communities, infrastructure and businesses. This has a significant impact on people across Wales and it can take a significant time to recover. It can also result in long term physical and mental health and wellbeing issues.

Observed impacts

Storm Ciara

During Storm Ciara (8 – 9 February) the catchments of the Rivers Conwy, Elwy and Upper Dee received the highest amounts of rainfall and experienced some of the highest river levels in Wales. Local authorities identified that 224 properties experienced flooding, most notably in Llanrwst (72 properties) and Llanfair Talhaiarn (31 properties). River levels in the River Elwy were higher than those experienced in 2012 when significant flooding also occurred in these areas. Many other examples of small localised flooding were identified, each significant to the affected communities. In each case, the relevant RMAs will be considering appropriate action.

In relation to NRW defences and structures where significant flooding and high river levels were experienced during Storm Ciara:

- In Llanfair Talhaiarn, Conwy County Borough Council are developing their Section 19 flood investigation report which NRW is actively supporting. Initial findings indicate that the exceptional flows in the Nant Barrog overwhelmed a culvert. There was also some overtopping of embankments by the River Elwy. Flows in the Nant Barrog on 9th February are estimated to have been greater than those experienced in 2012. More investigative work is being undertaken and options are being considered for further work by NRW. Further detail of this is available on the NRW website: www.naturalresources.wales/Llanfairtalhaiarn
- In Llanrwst, the majority of flooding was caused by extremely high flows in the Afon Bach and potentially the Cae Person, Local Authority managed ordinary watercourses that run through the town. Llanrwst is at risk of flooding from a number of watercourses including the River Conwy. Our evidence shows that during Storm Ciara that the combination of existing NRW walls and demountable defences worked effectively, preventing the flooding from being much worse. NRW is supporting Conwy County Borough Council in undertaking their investigation work and will consider any required further action once this is complete.

- In St Asaph, Denbighshire, the River Elwy experienced river levels and flows estimated to be in excess of the flood events in 2012, during which an estimated 320 properties and 70 caravans were flooded, and a fatality occurred. During Storm Ciara however, the NRW flood alleviation scheme, constructed after the 2012 floods, worked well, coping with the higher water levels than those experienced in 2012, and preventing a repeat of the widespread flooding of 2012. However, there was some localised flooding and further analysis work with Denbighshire County Council is ongoing.
- In Bangor on Dee, Wrexham, very high river levels during Storm Ciara damaged a flood bank that protects the village. This was closely monitored during the event and contingency measures were put into action, including the installation of temporary secondary defences. Work by NRW to repair this structure is programmed at the time of writing (July 2020).

Storm Dennis

During Storm Dennis (15 – 17 February 2020), intense rainfall over the South Wales Valleys and Mid Wales resulted in the highest river levels since records began across multiple catchments, resulting in the most significant flood impacts in Wales since the floods of December 1979. Local authorities have identified that 2,765 homes and businesses flooded as a result of Storm Dennis, along with other significant and widespread impacts across the catchments affected. Due to the nature and the severity of the flooding, it will take RMAs time to undertake detailed investigation work and identify potential options to take forward.

In many instances, the flood mechanisms and sources are multiple and complex and NRW will continue to collaborate with partners to further understand what led to such significant flooding, whether that be from main rivers, ordinary watercourses, surface water or drainage issues. It also raises questions about how we manage such huge quantities of water in the future – there are no easy answers.

Further local analysis and detailed assessment work will be carried out on a location-by-location basis. This report will not focus on specific detail and required action at the local level. As per previous explanations, local Section 19 reports will be produced by the local authorities where they deem it appropriate to do so. These will be produced in collaboration with other RMAs and will provide more specific detail at the local level., What follows is a summarised position in relation to NRW defences and structures where significant flooding and high river levels were experienced:

- The River Taff experienced significant impacts through fluvial flooding from the river itself. This was particularly so from Pontypridd down through, Treforest, Upper Boat, Treforest Industrial Estate, Nantgarw, Taff's Well and down into some areas of northern Cardiff. A thorough review of the entire Lower Taff has been instigated to consider in detail the likely causes of flooding and identify where action may be needed in the future.
- Where water flooded communities on the Lower Taff, our evidence suggests flood defences overtopped due to the volume of water in the River Taff. No flood defences failed, but river flows exceeded the design standard (typically 1 in 100 Annual Exceedance Probability (AEP) plus an allowance for climate change) that these defences had been constructed to, although the detailed study will determine if there are any localised issues to consider alongside that.

- Elsewhere on the River Taff communities including Hawthorn, Rhydyfelin, Glyntaff, Cilfynydd, Aberfan, Troedyrhiw and Pentrebach all experienced flooding. Most of these instances are believed to have been caused by surface water coming off valley sides or by smaller watercourses (ordinary watercourses).
- In the River Rhondda catchments, it is understood the river may have overtopped the floodwall at Porth. At Britannia, a non-flood defence highway retaining wall was breached, exacerbating the flooding to a number of properties from the River Rhondda. However widespread flooding was also experienced in Treherbert, Treorchy, Pentre, Ferndale, Ynyshir and Trehafod. In each of these locations analysis of the flooding is ongoing, but it is likely the flooding was from non-main river sources that are not managed by NRW.
- A specific and separate review has been completed on the management of Welsh Government Woodland Estate land above Pentre to ascertain if this contributed to the flooding experienced there.
- The River Cynon flooded properties at Mountain Ash where it's believed river defences became outflanked. Properties in Hirwaun also flooded from the Cynon. Options to manage the flood risk will be assessed upon the delivery of the recently commissioned Cynon Flood Modelling Study. Flooding was also experienced in a number of other locations in the valley at Aberdare, Cwmbach, Abercwmboi and Abercynon. These areas flooded from non-main river sources.
- The River Rhymney experienced flooding at a number of locations including Ystrad Mynach, Llanbradach, Bedwas, Machen, Began and Llanrumney. At each of these locations it's understood that overtopping of main river defences was one of the contributing factors. Local review work is underway to further refine this analysis. Significant flooding also occurred in New Tredegar although at this stage this is thought to be the result of non-main river sources.
- The River Usk experienced very high river levels and flooding was experienced in Brecon, Crickhowell, Llanwenarth and at Llanllowell. In each of these locations local flood defences were overtopped, leading to properties flooding. Flooding was also experienced at Usk although this is likely to have been through a combination of flood sources, but further investigation work is being undertaken to understand issues in this location.
- On the River Wye flooding was experienced in Builth Wells, Llanelwedd, Glasbury and Monmouth as the river overtopped local flood defences. Skenfrith and Osbaston on the River Monnow also experienced flooding however, with the exception of a small embankment at Osbaston, neither benefits from any NRW flood defences. Flooding in all of these locations is under review and actions will be identified on a case-by-case basis where viable.
- The flood defences at Monmouth performed as designed and protected the town centre. The left (Eastern) bank of the River Wye is currently undefended and flooding to properties was experienced in this area. There was also flooding to Forge Road from the River Monnow which is likely to have been from outflanking or overtopping of the flood defence. It's understood there was also surface water flooding to the Over Monnow area.

- Canal Side, Aberdulais at the confluence of the Rivers Dulais and Neath also experienced severe flooding, which has happened several times in recent years. This area suffers from a combination of fluvial main river flooding and drainage issues relating to the sewerage system. River levels on the River Neath were the highest on record and a combination of both these flooding sources along with debris being carried down the river channel and local structures that restrict flows in this location have led to flooding again. NRW is actively working in partnership with Neath Port Talbot County Borough Council and other related partners to consider how flood risk can be managed in this location.
- Flooding was also experienced in properties from the main river in Crumlin from the River Ebbw, in Ponthir and Caerleon from the Afon Lwyd, and in Ynysybwl from the Nant Clydach. Further survey and analysis work is planned in these areas to understand the mechanisms of flooding.
- Communities such as Ystalyfera in the River Tawe catchment, Llanhilleth in the River Ebbw catchment and Gorseinon in the Afon Lliw catchment all experienced notable flooding to properties. It is understood that in each of these areas non-main river sources of flooding were the primary cause of the flooding experienced.

Storm Jorge

141 homes and businesses were identified as flooded during Storm Jorge (28 February to 1 March) mainly across South East Wales. Some of these locations were only beginning to start recovering from Storm Dennis a fortnight beforehand. The impacts of Storm Jorge are thought to mostly relate to non-main river sources, predominantly surface water issues. However, flooding was experienced in Sully during Storm Jorge from both Sully Brook and the River Cadoxton.

Summary

The scale of the flood events in February is evident from the significant and widespread impacts listed above. During both Storm Ciara and Storm Dennis some areas of Wales experienced river flows estimated to be the equivalent of a 1:200 flood event (0.5% chance in any one year of an event of this scale happening).

In the time following all three events, NRW has carried out an extensive programme of asset inspections across all the impacted locations where we have a responsibility. 2,127 structures have been inspected. These have identified 131 defects and issues requiring repair work, all of which have either been addressed or are being built into work programmes to address in the future. All are being actively managed.

Issue
Significant and widespread flooding was experienced by communities across Wales during February.
Action (FD1): Continue to collaborate with Local Authorities delivering their local flood investigation reports (Section 19 reports).
Action (FD2): Complete detailed investigative analysis work to understand the mechanisms of flooding in areas known to have flooded from main rivers.
Action (FD3): Consider improvements to NRW flood alleviation schemes and structures on a prioritised basis.

Flood defence – points for consideration

The incidents described above comprise of the larger flooding events identified, though other flooding undoubtedly occurred across Wales. In summary, NRW assets performed well and to design standards, with no significant structural failures. Across the various events across the country they protected many properties, as well as strategic infrastructure.

Nevertheless, extensive flooding did occur. Some of it was linked to NRW flood structures being overtopped by high water levels which exceeded design standards. Many other incidents related to flooding from ordinary watercourses, road drainage and sewerage. Often the causes of flooding were complex, involving a combination of different flooding sources, each managed by different RMAs.

Any flooding of properties and communities is a traumatic experience for all involved. It takes a long time to recover and can lead to longstanding mental health and wellbeing issues. As well as protecting communities, flood defences also benefit a range of other receptors including vital utility and transport infrastructure. The regular maintenance and condition of flood defences are vital to their operation during significant weather events. Flood defences should therefore be considered as vital national infrastructure protecting people and property.

Effective flood risk management, therefore, requires effective collaboration between RMAs as well as co-operation to deliver services before, during and after the events. There are good examples of joint working and successful collaboration between authorities, but there is also a confusing and complex mix of different roles and responsibilities for the public to understand. It is often said that when you are flooded, you don't care too much where the water has come from or who is responsible, you just want something done about it.

Each RMA across Wales has different and often limited levels of capacity, resources and skills to be able to manage and address issues. This can present challenges of its own when it comes to delivering project work and collaborating with partners effectively.

Where flood defences were overtopped, detailed local review work is being undertaken to understand the issues and will be used to investigate any potential enhancements that can be made to local flood defences. The construction or improvement of flood defences however will always reflect economic impacts, environmental considerations, technical challenges, funding availability and the risk of causing detriment downstream by constructing a defence that retains more water within river channels and conveys it faster to downstream locations.

Common guidance standards (typically protecting against a 1 in 100² annual exceedance probability (AEP) flood plus an allowance for climate change) are used across the UK when designing defences. The defences across Wales are designed to these standards. In several locations across Wales these defences were overtopped (i.e. water come over the top of the defences). They did not fail, as they remained structurally sound. This raises questions as to whether the standard levels of protection used in the design are sufficient to manage the types of flood levels experienced in February, where in some locations floods exceeded 1 in 200 AEP flood levels.

² 1 in 100 standard of protection would be expected to protect the defended area behind the defence from all floods up to and including the 1 in 100 (1% chance in any one year of an event of this scale happening) flood event.

Climate change has accelerated and will continue to increase the frequency of flooding, so designing to a specific standard return frequency is challenging, as the hydrology is never stable. There is also a question around the size of defences required, rather than aiming for a specific return period event. However, we can't simply conclude that the defences need to be higher. Doing this alone would have implications - higher defences typically mean that water is pushed downstream to the next community, for example. They may also require space which is not available in the vicinity of some rivers, without causing significant disruption or even removal of properties which are located close to river banks.

Higher defences, even if they are technically feasible, may not be acceptable to communities who may not want to live behind higher walls or make significant changes to their local environment. There are many factors to consider, and there are significant challenges in improving defences in many of the areas impacted during February.

As an example, the issues experienced in the Lower Taff are being reviewed through a detailed investigation report, but indications are that the defences in these locations are suitable up to a 1 in 100 AEP flood. During Storm Dennis, it is thought that this area experienced river levels and flows equivalent to around a 1 in 200 AEP flood. Is the answer to build higher defences, which may be impractical and bring significant negative consequences? This needs to be assessed, alongside other possible options, such as establishing if water can be held back upstream or space be made to allow other areas to flood. None of these possible solutions are easy and there is no one solution for all circumstances.

So, flood risk management practitioners and policy makers need to consider what level of service it is appropriate to have for flood risk alleviation schemes. Consideration also needs to be given to the relative capacities and funding available to all RMAs if some of these issues are going to be resolved. The solutions are not simple or cheap to deliver. Economic, environmental, technical, funding and detriment challenges will all need to be overcome if significant improvements are to be achieved.

In some instances, it may not be possible to keep building defences higher and stronger. It may mean both RMAs and communities having to learn to live with the level of risk present in some of these areas. Consideration of the future and the ongoing Climate Emergency must also make every stakeholder involved consider the potential requirements for significant adaptation to flood risk in the future, which might not be achievable in all cases.

There is an overarching question on the level of service or standard of protection the public receives in Wales. How far do we go? How far can we go? What level of risk are people prepared to live with?

Actions to be discussed with partners

Roles and responsibilities for flooding rest with several different organisations, for good reason. But this makes the picture complicated to understand. Are the roles and responsibilities associated with different flood sources understood in Wales? Is this the most effective way to manage flood risk in Wales or are there opportunities to improve how these organisations work together?

Are the current flood defence standards of protection sufficient to manage the risk to communities? In some locations we may have to accept that it is impossible to reduce flood risk further due to the limiting factors which will prevent flood defences being larger.

Flood forecasting and warning

The operation of the Flood Warning Service in Wales is dependent on systems, procedures and the expertise of specialist staff. This includes staff who have full time roles that relate to maintaining and developing the systems and processes. There are also 'duty staff'; who are on incident rotas to operate the service on a continuous 24/7 basis via a series of standby rotas. Duty roles are undertaken on top of the day-job role and are pulled from a wider team than direct FRM staff, due to the numbers needed to run the service. The duty roles around detection, forecasting and warning involve many tasks and require specialist skills and decision-making, often in a dynamic, complex and pressured situation.

The Flood Warning Service comprises many component parts to provide an overall service. Some of these are visible to the public and many are "behind the scenes". There has been significant evolution and improvements in both the component parts and the overall service over the years based on learning from previous flood events, and particularly over the last 10 years since the 2007 floods, including much greater organisational collaboration with the Met Office and Flood Forecasting Centre. This has improved our ability to produce more effective forecasts, at longer lead times (up to five days for river and coastal flooding), communicate developing flood risk to professional partners and the public (for example the Flood Guidance Statement) and issue warnings at more refined scales for example at a community or sub-community level.

This, in turn, has improved the effectiveness of the service for customers considerably. Also, significant improvements have been made to services available on the NRW website such as improved flood maps, flood warning content and the ability to view real time river levels from NRW's Hydrometric Network on the NRW website. During February 2020 and preceding flood events since NRW was formed, our core detection, forecasting and warning systems have performed well and proven their resilience in demanding situations. However, there are still significant improvements required across the different systems and in the procedures, which underpin the service. These events also created substantial pressures on the capacity and resilience of duty rotas and individuals due to their scale and speed of onset.

The following sections examine how each aspect of the flood warning process performed, from detection through to forecasting, operation of the service, through to dissemination. The performance of flood forecasts and the accuracy and timeliness of flood warnings has been considered. It is clear that each of the duty roles involved in these processes requires strong technical expertise and knowledge, but these also need to be underpinned by clear guidance and procedures.

Hydrometry and Telemetry – Detection

The operation and management of the hydrometric network of river level and rainfall gauges across Wales, and the telemetry system which allows instantaneous data collection from across the network, are fundamental foundations of the Flood Warning Service. This detection element of the service plays a vital role in its operation. Without it we would be blind in responding to a flood incident as it unfolds, unable to know where impacts are greatest, where to warn and where to respond.

During the events of February, the network performed extremely well overall. In some of locations, specific gauges either "drowned out" as flood water overcame them or failed due

to the damage they received during the event from the extreme erosive forces of the flood flows, but overall the network operated successfully. The resilience of the service reflects the investment that has gone into the network in recent years and the advances in technology. There are some specific issues to highlight however:

- In some instances, gauges failed, mainly as a result of the environmental conditions they were experiencing during the event. During flood events of this size, it may be unsafe to carry out repairs due to Health and Safety constraints. There are contingency measures in place at some gauges, such as secondary sensors or alternative communications technology, however to date, this has been implemented on a risk-based approach at high priority sites only. Each additional piece of equipment comes with capital and revenue (maintenance and staff) costs, as well as increased data management requirements.
- The resilience of the network can be improved at a cost. We need to agree on the level of service required with respective clients of the network and a more strategic review carried out to inform these decisions.

Issue

Contingency measures can be installed across the Hydrometric Network, however the level of service to operate to is unclear, so there may be weaknesses in our monitoring resilience.

Action (HT1): Working with key clients of the Hydrometric Network, a strategic review of stations used for forecasting, warning and operational response should be undertaken to determine their criticality, which contingency measures are appropriate and help prioritise improvement works.

- During the event, duty officers experienced challenges in obtaining data from Environment Agency-managed stations located in the Herefordshire stretch of the River Wye, in response to a key gauge failing. This information is available through the Telemetry System however it is clear not all duty officers were aware of this, and it should therefore be highlighted to all duty officers.

Issue

Some duty officers found difficulty accessing information from gauging stations in England.

Action (HT2): Duty officers to receive training in how to obtain this information through the Telemetry System.

- Since the flood events the Hydrometry & Telemetry (H&T) teams have experienced significant difficulty in securing support from Integrated Engineering teams to carry out repair work to key network sites and infrastructure. In a number of locations issues still have not been resolved and in others, the H&T teams have had to commission technical engineering projects themselves, which is not necessarily within their skillset. This needs to be considered and rectified.

Issue

Repairs to hydrometric stations are not being undertaken due to the lack of support from wider teams and lack of a consistent model for this across Wales.

Action (HT3): The options for delivering hydrometric site maintenance for NRW needs to be reviewed and a consistent solution implemented as soon as possible.

Whilst no specific issues have been highlighted with the Telemetry System beyond some of the other points made in relation to specific flood warning issues later in this review, this system is critical to the operation of the Flood Warning Service and the Operational Response in the field. There is reliance on a few key individuals, and it is crucial that there is ongoing investment and support in this area. The Telemetry System is aging and is overdue for replacement, and the ongoing work to do this needs to be a key business priority.

Modelling and Forecasting

One of the most significant enhancements in the ability to issue accurate and timely flood risk advice and warnings made in recent years has been important improvements in flood forecasting capability and technology. Historically being able to issue advance warning of potential flooding was reliant on waiting for the rain to fall, monitoring river levels in large catchments, understanding relative lag times between locations and making key decisions based on observed data from river level sites, without any real understanding or prediction of what the rate of rise or peak levels might be.

The capability to now produce detailed forecasts for specific areas based on rainfall forecast information has opened up much greater potential to improve lead times for individuals, communities and risk management authorities to take more effective action. Using Met Office rainfall forecasts we are now able to make forecasts of river levels up to five days ahead. Trying to secure additional lead time through forecasting river response is particularly important for high risk areas such as the rapid response catchments of the South Wales Valleys, where lead times are minimal. In principle, warnings can also be focused on smaller areas, reducing false warnings and increasing the chance that people will take notice when warnings are issued.

NRW operates a 24/7 flood forecasting rota which works in close collaboration with the Met Office and Environment Agency through the Flood Forecasting Centre (FFC). Monitoring and Forecasting Duty Officers (MFDOs) and Assistant Monitoring and Forecasting Duty Officers (AMFDOs) process detailed forecasts using river catchment and coastal models. These forecasts are then used to inform the five-day forecast issued on the NRW website, the Flood Guidance Statements issued in collaboration with the FFC and by Flood Warning Duty Officers (FWDOs) in their Flood Advisor Service telecons with partners and their decisions to issue Flood Warnings.

The review has considered wide ranging feedback relating to aspects of flood forecasting. Comments and issues have included:

- The main areas of feedback in relation to flood forecasting relate to the uncertainty involved in the information provided. Some of the forecast runs appear to produce accurate results whereas others for a variety of reasons have not. This introduces confidence issues in utilising the forecast information supplied by MFDOs.
- Feedback linked to this highlighted that the communication and discussions back and forth between MFDOs and FWDOs are crucial in discussing the level of confidence associated with a forecast. It was commented that this had improved but some residual communication issues still exist. FWDOs highlighted that they wanted to

understand the forecasts more, the confidence MFDOs had in the forecasts and the range of uncertainty in the model results.

- Due to the complexity in both rainfall forecasts and flood modelling there will always be several sources of uncertainty in the forecasts, but they do provide an extremely useful advance on the lead time compared to historic methods. The need to deal with uncertainty and quantify it is likely to increase in the future as we and our partners such as the Met Office and Flood Forecasting Centre introduce probabilistic capabilities into the forecasting chain, with greater use and reliance on scenarios such as “best estimate” and “reasonable worst case”. Each time a significant weather event is experienced it enables the forecasting models to be refined and calibrated and therefore improvements will continue to be made.
- The most significant challenges remain in the accuracy of Met Office rainfall forecasts at a catchment scale, especially in the short term (up to six hours ahead) along with a current reliance on a single deterministic forecast which hinders assessment of forecast uncertainty and confidence, as opposed to a probabilistic forecast which shows the range of uncertainty.
- Significant advances have been made in Met Office modelling of rainfall at longer lead times (12 hours or more) but particular issues remain in the “nowcast” period (next six hours) where forecast products from the Met Office try to merge actual radar observations, which are known to be poor over parts of Wales, with meteorological model forecasts. Sometimes significant run to run variations in forecasts are experienced which cause decision challenges for our duty officers when forecasts are fluctuating above and below trigger levels.
- Whilst NRW are making use of some probabilistic forecasts for coastal forecasts, river forecasting still depends on a single deterministic rainfall forecast product from the Met Office, rather than probabilistic products which have become available in recent years

Issue

Flood forecasting is challenging and uncertainties in forecast data and model outputs create uncertainties in decision making. Greater use of probabilistic forecasts in the future will increase the opportunities to present and communicate forecast confidence to users, and integrate this into decision making for issuing Flood Warnings and our communications on flood risk.

Action (MF1): MFDOs and FWDOS should understand each other’s roles and the different factors each role must consider in decision making. Consideration should be given to improving the way current forecast data and confidence is presented to duty officers as well as the messages and communications between each role, based on the understanding of each other’s roles.

Action (MF2): NRW to work with the Flood Forecasting Centre and Met Office to explore opportunities to make greater use of probabilistic forecasts in its decision making on flood warning, operational response and incident management, including determining the technological, investment and training requirements along with the significant cultural changes needed to achieve this.

- Other issues highlighted related to the preparation and issuing of the Flood Guidance Statement (FGS). This is produced with the FFC, Met Office and Environment Agency and provides a five-day risk assessment on the likelihood and impact of flooding for all sources of flood risk. It provides a key tool within incident management, for example, a Medium Risk (Amber) status on the FGS instigates a range of preparedness activities throughout the different RMAs, including multi-agency teleconferences.
- The FGS uses an impact-likelihood matrix shown below in Figure 3. It is important to reflect on both the forecast likelihood and impacts when considering the information issued on the FGS. Considering the overall flood risk or colouring alone can mask the difference between forecast Minor, Significant and Severe impacts. This matrix is agreed across the Environment Agency, Met Office, FFC and NRW and is also used in Scotland by the Scottish Environment Protection Agency.

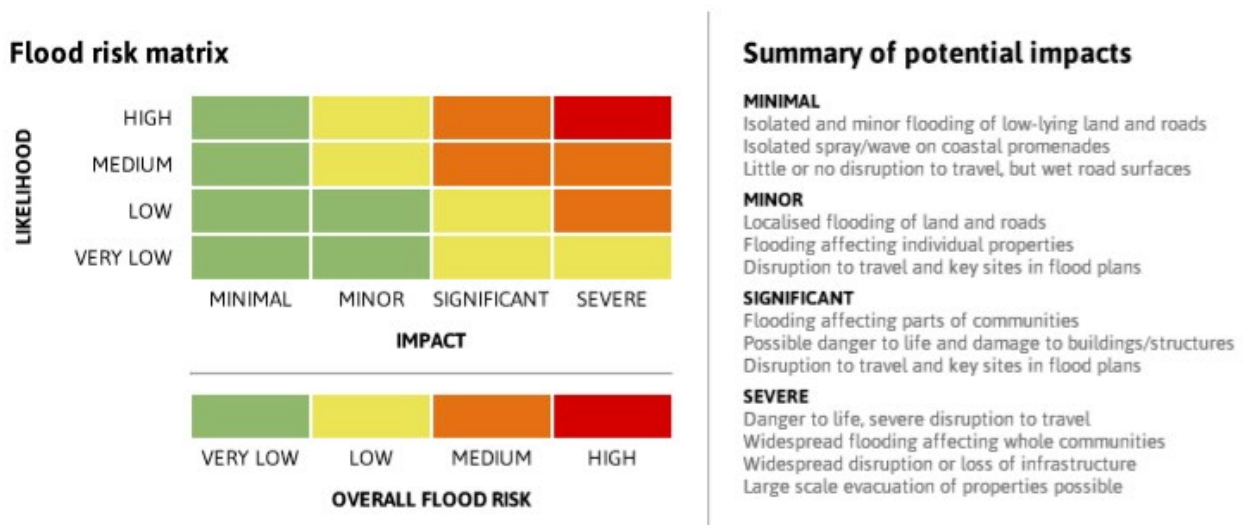


Figure 3 – Flood Risk Matrix from the Flood Guidance Statement

- In advance of Storm Ciara, minor impacts were identified at medium likelihood and Low Risk level (Yellow) two days in advance of the event (6 February 2020). The day before the event (7 February 2020) the status changed to significant impacts at a very low likelihood, retaining its Low Risk level (Yellow). On the Saturday of the event (8 February 2020), the status changed to show the likelihood in the forecast increased from very low to low, but the overall status remained at Low Risk level (Yellow). Figure 4 shows the progression of the FGS status in the build up to Storm Ciara.
- In the lead up to Storm Dennis, significant impacts were identified at medium likelihood and Medium Risk level (Amber) two days in advance of the event. On the Saturday of the event (15 February 2020), the status moved to identify severe impacts at a low likelihood for river flooding, retaining its Medium Risk level (Amber). The status escalated to High Risk (Red) at 6am on the Sunday morning (16 February 2020) when the majority of flooding was either in progress or in some cases had already happened. Figure 5 shows the progression of the FGS status in the build up to Storm Dennis.

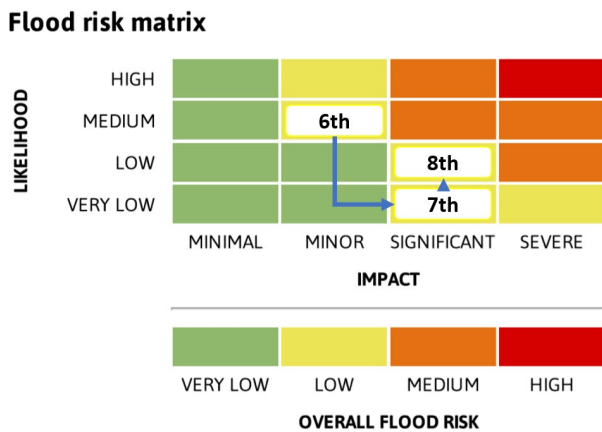


Figure 4 – Status of the Flood Guidance Statement in advance of Storm Ciara by date

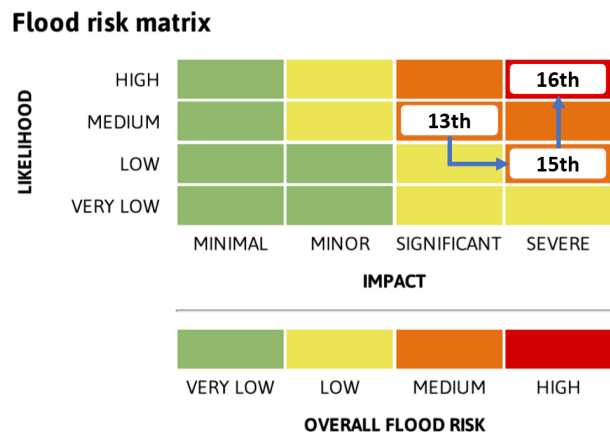


Figure 5 – Status of the Flood Guidance Statement in advance of Storm Dennis by date

- Whilst the FGS is a tool for a more medium-term outlook and is used primarily to plan, prepare and escalate response by NRW and professional partners when flooding is forecast, it is also available to the public on the NRW website (5 Day Flood Forecast). It is unclear what use the public make of this information, the visibility of this product for informing the public of developing flood risk and the public’s perception of what the different status levels mean and whether they would have taken any action at different risk levels. This issue is also considered later within the Communications section.

Issue
The Flood Guidance Statement identified the level of impacts in advance of the events, but there is feedback that not all stakeholders understand or appreciate the link between the FGS headline colour and the forecast impacts and likelihood.
Action (MF3): NRW should review the plans and training for relevant duty officers to ensure that the risk matrix in the Flood Guidance Statement is properly understood and that actions and communications are linked to forecast impacts, not the risk colouring. Where necessary further training should be provided, working with the Flood Forecasting Centre
Action (MF4): NRW should review its procedures on how to determine severe flood impacts so it is better able to make timely decisions with the Flood Forecasting Centre to escalate the risk in the Flood Guidance Statement and public 5 day forecast.
Action (MF5): The flood risk matrix used to determine the risk colouring of the Flood Guidance Statement should be reviewed. This will require additional work with external partners outside Wales who use and depend on the matrix including the Flood Forecasting Centre, Environment Agency, Met Office and Scottish Environment Protection Agency.

Accuracy

A detailed review of the performance of the flood forecasting models has been undertaken by the Flood Forecasting team. The accuracy of the results produced by these models is dependent on a wide range of factors but fundamentally is impacted by the level of accuracy

present in the rainfall projections and forecasts provided by the Met Office and FFC which feed the local models.

Model runs provide vital information for specific river level sites used in the issuing of flood warnings, both in estimating the timing of the relevant flood peak and the expected levels the rivers may reach. These models are run continuously in the build-up to and during an event, utilising the best available data at each run, both from our own observations of rainfall and river levels and from Met Office forecast rainfall data.

Figures 6 and 7 below highlights the analysis undertaken on the River Taff at Merthyr Tydfil and Pontypridd and illustrate some of the issues experienced and the accuracy of flood forecasts on the River Taff. The analysis shown below is an example of the more in- depth review work being undertaken across Wales on our forecasting information. Each catchment is different and presents different forecasting challenges.

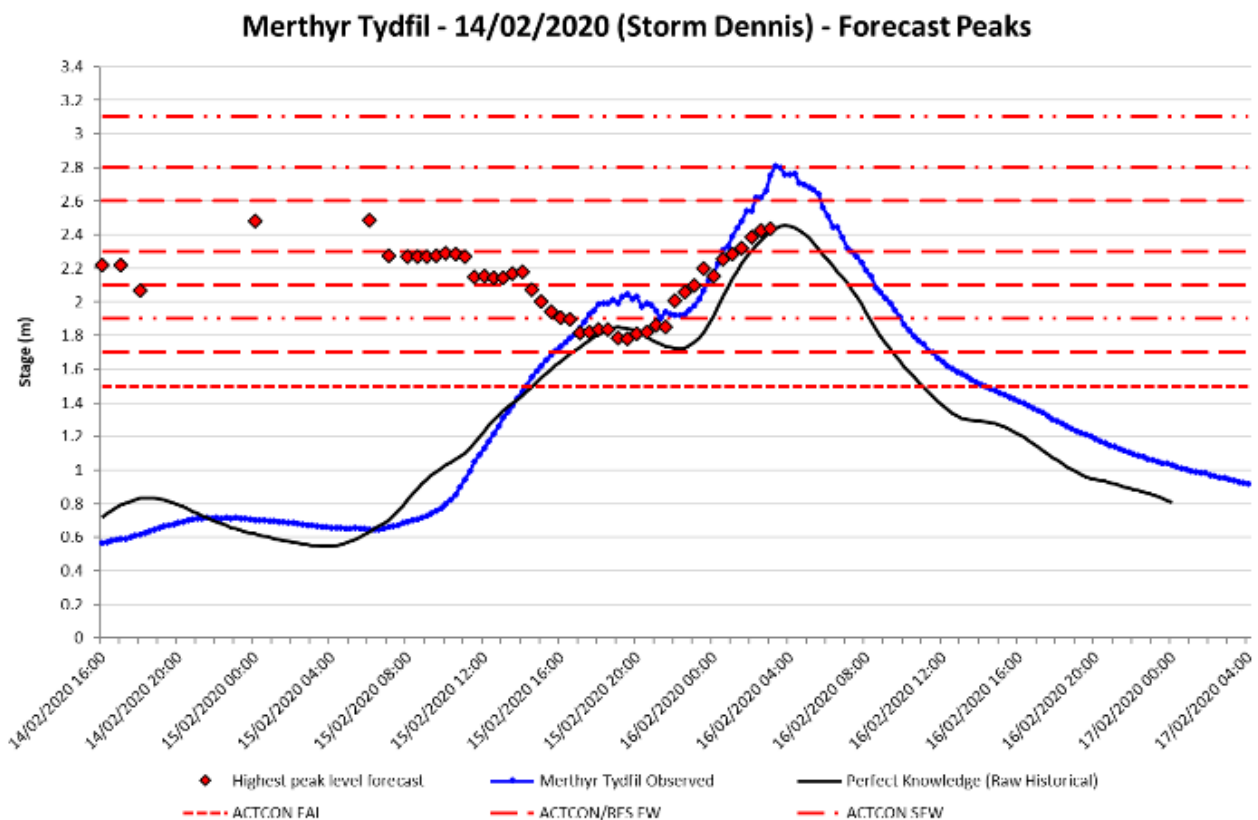


Figure 6 – Forecast Peaks at Merthyr Tydfil during Storm Dennis

Pontypridd - 14/02/2020 (Storm Dennis) - Forecast Peaks

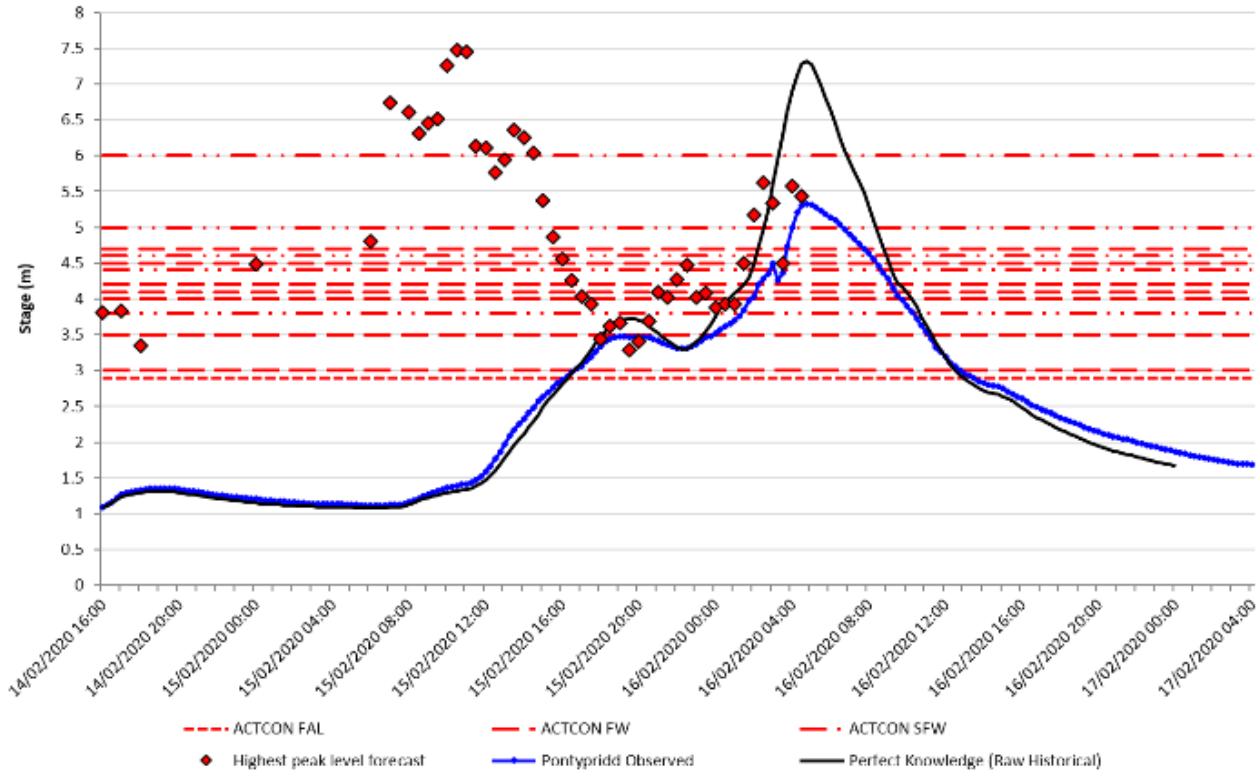


Figure 7 – Forecast Peaks at Pontypridd during Storm Dennis

Figures 6 and 7 show the observed river level (blue) and perfect knowledge forecast (black) hydrographs. The perfect knowledge forecast is from a model run after the event using observed rainfall data and is a good indicator of whether the underlying river forecasting model performs well when the variation from rainfall forecasts at the time of the event is removed. The red diamonds are the highest peak level predicted for the event by the operational forecast run at that time. In a perfect set of forecasts, the red diamonds would therefore show a straight line corresponding to the observed peak level.

If the diamonds look more like the hydrograph shape this usually indicates that event rainfall totals were underestimated at the time by the rainfall forecasts, since forecasts were only just ahead of, or even failing to keep up with, observed levels. The dashed red horizontal lines indicate the threshold triggers duty officers are considering for issuing flood warnings.

As can be seen by this information the models themselves operated well in this area with the perfect knowledge forecast following the pattern of the observed river levels. The plots also show an under-estimation of peak level at Merthyr and an over-estimation at Pontypridd. This however is based on the models being run on known actual rainfall data, and whilst this demonstrates good model performance, they still require further calibration for events of this scale and our models have to be calibrated on the historic event data available prior the February floods. It is also evident that the highest peak level forecast varied significantly during the event (red diamonds).

This reflects the continuously changing Met Office rainfall forecast information which feeds these models and highlights a lot of variation and uncertainty in this forecast rainfall data. This is both in terms of volumes and spatial distribution. The topography of the valleys area makes accurate forecasts very challenging. Rainfall falling just five or 10 miles in a different direction can mean the impacts are in a different catchment. During Storm Dennis, much depended on forecasting the location and timing of a spike of very high intensity rain.

The detail of this was very hard to predict, despite the forecasting capabilities in the Met Office and Flood Forecasting Centre. The forecasts did fluctuate considerably, impacting model predictions (as can be seen from the red diamonds on the plots above). This shows the scale of the challenges in forecasting in such circumstances. There have been major improvements in forecasting in recent years, but it remains inherently uncertain, especially for very high intensity and unusual rainfall events.

This uncertainty complicates decision making for duty officers receiving these reports, with expected flood peaks varying significantly from each forecast model run. A lot of time was spent interpreting forecasts that shifted considerably between different model runs. A key part of the decision-making for duty officers is the balance between being precautionary and issuing warnings, but with the risk that events do not materialise, and the public losing faith in the warnings. There is a desire for as much certainty as possible, and this is challenging in uncertain and rapidly changing events. This emphasises the importance of experience and knowledge of the area as well as technical expertise and willingness to take decisions when they are necessary as key requirements for officers in these roles.

Much more detail is available within the detailed analysis undertaken by the Flood Forecasting team. They are in discussions the Met Office regarding the variation in rainfall forecast quality at short lead times, in particular with the “nowcast” period (next six hours). This is a recurring issue, particularly over the South Wales Valleys catchments, but it is also relevant to other areas in Wales. Weather radar coverage and quality is also a recurring issue across Wales and poor quality radar observations of actual rainfall can in turn affect the quality of short term rainfall forecasts. A recent review of the UK weather radar network led by the Met Office and Environment Agency and with NRW input, identified Wales as having two of the top three locations in the UK where investment in additional weather radars would offer the greatest benefit, partly because the benefit would be to parts of both Wales and England.

As well as improving rainfall forecasts, flood forecasting service coverage is not complete across Wales. The flood forecasting service provided by NRW for rivers in Wales depends on locally calibrated catchment models. Whilst coverage of these models has steadily increased across Wales in recent years, some significant gaps remain where there is currently no modelling capability to make forecasts of flooding at a local catchment or community scale to inform our flood warning or operational response to a flood.

Also, whilst these locally refined models usually offer the best modelling solution for the rivers where we provide a flood warning service or have an operational response, they do depend on the availability and investment in a local telemetered rainfall and river gauge network for model calibration and operational forecasting. On some smaller faster responding watercourses, especially those where it is not feasible to offer a conventional warning service based on monitoring and forecasting local river levels, there may be opportunities to look at other broader scale tools, such as the Grid-to-Grid model developed by CEH Wallingford and used operationally by the Flood Forecasting Centre, to help inform NRW’s flood incident management and response where we are not able to develop local catchment models.

The Met Office has been tasked by Defra with providing better short lead-time rainfall forecasts to allow for surface water flooding to be forecast more accurately and they already have improvements to their immediate term forecasting in the pipeline. Both of these measures could improve the quality of the short lead-time forecasts we will receive in the future but NRW needs to actively engage with the Met Office to look for and maximise opportunities for improving the weather radar network and catchment scale rainfall forecasts

in Wales. Any new radars would require significant investment from NRW and other partners who would benefit, including the Environment Agency and Met Office.

Issue
Whilst local flood forecasting models appear to have operated well, underlying issues relating to variations in short-term rainfall forecasts are evident, there are gaps in forecasting model coverage and concerns remain over the coverage and quality of the UK weather radar network across Wales.
Action (MF6): NRW should work jointly with the Met Office to review the accuracy, stability and suitability of the real time forecast rainfall products it currently receives, with particular focus on the “nowcast” period.
Action (MF7): The Flood Forecasting team should review the coverage of flood forecasting models across Wales, develop a prioritised plan to address gaps where appropriate and explore what opportunities the broad scale Grid-to-Grid model may offer Wales, especially in providing a forecasting capability for small rivers where it is not feasible to build locally calibrated catchment models.
Action (MF8): Work with Met Office, Environment Agency, Scottish Environment Protection Agency and Department for Infrastructure Northern Ireland to explore opportunities and understand the investment required to improve the coverage and quality of the UK weather radar network over Wales.

Operation of the Service

Consistent feedback has been raised throughout the review process which highlights the pressure staff felt during the events while operating the Flood Warning Service. Whilst much good work was done, significant issues have been highlighted from the feedback and contributions to this review regarding capacity, processes, ways of working and some systems.

The Flood Warning Duty Officer (FWDO) is the duty role that decides which warnings to issue. It is accompanied by an assistant – AFWDO. The AFWDO typically processes the warning once the FWDO has decided to issue them. As well as monitoring river levels and issuing warnings, there are other significant expectations and demands on the FWDO role that are very difficult to balance. During the February events, these included:

- Responding to phone calls and answering ‘big’ questions, for example, do we evacuate significant urban areas, such as large areas of Cardiff? Where will we be issuing Significant Flood Warnings?
- Do we instigate significant operational responses, for example lowering the levels of Cardiff Bay due to risk from tide-locking?
- Dialling into, and providing input to different meetings, such as Flood Advisory Service telecons and Tactical Co-ordinating Groups.
- Interpreting data on reports of flooding, for example whether from main river or surface water flooding.
- Prioritising locations for inspections with limited resource availability.
- Providing advice and instructing operational responses.
- Analysing data, stored in different locations, to understand historic levels and the response taken to these to assist with decision-making.
- Analysing and interpreting output from flood forecasting models.

- Dealing with faults at river gauges, where H&T were unable to attend site due to Health & Safety concerns.
- Managing updates to existing flood warning messages.

These tasks had to be undertaken while watercourses were rising quickly and sometimes exceeding numerous trigger levels, requiring simultaneous consideration and action.

For example, the Eastern Valleys FWDO experienced 130 threshold trigger alarms through the telemetry system, all requiring consideration and action between 11pm (15 February) and 4.15am (16 February). Over just five hours this equates to an average of one every two to three minutes – but with many triggering simultaneously.

“I can’t think of harder decisions we have to take anywhere in the organisation or at any other time than in those moments people faced in this event” – Director of Operations

The issues identified in relation to the operation of the Service are:

- In the lead up to and during the February events 243 Flood Alerts were issued, including 52 during Storm Ciara, 65 during Storm Dennis and 47 during Storm Jorge. Flood Alerts act as an early warning stating “flooding is possible, be prepared”. They are also used by a range of stakeholders who may be impacted by the flooding of low-lying land rather than properties, for example farmers knowing when they may need to move livestock. They are usually issued at a more generalised catchment scale than the community-specific Flood Warnings, although some community Flood Alerts are issued in parts of north Wales.
- Whilst these messages have value, they also take time to consider and issue. Feedback following the February events has highlighted how the effort taken issuing these in the days prior to the peak of the storms potentially over-utilised staff capacity in advance of the busiest times of the events. Further work should be considered to improve the efficiency of issuing Flood Alerts, so they are not as onerous to manage for duty officers.

Issue

The issuing of Flood Alerts took time and effort to consider and manage in the periods leading up to the peak of each storm, this potentially expended a lot of time and energy in advance of being required in the key moments of the event, burning out duty officers.

Action (FW1): Review the value of Flood Alerts for customers for all sources of flooding, seek opportunities to make the analysis, decision making and issuing of Flood Alerts more efficient. **This should be included within the Flood Warning Service Review Implementation Programme.**

- National and Local Flood Advisory Service telecons with government and partner organisations are an important step in the preparation for any expected large flood event. They are triggered when the Flood Guidance Statement is Amber or Red, so when medium or high overall risk is being forecast. They can be triggered outside of these circumstances if there is a need to share information or update the government and local partners. The telecons provide information to raise awareness of developing flood risk to enable the government and partners to help make informed decisions about any escalation of their flood response.

- Feedback on telecons highlights that in some instances they worked well and provided a useful forum to prepare incident response, but issues have been highlighted relating to the lack of clarity regarding attendance and who was leading some of these calls. It has also been highlighted that, with the changes in operational working areas, a significant number of duty officers now have to attend the Dyfed Powys Local Resilience Forum (LRF) calls, potentially 3 DTMs and 5 FWDOs. This caused confusion during the incidents and could be addressed more efficiently, therefore saving vital duty officer time.

Issue

Local Flood Advisory Service telecons drew in multiple duty officers and there was uncertainty on roles.

Action (FW2): Roles and responsibilities for Local Flood Advisory Service telecons should be reviewed and restated to duty officers.

Action (FW3): A more efficient approach to NRW attendance at cross boundary LRFs is required and should be implemented taking account of the latest operational boundaries.

- Significant time during the event was taken ensuring that updates were issued in relation to already issued Flood Warnings, at the detriment of fully considering the issuing of new Flood Warnings. It has been highlighted throughout the review process how much of the information provided through updates is now available through other channels due to recent enhancements on the NRW website such as Rainfall, River and Sea Levels Online.
- We are unclear on the value of providing these message updates, so further customer analysis and feedback should be considered. Opportunities to reduce the resource requirements of this work through automation or public self-service online should also be considered. The issuing of message updates on existing Flood Warnings should be made a secondary priority to the issuing of new Flood Warnings.

Issue

Issuing updates to Flood Warning messages became time consuming and impacted the operation of the Flood Warning Service.

Action (FW4): Seek opportunities to make the issuing of message updates more efficient and undertake analysis work to determine their current value to customers, this should include efforts to implement more automation or self-service for customers. **This should be included within the Flood Warning Service Review Implementation Programme.**

- The issuing of Flood Warnings is a process that requires experience alongside analytical, judgment and decision-making skills. Duty officers need to consider a range of factors including forecast data, historical information, on site observations, upstream environmental data including rainfall and river levels and knowledge of the level at which the onset of flooding is expected to occur.
- Resultant Thresholds are water levels calculated at our river gauges in advance of incidents that provide duty officers with key flood impact information on the level at which nearby communities and infrastructure are expected to start flooding. They are key contextual information for consideration when issuing Flood Warnings and managing our operational response.

- Understanding Resultant Thresholds and the level at which the onset of flooding occurs is vital information for duty officers to consider when issuing warnings and reporting the potential and actual flooding impacts during a flood. It is also critical for assessing the performance, timeliness and accuracy of the warning service after a flood. However, it is not always easy to set Resultant Thresholds reliably. This is particularly so in areas that have flood defences and rarely experience flooding, as there is little historical data to use.
- This event demonstrated that in many locations the information relating to when flood defences will be overtopped, or when properties will begin to flood, is lacking within our procedures and systems. This information can also support our ability to highlight expected impacts to both the public via our Flood Warning messages and to incident response partners, for example within our SITREPs.
- Additionally, some Resultant Thresholds may be unreliable because of low spots in defences or alternative routes for flooding, for example from unknown weak spots in the defences or from other watercourses in the vicinity. For these reasons Flood Warning procedures include triggers for sending officers to site to verify what is happening on the ground and to gather data which will help improve threshold data for managing future flooding.
- Staff undertaking these tasks need to be trained, competent and available on-call. During the events in February, given the size and extent of what was happening and the need for operational response across the whole area, there was not enough capacity to do the on-site verification.

Issue

The lack of reliable Resultant Thresholds and the absence of on-site observations significantly increased uncertainty, affecting the speed and accuracy of decision making, as well as the ability of duty officers to take prompt decisions and manage overall workloads.

Action (FW5): Analysis work to understand and refine thresholds should be undertaken, using new information from these events, coupled with our existing flood models, with a focus on developing Resultant Thresholds where they are currently missing, especially for high risk locations where it is feasible to do so.

Action (FW6): Review options to either reduce reliance on on-site observations or increase capacity to do such observations.

- 3,130 properties flooded in February 2020 including 2,765 properties flooded during Storm Dennis. Although, no fatalities have been associated directly with the flooding. However, the fact only four Severe Flood Warnings were issued during Storm Dennis should be cause for further consideration and review of the use of Severe Flood Warnings.
- During the February events, it is clear that the complex decision-making and judgment used to issue flood warnings became increasingly challenging. This is even more significant when it comes to decisions surrounding the issuing of Severe Flood Warnings as these are issued by NRW in consultation with professional partners, so can lead to substantial implications for all partners involved in managing a flood incident.

- It is evident through the feedback obtained that there was a lack of complete clarity in both the procedures for issuing Severe Flood Warnings and the roles and responsibilities of all involved. The experience of duty officers involved in these decisions was a key factor in the effectiveness of our response. For example, feedback from North Wales officers demonstrated that decisions made during Storm Ciara benefitted from the previous experience of issuing Severe Flood Warnings from the prior events they had experienced, notably St Asaph in 2012.
- Severe Flood Warnings are normally associated with a risk to life. This is typically considered in relation to the depth and local velocity of flood water alongside the level of debris present. The anecdotal evidence reported by members of the public and the images of flooding taken during these events suggests the risk to life could have been considered high in many of the impacted communities.
- On the River Taff, five river gauge thresholds to consider issuing Severe Flood Warnings were exceeded, but these warnings did not get issued. In addition, the Severe Flood Warning at Pontypridd was issued relatively late compared to the timing of reports of significant flooding. As explained previously, the decision to issue a Flood Warning or Severe Flood Warning relies on multiple factors, for example onsite observations would need to be used alongside a forecast.
- There is a whole range of pressures during a live incident. These included lack of field data, forecast uncertainty, volume of triggers activated across the whole catchment, significant implications of decisions, unfamiliar territory and exceptional events, possible lack of total clarity on procedures and roles and responsibilities, and the range of tasks that the duty officers are expected to perform. Staff were put in very difficult positions, and there needs to be full consideration of how to avoid or reduce the risk of this happening again.
- There is a strong reputational impact if Severe Flood Warnings are issued incorrectly and current guidance and procedures relating to the issuing of Severe Flood Warnings were followed by officers during this event. However, with hindsight, issuing additional Severe Flood Warnings was necessary given the threat from the flooding which took place, and with better information and more time to consider decisions it is likely they would have been issued.
- We are recommending measures to improve the procedures and the flow and quality of information available to FWDOs. Yet there will always be uncertainty and at times insufficient real time information in an event of this scale. A discussion is needed to establish how the balance of risks should be established. Information gathered from these events will be used to inform the issuing of warnings in the future.

Issue

The decision-making process related to the issuing of Severe Flood Warnings is challenging and more Severe Flood Warnings should have been issued based on the flooding impacts experienced.

Action (FW7): The procedures, guidance and decision-making processes relating to Severe Flood Warnings should be reviewed. This should include analysis of the public perception of Severe Flood Warning levels and consideration of the risk appetite the organisation has for issuing more or less Severe Flood Warnings. **This should be included within the Flood Warning Service Review Implementation Programme.**

Action (FW8): Further training and exercises, particularly for major incidents and incorporating the use of Severe Flood Warnings are needed, building on the experience of officers who have faced these situations in previous events.

Action (FW9): Roles and responsibilities in relation to the decision making on issuing Flood Warnings and Severe Flood Warnings should be clarified and restated to all relevant duty officers.

- Due to recent organisational changes the management of the Severn, Vyrnwy and Teme areas has been handed over to NRW officers in North Wales. This has created challenges in both understanding local operational issues and differences in approach from teams based in North and South Wales. Procedures and differences in service need to be reviewed and updated to ensure consistency of service across Wales.

Issue

The differences being experienced in managing the Flood Warning Service in Severn, Vyrnwy and Teme area of Wales compared to other areas of Wales have been highlighted by the recent changes in NRW organisational boundaries.

Action (FW10): Procedures and the level of service provided in the Severn, Vyrnwy and Teme areas should be reviewed and made more consistent with the rest of the service. Further handover work and development of more detailed understanding of the specific local issues is required.

- Several site-specific issues and improvements were highlighted in relation to specific flood warning areas including improvements to some threshold triggers, clarity in some messages and some minor errors in procedures. These have been fed back to the relevant local teams for action.
- An issue has been highlighted regarding the functionality of automated warnings that have been piloted in some communities where there is rapid onset flooding, and where the issuing of warnings is directly linked to the telemetry system without any human duty officer intervention. Changes in how our NRW telemetry system communicates with the Environment Agency flood warning system, which we still take as a managed service now requires manual intervention and has a reliance on trigger alarms being highlighted to duty officers. This requires additional development work within the telemetry system and is not possible with the current system. This issue could lead to potentially missed flood warnings in previously automated areas.

Issue

Previously automated warnings now require manual intervention due to compatibility issues between detection and warning systems

Action (FW11): Development work within the telemetry system should be undertaken to reinstate automated warnings in areas where this has become an issue – or, if this is not possible due to current system limitations, then the management of previously automated warnings should be reviewed to ensure procedures are adequate.

- Most of the feedback about the 24/7 operational systems used to detect, forecast, warn and inform of flooding has been positive and supportive of recent enhancements

to key systems and data. Some specific and relatively minor issues have been highlighted and these have been passed on to relevant system custodians to consider and action. There are already improvement projects underway which will address some of these issues.

- The labelling of some flood warning trigger thresholds within the telemetry system led to three flood warnings being issued late on the River Teifi. This needs to be resolved to help avoid issuing late flood warnings in the future. If this is dependent on future enhancements to the telemetry system, then interim measures need to be actioned.

Issue

Threshold trigger labelling within the Telemetry system led to warnings being issued late during the event specifically on the River Teifi

Action (FW12): Improvements are needed to the way trigger information is displayed on the Telemetry system, specifically sites with multiple thresholds. This should be included within the development of the new Telemetry system.

Action (FW13): Duty officers should be reminded of the correct procedures and provided with refresher training, as an interim measure.

- The Incident Communication Centre (ICC) is the 24/7 handling centre for incident reporting and queries from the public. It also acts as a gateway to provide key information to incident duty officers. This includes monitoring the telemetry system for alarms being triggered by threshold exceedances at the rainfall and river gauges. The ICC operators contact duty staff to notify them when the alarms hit triggers that require action from the duty staff.
- During Storm Dennis, the ICC became inundated and overwhelmed by the number of calls it was receiving from the public, preventing the ICC from being able to raise alarms from the telemetry system with duty officers. This led to confusion for some officers in how to handle and monitor these alarms and it also increased the workload on FWDO's who had to address the numerous alarms which were being triggered throughout the night.

Issue

The Incident Communication Centre became overwhelmed by calls from the public which meant staff were unable to assist duty officers by phoning through and accepting alarms on the telemetry system

Action (FW14): Contingency procedures for these circumstances should be developed and implemented.

- Feedback in relation to the guidance available to duty officers and the training they had experienced was positive. There will always be a requirement to ensure duty officers are kept up to date with the latest process and systems enhancements and to refresh knowledge of procedures. The existing mechanisms for doing this through weekly handover sessions and specific training were reported as being effective. However, some operational guidance requires updating. This is a relatively minor issue but should be actioned.

Issue

Some guidance hasn't been reviewed for several years and some dates back from legacy (pre-NRW) ways of working

Action (FW15): Guidance should be reviewed, and updates made, especially where this hasn't been undertaken since the formation of NRW.

The operation of the Flood Warning Service came under significant pressure during February and at times became overwhelmed. This was due to both the issues highlighted above relating to ways of working but also due to the capacity available on duty rotas during these periods. This is discussed further later within this review document, but it should be considered alongside the issues raised in this section as a critical issue that impacted the operation of the service.

Accuracy and Timeliness

During February 2020 NRW issued 430 flood warnings and alerts making it the busiest month in operation since the system took its current format in 2005. 243 Flood Alerts were issued, 181 Flood Warnings and six Severe Flood Warnings. Storm Dennis led to 65 Flood Alerts, 89 Flood Warnings and four Severe Flood Warnings alone.

As has been highlighted, the successful issuing of a flood warning is dependent on the detection, forecasting, monitoring and decision-making of duty officers, all supported by key systems, field equipment and procedures. Whilst the vast majority of warnings were issued in a timely manner, some were either missed or sent after the onset of flooding.

As described above, a large number of warnings were successfully issued in a timely fashion. However, following analysis of the warnings issued during Storm Dennis, it was regrettably identified that warnings were not issued in 12 flood warning areas:

- River Rhymney at Ystrad Mynach
- River Rhymney at Dyffryn Industrial Estate
- River Rhymney at Llanbradach
- River Rhymney at Bedwas House Industrial Estate
- River Rhymney at Caerphilly
- River Rhymney at Bedwas
- River Rhymney at Pant Glas Industrial Estate
- River Rhymney at Machen
- River Rhymney at Llanrumney
- River Rhymney at Industrial Area near Rumney Bridge
- River Rhymney at Began
- River Towy at Llandeilo to Llanwrda

Six flood warnings were also issued later than they should have been:

- River Teifi at Newcastle Emlyn – issued at 8.20am (16 February 2020)
- River Teifi at Cenarth – issued at 8.20am (16 February 2020)
- River Teifi at Llechryd – issued at 8.20am (16 February 2020)
- River Taff at Nantgarw – issued at 5.19am (16 February 2020)
- River Taff at Forest Farm and Melingriffith – issued at 6.50am (16 February 2020)
- River Taff at Radyr Court Rd, Cardiff – issued at 8.46am (16 February 2020)

Duty Officers use data from gauges at New Tredegar and Bargoed to consider the issuing of the first eight of these flood warnings on the River Rhymney. The gauge at Machen is used to issue the latter three downstream Rhymney flood warnings. The recorded logs show that the threshold set to consider issuing a flood warning for eight of these warning areas triggered at 1.11am (16 February 2020) at New Tredegar and 2.01am (16 February 2020) at Bargoed. Similarly, the threshold to consider the downstream three flood warnings was triggered at 2.25am (16 February 2020) at Machen.

It is not possible to verify for certain whether these warnings were missed due to a lack of resultant thresholds and availability of operatives on site to validate when flooding occurred. However, gauge data and reports of flooding in some of these locations following the events underline that these warnings should have been issued.

The records show that between 1am and 2.30am on 16 February 2020 the telemetry system highlighted 61 threshold alarms related to 41 different flood warning areas or operational response triggers. It was a very busy period and figure 8 highlights the frequency at which alarms were being triggered on the Eastern Valleys FWDO rota. Each alarm requires time and consideration by a single duty officer in the early hours of the morning during one of the most significant flood events experienced in a generation in this area.

The warning for the River Towy at Llandeilo to Llanwrda was not issued, this was also a factor of the intense nature of the event and the number of alarms being triggered.

Typically, in times as demanding as this on a single duty officer, additional duty officers are brought in to support rotas. However, this did not happen during this incident. It is clear that the circumstances were extremely challenging and too much for one duty officer to handle. One officer cannot give the level of service expected in such circumstances. Either the amount of resource available during a flood needs to increase, or the number of tasks required needs to decrease. The options need to be thoroughly assessed, and changes made.

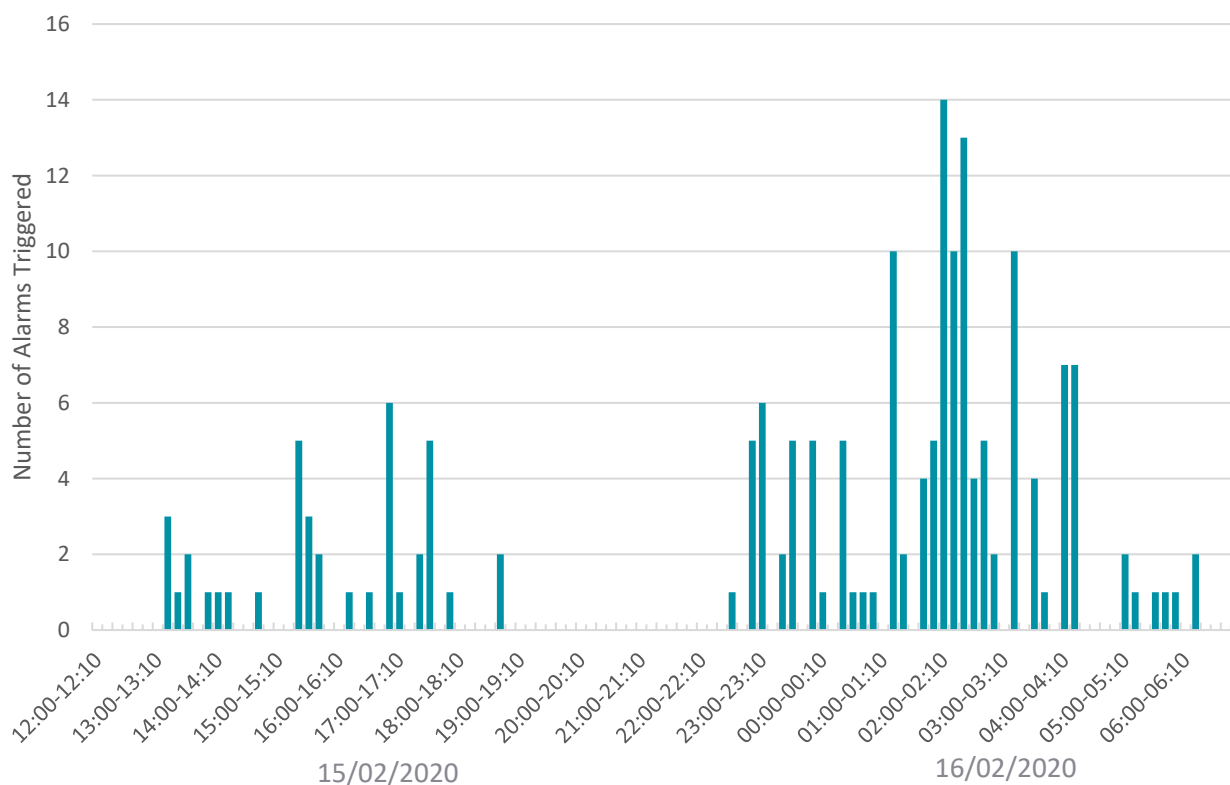


Figure 8 – Number of alarms triggered per ten minutes on the Eastern Valleys FWDO rota

It is therefore concluded that these flood warnings were not issued due to the service becoming overwhelmed and measures to prevent this happening again should be instigated immediately.

The reasons for late flood warnings on the River Teifi were due to a combination of issues with the telemetry system (Actions FW12 and FW13) and the lack of appropriate procedures that should have been instigated.

The three flood warnings on the River Taff are judged using “consider” thresholds set at Pontypridd, which were reached at 1.50am (16 February 2020), and Upper Boat, which were reached at 2.27am (16 February 2020). In the case of Nantgarw, there are also resultant thresholds set within the system which are used to indicate the likely onset of flooding at Nantgarw. These were reached at 3.43am (16 February 2020) at Pontypridd and 4.13am (16 February 2020) at Upper Boat. Anecdotal evidence reported through news outlets and social media also indicates properties in Nantgarw began flooding before the flood warning had been issued.

There were missed flood warnings on the River Rhymer and these late flood warnings could have had significant consequences for members of the public, unaware of the severe flood incident developing in the early hours of the morning. These again relate to the service becoming severely stretched by the demanding and hectic nature of issuing the flood warnings on that morning. Figure 8 above illustrates the number of thresholds being triggered. Measures should be implemented to prevent this from occurring again.

As discussed earlier within this review (Actions FW7-9) there are also issues to consider in relation to the issuing of Severe Flood Warnings. The improved understanding of flooding extents, mechanisms and the specific river levels where the onset of flooding is known to have occurred from these events will all improve the future operation of the service. These

changes will improve the accuracy of Flood Warnings in future events and lessons will be learnt from these issues.

Issue
Some flood warnings were missed, and some were issued late.
Action (D1): The capacity and resilience of the flood warning duty rotas should be reviewed during times of extreme pressure and workload demand. This should include options for bringing in additional support rotas.
Action (D2): A review of roles and responsibilities for the FWDO and AFWDO role should be undertaken with a focus on what is expected of the role and where it may be possible to reduce the workload demand on this key role. This should be included within the Flood Warning Service Review Implementation Programme, but tactical options may need to be considered earlier than this.

Other issues and recommendations issued within this review report directly relate to the contributing factors for these warnings being not issued as expected or being issued late, they are found in the Operation of the Service and Operational Capacity sections.

Flood Warning Service Review (FWSR) Overview

Between April 2018 and December 2018, a detailed and thorough review of the Flood Warning Service was undertaken by NRW staff. It found a number of improvement areas and identified a series of recommendations to make the service more efficient and effective and tailored to the needs of our customers in Wales. Many of these would help alleviate some of the issues identified in the previous sections. A detailed Implementation Programme has been developed, over a five-year delivery period, recognising that resources are limited and work needs to be prioritised. Improvements will also take time to deliver. Progress of this work has been constrained by lack of resources and the requirements of working on other key enhancements to our business-critical systems such as flood warnings and river levels online during this period.

The Implementation Programme will consider the main areas of improvement work required to deliver the recommendations of the Flood Warning Service Review (FWSR). The plan includes significant review and improvement works to policy and processes in the levels of service we provide and how the service is operated. NRW needs to undertake the development of a new Flood Warning System (FWS) when the current contract under the EA Managed Service expires in December 2022. Options for taking this forward are currently being considered before a preferred option is selected later this year. Any of the options will require significant investment in a new system.

Several of the issues identified and recommended actions made by this review into the events of February 2020 directly link to the delivery of the FWSR implementation phase. The FWSR improvements to systems, policies and processes will take time and will require significant funding and resourcing. The tasks cannot be delivered within the existing resource envelope, without deprioritising other critical activities - these other activities include running the existing service and making critical ICT enhancements and are not possible to deprioritise. Therefore, an additional seven Full Time Equivalent members of staff (FTEs) are required at an estimated additional annually recurring cost of £370k. Non-staff costs in relation to system development, procurement and operation are also likely to be significant, but difficult to assess until the development work is undertaken.

The improvements this work will bring will be vital in rectifying some of the issues experienced in February 2020 and should be taken forward as a priority.

Flood Warning points for consideration

The Flood Warning Service operated by NRW provides vital information to customers in flood risk areas. It provides advance warning and gives time for people to take action to protect both themselves and their property. The operation of the service is dependent on a complicated chain of systems, tools and procedures all of which are pivotal to the successful issuing of warnings.

There has been significant enhancement to many of the component parts of the Flood Warning Service in recent years. However, some elements still require review and enhancement work to catch up with the capabilities and improvements offered by other improvements, such as key system enhancements for flood warnings and telemetry.

The level of service to customers has improved over time, with an expansion of the service coverage and also improvements in accuracy, resolution and lead time due to technological advances. Warnings have moved from broader catchment areas to community-specific warnings. At the same time there are still significant uncertainties involved in predicting the weather and its impacts, especially in rapid response catchments in parts of Wales including the South Wales valleys impacted during Storm Dennis. This is an area where continuous improvements are needed and requires sustained investment.

Equally important are the skills and expertise of the staff who run the service on a 24/7 duty rostered basis. While gathering evidence for this review, the level of pressure experienced by staff, sometimes in very difficult positions while having to make significant decisions relating to extremely dynamic and complicated situations, has been extremely evident. Staff have provided support to each other both during and after the flood events of February, which has also been clear to see.

At key points during Storm Dennis it is clear that the service became overwhelmed. This is a procedures, capacity and resilience issue, not a reflection on the individual staff involved, who were dealing with impossible demands during the incident. The challenge was beyond any we or our predecessors had faced in Wales before. We had too few people to deal with the peak workload, and in hindsight, our contingency plans were found wanting for an event of this scale.

A lot is asked of key roles during incidents, and this needs to be recognised. It is clear that too much was being asked of duty officers at times during these events. The FWDO role specifically has become more involved with many different aspects of the service and opportunities to make some procedures more efficient or to change the load on this role should be reviewed. The same applies to a lesser but still important extent to other duty roles, including the MFDO, which were also pulled in different directions during the event.

In reviewing the effectiveness, accuracy or timeliness of flood warnings, the benefit of hindsight needs to be acknowledged. Clarity following an event masks the significant complexities and uncertainties experienced by officers during that event. This is made more challenging due to the lack of on-site validation of river levels by operatives, and the lack of Resultant Thresholds within the operating procedures.

It is clear that in some locations the Flood Warning Service was overwhelmed in these events; the level of service we aim to give as a Category 1 Responder could not be met given the demands of the extreme weather events in several areas. Staff performed beyond the call of duty in difficult circumstances and should not be put in the same situation again, although the extreme severity and scale of these events has to be recognised. The level of service expected and achievable applies to all elements of our flood risk management services and is discussed further in the Incident Management section.

Improving the service will require adequate support in both funding and resources to deliver key improvements, some of which are already recognised as a necessity. Where there is not this support, the level of service will need to be adjusted downwards to fit the resources.

A wider point for consideration is the organisation's appetite for risk in relation to flood warnings. Should we issue Flood Alerts, Flood Warnings and Severe Flood Warnings earlier in an event, even if uncertainties remain and there is an increased chance of false warnings? NRW needs to assess the benefits and the risks of waiting for greater accuracy before broadcasting warnings. Ultimately, the warnings must provide customers with enough time to make active use of them, whilst also effectively communicating the severity of what may be expected.

An important consideration is how our Flood Warnings are received, and the actions that households and communities take in response to these warnings. Our experience of working with communities over several years, particularly when there has not been a recent flood, there is an under-appreciation of the pace and severity of flooding. This is supported by much evidence highlighting the challenges of engaging communities in what can be rare, but significant events.

How communities receive and react to flood warnings must also be considered; they need to be best prepared to take the right actions. We also need to assess whether the significance of the different levels of warning, as well as the pace of flooding, is understood by the communities.

Actions to be discussed with partners

What is the risk appetite across all partners for issuing flood warning messages with different levels of certainty? Should Flood Alerts, Flood Warnings and Severe Flood Warnings be issued earlier with less confidence?

Do the public and partners understand the flood warning messages, and what they mean? How do we most effectively raise awareness of flooding and the actions householders and communities can take to live with flooding, now and in the future?

Operational response

NRW has a number of assets that require an operational input during flood events, this includes the installation of demountable defences and the need for closure of flood gates. NRW currently has over 150 Operational Response sites across Wales which require operational input. Figure 9 below shows the geographical spread of these sites.

Operatives also carry out other proactive work such as checking and clearing the trash screens on structures when poor weather and heavy rainfall is forecast. Additionally, operatives and equipment may also be deployed in reaction to events, for example, the use of high-volume portable pumps in key locations, or clearing obstructions from bridges or culverts. Operatives may attend sites to provide key information from the field back to incident rooms to inform decision making, and at times, they may be called to assist other Risk Management Authorities and emergency services. There are likely to be other operational responses required either to known asset issues which need to be managed in high flows, or in response to issues highlighted by the public such as blockages in rivers and under structures.

NRW's operational response to flood events is managed through a combination of duty rostered staff and by calling in additional field staff if required during an incident. This is mostly overseen and managed by the Flood Incident Duty Officer (FIDO) and Assistant Flood Incident Duty Officer (AFIDO) working in co-ordination with relevant Site Controllers to deliver response work in the field, this is done through Operational Field Teams where applicable.

Currently, nine operational rotas exist to carry out the incident response work described above. These rotas are linked to NRW's operational places and provide Wales-wide coverage. Typically, an operational response is carried out in pairs, or in some instances three operatives working on site, due to both the work required often needing multiple individuals but also for health and safety reasons such as preventing lone working.

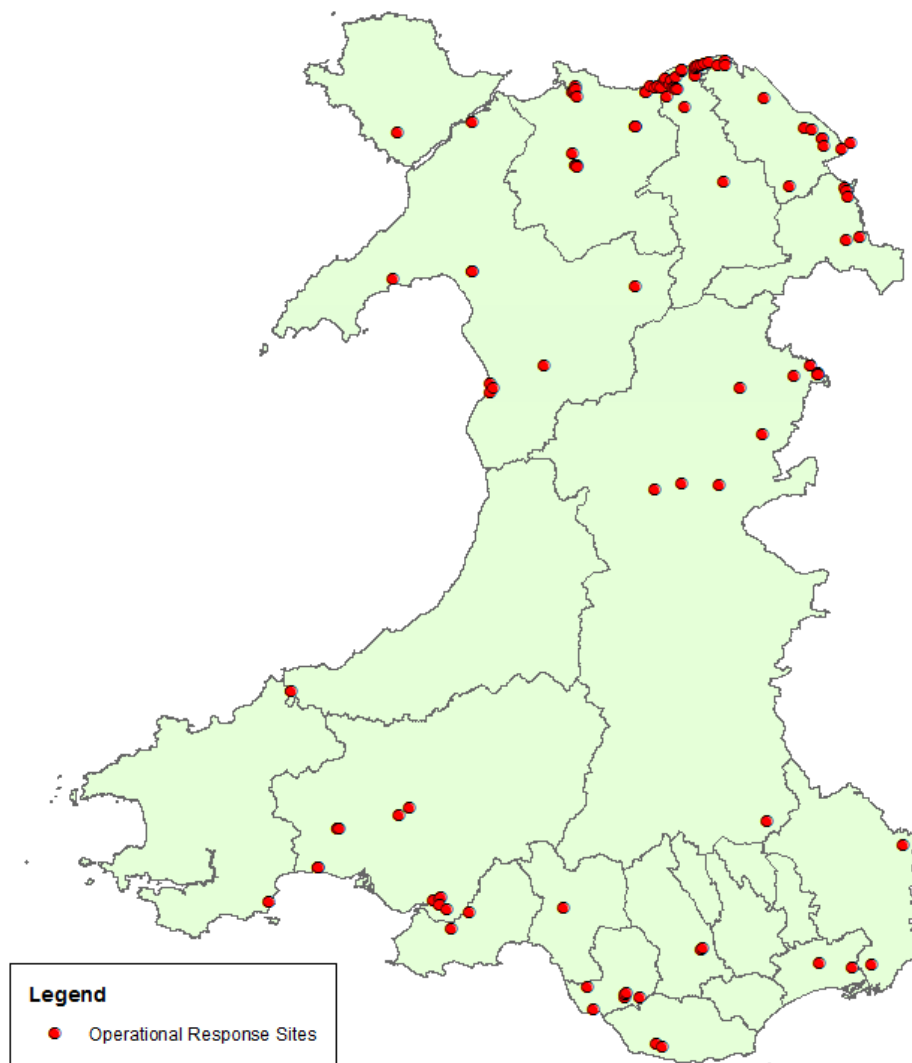


Figure 9 – Operational Response Sites in Wales

The following is a summary of the operational response issues found during this review:

- CCTV and remote monitoring of operation sites was highlighted as very useful and worked well in most instances where it is available. This can help prioritise on-site response actions more effectively, save extensive amounts of travel time, and provide key information to duty officers back in the incident rooms. However, there is inconsistency in the CCTV uptake and capacity, as well as how these systems operate across Wales. There is the potential for a more strategic implementation of this technology.

Issue

CCTV and remote monitoring of sites has proven useful at key sites during flood incidents.

Action (OR1): Use of remote monitoring technology should be considered across more of the key operational sites and locations where we issue Flood Warnings.

- The feedback on operational structures that had to be implemented during the flood events, such as gates and barriers, was mostly positive. Some specific actions on structures have been passed on to the relevant teams. The operation of the newly

installed demountable barrier in Llanrwst gained particularly positive feedback from those involved with installing it.

- Overall there was mostly positive feedback on our operational work and the procedures in place to prepare for and respond to a significant flood incident. Some minor comments have been made about specific operational procedures and these have been fed back to relevant teams for consideration and action.
- Communication between duty officers was highlighted as another positive area, with the ability to obtain feedback from sites also important. The improved use of tools, such as WhatsApp, to be able to send images from site back to incident rooms was also commended. But there are several equipment and network issues associated with this, these are addressed later in this report.
- The importance of training and exercising operational response work has been emphasised. This has the benefits of familiarising operatives with structures and operational kit, as well as testing procedures and developing contingency plans around key structures.
- Whilst attempting to carry out operational work in Llanfair Talhaiarn, it was reported that our operatives experienced significant verbal abuse and public interference. Whilst unfortunately there is always the potential for these situations to arise, particularly at highly pressured times during a live flood incident, operatives should not have to experience this treatment in communities they are trying to support. Whilst no specific requirements have been identified by operatives who experienced this, 'hostile situations training' should be considered for individuals in public-facing incident roles.

Issue

Operational support experienced some isolated but significant cases of verbal abuse and public interference while carrying out their incident response work.

Action (OR2): Consider where appropriate the need for training on understanding the root causes and ways to work in partnership with communities to help reduce the risk of conflict, including the need for further hostile situations training for those involved with public facing duty roles and post-event work.

- The incident reporting and management system, Wales Incident Recording System (WIRS), was considered overly complex, and some officers had difficulties closing down actions on the system. There were also issues highlighted in relation to the ICC becoming overwhelmed and not able to alert relevant officers to required actions on WIRS. Overall, these are considered less major than other issues in the feedback, nevertheless they have been passed on to the relevant teams for consideration.
- In several locations, issues were highlighted relating to road closures required either to erect demountable flood defences, or to prevent drivers from entering flood water. This is often dependent on local highway teams with Local Authorities, and where appropriate local feedback has been passed on to relevant partners.
- NRW has a regulatory role in relation to the third party owned Reservoir Safety, but as potential incidents arose during the February 2020 storms, it became unclear for duty officers which procedures to instigate. From a regulation and advisory perspective, there is no 24/7 capacity within NRW and therefore providing advice on

these issues as they occur is only possible during office hours. Procedures and guidance for these circumstances should be improved.

Issue
Confusion arose during the incident in regard to our regulatory response to third party owned reservoir issues.
Action (OR3): Procedures and guidance relating to incidents at third party owned reservoirs should be improved and training provided to duty officers.

The Operational Response work issues that this review has highlighted needs to be considered in relation to the Operational Capacity which is addressed later in this report. In particular, staffing levels and equipment issues that arose during the flood events need to be looked at. The requirements for strong knowledge and experience, as well as good local operational knowledge, were highlighted as key for the roles undertaking this response work. In some cases, this was linked strongly to some of the good practice experienced during these incidents, and this should be recognised.

Incident Management

In the lead up to and during incidents, NRW operates an incident management structure to ensure command and control of all incidents within our remit, for example flooding. This includes the strategic elements of managing our response to an incident of this scale by reporting of the situation and coordinating the activities with professional partners and RMAs. It is vital that the different organisations work together to deliver an effective multi-agency incident response. Collectively RMAs work within the Joint Emergency Services Interoperability Principles (JESIP)³ to improve multi-agency work during incidents.

The command and control hierarchy works through the organisation at different levels from local area-based Duty Tactical Managers (DTMs), through to the national DTM and Duty Strategic Manager (DSM). Links are made to collaborating partners through the different multi-agency coordinating groups which operate at a Local Resilience Forum (LRF) level. There are four in Wales, these cover North Wales, Dyfed Powys, South Wales and Gwent. There is also a national coordination cell hosted by the Welsh Government.

Working with others

The overarching management and control of a significant incident, such as those experienced in February 2020, requires an extremely well-coordinated response. Whilst the management of our incident response was effective, a number of issues have been highlighted:

- Numerous duty officers highlighted the sheer volume of calls, both internally and externally, that they experienced during the extreme flood events. When considered alongside the issues experienced in both capacity and the operation of some of our key systems and services, in some cases these were a distraction. Consideration of the relevant responsibilities of the key incident management roles is required, this is linked to Actions D1 and D2 which has been previously highlighted.
- Some feedback queried whether NRW or other organisations mobilised quickly enough at a strategic level for the scale of events that unfolded. There was also a lack of complete clarity on the escalation of the suite of briefing telecons within the LRF and Coordinating Group structures. Some staff attending the Coordination Group meetings felt underprepared. This could reflect the rarity or inexperience of attending these groups but may also reflect the lack of strategic momentum and clear direction in the build up to these events.
- The involvement of the Welsh Government in the coordination and management of the flood incidents, particularly with Storm Dennis, has been questioned by some staff. Issues flagged include lack of clarity on whether WG would open the Emergency Coordination Centre Wales (ECCW) and the involvement with National Flood Advisory telecons, as well as uncertainty regarding contact points over the weekend. This should be highlighted to the Welsh Government, and consideration should be given to both NRW and Welsh Government procedures.

³ Joint Emergency Services Interoperability Principles, viewed July 2020, <<https://jesip.org.uk/home>>

Issue

Feedback indicated a lack of clarity on the LRF and Welsh Government escalation procedures over the course of the events.

Action (IM1): Discussions with the LRFs and Welsh Government to consider further if further improvements are needed to the joint incident response escalation procedures.

- The LRF Strategic Coordinating Groups (SCGs) and Tactical Coordinating Groups (TCGs) placed a high demand on our duty officers' time. We need to consider how these important external dependencies are serviced, ensuring our staff feel properly briefed and prepared to attend, and that we are not placing too many demands on the same officers.
- Issues highlighted relating to the TCGs were mostly about their level of impact on MFDOs and FWDOs. In times of extreme workload during the incident, calls took vital time away from duty officers; this could have been handled more effectively. Several instances also cite a lack of clarity regarding procedures at these groups, and an improved understanding of roles and responsibilities is required.

Issue

Officers attending important external forums highlighted the resource demand this placed on them at times of peak workload and in some cases felt under-prepared.

Action (IM2): Review procedures for attending important external forums, test how we would respond in the future and clarify expectations on certain roles to attend.

- The feedback on this area also relates to Actions FW2 and FW3, highlighted within the flood warning review section, which specifically underlined Dyfed Powys as a potential for inefficiency with NRW's current duty operational boundaries.
- Some officers highlighted concerns that elements of the TCGs steered away from the principles set out within the JESIP ways of working, this included the use of technical jargon and unfamiliar acronyms. This will be fed back to partners through the appropriate routes, equally further training requirements should be considered where this is identified as an issue internally.
- Most feedback was positive about working relationships with other organisations and the cooperation and support received. Communication challenges occurred, mostly following the flood events, and these are covered later in this review report.
- The DTM roles received positive feedback but there were some concerns in relation to inconsistencies in how the role was applied across Wales.
- Senior management support for the DTM during Storm Dennis was appreciated as this enabled the DTM to focus on the delivery of the local incident response. Further training may be required in relation to major incident response efforts for DTMs.

Issue

Some inconsistencies in approach across the DTM roles were highlighted, coupled with varying levels of experience in dealing with major flood incidents.

Action (IM3): We need to consider the support required and level of expectation of multifunctional roles during major incidents, this may include further training. Exercises for DTMs regarding major incidents should be considered providing clarity over the responsibilities of the role.

An extremely strong sense of teamwork, people supporting their colleagues throughout the incident and the period since, has been highly evident. However, many staff provided feedback stating that the organisational changes that have happened since the creation of NRW have created uncertainties relating to roles and responsibilities, rota structures and allowances. Some of these issues have been clarified and taken forward since the time of the events (February 2020), but some elements still require further clarification.

Issue

Some of the organisational changes in recent years have left residual issues in regard to roles and responsibilities, rota structures and allowances, which require clarification.

Action (IM4): Follow up on the issues and feedback raised and provide further clarification as required.

With issues relating to the Flood Warning Service becoming overwhelmed, some degree of contingency planning should be developed that allows for either fall-back procedures, or some elements of decision making to be streamlined when NRW is experiencing such extreme capacity pressures during these large-scale weather events.

NRW should consider whether a clearer “major incident mode” is needed, this could instigate an array of different actions across the organisation to ensure NRW is focussed on managing major incidents.

If this had been declared during Storm Dennis, it may have allowed for more efficient processes, additional support, and a wider understanding of what this section of the business was going through at the time. It would also carry benefits into the recovery phase with the severity of the incident and the resources required to recover effectively - potentially receiving a higher priority status.

Issue

Some of our key services became overwhelmed during these exceptional events. There is also feedback as to whether NRW and other organisations escalated the response sufficiently early

Action (IM5): NRW to consider whether a clearer “Major Incident Mode” with associated fall-back procedures would assist in responding to incidents of this scale.

Incident Procedures

In relation to specific procedural issues experienced and highlighted by duty staff, the following points have been highlighted:

- Preparation before the flood events in some areas was put in place early. Staff valued rotas being formed as early as possible, and many felt well prepared due to the training they had received and the procedures in place to support them. However, challenges have been noted on the Incident Management side of the response preparation, with some feeling that not enough was done to highlight the scale of the event at the strategic level including the work with partners. Despite this, it is recognised that the events escalated rapidly.
- Pre-incident preparation seems effective at an operational level, but procedures should be reviewed, and additional processes or training should potentially be put in place to ensure the strategic side of the incident is prepared.
- Despite some of the specific issues highlighted through this review, most incident management procedures and guidance documents received positive feedback. However, there are some procedures and documents which require review and updating from legacy documents (this links to Action FW15 outlined earlier in this review).
- Rota specific email accounts have been created to ensure that consistency is applied when sending messages from specific roles, this also allows more effective handovers between shifts and helps to provide a clear audit trail of correspondence after an event. At times during February 2020, it was evident these were not always used, and some officers resorted to using personal email accounts.

Issue

Some duty officers used personal email accounts rather than rota-specific generic accounts. This added confusion and meant handovers between officers were less efficient than they should have been.

Action (IM6): Duty officers and external partners should be reminded of the use of email accounts and ensure duty-specific accounts are used for all incident related correspondence.

- During incidents, NRW instigates standardised situation updates reporting through “SITREPs”. This allows consistent incident reporting to take place and produces a consolidated overview of the latest issues for incident managers to consider. This process was recognised as important but it equally distracted officers from key activities such as the consideration of flood warnings at key moments during the event. Options to review how this process is undertaken more effectively and efficiently at times during a major incident should be considered, additional support roles may be required to deliver these reports when officers are pressured with extreme workloads.
- Record keeping during the event at times became extremely difficult for duty officers to keep on top of. Accurate logs of key decisions made at times during incidents are extremely important when considering post-event reviews, particularly if there are specific issues or lessons to investigate. As the various services came close to, and in some cases did become overwhelmed, record keeping became a low priority. Additional support could provide much needed resources to assist with tasks such as duty logs. This should be considered further if NRW is experiencing a major incident where additional roles may be required to support front line duty officers.

Issue

Situation reporting and record-keeping became increasingly challenging to keep up at the peak of these flood incidents.

Action (IM7): When NRW is experiencing a major incident consideration should be given to drafting in additional support to assist front line duty officers in carrying out activities such as duty logs and wider requests for information.

Incident Management points for consideration

Throughout all the data collection and analysis work this review has undertaken there has been consistent praise in relation to how duty officers interacted with each other and performed their duties to the best of their abilities in very testing circumstances. Communication during events such as those experienced in February is vital for the safe and effective management of incidents. Duty officers reported praise for their colleagues in relation to this throughout the review.

Numerous elements of feedback received while this review took place suggest that there are inconsistencies across Wales in how some roles are undertaken. The responsibilities for each role appear to be blurred in some areas causing some of the issues highlighted in this review. Better awareness of responsibilities and work pressures may help to improve understanding between duty officers.

Operationally, incident preparation seems to have worked effectively. However, staff have raised concerns about the level of awareness and understanding of the likely significance of coming events, and a resultant unwillingness in the wider organisation to accept some routine business disruption in order to scale up, and plan response and capacity in advance, both during the incident itself and the recovery afterwards.

The challenges of capacity and resilience need to be considered within the choices made around the level of service desired by Government and stakeholders from the flood risk management service. Significant enhancements can be made to systems and procedures and duty rota numbers can be bolstered. These, however, come with a cost in time, effort and financial implications.

There needs to be recognition of the disparity between the level of service expected by customers and that which we are able to provide across all our flood risk management activities. The service that NRW provides is a function of resources and capacity. It is constrained by what is technically possible, for example, despite the power of modern computing, it is extremely challenging to be able to forecast and warn for all flood events. The rapid response nature of many catchments in Wales makes this even more challenging.

Despite investment in our flood risk management services, the events of February 2020 showed our operations were severely stretched with limited resilience if events had continued for a longer period. There is a need for a wider debate around the level of service the public expects, the service NRW is able to provide and how the gap between the two is addressed.

NRW needs to identify what it can and cannot deliver during incidents on this scale and communicate with others effectively to ensure roles and service levels are understood. NRW is not an emergency service with significant incident response resources at its disposal. Although NRW is rightly a Category One Responder under the Civil Contingencies Act

(2004) and has approximately 2,000 staff, the ability to be able to utilise all of its available resources is critical in events of this scale. NRW needs to develop a whole-organisation response to flood events.

Actions to be discussed with partners

Feedback has questioned whether NRW and partner organisations mobilised early enough before these incidents. Should NRW and others consider how they mobilise earlier ahead of significant events?

What level of flood risk management service is practical, realistic and feasible given the current systems, operational capacity and funding levels?

What level of flood risk management service is expected by customers and other key stakeholders?

What will it take to deliver this level of flood risk management service in terms of time, resources and funding?

Operational capacity

One of the most significant themes highlighted throughout the review process is the capacity issues experienced by staff before, during and after the flood events of February 2020. Constraints in both staffing and equipment exacerbated issues and constrained key incident management services.

Staffing

Duty Rota Resilience and Capacity

The majority of incident management services operated by NRW are dependent on a staff rota system to operate key systems and processes. These are 24/7 standby rotas during peacetime and low level incidents and temporary shift rosters during a prolonged incident. In some cases, staff are required to be on a rota as part of their contractual conditions of employment; but in most cases, there is not such a contractual requirement and staff voluntarily put themselves forward to be on a rota.

Many of these rotas require specialist skills and competencies specific to each role. Whilst each role has staff on standby on a 24/7 basis, rotas only cover the basic requirements for service provision during routine flood incidents. This business model keeps routine costs down compared to running a 24/7 365 days per year operational centre with shift workers, but rotas need to be supplemented by additional staff during the more significant events.

Working and recovery time considerations mean that during larger incidents additional staff have to be brought in early by looking for additional non-rostered staff to volunteer to enter onto shift patterns from a bank of available officers. In most instances a rolling eight-hour shift pattern will be instigated, requiring three to cover a single 24-hour period. At times during February 2020, this was not the case for some roles and individuals.

Typically, duty rotas aim to be operated on a 1-in-6 to 1-in-8 week basis, which provides suitable breaks between duty weeks. It also allows officers to be on duty frequently enough to ensure that knowledge and experience of procedures and systems are retained, and officers are confident in fulfilling their roles. This is supported by regular training and weekly handovers between duty officers.

The duty roles involved in delivering the Flood Warning Service across Wales are shown in Table 1.

	Duty Role	No. of staff in the rota pool
North	FWDO (West)	6
	FWDO (Severn Vyrnwy Teme)	6
	Dee FWDO	6
	FWDO (East)	6
	AFWDO	8
South West	FWDO (West) *	9
	FWDO (East) *	10
	AFWDO	7
South East	FWDO (Eastern Valleys) *	9
	FWDO (Wye & Usk) *	10
	AFWDO (Eastern Valleys) *	12
	AFWDO (Wye & Usk) *	12

National	MFDO *	6
	AMFDO *	7
	Telemetry Duty Officer	7

Table 1 – Duty Officers per duty role (* some duty rotas are supported by staff on multiple rotas)
(Data based information available at the time of writing, this may change)

In some instances, duty officers rotate between duty roles or may be on more than one rota. The above information highlights that there is minimal resilience on several rotas and in several areas, staff may be on rota more often than a 1 in 6 weeks basis. In practice, rota demands may be more frequent as staff may be on leave or unavailable for other reasons. Table 2 provides context on the number of flood warning and alert areas managed by each duty role.

FWDO Area	Fluvial		Tidal and Coastal		Both Fluvial and Tidal		Total		
	Flood Alert Areas	Flood Warning Areas	Flood Alert Areas	Flood Warning Areas	Flood Alert Areas	Flood Warning Areas	Flood Alert Areas	Flood Warning Areas	
North	Dee*	4	4	0	0	0	0	4	4
	East	3	12	1	36	0	0	4	48
	West	8	15	2	15	0	0	10	30
	Severn Vyrnwy Teme	3	23	0	0	0	0	3	23
South West	East	6	53	0	37	10	10	16	100
	West	6	46	0	0	7	5	13	51
South East	Wye and Usk	6	13	3	17	0	0	9	30
	Eastern Valleys	8	63	0	0	0	0	8	63

Table 2 – Flood Warning and Alert Areas being managed per duty role
(*The Dee FWDO role forms part of the Dee Regulation officer role and therefore is not just a flood warning role)

Whilst these figures alone do not portray the specific workload of any one specific flood event, they do indicate the distribution of warning areas that need to be considered. At times of increased activities most rotas work on a basis of bringing in additional staff to incident rooms to bolster resilience. Given the size of some rotas highlighted in Table 1, it is likely to be extremely difficult to achieve sustained periods of shift patterns or additional support on rotas to cover any length of time.

During Storm Dennis the Flood Warning Service capacity was stretched to the extent that some warnings were not issued, or some were issued late. This is a significant concern and represents an important risk to the organisation.

For Incident Management roles related to the strategic management of incidents and the command and control elements required during incidents, Table 3 below highlights the staff numbers on each rota. In addition to rota duty roles, there are a number of other roles such as Strategic Liaison Officers and media spokespeople, which are required during incidents.

Duty Role	No. of staff
Duty Strategic Manager	6
Duty Tactical Manager Wales	8
Duty Tactical Manager North	7
Duty Tactical Manager South West	7
Duty Tactical Manager South East	8
Duty Communications Officer	13

Table 3 – Duty Officers per incident management duty role
(Data based information available at the time of writing, this may change)

These roles are crucial to the effective management of incidents. At times during the storm events of February 2020, the Duty Tactical Manager (DTM) roles were central to decision making on key issues and supporting duty officers throughout the incident, as well as dealing with other incidents such as landslides. There has been feedback that these roles require an understanding of both the local areas they represent as well as the operational requirement of managing flood events effectively. It is important therefore the officers within these roles have that understanding of the relevant business areas.

NRW's operational capacity in the field is constrained by the number of operatives available which typically come from the Integrated Workforce teams. FRM routine maintenance activity has faced increasing pressures in recent years due to flatlined or minimal increases to revenue budgets. This has a knock-on effect in limiting the capacity or resilience of numbers to deliver NRW's operational response roles during flood incidents. Table 4 highlights the comparable team sizes available to undertake these roles.

	Duty Role	No. of staff
North	FIDO (West)	6
	AFIDO (West)	6
	FIDO (East)	6
	AFIDO (East)	6
	Conwy & Ynys Mon	4 pairs
	Eryri	3 pairs
	Meirionnydd & North Powys	4 working in 3s
	Clwyd & Upper Dee	5 pairs
	Lower Dee	5 pairs
	Bala Sluices	6
South West	FIDO (South West)	8
	AFIDO South West	9
	SIO (South West)	6
	Ops Western	5 pairs
	Ops Western Valleys	4 pairs
South East	FIDO South East	7
	AFIDO South East	6
	Ops Eastern	6 pairs
	Ops Eastern valleys	7 pairs
National	MEICA	6

Table 4 – Duty Officers per operational duty role

(Data based information available at the time of writing, this may change)

These roles oversee and direct both the proactive and reactive response work that is undertaken. There are some activities carried out in advance of expected weather events such as checking and clearing trash screens, operating assets such as flood gates and placing stoplogs. Other activities are reactive and difficult to plan for such as monitoring key sites, dealing with blockages in rivers, clearing screens and deploying temporary measures such as pumps.

There are over 150 operational response sites listed within operational guidance procedures where staff have to be deployed before and during incidents. Some of these are in remote and widespread locations across operational areas, whilst others are able to be picked up on a single batch run, for example checking and clearing screens in advance of an event. Staff numbers required to sustain NRW's operational response requires more detailed analysis looking at sequencing, resource needs, skill requirements and travel time. However, it is critical that a resilient number of staff are available to respond during an incident to secure the effective management of NRW's operational response.

The breakdown of operational response sites with the current procedures is shown in Table 5. This does not include requirements to address temporary operational needs such as known asset defects, incomplete construction work, or incident reports which require consideration and action, such as tree blockages. Importantly it does not include the real-time site reporting of conditions, which can be vital to the issuing of flood warnings or additional operational response.

Response Team	No. of Ops Response Sites
South West Western	16
Western Valleys	19
South East Eastern	6
Eastern Valleys	6
Eryri	8
Meirionnydd & North Powys	18
Conwy & Ynys Mon	22
Lower Dee	22
Clwyd & Upper Dee	42

Table 5 – Operational Response Sites (based on current procedures)

It is rare for any significant flood incident response to have passed through in under eight hours and therefore the implementation of shift patterns is vital, as is bringing in additional resources to bolster numbers in the lead up to an incident. However, given the number and range of tasks undertaken by operatives, and the travel times involved, the resource available (see Table 4) can quickly be exhausted. The public or our professional partners often think we have more resource at our disposal than we actually have. We are not an emergency service and we do not have the resource levels of other organisations. We need to manage expectations.

This review has captured significant feedback on the issue of duty rota resilience and the above evidence clearly shows there is extremely limited resilience our ability to manage a flood incident over any sustained amount of time. Capacity problems in both flood warning and operational functions caused significant service shortcomings, specifically flood warnings not being issued or being issued late. If Storm Dennis had gone on longer, been

more widespread, had a concurrent coastal, reservoir failure, or other serious environmental incident implicating the generic non-flood roles, we would have been even further stretched.

We also need to consider the challenges of being able to retain and attract people to duty rotas. Whilst the recently completed Allowances Review has made some changes, several issues in relation to pay inequality have been raised by some staff. The level of requirements of the officers on duty during these events has led many to question whether they wish to stay on these rotas.

To provide a sustainable level of incident management and response capacity, the staff available on rotas needs to be reviewed and available resources increased. This will require leadership and effort from management teams. The challenges of attracting and retaining people to rotas also need to be considered including aspects such as; time between expected duty weeks, pay, managerial support, welfare, recovery and fundamentally a review of what is being asked of duty officers, both in terms of decision making and the complexity of some of the roles undertaken.

Issue
Resilience of rotas is extremely limited; some rotas are at or below minimal sustainable levels
Action (OC1): Additional duty officers should be sought for the majority of duty rotas, recognising that this may require a change in approach. All officers need to receive suitable training and support.
Action (OC2): A review of the optimum resourcing levels for each rota should be undertaken and a minimum operating model established.
Action (OC3): Issues experienced by officers and highlighted through this review regarding retaining and attracting people to rotas should be investigated further and where appropriate, action should be taken to resolve issues.

Health and Safety

The review has also identified some significant Health and Safety related concerns which relate to capacity issues and staff numbers becoming stretched. The number of hours worked is a notable issue, with some officers reporting shift lengths of 12 hours and up to 24 hours. While this demonstrates admirable individual commitment, it is not acceptable, and we need systems in place which provide adequate capacity.

Similarly, recovery time between duty shifts or between those shifts and returning to 'day job' roles was highlighted as an issue. Many staff, already tired from responding to the incident were immediately required to support the recovery work during the aftermath of the events in February 2020. Duty rota managers and the 'day job' line managers need to ensure staff are looked after and adequate rest periods are taken.

Issue

Working hours and adequate recovery time were highlighted as concerns following the February events.

Action (OC4): Everyone involved in duty rotas and their management should be aware of working time directives and ensure that prolonged shifts are avoided as well as adequate recovery time being taken both during and following an incident.

Rota Preparation and Planning

A key aspect in relation to rotas allowing adequate capacity to cope with an expected severe weather incident is advance planning. This received both positive and negative feedback; in some cases shift rotas were established early on, whilst in other areas feedback has indicated they were not, or the expectations of officers were unclear. Clear decisions need to be made at an early stage. Forecast information including the Flood Guidance Statement and Met Office weather warnings are key tools to enable this to be done effectively. These come with a degree of uncertainty, but it is better to prepare for a reasonable worst-case scenario and then stand down, than the other way around. There needs to be greater and earlier clarity on whether staff on a rota, but not on duty week, are likely to be needed or not.

Issue

Establishing and confirming rota shift arrangements as early as possible was highlighted as an issue where it did not happen and good practice where it did.

Action (OC5): When a risk of an event occurs, establish rota shift arrangements as early as possible. Clear expectations for officers should then be confirmed to enable them to plan effectively.

Another element of rota planning includes the suggestions of establishing contingency measures within rotas, whereby some staff may be able to step in and provide additional support where required from alternative rotas or geographic areas. An alternative in events where officers are expected to be extremely busy is “doubling up” on rotas if possible. Some feedback was received on the need to better support inexperienced officers, for example by ‘shadowing’. This links to issues outlined in the flood warning section and the subsequent recommendation to bringing in additional support where possible.

Equipment

Incident Management and response work is dependent on a wide array of equipment, tools and systems. Issues that require action and resolution have been highlighted in a number of areas.

Field Equipment including vehicles

- The majority of feedback in relation to our operational response equipment such as high-volume pumps was positive, but issues have been highlighted in being able to mobilise such equipment to where it is needed during an incident. The need for additional pump equipment has also been raised. This is also sometimes utilised in support of our professional partners and other RMAs.

Issue

Mobile pump equipment is used in a variety of locations and circumstances, however, there are areas where this could potentially be improved.

Action (OC6): Review of operational equipment including pumps should be undertaken and where found likely to improve services additional equipment should be considered for purchase.

- The lack of suitable available vehicles was raised compellingly in feedback. There were not enough 4x4 vehicles available, and the vehicles available did not have the capability or equipment to tow trailers and heavy pumps. These were highlighted as key shortcomings as well as a lack of training for some individuals in driving in poor conditions or when using 4x4 vehicles.
- A review of the fleet and plant available during incidents is underway and has proposed both short-term and long-term resolutions. This has been an issue for a number of years however and requires resolution as soon as possible.

Issue

Some vehicles were either unavailable or unsuitable for the conditions experienced during the storms, this impacted our operational response capabilities.

Action (OC7): Review vehicles and plant available for incident response work. Fleet structure should take account of incident response requirements and not just “day job” requirements.

Action (OC8): Where necessary additional training should be provided to operatives expected to drive in severe weather conditions and when utilising 4x4s.

- Mobile phones were highlighted as unsuitable in some circumstances during these events. Some highlighted issues relating to the poor weather conditions and others highlighted long standing issues with the availability of mobile network signal while responding to incidents, including while working from home or offices.

Issue

Mobile phones were unsuitable for use at times during the flood events due to either lack of network signal or the poor weather conditions impacting equipment.

Action (OC9): Mobile phones issued to duty officers should be reviewed with consideration of both network signal coverage and the resilience of handsets in poor weather conditions.

- Generally, most feedback in relation to Personal Protective Equipment (PPE) was positive in how it performed in extreme conditions. Some feedback highlighted that we should further consider NRW branding and how the condition of this equipment affects our public image. Local teams have purchased new and additional items as required following the incident

ICT

- During the peak of Storm Dennis, the NRW external website initially struggled to deal with the increase in site traffic on Saturday 15 February and significant issues and

some more prolonged down-time was experienced between 7.30-10.00am on the 16 February 2020. This was a pivotal time when members of the public were looking for information on Flood Warnings, river and rainfall levels, flood maps and critical information on what to do before, during and after a flood.

- Whilst service was restored within three hours and our Floodline service continued to be available during this time for the public to access live flood information and advice, the NRW website is a critical element of NRW's communications route, providing live flood information to the public. Any service interruption is unacceptable. The resilience of the website needs to be a business priority and improvements to its resilience implemented. Contingencies also need to be in place should the website be lost for any appreciable length of time. Given its urgency, this action was prioritised immediately after the events following a specific review of this issue.

Issue

The NRW website went down during Storm Dennis, preventing the public from being able to obtain vital information.

Action (OC10): The resilience of the website should be reviewed, and improvements made immediately. The website and the team that supports it needs have the capacity and resilience to deal with the increase in web traffic during times such as flood incidents. Contingency plans also need to be properly accounted for within business continuity plans and operational flood duty procedures in case of serious or prolonged website disruption.

- Mixed comments were received on the ability to carry out web conferences and telecons. The use of Skype was highlighted as beneficial during the incident in most cases, but equipment limitations in some offices impacted our ability to communicate effectively with both partners and media representatives. Improvements required have been highlighted by local teams and are being actioned.
- Issues relating to out of hours ICT support during flood incidents also need consideration. Feedback suggests that the wider businesses understanding of flood events and their requirements improved during the February events, however several problems were highlighted where the turnaround time on fixes was longer than expected. ICT business support teams need to understand the criticality of some key systems and implement support services accordingly.

Issue

ICT products and support services need to be resilient to these types of significant events.

Action (OC11): ICT department should review the levels of resilience for key incident management systems and supporting infrastructure and implement improvements as required.

- The ability to carry out duty work at home was highlighted positively with the equipment available to staff including laptops and Skype headsets reported as working well. This may lead to the consideration of different working practices in the future and consideration of when incident rooms are required to open.

Incident Rooms

- During Storm Ciara, power was lost at the Buckley office which meant the incident room became unavailable at short notice. Contingency measures were quickly introduced which meant several staff having to relocate to home-working. Where critical facilities such as incident rooms are present consideration should be given to wider and more effective contingency measures. Since the incident, a back-up generator at Buckley is in the process of being installed alongside improvements to other incident rooms and offices.

Issue

The Buckley incident room lost power and without any contingency on site for alternatives, had to close.

Action (OC12): All sites with an incident room should consider the contingency plans in place and the equipment which is required, for example, back-up generators.

- Incident rooms received wide ranging feedback on a number of specific issues and, where appropriate these have been dealt with by local teams. However, this feedback has highlighted the different requirements of various incident rooms and in some cases the additional support required by Facilities and ICT teams to ensure equipment is available and operational.
- The decision-making around opening of incident rooms and some of the other office-specific procedures received varying feedback and should be considered for review and where relevant additional training may be required.

Issue

The use of incident rooms and the availability of key equipment had numerous elements of feedback highlighted.

Action (OC13): Review of incident room equipment should be undertaken in line with standard equipment lists that have now been produced.

Action (OC14): A review of procedures relating to the opening and closing of incident rooms should be considered.

Action (OC15): Where relevant, additional training requirements for officers in out of hours procedures and use of any specific incident room kit should be undertaken.

Communications

Clear and effective communication with the public and with professional partners before, during and after an incident is vital. It ensures NRW's organisational messages are received and understood by all key stakeholders. NRW operates a duty rota to provide communications support. This deals with key statements being issued by the organisation and liaises with media requests for information or interviews.

NRW dealt with a significant number of media requests during and after the flood events. Storms Ciara and Dennis generated 499 articles in a wide range of media outlets which were supported by NRW communications. 42 media interviews were given by NRW staff, appearing multiple times across Welsh and UK broadcast outlets. Key points have been highlighted by staff involved in these activities during February 2020:

- NRW featured at the centre of most news coverage of the incidents which is positive in regard to our role being further understood by the public. However, the lack of staff numbers to undertake these interviews left the same small group of representatives carrying out a significant number of interviews whilst often also delivering other duty roles. A wider pool of media spokespeople (especially bilingual) should be developed and out of hours arrangements for this should be considered.
- Other issues relating to media requests highlighted that in some instances reporters spoke directly to operatives on site which distracted them from their tasks and also left some in difficult situations with no media training. Media representatives should be aware that this is inappropriate, and all media enquiries should be handled centrally. Staff also need to feel confident and supported to push enquiries back to central communications representatives if they are approached directly by the media.
- Feedback was positive in relation to the preparation that was put into media interviews and spokespeople felt well prepared with the lines to take and wider support provided by the communications team during the incidents. The pressure on the communications team handling the volume of media requests was highlighted as another capacity issue.

Issue

NRW received a significant number of media requests and requests for interviews, these were dealt with extremely well by a small number of representatives.

Action (C1): NRW should identify additional staff members and senior managers to act as media spokespeople and should provide them with appropriate training.

Action (C2): Site based operatives should be provided with further training in how to deal with reporters, provided with more information on the process that should be followed and given the confidence to 'push back' on these requests if necessary.

- Social media now plays a critical role in communicating directly with the public. This was beneficial during the events of February 2020, enabling NRW to share key messages and obtain useful insight into the public's experience of events. NRW has a number of staff members linked to official social media accounts and issuing messages through these platforms added a more human quality to NRW's communication with the public. Staff feedback suggested that the use of social media in helping them manage incidents and inform the public should be expanded.

- A key advantage of social media is the ability to obtain direct information, photos and videos from members of the public within the impacted communities. When NRW's operational capacity was limited and officers could not be on site in key locations, social media provided useful feedback in some instances as to what was happening.
- Communications play a vital role in awareness raising prior to any flood incident. Key messages are distributed through NRW's communication channels, but more strategic themes could be prepared in advance to support these messages. Pre-prepared messages highlighting important awareness and resilience messages should be developed, including visual graphics such as the five-day flood forecast. There should also be more consideration given to the strategic messages NRW wishes to broadcast before, during and after an event.

Issue

Communicating NRW's key awareness raising and resilience related messages is important before, during and after flood incidents.

Action (C3): NRW should prepare a communications plan and materials to further support key messages in advance of events. These should consider some of the wider strategic messages NRW wishes to communicate when there is a developing flood risk.

- There was a lack of information on the NRW website both during and immediately after the flood events in February 2020. Relevant information for the public didn't have any presence on the website's homepage and it took some time for the website to reflect the flood incidents. The website is a key communications support channel and further work to improve the flood risk information provided should be undertaken. The NRW website should be reviewed with regard to its role during a flood incident and how it may need to temporarily change to reflect customer needs during recovery from severe flooding.

Issue

NRW's website took time to reflect the flood incidents and important flood risk information was difficult to find and not easily accessible for the public.

Action (C4): Improvements to the website should be undertaken to make key information more readily available to the public before, during and after a flood incident. Consideration should also be given to the content of the NRW website homepage during a significant incident and the content, promotion and use of the 5 Day Flood Forecast should be reviewed.

- Data gathering from social media and wider online published content has helped provide a further understanding of some of the issues experienced during the February events. The ability to use photos and videos shared by members of the public is useful both for internal analysis of the flooding but also in communicating the impacts of the flooding after an event. However, there is no internal process to review and appropriately collect this information, including obtaining relevant permissions.

Issue

Collecting information, photos and videos shared by the public on social media and wider online published content is useful, but no procedures exist to manage this effectively.

Action C5): Procedures for collecting online media content during and after flood events should be considered. This should include exploring social media harvesting and filtering tools, guidance for obtaining relevant permissions and clarity on how the information will be used.

- The increasing use of WhatsApp as a communications tool between staff on site, incident rooms and communications colleagues was highlighted as positive. Group chats and the ability to share images proved very useful, although there were still challenges associated with mobile phone equipment, as highlighted earlier in this review. Our communications team should be praised for their work in this area.

Recovery phase

As the storm events of February 2020 passed, the organisation moved into the recovery phase. This phase of activity brings different sets of pressures compared to the 'response' phase. It includes a significant range of activities, including operational work and repairs to bring the organisation back to a state where normal activities can resume as well as ensuring that all relevant impacts of the event and work required are understood.

A range of issues have been raised:

- The recovery work that happened following Storm Dennis was initially disorganised. There was no procedure to follow or overarching coordination of the recovery work. This introduced inconsistencies, potential inefficiencies and in some instances, key issues may have been missed. This was rectified to a degree when a Recovery Manager was appointed, 10 days after the events of 16 February and eight days after the main flood risk on the River Wye. Triggers, processes, procedures and accountabilities, including leadership focus, for recovery works need to be clearly defined, built into the incident response and be ready to implement immediately after an event.
- NRW should properly instigate and manage the recovery for significant incidents. A lead role for this should be established to introduce appropriate governance and a procedure for all key work activities should be introduced. Many of the issues identified in this review could and should be linked to these procedures.

Issue

The initial recovery phase, whilst undertaken to the best of everyone's ability, lacked timely coordination and governance.

Action (R1): A lead role to manage and oversee the recovery phase should be appointed as soon as possible after a significant flood event, preferably during the response phase so there is no gap or delay in managing recovery.

Action (R2): Procedures should be developed for key recovery activities and a formalised major incident recovery plan developed with guidance for how recovery is initiated and managed.

- Post-event debriefs for staff are important in identifying issues and lessons learnt, but also to help with staff wellbeing and support during and after the event. Whilst debriefs happened in each location, these were inconsistent in both approaches and in who attended. There is a lack of clarity around the timing of debriefs and who should lead them. There are areas of the business which do not get regularly invited to debriefs and therefore miss the opportunity to provide important feedback. This should be improved, with better procedures available.

Issue

Post-event debriefs lack consistency across Wales, with some uncertainty on when to undertake them and who they should be led by. There is also a risk that some parties miss out on being able to contribute.

Action (R3): A clear procedure and improved guidance in relation to post-event debriefs should be established. This should form part of a Major Incident Recovery Plan (Action R2)

- A consistent element of feedback from staff related to the lack of lessons being learnt from previous events. Post-event reviews have a long history in FRM and substantial changes to the way NRW and the wider industry manages flood risk have been undertaken on the back of reports such as Bye (1998) and Pitt (2008) as well as other more recent flooding events in Wales.
- There have also been numerous flood event reviews in Wales that staff have contributed to which appear not to have been taken on board and actioned, or the focus has been on 'quick wins' at the expense of deeper and more complex issues. Identifying lessons is not the same as learning from them and action plans must be developed from any post-event review work, including this report. Some staff lack trust that change will be implemented, and a shift is required to ensure there is the implementation of actions and the learning of lessons. Capacity to deliver improvements and changes following events such as these has to be created.

Issue

Implementing actions to address all lessons from previous events has been widely identified as a shortcoming.

Action (R4): Ensure those responsible prioritise and deliver on the actions to address issues identified in this and prior reviews. A more effective means of capturing lessons and delivering actions following post-event reviews should be established.

- It is vital that staff involved in these significant incident responses are given appropriate time and space to recover both physically and mentally. During the recovery phase, it became quickly evident that the same people involved in the incident itself were carrying out important roles in the direct recovery. Staff felt a level of commitment to their colleagues, roles and responsibilities which meant they continued to work, but this may not have been appropriate in all instances and staff wellbeing should be monitored closely during these times.
- Resources to undertake recovery work, and to learn lessons, for example, identifying areas flooded at different water levels, were overstretched in the immediate aftermath of the incident. Wider areas of the business or external support should be engaged within the service and by leadership and be drawn on for assistance. There is currently no mechanism or procedure to do this. If in future additional support is bought in, it is important that those undertaking these activities have the appropriate training and knowledge to do so.

Issue

Extra resources are needed following an incident to undertake recovery and post incident learning. The ability to undertake various elements of recovery work relied on already tired staff, who were also fully committed to their 'day job'.

Action (R5): NRW needs to develop mechanisms for wider support to assist with recovery work following significant incidents, recognising appropriate training and knowledge needs to be in place.

- It is vital to capture as much information as possible post-event so NRW's understanding of flood risk can be improved for future events. The requirements for

this work could be established as a clear procedure to instigate, with clear specifications on requirements in advance of any future event.

- Post-event data capture, including survey work and asset inspections, required specialist skills and resources in the aftermath of Storm Dennis. Asset inspection work programmes were established quickly to review all potential flood defence defects, external resource was also procured to deliver post-event data capture and surveys.

Issue

Post-event asset inspections and data capture through surveys lack any clear procedure, guidance or consistency of roles across teams.

Action (R6): Procedures for both post-event asset inspections and surveys for flood extents and mechanisms should be established, to be instigated as part of a wider recovery procedure. This should form part of a Major Incident Recovery Plan.

- Following the flood events, a number of asset defects and emergency repairs to flood defences were identified. Emergency funding and mechanisms to access it were established immediately which streamlined some aspects of delivery ability. Overall, coordination of repair works was undertaken effectively. However, in some areas such as Hydrometry and in mid Wales, there was a lack of clear technical support to deliver repair work, which needs to be resolved.
- NRW received a high number of enquiries from the public, media, stakeholders and partners in the period following the flood events. The volume of requests made this extremely difficult to manage initially. Clear lines to take to ensure consistency were required and a more effective way of managing requests should have been established earlier.
- A fortnight after Storm Dennis a single point of contact was established following senior management instruction, to begin coordinating and prioritising responses. This provided much-needed support to operational colleagues who were becoming overwhelmed by the number of requests. The high volume of correspondence has continued months after the events.
- With hindsight, a single point of contact should have been put in place as soon as possible post-event. Clear lines to take on key issues should be established as early as possible. Frequent and common information requested at a basic level should be more accessible for the public through channels like the NRW website. A system for managing correspondence should also be established as early as possible.

Issue

A high volume of enquiries and information requests came in after the flood events of February 2020, these needed clear and effective coordination.

Action (R7): A single point of contact should be established as soon as possible after a significant incident and procedures developed to instigate and manage this process. This should form part of a Major Incident Recovery Plan (Action R2)

Action (R8): Frequently requested information should be reviewed and made more readily available on the NRW website or via internal briefing notes.

Action (R9): Clear lines to take on key issues should be established as early as possible in the recovery phase, and with clear identification of responsibilities for production.

- Direct community support and oversight of recovery work at a community level is the responsibility of the relevant Local Authority, although NRW has a role in promoting flood awareness and resilience in these communities. Our role in post-event community engagement and support was highlighted as an area of uncertainty for staff and also as an area for improvement.
- Whether we take an active role within communities providing direct support and advice to impacted property owners or not, NRW staff are present in these communities, undertaking a wide range of post-event activities. It was evident that some staff visiting these communities were unprepared for what they might face, and, in some cases, they were upset by talking to members of the public who had experienced trauma. NRW provided counselling support for staff immediately after the events although the response to this was mixed.
- NRW must consider the situations staff are being sent into and staff should be prepared and trained to deal with these situations. There was limited information or signposting available for staff to provide to members of the public and this should be considered in advance of any future events. Training, information literature, generic contact information and wider engagement support should be considered.

Issue

NRW's post-event community engagement role was unclear, and staff were ill-prepared and equipped to deal with the issues members of the public raised.

Action (R10): Clarity on NRW's post-event community engagement role should be established, taking into account resource capacity.

Action (R11): Staff likely to be working in flood-impacted communities should receive further training in dealing with individuals who have experienced trauma. This includes those staff directly engaging but also those carrying out other recovery activities in these areas.

Action (R12): Improved information and guidance literature should be considered for staff to carry with them while on site in flood-impacted communities. Staff should also be aware of where to signpost members of the public to for further information.

- Through carrying out this review work and undertaking the production of evidence reports it is evident that post-event impact information is very difficult to obtain, and there are vast inconsistencies that exist in how information is reported. There is no clear mechanism to consistently collect this information and improvements to this should be considered.
- Section 19 reports are the responsibility of relevant Local Authorities, but there is limited consistency as to how these are produced and the timescales for production vary significantly. Post-event investigations at a local level should ideally attempt to understand the extent and mechanisms of flooding and identify clear actions for RMAs to pursue afterwards so the public is clear on what action is being taken.
- Consideration should be given to improved consistency and reporting of flood impact data and flood investigation reports post-event. It will require the Welsh Government,

NRW and multiple RMAs to work together. There is a clear gap in this way of working at present.

Issue

Post-event reporting on flood impacts and the wider production of Section 19 reports have a number of inconsistencies and some clear gaps in their oversight.

Action (R13): Identify improvements to post-event reporting of key statistics and impacts, as well as improving oversight of flood investigation reports to improve consistency.

The recovery phase of any incident is crucial to enable immediate issues to be resolved and lessons to be learnt. It is clear from undertaking this review that improved structure, governance and oversight of the recovery phase was instigated after the event, however improvements to the guidance and procedures to implement these activities should be considered in advance of any future flood event.

Conclusions

The flood events of February 2020 had a significant and widespread impact across Wales. NRW's incident response and the services it provides to the public faced extreme challenges during this period and lessons must be learnt from the experiences and issues the organisation experienced.

The rainfall and river data show the storms in February 2020 were exceptional and stretched all incident responder organisations. NRW staff worked professionally and diligently throughout the period, for example in issuing unprecedented numbers of warnings and responding to events on the ground. There are many examples of good practice and the actions of NRW staff made a difference to the communities affected. This review inevitably concentrates on the lessons learnt and improvements should be considered, but this must be taken in the context of the positive elements of work that occurred, as well as the scale and severity of the prevailing weather conditions at the time.

The feedback received from staff has contributed significantly to this review. Many NRW staff were deeply affected by their experiences during the events of February 2020. It is also clear that they care deeply about the service and want it to be as good as it possibly can be. However, whilst there are many elements of good practice, and the dedication and professionalism of the staff involved is abundantly evident, the review has identified significant issues to be addressed.

This review highlights a number of improvements required by the organisation and it is vital not to just accept the learning, but to implement the actions to truly embed the improvements within the organisation and its culture. At the same time, it needs to be recognised that it will not be possible to fully predict with certainty the consequences of events like those seen in February 2020. We are unlikely to ever be able to fully manage and mitigate against all such events, and the need for adaptation to climate change also needs to be understood by all sectors of society. Whilst we can reduce some of the risks through managing the likelihood of and impacts from flood events, we cannot control the weather and prevent all impacts. These messages need to be understood by all stakeholders.

This review identifies 10 key areas with actions for improvement, which are consolidated as an annex to this report. Timescales and associated costs for improvements have been made alongside the identification of leads to take forward each recommendation. These recommendations need to be actioned and delivered to prevent some of the issues and near misses experienced from happening in future events. These actions cover elements that NRW can address, either in the near or long term. Given the size and scale of the changes required, it is recommended that these improvements are managed as a programme of work with a Senior Responsible Owner at Executive Team or Chief Exec level, with regular reporting to Executive Team and Board.

Whilst many quick win improvements have already been made since February 2020, there is still significant work to do. Additional resource will be required to deliver these improvements. For example, the Flood Warning Service review implementation programme will take an estimated minimum of seven additional FTEs and five years to deliver in full, though of course, many elements will be delivered sooner. It is hard to estimate the whole requirements and timeframes accurately at this stage; it may require 30 FTEs to deliver the improvements outlined for the next 12 months. It is roughly estimated that 60-70 additional

staff over the current baseline are needed over the longer term to sustain the overall service at the levels described by the actions and improvements in this report.

These staff numbers represent additional permanent staff to undertake and sustain new improvement work relating to flood forecasting and warning, asset management and planning, flood risk mapping and modelling, asset maintenance and operational incident response, hydrometry and telemetry work, as well as support work in areas such as ICT and finance. New staff would also be added to our incident rotas for out of hours response, thereby bolstering our resilience for this work. This would be in addition to increasing the numbers of staff from across the organisation who can be available for incident response, to strengthen our whole organisational response to incidents. It needs to be noted that many of the incident roles are specialist roles that cannot be done by non-specialist staff, so it is not just a question of increasing the numbers, but also the required skills.

Some additional revenue budget has been allocated by the Welsh Government in the 2020/21 financial year which is being utilised to source some of the staff requirements in the short term. This additional funding is welcome, but the expectation is events of this scale will become more frequent. We, therefore, need to invest more to be better equipped to cope with the impacts of climate change. The need is greater in size and longer in duration than the allocation, and more resource is necessary on a permanent basis.

Overall, the main issues that need addressing can be summarised as:

- Shortfalls in the flood warning service provision, evident in such significant and extreme events.
- Capacity limitations, especially out of core hours, to effectively warn for and respond to significant flood events.
- The need to develop a whole organisation response to flood events so we are resilient and prepared for major incidents.
- Improvements needed in our actions in the lead up to events and the recovery from them.
- Across all these elements, there are choices to make about the level of service that is practical, realistic and feasible, and the associated implication for investment that will be required.

To truly learn the lessons from the February 2020 flood events, there needs to be a fundamental consideration of the choices that we as a society, and governments and other decision-makers in particular, have on how the risks are managed. The new National Strategy for Flood and Coastal Erosion Risk Management from Welsh Government sets out the direction for Wales, the strategic aims and objectives, and the main actions and measures to achieve the objectives. It also sets out the full range of options available to help manage risks, including catchment management approaches and measures to protect further communities at risk through strong planning and development control practice. Within this context, there are still choices about the 'level of service', and this concept is used throughout this review document. It is used in two senses. Firstly, there are choices that Wales as a society, from communities through to government, makes about the level of flood risk management service it wants to see and is prepared to support. This applies to whether society wants, and is prepared to support, more done and in any or all of the wide variety of measures that can be used to manage flood risk. How much effort and budget should go into flood warnings, flood awareness, flood defences, planning control, creating storage areas in catchments to hold back water, creating resilient properties – and all the

other possible interventions? This applies across all the organisations that have a role, from the national to local level, and also down to the actions householders and individuals can take themselves.

The second sense in which 'level of service' is used is specific to the services that NRW operates. Inherent in the notion of flood risk management is that it is a risk management process, and that the activities that are undertaken to manage the risk can be pitched at different levels. There is a clear link between the service level that can be provided and the resources and capacity available. More can be done to manage the risks further, but this will require extra resources to do so. Equally, we could do less and accept that the resultant flood risks are greater.

An important conclusion of this review is that the resource at our disposal does not match the size of the task at hand for an event of this significance. Furthermore, the expectations of delivery from all stakeholders increase all the time. Consequently, the level of service we were able to provide was not the same as the level of service many expected from us. It was assumed by many that NRW is geared and resourced to manage risks at the level of the events we experienced in February 2020. The evidence of the events was that despite the dedication and efforts of all staff involved, we were not able to fully deliver the level of service that was needed or expected and fell short in some areas. Such events are likely to be more frequent in the future. We have to be realistic about that gap and look at the choices we have to address it. We can improve some elements of our existing service with current resources, but we need a common understanding of the level of service Wales wants and is prepared to support

This review has looked at NRW's performance only, but there are wider considerations that go beyond one organisation's role. For example, there are many organisations involved in managing flood risk in Wales and it can be confusing and frustrating for customers. How can we work more effectively together and deliver the best joined up approach for customers? Flood defences are built to industry standards of protection, but still, they overtopped in places. Can we and should we build higher defences, and what are the implications of that? How do we best deal with such huge quantities of water?

These issues have been captured as key discussion points. They cover aspects that are more significant and have wider implications than this review of NRW's performance during these events. They relate to the level of service desired and expected and need to be considered by groups wider than FRM managers in NRW. These conversations will be taken forward by senior managers in NRW at the appropriate forums. For example, the Flood and Coastal Erosion Committee, as the statutory committee with a role to advise Welsh Government Ministers, is a likely route for such discussions, and this can be explored. Similarly, this committee would be well placed to consider the Wales-wide implications of the floods and the conclusions from the various reviews being undertaken by the different authorities.

Actions to be discussed with partners

Roles and responsibilities for flooding rest with several different organisations, for good reason. But this makes the picture complicated to understand. Are the roles and responsibilities associated with different flood sources understood in Wales? Is this the most effective way to manage flood risk in Wales or are there opportunities to improve how these organisations work together?

Are the current flood defence standards of protection sufficient to manage the risk to communities? In some locations, we may have to accept that it is impossible to reduce flood risk further due to the limiting factors which will prevent flood defences being larger.

What is the risk appetite across all partners for issuing flood warning messages with different levels of certainty? Should Flood Alerts, Flood Warnings and Severe Flood Warnings be issued earlier with less confidence?

Do the public and partners understand the flood warning messages, and what they mean? How do we most effectively raise awareness of flooding, and the actions householders and communities can take to live with flooding, now and in the future?

Feedback has questioned whether NRW and partner organisations mobilised early enough before these incidents. Should NRW and others consider how they mobilise earlier ahead of significant events?

What level of flood risk management service is practical, realistic and feasible given the current systems, operational capacity and funding levels?

What level of flood risk management service is expected by customers and other key stakeholders?

What will it take to deliver this level of flood risk management service in terms of time, resources and funding?

Since the events of February, NRW has addressed many of the immediate issues through its recovery programme of work. Elements of this work are ongoing. This work is captured elsewhere and not directly part of this review, but it is an important element of putting Wales and NRW in a better place for future events of this kind. Some of the actions in this review will take time to deliver and they may need some deep and complex conversations with customers and stakeholders, but it is crucial they are addressed. Some recommendations in this review can be delivered in the immediate term, but some will take longer to deliver and as fresh pieces of work, will require allocation of resources to deliver. It is important to recognise that the impacts, recovery and improvements required after Storm Ciara, Dennis and Jorge will take time to address.

We must also recognise that there are enormous challenges to face. The climate science says that we can expect more intense and more frequent extreme weather events. We cannot stop the rain and managing such huge quantities of water, and the rapid nature of many of our rivers and the subsequent rapid flooding, is exceptionally challenging. We need to adapt to the changing climate, which means making big decisions about how and where we live and work, as well as reducing carbon emissions. We need to learn to live with water better than before, and water management has to be at the heart of many of the decisions we make about spatial planning and development such as where we put or continue to keep people and property, communities and businesses. We have made great progress in the last decade, but planners need to recognise flood risk more and be prepared to take a longer-term view, rejecting developments if necessary

These and other questions need to be part of the bigger debate about how we collectively manage flood risk across Wales in the future and respond to the challenges of climate change, building on the policy and strategy framework provided by the Welsh Government's new National Flood and Coastal Erosion Risk Management Strategy. The actions for NRW in this review report need to sit alongside that wider context and debate with Welsh Government and other partners.

This recovery and improvement work comes at a time when Wales has experienced the Covid-19 pandemic which has had significant effects on people, businesses, services and the wider economy of Wales. The opportunities in a green recovery from the pandemic in response to the climate emergency must be taken. Flood risk management is regarded as a key pillar within that wider context. Flooding, and water management more widely, is a key element of the well-being and sustainability of communities and future generations.

NRW will play its part at both ends of the scale. We will continue to do our utmost to deliver the best level of flood risk management service we can with the resources we have, but also recognising and being realistic about the limitations. We will also play our part in shaping Wales' response to the significant climate emergency challenges of the future.

But we cannot solve flooding or address the issues alone, we all need to work collectively, across organisations and across communities, to rise to the challenges.

Consolidated recommendations and proposed action plan

This action plan summarises the **10** key areas for improvement this review has identified and proposes leads to deliver these improvements, indicative costs and likely timescales for expected delivery. Indicative costs are outlined but require further development in many areas. Timescales are set out as either short term (0 to three months), medium term (three to 12 months) or long term (one year plus).

Issue	Ref.	Action	Proposed lead	Indicative Cost	Indicative Timescale
Key Area 1: Flood Defences					
Significant and widespread flooding was experienced by communities across Wales during February.	FD1	Continue to collaborate with Local Authorities delivering their local flood investigation reports (Section 19 reports).	Flood and Water Management Operations Managers	Staff time	Work already underway but outcomes due in the short term dependant on the timescales Local Authorities are working to
	FD2	Complete detailed investigative analysis work to understand the mechanisms of flooding in areas known to have flooded from main rivers.	Flood and Water Management Operations Managers	Moderate capital requirements	Work already underway but outcomes due in the medium term
	FD3	Consider improvements to NRW flood alleviation schemes and structures on a prioritised basis.	Flood and Water Management Operations Managers	Unknown - potentially significant capital requirements	Unknown - long term
Key Area 2: Hydrometry and Telemetry – Detection					
Contingency measures can be installed across the Hydrometric Network, however the level of service to operate to is unclear, so there may be weaknesses in our monitoring resilience.	HT1	Working with key clients of the Hydrometric Network, a strategic review of stations used for forecasting, warning and operational response should be undertaken to determine their criticality, which contingency measures are appropriate and help prioritise improvement works.	EPP Hydrometry & Telemetry Team with Forecasting, Warning & Community Resilience Sub-Group	Staff time, potentially minor capital requirements	Medium term

Issue	Ref.	Action	Proposed lead	Indicative Cost	Indicative Timescale
Some duty officers found difficulty accessing key information from gauging stations in England.	HT2	Duty officers to receive training in how to obtain this information through the Telemetry System.	Operations Warning & Informing Teams	Staff time	Short term
Repairs to hydrometric stations are not being undertaken due to the lack of support from wider teams and lack of a consistent model for this across Wales.	HT3	The options for delivering hydrometric site maintenance for NRW needs to be reviewed and a consistent solution implemented as soon as possible.	Flood Risk Management Business Board	Staff time	Short term
Key Area 3: Modelling and Forecasting					
Flood forecasting is challenging and uncertainties in forecast data and model outputs create uncertainties in decision making. Greater use of probabilistic forecasts in the future will increase the opportunities to present and communicate forecast confidence to users, and integrate this into decision making for issuing Flood Warnings and our communications on flood risk.	MF1	MFDOs and FWDOs should understand each other's roles and the different factors each role must consider in decision making. Consideration should be given to improving the way current forecast data and confidence is presented to duty officers as well as the messages and communications between each role, based on the understanding of each other's roles.	Forecasting, Warning & Community Resilience Sub-Group	Staff time	Commence in the short term but delivery may be over a medium term
	MF2	NRW to work with the Flood Forecasting Centre and Met Office to explore opportunities to make greater use of probabilistic forecasts in its decision making on flood warning, operational response and incident management, including determining the technological, investment and training requirements along with the significant cultural changes needed to achieve this.	Flood Forecasting Team	Staff time potentially Moderate capital requirements	Long term

Issue	Ref.	Action	Proposed lead	Indicative Cost	Indicative Timescale
The Flood Guidance Statement identified the level of impacts in advance of the events, but there is feedback that not all stakeholders understand or appreciate the link between the FGS headline colour and the forecast impacts and likelihood.	MF3	NRW should review the plans and training for relevant duty officers to ensure that the risk matrix in the Flood Guidance Statement is properly understood and that actions and communications are linked to forecast impacts, not the risk colouring. Where necessary further training should be provided, working with the Flood Forecasting Centre.	Forecasting, Warning & Community Resilience Sub-Group	Staff time	Commence in the short term but delivery may be over a medium term
	MF4	NRW should review its procedures on how to determine severe flood impacts so it is better able to make timely decisions with the Flood Forecasting Centre to escalate the risk in the Flood Guidance Statement and public 5 day forecast.	Forecasting, Warning & Community Resilience Sub-Group	Staff time	Medium term
	MF5	The flood risk matrix used to determine the risk colouring of the Flood Guidance Statement should be reviewed. This will require additional work with external partners outside Wales who use and depend on the matrix including the Flood Forecasting Centre, Environment Agency, Met Office and Scottish Environment Protection Agency.	Head of Flood and Incident Risk Management & National Flood Risk Services Manager	Staff time	Commence in the short term but delivery may be over a long term
Whilst local flood forecasting models appear to have operated well, underlying issues relating to variations in short-term rainfall forecasts are evident, there are gaps in	MF6	NRW should work jointly with the Met Office to review the accuracy, stability and suitability of the real time forecast rainfall products it currently receives, with particular focus on the “nowcast” period.	Flood Forecasting Team	Staff time	Discussions ongoing already but solution may be over the long term

Issue	Ref.	Action	Proposed lead	Indicative Cost	Indicative Timescale
forecasting model coverage and concerns remain over the coverage and quality of the UK weather radar network across Wales.	MF7	The Flood Forecasting team should review the coverage of flood forecasting models across Wales, develop a prioritised plan to address gaps where appropriate and explore what opportunities the broad scale Grid-to-Grid model may offer Wales, especially in providing a forecasting capability for small rivers where it is not feasible to build locally calibrated catchment models.	Flood Forecasting Team	Staff time potentially Moderate capital requirements	Commence in the medium term but delivery may be over a long term
	MF8	Work with Met Office, Environment Agency, Scottish Environment Protection Agency and Department for Infrastructure Northern Ireland to explore opportunities and understand the investment required to improve the coverage and quality of the UK weather radar network over Wales.	Flood Forecasting Team	Staff Time potentially Significant capital requirements (weather radar)	Discussions ongoing already but solution may be over the long term
Key Area 4: Operation of the Flood Warning Service					
The issuing of Flood Alerts took time and effort to consider and manage in the periods leading up to the peak of each storm, this potentially expended a lot of time and energy in advance of being required in the key moments of the event, burning out duty officers.	FW1	Review the value of Flood Alerts, seek opportunities to make the analysis, decision making and issuing of Flood Alerts more efficient.	Flood Warning Service Review Implementation Programme	Overall FWSR Project Significant	Overall FWSR Project to be delivered in the long term (though individual tasks will be prioritised)
Local Flood Advisory Service telecons drew in multiple duty officers and there was uncertainty on roles.	FW2	Roles and responsibilities in relation to Flood Advisory Service telecons should be reviewed and restated to duty officers	Forecasting, Warning & Community Resilience Sub-Group	Staff time	Medium term

Issue	Ref.	Action	Proposed lead	Indicative Cost	Indicative Timescale
	FW3	A more efficient approach to NRW attendance at cross boundary LRFs is required and should be implemented taking account of the latest operational boundaries.	Incident Management Team	Staff time	Medium term
Issuing updates to Flood Warning messages became time consuming and impacted the operation of the Flood Warning Service.	FW4	Seek opportunities to make the issuing of message updates more efficient and undertake analysis work to determine their current value to customers, this should include efforts to implement more automation or self-service for customers.	Flood Warning Service Review Implementation Programme	Minor but Overall FWSR Project Significant	Interim quick fixes already being made Overall FWSR Project to be delivered in the long term (though individual tasks will be prioritised)
The lack of reliable Resultant Thresholds and the absence of on-site observations significantly increased uncertainty, affecting the speed and accuracy of decision making, as well as the ability of duty officers to take prompt decisions and manage overall workloads.	FW5	Analysis work to understand and refine thresholds should be undertaken, using new information from these events, coupled with our existing flood models, with a focus on developing Resultant Thresholds where they are currently missing, especially for high risk locations where it is feasible to do so.	Operations Warning & Informing teams	Staff time and project costs Moderate	Medium term
	FW6	Review options to either reduce reliance on on-site observations or increase capacity to do such observations.	Operations Warning & Informing teams	Staff time	Medium term
The decision-making process related to issuing of Severe Flood Warnings is challenging and potentially more Severe Flood Warnings should have been issued based on the flooding impacts experienced.	FW7	The procedures, guidance and decision-making processes relating to Severe Flood Warnings should be reviewed. This should include analysis of the public perception of Severe Flood Warning levels and consideration of the risk appetite the organisation has for issuing more or less Severe Flood Warnings.	Flood Warning Service Review Implementation Programme	Minor but Overall FWSR Project Significant	Overall FWSR Project to be delivered in the long term (though individual tasks will be prioritised)

Issue	Ref.	Action	Proposed lead	Indicative Cost	Indicative Timescale
	FW8	Further training and exercises, particularly for major incidents and incorporating the use of Severe Flood Warnings are needed, building on the experience of officers who have faced these situations in previous events.	Operations Warning & Informing Teams and Incident Management Team	Staff time	Medium term
	FW9	Roles and responsibilities in relation to the decision making on issuing Flood Warnings and Severe Flood Warnings should be clarified and restated to all relevant duty officers.	Forecasting, Warning & Community Resilience Sub-Group	Staff time	Short term
The differences being experienced in managing the Flood Warning Service in Severn, Vyrnwy and Teme area of Wales compared to other areas of Wales have been highlighted by the recent changes in NRW organisational boundaries.	FW10	Procedures and the level of service provided in the Severn, Vyrnwy and Teme areas should be reviewed and made more consistent with the rest of the service. Further handover work and development of more detailed understanding of the specific local issues is required.	Operations North Warning & Informing Team	Staff time	Medium term
Previously automated warnings now require manual intervention due to compatibility issues between detection and warning systems	FW11	Development work within the telemetry system should be undertaken to reinstate automated warnings in areas where this has become an issue – or, if this is not possible due to system limitations, then the management of previously automated warnings should be reviewed to ensure procedures are adequate.	Telemetry Replacement Project and Operations South Warning & Informing Team	Telemetry Replacement Project & FWSR Project have Significant costs	Interim measures introduced in the short term , but solution will be long term
Threshold trigger labelling within the Telemetry system led to warnings being issued late during the event specifically on the River Teifi	FW12	Improvements are needed to the way trigger information is displayed on the Telemetry system, specifically sites with multiple thresholds. This should be included within the development of the new Telemetry system.	Telemetry Replacement Project	Minor but Overall Telemetry Replacement Project costs Significant	Overall Telemetry Replacement Project to be delivered in the long term

Issue	Ref.	Action	Proposed lead	Indicative Cost	Indicative Timescale
	FW13	Duty officers should be reminded of the correct procedures and provided with refresher training, as an interim measure.	Operations South Warning & Informing Team	Staff time	Short term
The Incident Communication Centre became overwhelmed by calls from the public which meant staff were unable to assist duty officers by phoning through and accepting alarms on the telemetry system	FW14	Contingency procedures for these circumstances should be developed and implemented.	Incident Communication Centre Team	Staff time	Short term
Some guidance hasn't been reviewed for several years and some dates back from legacy (pre-NRW) ways of working	FW15	Guidance should be reviewed, and updates made, especially where this hasn't been undertaken since the formation of NRW.	Forecasting, Warning & Community Resilience Sub-Group and Flood Warning Service Review Implementation Programme	Staff time	Seek to prioritise in the short term but delivery will be in the long term and may link to FWSR
Key Area 5: Flood Warning Dissemination					
Some flood warnings were missed, and some were issued late.	D1	The capacity and resilience of the flood warning duty rotas should be reviewed during times of extreme pressure and workload demand. This should include options for bringing in additional support rotas.	Flood and Water Management Operations Managers	Review delivery has Minor costs, but implementation may lead to Moderate costs	Review in the short term implementation likely in the long term and may link to FWSR

Issue	Ref.	Action	Proposed lead	Indicative Cost	Indicative Timescale
	D2	A review of roles and responsibilities for the FWDO and AFWDO role should be undertaken with a focus on what is expected of the role and where it may be possible to reduce the workload demand on this key role.	Forecasting, Warning & Community Resilience Sub-Group and Flood Warning Service Review Implementation Programme	Staff time	Medium term
Key Area 6: Operational Response					
CCTV and remote monitoring of sites has proven useful at key sites during flood incidents.	OR1	Use of remote monitoring technology should be considered across more of the key operational sites and locations where we issue Flood Warnings.	Asset Management Sub-Group	Review delivery has Minor costs, but implementation may lead to Moderate costs	Long term
Operational support experienced some isolated but significant cases of verbal abuse and public interference while carrying out their incident response work	OR2	Consider where appropriate the need for training on understanding the root causes and ways to work in partnership with communities to help reduce the risk of conflict, including the need for further hostile situations training for those involved with public facing duty roles and post-event work.	Operations Managers	Minor	Short term
Confusion arose during the incident in regard to our regulatory response to third party owned reservoir issues.	OR3	Procedures and guidance relating to incidents at third party owned reservoirs should be improved and training provided to duty officers.	Reservoir Regulation Team	Staff time	Medium term
Key Area 7: Incident Management					
Feedback indicated lack of clarity on the LRF and Welsh Government escalation procedures over the course of the events.	IM1	Discussions with the LRFs and Welsh Government to consider further if further improvements are needed to the joint incident response escalation procedures.	Head of Flood and Incident Risk Management	Staff time	Medium term

Issue	Ref.	Action	Proposed lead	Indicative Cost	Indicative Timescale
Officers attending important external forums highlighted the resource demand this placed on them at times of peak workload and in some cases felt under prepared.	IM2	Review procedures for attending important external forums, test how we would respond in the future and clarify expectations on certain roles to attend.	Incident Management Team	Staff time	Medium term
Some inconsistencies in approach from the DTM role were highlighted, coupled with varying levels of experience in dealing with major flood incidents.	IM3	We need to consider the support required and level of expectation of multifunctional roles during major incidents, this may include further training. Exercises for DTMs regarding major incidents should be considered providing clarity over the responsibilities of the role.	Incident Management Team	Staff time	Medium term
Some of the organisational changes in recent years have left residual issues in regard to roles and responsibilities, rota structures and allowances, which require clarification.	IM4	Follow up on the issues and feedback raised and provide further clarification as required.	Executive Team	Staff time	Short term
Some of our key services became overwhelmed during these exceptional events. There is also feedback as to whether NRW and other organisations escalated the response sufficiently early	IM5	NRW to consider whether a clearer "Major Incident Mode" with associated fall-back procedures would assist in responding to incidents of this scale.	Incident Management Business Board	Staff time	Medium term
Some duty officers used personal email accounts rather than rota-specific generic accounts. This added confusion and meant handovers between officers were less efficient than they should have been.	IM6	Duty officers and external partners should be reminded of the use of email accounts and ensure duty-specific accounts are used for all incident related correspondence.	Incident Management Team	Staff time	Short term

Issue	Ref.	Action	Proposed lead	Indicative Cost	Indicative Timescale
Situation reporting and record keeping became increasingly challenging to keep up at the peak of these flood incidents.	IM7	When NRW is experiencing a major incident consideration should be given to drafting in additional support to assist front line duty officers in carrying out activities such as duty logs and wider requests for information.	Incident Management Team	Staff time	Medium term
Key Area 8: Operational Capacity					
Resilience of rotas is extremely limited; some rotas are at minimal sustainable levels	OC1	Additional duty officers should be sought for the majority of duty rotas, recognising that this may require a change in approach. All officers need to receive suitable training and support.	Incident Management Business Board	Minor staff time but implementation costs may be Moderate	Work already underway and will be completed in the medium term
	OC2	A review of the optimum resourcing levels for each rota should be undertaken and a minimum operating model established.	Incident Management Team	Staff time	Work already underway and will be completed in the medium term
	OC3	Issues experienced by officers and highlighted through this review regarding retaining and attracting people to rotas should be investigated further and where appropriate, action should be taken to resolve issues.	Incident Management Business Board	Minor staff time but implementation costs may be Moderate	Work already underway and will be completed in the medium term
Working hours and adequate recovery time were highlighted as concerns following the February events.	OC4	Everyone involved in duty rotas and their management should be aware of working time directives and ensure that prolonged shifts are avoided as well as adequate recovery time being undertaken both during and following an incident.	Duty Rota Managers	Staff time	Short term

Issue	Ref.	Action	Proposed lead	Indicative Cost	Indicative Timescale
Establishing and confirming rota shift arrangements as early as possible was highlighted as an issue where it did not happen and good practice where it did.	OC5	When a risk of an event occurs, establish rota shift arrangements as early as possible. Clear expectations for officers should then be confirmed to enable them to plan effectively.	Duty Rota Managers	Staff time	Short term
Mobile pump equipment is used in a variety of locations and circumstances, however there are areas where this could potentially be improved.	OC6	Review of operational equipment including pumps should be undertaken and where found likely to improve services additional equipment should be considered for purchase.	Land and Assets Operations Managers	Minor staff time but implementation costs may be Moderate	Medium term
Some vehicles were either unavailable or unsuitable for the conditions experienced during the storms, this impacted our operational response capabilities.	OC7	Review vehicles and plant available for incident response work. Fleet structure should take account of incident response requirements and not just “day job” requirements.	Fleet Management Team	Minor staff time but implementation costs may be Moderate	Medium term
	OC8	Where necessary additional training should be provided to operatives expected to drive in severe weather conditions and when utilising 4x4s.	Land and Assets Operations Managers	Minor	Medium term
Mobile phones were unsuitable for use at times during the flood events due to either lack of network signal or the poor weather conditions impacting equipment.	OC9	Mobile phones issued to duty officers should be reviewed with consideration of both network signal coverage and the resilience of handsets in poor weather conditions.	Business Support Services Team	Minor staff time but implementation costs may be Moderate	Work already underway and will be completed in the medium term

Issue	Ref.	Action	Proposed lead	Indicative Cost	Indicative Timescale
The NRW website went down during Storm Dennis, preventing the public from being able to obtain vital information.	OC10	The resilience of the website should be reviewed, and improvements made immediately. The website and the team that supports it needs have the capacity and resilience to deal with the increase in web traffic during times such as flood incidents. Contingency plans also need to be properly accounted for within business continuity plans and operational flood duty procedures in case of serious or prolonged website disruption.	Digital Comms & ICT Department	Moderate	Technical system solutions have been implemented Staffing and procedural improvements are expected in the short term
ICT products and support services need to be resilient to these types of significant events.	OC11	ICT department should review the levels of resilience for key incident management systems and supporting infrastructure and implement improvements as required.	ICT Department	Minor staff time but implementation costs may be Significant	Seek to prioritise in the short term but delivery will be in the long term
The Buckley incident room lost power and without any contingency on site for alternatives, had to close.	OC12	All sites with an incident room should consider the contingency plans in place and the equipment which is required, for example, back-up generators.	Incident Management Team and Facilities Teams	Minor staff time but implementation costs may be Moderate	Work already underway and will be completed in the short term
The use of incident rooms and the availability of key equipment had numerous elements of feedback highlighted.	OC13	Review of incident room equipment should be undertaken in line with standard equipment lists which have now been produced.	Incident Management Team	Minor staff time but implementation costs may be Moderate	Short term
	OC14	A review of procedures relating to the opening and closing of incident rooms should be considered.	Incident Management Team	Staff time	Short term
	OC15	Where relevant, additional training requirements for officers in out of hours procedures and use of any specific incident room kit should be undertaken.	Incident Management Team	Staff time	Short Term

Issue	Ref.	Action	Proposed lead	Indicative Cost	Indicative Timescale
Key Area 9: Communications					
NRW received a significant number of media requests and requests for interviews, these were dealt with extremely well by a small number of representatives.	C1	NRW should identify additional staff members and senior managers to act as media spokespeople and should provide them with appropriate training.	Communications and External Relations Team	Staff time	Medium term
	C2	Site based operatives should be provided with further training in how to deal with reporters, provided with more information on the process that should be followed and given the confidence to 'push back' on these requests if necessary.	Communications and External Relations Team	Staff time	Short term
Communicating NRW's key awareness raising and resilience related messages is important before, during and after flood incidents.	C3	NRW should prepare a communications plan and materials to further support key messages in advance of events. These should consider some of the wider strategic messages NRW wishes to communicate when there is a developing flood risk.	Community Engagement and Resilience Team & Communications and External Relations Team	Staff time	Medium term
NRW's website took time to reflect the flood incidents and important flood risk information was difficult to find and not easily accessible for the public.	C4	Improvements to the website should be undertaken to make key information more readily available to the public before, during and after a flood incident. Consideration should also be given to the content of the NRW website homepage during a significant incident and the content, promotion and use of the 5 Day Flood Forecast should be reviewed.	Digital Comms Team & Strategic Planning and Investment Team	Moderate	Medium term

Issue	Ref.	Action	Proposed lead	Indicative Cost	Indicative Timescale
Collecting information, photos and videos shared by the public on social media and wider online published content is useful, but no procedures exist to manage this effectively.	C5	Procedures for collecting online media content during and after flood events should be considered. This should include exploring social media harvesting and filtering tools, guidance for obtaining relevant permissions and clarity on how the information will be used.	Community Engagement and Resilience Team & Communications and External Relations Team	Staff time	Medium term
Key Area 10: Recovery					
The initial recovery phase, whilst undertaken to the best of everyone's ability, lacked timely coordination and governance.	R1	A lead role to manage and oversee the recovery phase should be appointed as soon as possible after a significant flood event, preferably during the response phase so there is no gap or delay in managing recovery.	Incident Management Business Board	Staff time	Medium term
	R2	Procedures should be developed for key recovery activities and a formalised recovery plan developed with guidance for how recovery is initiated and managed.	Incident Management Business Board	Staff time	Medium term
Post-event debriefs lack consistency across Wales, with some uncertainty on when to undertake them and who they should be led by. There is also a risk that some parties miss out on being able to contribute.	R3	A clear procedure and improved guidance in relation to post-event debriefs should be established.	Incident Management Team	Staff time	Work already underway and will be completed in the short term
Implementing actions to address all lessons from previous events has been widely identified as a shortcoming.	R4	Ensure those responsible prioritise and deliver on the actions to address issues identified in this and prior reviews. A more effective means of capturing lessons and delivering actions following post-event reviews should be established.	Incident Management Team	Staff time	Medium term

Issue	Ref.	Action	Proposed lead	Indicative Cost	Indicative Timescale
Extra resources are needed following an incident to undertake recovery and post incident learning. The ability to undertake various elements of recovery work relied on already tired staff, who were also fully committed to their 'day job'.	R5	NRW needs to develop mechanisms for wider support to assist with recovery work following significant incidents, recognising appropriate training and knowledge needs to be in place.	Incident Management Business Board	Minor staff time but implementation costs may be Moderate	Medium term
Post-event asset inspections and data capture through surveys lack any clear procedure, guidance or consistency of roles across teams.	R6	Procedures for both post event asset inspections and surveys for flood extents and mechanisms should be established, to be instigated as part of a wider recovery procedure.	Flood Risk Analysis Sub-Group	Staff time	Medium Term
A high volume of enquiries and information requests came in after the flood events of February 2020, these needed clear and effective coordination.	R7	A single point of contact should be established as soon as possible after a significant incident and procedures developed to instigate and manage this process.	Incident Management Business Board	Staff time	Medium term
	R8	Frequently requested information should be reviewed and made more readily available on the NRW website or via internal briefing notes.	Strategic Planning and Investment Team	Staff time	Medium term
	R9	Clear lines to take on key issues should be established as early as possible in the recovery phase, and with clear identification of responsibilities for production.	Strategic Planning and Investment Team	Staff time	Medium term
NRW's post-event community engagement role was unclear, and staff were ill-prepared and equipped to	R10	Clarity on NRW's post-event community engagement role should be established, taking into account resource capacity.	Community Engagement and Resilience Team	Staff time	Medium term

Issue	Ref.	Action	Proposed lead	Indicative Cost	Indicative Timescale
deal with the issues members of the public raised.	R11	Staff likely to be working in flood impacted communities should receive further training in dealing with individuals who have experienced trauma. This includes those staff directly engaging but also those carrying out other recovery activities in these areas.	Community Engagement and Resilience Team	Staff time	Medium term
	R12	Improved information and guidance literature should be considered for staff to carry with them while on site in flood impacted communities. Staff should also be aware of where to signpost members of the public to for further information.	Community Engagement and Resilience Team	Minor staff time and implementation costs may be Minor	Medium term
Post-event reporting on flood impacts and the wider production of Section 19 reports have a number of inconsistencies and some clear gaps in their oversight.	R13	Identify improvements to post-event reporting of key statistics and impacts, as well as improving oversight of flood investigation reports to improve consistency.	Strategic Planning and Investment Team	Staff time	Medium term

Glossary

Acronym	
ACTCON	Action Consideration Threshold
AEP	Annual Exceedance Probability
AFIDO	Assistant Flood Incident Duty Officer
AFWDO	Assistant Flood Warning Duty Officer
AMFDO	Assistant Monitoring and Forecasting Duty Officer
DSM	Duty Strategic Manager
DTM	Duty Tactical Manager
FFC	Flood Forecasting Centre
FGS	Flood Guidance Statement
FIDO	Flood Incident Duty Officer
FWDO	Flood Warning Duty Officer
FWS	Flood Warning System
H&T	Hydrometry and Telemetry
ICC	Incident Communications Centre
ICT	Information and Communication Technology
LRF	Local Resilience Forum
MEICA	Mechanical Engineering Instrumentation Control and Automation Team
MFDO	Monitoring and Forecasting Duty Officer
RMA	Risk Management Authority
SCG	Strategic Co-ordination Group
SITREP	Situation Report
TCG	Tactical Co-ordination Group
WIRS	Wales Incident Recording System