Emergency Preparedness, Response, & Recovery:

Identifying lessons learned by the UK highway sector from extreme-weather emergencies (2015-2020)

An independent report prepared for on behalf of:

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"The past is not preparing us for the future. Resilience will not come from doing what we always have done. Time to act was yesterday. Today we must adapt."

Craig Fugate, Federal Emergency Management Agency (FEMA)
Administrator under President Barack Obama
(Twitter, 11/12/2018)

Foreword

When I was originally approached by Steve Berry OBE and John Lamb, then President of the Local Government Technical Advisers Group (LGTAG), to undertake this review in 2018, none of us could have anticipated the resilience challenges that were to be unleashed on the world.

The evidence for this review was collected predominantly prior to the emergence of COVID-19 and its development into a global pandemic. However, much of the detail that underpins this report's findings in respect to extreme weather resilience are directly relatable to how the highway sector has stepped up to the challenges experienced over the last year.

Discussions I have had over the last few months have indicated that the sector has risen to every challenge it has been confronted with.

Throughout the past year the focus on preserving the 'community lifeline' functioning of the highway network has been foremost in people's minds. Working at Strategic, Tactical and Operational levels with their partner agencies, suppliers and communities, highway authorities have readily adapted to new Covid-safe working practices.

Interestingly in accord with this review, the importance of peer support networks has been championed, with the sector institutions taking a lead in providing forums for the discussion of challenges faced; illustrating perhaps the applicability of the aphorism "A problem shared is a problem halved"?

Although initial uncertainties led to some disruption, the Department for Transport responded to sector concerns, by providing clear support for the designation of highway practitioners as essential workers. This assisted in public communications, with the #HighwayHeroes hashtag resoundingly praised for its clear message that works were being done *for* communities, to build network resilience.

Resilient networks were adjusted to include Covid testing and vaccination centres, with many authorities expanding their protocols and sometimes their capabilities to ensure safe access to these critical sites included the 'last 100m'.

As in other sectors, the pandemic has also catalysed 'new ways of working'. Working from home has become the new normal for many, with IT departments achieving "5 years' worth of upgrading in 3 weeks" to support this. Many safety critical tasks, however, have still needed to be conducted on site. Here again the adoption of IT appears to have had a significant effect in ensuring the continuity of inspections. In-cab operations have also been adapted, both physically with screens and spacing or through IT which has increased, for example, the accuracy with which surface treatments can be applied.

All these factors support the conceptualisation, the understanding, of resilience that is used in this report. Fundamentally, this encompasses social, environmental, and

economic considerations, but also highlights the importance of resilience, as including the ability to adapt and transform when required. This year the sector has clearly demonstrated that.

This is not to say that all is perfect for, undoubtedly, challenges remain. As vaccination continues to reduce infection risks, so the challenges presented by an aging infrastructure and a changing climate will remain.

From this perspective, I believe the observations I make in this report are relevant and I hope they provide useful prompts for a sector which a I am confident is committed to continuously improving network resilience.

Finally, I think it is important to say a few words about Steve Berry OBE.

Throughout this review one theme has been consistent. That is the amount of respect and fond regard the sector held for Steve. It became clear to me that Steve's role in overseeing the DfT response to the extreme weather events discussed was seen by many as pivotal in assisting affected authorities' progress from intense response into stabilisation and recovery. It was obvious to me that this respect had been generated because of Steve's steadfast support and advocacy of sector resilience over years.

This commitment was perfectly illustrated to me by the fact that it was Steve, along with John Lamb – another sector-resilience advocate – who commissioned this report. Steve's untimely death is a tragedy. Accordingly, my hope is that in highlighting the experiences, the issues and the opportunities presented in this report some of his strength of purpose will be translated into action.

Dr Hugh Deeming

HD Research Ltd.

Acknowledgements

I would like to take this opportunity to express my gratitude to all the participants[1] from the highway authorities and operators who so generously offered their time and insights to this project. I hope that in describing their personal and organisational learning and outlining their suggestions for improved practice in this report, I have fulfilled their concerted wish to ensure that their experiences could be used by others to increase highways resilience across the UK.

I would also like to take this opportunity to thank John Lamb specifically. His support during my writing of this report has been priceless and his obvious commitment to building sector resilience is genuinely commendable.

The report in final draft format was shared and opened to peer review across key elements of the sector including devolved assemblies. It therefore provides a significant contribution towards creating consistently high standards of Network Resilience and through associated support arrangements and training will support a world class response to the increasing threats to Highways Assets and transport networks.

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[1] Footnote: a list of principal participants appears at Appendix 4.

1. Executive summary

As a result of extreme weather events, their effects and their impacts on the UK highways network, the Department for Transport (DfT) commissioned research to identify any lessons that have been learned for ensuring the resilience of the highway network.

The focus of the research was to investigate a specific time window, between the winter storms and floods of 2015 (Storms Desmond, Eva and Frank) and Spring 2020. This period was chosen because events prior to the winter of 2015 (e.g., of the harsh winters of 2009-2010 and floods of 2013/2014) had been reviewed and changes had been integrated from these reviews into guidance and should be evident in practice as a result.

This investigation maintained a perspective that always recognised that **Integrated Emergency Management** (IEM) is a joint endeavour that requires all involved to understand where their organisation's plans, practice and procedures integrate with and/or can be made to better integrate into the broader multi-agency context that is defined by extreme-weather IEM.

In all, nine broad themes were identified and discussed:

- Multi-Agency Integrated Emergency Management (IEM);
- The concept of stabilisation;
- Resilient Networks;
- The Strategic Road Network (SRN), local highways interface;
- Collaborative working, Mutual Aid and Military Aid;
- The role of Ministerial Groups: COBR, Lead Government Departments and the Ministerial Recovery Group (MRG);
- Democratic institutions and community resilience;
- Business Continuity Management (BCM), training and exercising; and
- Corporate memory and learning lessons.

Overall, the review found clear evidence of authorities within the highways sector that have coped well under the intense and sustained pressures placed on them by a variety of extreme-weather hazards.

Evidence of innovation and learning has been clearly apparent. It is also obvious that an encouraging amount of effort is being expended in collaboration. Local highway authority personnel are working to build resilience, both internally in their authorities (e.g., by developing integrated contingencies alongside their authorities' resilience units) and externally, with other authorities and responder agencies, but also with suppliers and communities.

Examples of highways authorities warning and informing the public about hazards, including the increasing use of **Social Media** in pulling information from and pushing it to the public during incidents, clearly illustrate a broadly held understanding of the importance of effective communication strategies.

Such findings are encouraging. However, persistent challenges to sector resilience are also identified. This includes the observation that whilst extremely competent in dealing with highways issues during incidents, practitioners in the sector do not necessarily have access to the tailored training in emergency management that could further enhance their contribution to multi-agency working. This focus on achieving resilience in the sector by facilitating the development a broad cadre of **Suitably Qualified, Experienced and Empowered Personnel** (SQEEP) at all tiers of management runs through the report.

As **'lifeline' infrastructure**, highways provide vital communication links for the travelling public, as well as hosting other lifeline networks (gas, fibre) and connecting other critical infrastructure systems. Accordingly, improving data capture, data sharing and analysis processes will enhance risk-based decision making by providing opportunities to proactively avert failure of key assets (e.g., bridges, retaining walls) during major incidents.

The lack of a systematic **Rapid Impact Assessment** (RIA) process in the sector also leads to inconsistencies in authorities' ability to apply risk-based approaches to the management of impacts to highway assets when the worst does happen.

Highway authorities have access to key data sets, which are vital in facilitating multi-agency Shared Situational Awareness during incidents: yet these data are not amenable for integration into the government's *ResilienceDirect* IT system. Accordingly, the need for highways authorities to actively collaborate in the development of **Multi-Agency Information Cells** (MAIC) with their Local Resilience Forum partners was evident.

The concept of **Shared Situational Awareness** was also discussed in relation to understanding the sector's ability to dynamically assess single points of failure in their networks. This highlighted the importance of collaborative working with partners (e.g., utilities) to ensure that plans exist for risk assessing and managing vulnerable assets effectively.

Community resilience was found to be a well-understood concept across the participating Highway Authorities. The key importance of nurturing strong relationships between Highway Authority officers their resilience units and the communities they serve was clearly illustrated using examples from farmer winter service contracts to the operation of emergency rest centres.

Finally, Cumbria's Infrastructure Recovery Programme and its delivery following the devastating effects of Storm Desmond have been used to illustrate a key example of sector leadership in supporting the **long-term recovery** of hazard affected communities.

This report identifies sector learning from the experiences of a number of highway authorities and underlines the value of collaborative working and the sharing of experiences by those who have recently suffered major events. The **professional development** of key personnel at all levels will ensure they are qualified, experienced and empowered to make crucial decisions as part of an integrated team as and when circumstances dictate.

2. Introduction

1. As a result of recent extreme weather events, their effects and their impacts on the UK highways network the Department for Transport (DfT) commissioned research to identify any lessons that have been or could be learned.

2. The focus of the research was to investigate a specific time window, between the winter storms and floods of 2015 (Storms Desmond, Eva and Frank) and Spring 2020[2]. This period was chosen because events prior to the winter of 2015 (e.g., of the harsh winters of 2009-2010 and floods of 2013/2014) had already been reviewed and many changes had been integrated from these experiences into guidance and practice as a result.

3. This investigation, therefore, was partially designed to assess whether recommendations delivered by the Quarmby (2010) review into winter resilience and the more-encompassing Brown et al. (2014), review into transport-network resilience to extreme weather had been adopted, but also whether other lessons had been learned by those affected since those reviews, which could inform highways management practice nationally.

4. Focussing on this time window also meant that analysing the experiences of specific Local Highways Authorities (henceforth, Highway Authorities) would form the basis of the research. This is because, whilst all UK Highway Authorities are at some point affected by extreme-weather emergencies, the magnitude of the winter 2015/2016 storm season led to the impacted authorities dealing with events that were significantly out of the ordinary. In fact, from Cumbria and Calderdale's perspective the impact of those winter storms could legitimately be described as disastrous[3].

5. From this perspective it is clear that learning identified by these authorities requires the acknowledgement and consideration of other authorities, by whom contingencies for such events may have been developed, but whose plans have not yet been tested to such extreme extents.

2.1 Reviewer

6. DfT were keen that an independent expert on resilience should conduct this review. For this reason, Dr Hugh Deeming (the author) was commissioned, with a clear remit to investigate recent lessons identified and learned from extreme-weather events by the highways sector. Having expertise in resilience studies and a record of investigating emergency response and

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[2] Footnote: The data collection for this report concluded prior to the designation of COVID-19 as a global pandemic and before the UK's first lock-down in March 2021. The sector's response to COVID-19 has been described in two additional addendum reports published in July and December 2021.

[3] Footnote: A disaster is defined in the UK Civil Protection Lexicon as: an "Emergency (usually but not exclusively of natural causes) causing, or threatening to cause, widespread and serious disruption to community life through death, injury, and/or damage to property and/or the environment"

recovery from extreme-weather and other emergencies[4] Hugh brought a perspective that encompassed the importance of understanding actions and practices that define sector-specific operations, but in a way that positioned those actions and practices within emergency contexts defined by coordinated multi-agency activities in complex environments.

7.   This means that unlike other reviews that have focussed more closely on the technical aspects of highway management (e.g., road-surface compositions and de-icing treatments) this review would take a more organisational-resilience approach.

8.   In order to provide vital sector-specific context, to ensure Hugh gained the important foundational knowledge of the sector and key individuals within it, John Lamb, the then sitting President of the Local Government Technical Advisers Group (LGTAG), provided critical oversight and guidance. In addition, an initial project scoping paper written by John (Appx 1) served to provide important signposts and questions related to the sector's capabilities and capacities, which guided the author's initial investigations.

2.2 Data collection

9.   The initial research commenced with the interview of key-informants from the Highway Authorities across the north of England and in south western Scotland. As interviews progressed, however, key informants suggested contact with other Highway Authorities. This process of research sampling through recommendation is referred to as 'snowballing'. Table 1 lists the Highway Authorities, the local authorities and the weather events that provided context for the discussions.

10.   Table 1 also identifies events that were not weather related, but which nevertheless also had significant impacts on the affected local authorities' highway networks. So, whereas, extreme weather *hazards* are the principal focus of this research, in the context of emergencies (as defined by the Civil Contingencies Act 2004 and the National Risk Assessment), the Manchester and Salisbury events represented the manifestation of malicious *threats* (e.g., terrorism), which bore common consequences to weather hazards across affected highways networks (e.g., prolonged diversions).

11.   Within UK Local Risk Management Guidance[5], it is suggested that planning for 'common consequences' allows responders to develop generic plans which can be deployed to mitigate the impacts of hazards and threats. This is suggested to be more effective than preparing plans specific to the effects of those hazards and threats individually. For example, road closures and diversions can be regarded as a common consequence that may follow the

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[4] Footnote: For example, Hugh was the lead author of both Cumbria County Council's reviews, into their acute-phase response to and longer-term recovery from Storm Desmond, as well as being a panel member of the Kerslake Review into the preparedness for and response to the Manchester Arena attack.

[5] Footnote: LRMG is a guidance document that informs the risk assessment process undertaken by the UK resilience sector.

manifestation of a plethora of diverse hazards, from storms to chemical spills, to public demonstrations.

12. From this perspective talking to individuals who had been involved in major incidents other than extreme-weather events proved insightful, because it illustrated and reinforced sometimes surprising similarities in how events unfolded or were managed. For example, the effect of exposure to a series of storms throughout November and December 2015 stressed authorities in Cumbria's abilities to balance between the need to respond, to transition to recovery, and then to bounce back to response again days later, whilst maintaining those recovery efforts. Likewise, in Wiltshire, once the initial poisoning incident had been contained in Salisbury the recovery began, only for the next poisoning to occur in a different location, throwing the agencies back into response and containment mode. In effect, whilst the stimuli were different, the learning points identified were very similar.

Table 1: Local Highway Authorities contacted for interview

Calderdale (West Yorks)	Winter storms 2015; Beast from the East (BftE)
Cumbria	Winter storms 2015; BftE; Storm Callum 2018
Devon	Flooding and winter (general); BftE
Derbyshire	Toddbrook Dam, flooding (general); BftE
Dumfries and Galloway	Winter storms 2015; BftE
East Sussex	Flooding and winter (general)
Greater Manchester	Flooding and winter (general); BftE; Manchester Arena attack 2017
Lancashire	Winter storms 2015; BftE
North Yorkshire	Winter storms 2015; BftE; Reeth/Grinton floods (2019); Tour de France/Yorkshire[6],
Northumberland	Winter storms 2015; BftE
Perth and Kinross	Flooding and winter (general); BftE
Somerset	Flooding and winter (general); BtfE
South Yorkshire	Sheffield and the River Don floods 2019
Wiltshire	Flooding and winter (general); Skripal incident 2018 (Salisbury)

13. Discussions were also conducted with Highways England (HE), to identify any lessons in relation to the effectiveness of the points at which the

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[6] Footnote: As neither a hazard nor a threat, the Tour de France discussion with North Yorkshire focussed on learning from a major event, which had seen the Highway Authority taking a principal role within a multi-agency coordination framework overseeing large-scale event management.

motorways and trunk roads overseen by HE, interface with the networks operated by Local Highway Authorities. This was important, because whilst the Strategic Road Network operated by HE and its suppliers constitutes only 3% of the national road network, disruption to the SRN can and has had rapid and significant impacts on the local highways network. Professional bodies were also contacted, with leading members or officers from the following institutions contributing to the data collection and analysis. These bodies were:

- Local Government Technical Advisers Group (LGTAG)
- Association of Directors of Environment, Economy, Planning and Transport (ADEPT)
- National Winter Service Research Group (NWSRG)
- Local Government Association (LGA)
- Society of Local Authority Chief Executives (SOLACE)

14. Due to the limited but purposively applied engagement approach adopted it should be clear that only a partial view of current local highways management has been attained.

15. In doing this, however, the project has focussed on seeking out examples of major incidents where either notable and/or adaptive practice has occurred, or of where experiences have exposed holes in doctrine or practice that need to be confronted. Accordingly, the author will make observations rather than recommendations and it will be left to the sector to either accept the validity of these observations (coming as they do from an independent researcher) as indicators that there is sufficient resilience in the sector to deal with extreme weather events, or as evidence of the need for change.

2.3 Doctrine

16. A review of current doctrine within the sector was also conducted, with principal focus given to contextualising the findings against existing highways guidance as well as more broadly in terms of understanding highways resilience as a key component in the delivery of effective emergency planning and resilience.

17. The key documents referred to in this analysis included[7]:

- UKRLG (2016) Well-Managed Highway Infrastructure
- UKRLG (2013) Highway Infrastructure Asset Management
- Brown (2014) Transport Resilience Review: A review of the resilience of the transport network to extreme weather events
- Quarmby (2010) The Resilience of England's Transport Systems in Winter
- HM Government (2012) Emergency Preparedness: Guidance on Part 1 of the Civil Contingencies Act 2004

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[7] Footnote: Other literature reviewed will be referenced throughout the report.

- HM Government (2013) [Emergency Response and Recovery Non-statutory guidance to complement Emergency Preparedness.](#)
- Deeming and Otley (2018) [A review of recovery processes following Storm Desmond's impacts on Cumbria (5th/6th Dec 2015)](#)
- Cross (2018) [Multi-agency flood plan review: final report](#)

18. *What became interesting very quickly for a reviewer who was unfamiliar with the intricacies of the highways sector, was the scale of detailed guidance contained in the sector's 'bible', the UK Roads Liaison Group's (UKRLG) document* Well-Managed Highways Infrastructure.

19. What was particularly striking was the similarity in style between this document and other guidance documents such as those related to the UK resilience sector, e.g., HM Government's *Emergency Response and Recovery*. These types of over-arching doctrine are useful because they are comprehensive in laying out responsibilities in the form of *must* do, *should* do and *could* do guidance.

20. Principally, Well-Managed Highways directs the reader to higher layers of doctrine which outline a highway authority's statutory duties, i.e., it tells the reader what s/he *must* do to comply with the law (e.g., the duties placed on Highway Authorities by The Highways Act 1980 in relation to winter service provision). However, the bulk of the guidance is conceived to explain what authorities *should* or *could* do to ensure their highway network is effectively managed.

21. What *should* and *could* styles of guidance provide is the flexibility for them to use the guidance that is most appropriate for them to manage networks in the best way relative to their local social, economic, political and geomorphological contexts. In effect, what this type of doctrine acknowledges is that 'one size will not fit all'.

22. *However, in the context of this review, there is another way to consider the framing of* must, should *and* could *that is not focussed as clearly on the difference between legal obligation and optional 'good practice'.*

23. Rather, in terms of understanding highways management in the context of extreme-weather events, what was important for this review to identify was whether major-incident and, for want of a better phrase, disaster-affected authorities have reconsidered what they *must* do in more normative, rather than strictly legal, terms. In effect, the question became, have these authorities' practices and procedures adapted to reflect any new understanding of the realities of providing network continuity following their lived experience of response to and recovery from one or more extreme-weather events?

24. An example to illustrate this point is the importance of a comprehensive communications strategy that includes the role of social media in crisis communications. Whilst it will be discussed in detail later in the report, the importance of a social-media strategy, which allowed network-related information to be drawn (pulled) from the public as well as broadcast (pushed) to the public was considered as essential (i.e., a *must* have) by the local authorities interviewed.

2.3.1 Working definition: Resilience

25. In their review of transport resilience Brown et al., defined resilience to extreme weather as a combination of three layers:

- Firstly, "it is about increasing the physical resilience of transport systems to extreme weather, so when extreme weather is experienced, people and goods can continue to move.
- Secondly it would be both very difficult and prohibitively expensive to ensure total physical resilience, so it is equally about ensuring processes and procedures to restore services and routes to normal as quickly as possible after extreme weather events have abated.
- Thirdly, as part of this it is essential to ensure clear and effective communications to passengers and transport users, so that the impact of disruption on people and businesses is minimised"

26. Brown et al., suggest that there is a need to consider all three of these layers if impacts of extreme weather are to be reduced.

27. This approach to understanding resilience is reasonable in the context of highways infrastructure. This is because it allows the authors to largely treat the network as a physical entity which, if 'well managed' should be able to 'bounce back' from the application of a stress (e.g., flood water). Declaring the importance of "processes and procedures" and the need for an effective public communications strategy are also critical because they highlight the more socio-technical and social aspects to be considered, i.e., sector practice and user needs.

28. The perspective this review takes is slightly different. Principally, this is because this review explicitly regards the delivery of effective highways management as involving a system comprising environmental, social, economic, physical and human factors. Accordingly, for such a complex system to be resilient over time requires not only a range of physical and skills-based assets and management processes, but also requires a flexibility in approach that encompasses experiential learning and change.

29. Interestingly, whilst this report was being prepared another useful concept was introduced into the highway glossary by the US Federal Emergency Management Agency (FEMA). In 2019 FEMA issued new guidance on the management of 'community lifelines'[8] (Box 1).

Box 1: FEMA 'Community Lifelines'

In September 2019, the US Federal Emergency Management Agency (FEMA) issued new guidance on the management of seven designated types of infrastructure which they defined as 'community lifelines'.

These listed infrastructure are: safety and security; food, water & shelter; health and medical; energy (power & fuel); communications; hazardous materials; transportation. Each of these infrastructures, FEMA suggests, bear three key attributes [emphasis added]:

- Lifelines are **the most fundamental services** in the community that, **when stabilised**, enable all other aspects of society to function.

- Lifelines are the **integrated network of assets**, services, and capabilities that are used day-to-day to support the recurring needs of the community.

- When disrupted, **decisive intervention** (e.g., rapid service re-establishment or employment of contingency response solutions) is required to stabilize the incident.

This framing of specific services and assets as lifelines is useful, because it underlines for those managing them the importance of adopting risk-based asset management approaches befitting this function.

Most importantly, and whilst not wishing to accept a US concept into the UK emergency management lexicon unquestioningly, there is an overriding factor that makes consideration of this concept particularly relevant for this review.

This is that designating highways as community lifelines bears a dual imperative: 1) highways can be considered as lifelines in their own right, 2) highways also host (e.g., aligned gas and water), carry (e.g., hazardous material in transit) or connect (e.g., facilities, buildings and assets) all the other types of infrastructure. This gives them a primary importance.

30. Taking this perspective on the complexity and lifeline importance of highways, it is sensible to examine what resilience means for such a system in the specific context of extreme weather events. There is increasing evidence that extreme weather is becoming more common and that these

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[8] Footnote: FEMA Lifelines: https://www.fema.gov/emergency-managers/practitioners/lifelines

weather events may be gaining in magnitude, intensity and/or frequency. It also appears that this trajectory will continue as a result of on-going human influence on the environment (Allen et al., 2018). It is important, therefore, to adopt an optic for this work that acknowledges all the interlinked and dynamic lifeline qualities of the local highways system. Accordingly, for this research the definition of resilience employed is that developed by the Intergovernmental Panel on Climate Change (IPCC, 2014), whose remit focusses directly on understanding weather and climate effects on social, economic and environmental systems:

> "The capacity of social, economic, and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity, and structure, while also maintaining the capacity for adaptation, learning, and transformation." (Ibid., p.4)

31.   What this framing of resilience introduces are the key components of 'essential function' (i.e., Brown et al.'s focus on the physical properties of the highways system), but also the importance of understanding that to stay resilient over time requires the capacity to initiate system change.

32.   This perspective also aligns directly with the resilience framework defined by the National Infrastructure Commission, which encompasses the six key elements of: anticipate, resist, absorb, recover, adapt, and transform (National Infrastructure Commission, 2020).

33.   Framing resilience this way, this review has not only investigated how Highway Authorities have kept their networks running in the face of extreme weather events. It has been concerned to draw out how learning from the experience of these events has influenced the way the people managing these systems have been open to, or indeed have actively embraced, adaptation and change to ensure the resilience of their local communities, concurrently with keeping their part of the national highways network running.

34.   In short, the basis on which this review has been conducted has been one where resilience, as it reflects the condition and management of the highways network, is conceived of as an on-going process rather than as a desirable end state.

2.3.2 The Civil Contingencies Act (CCA), Responder duties and Resilience Standards

35.   In reviewing the Highway Authorities' experiences with extreme weather, it is important to also acknowledge that preparedness for, response to and recovery from weather emergencies is carried out as a multi-agency endeavour.

36.   Since 2004 the concept of Integrated Emergency Management (IEM) has been guided by the Civil Contingencies Act (the Act), which defined the Local Resilience Forum (LRF) as the process through which formally designated responder agencies should collaborate to understand risks they

face in their geographic areas of operations[9]. Models of IEM differ, but the model now being used within the UK civil protection sector to underpin the Cabinet Office's new Resilience Standards consists of an 8-stage cycle, which contains explicit stages of validation and learning (Figure 1). Introducing these additional stages to the traditional 6-stage model that was presented in earlier doctrine is designed to actively promote the professionalisation of civil protection, but also to encourage the development of a culture that both learns from events and adapts to potentially changing hazards and threats (MacFarlane, 2018).
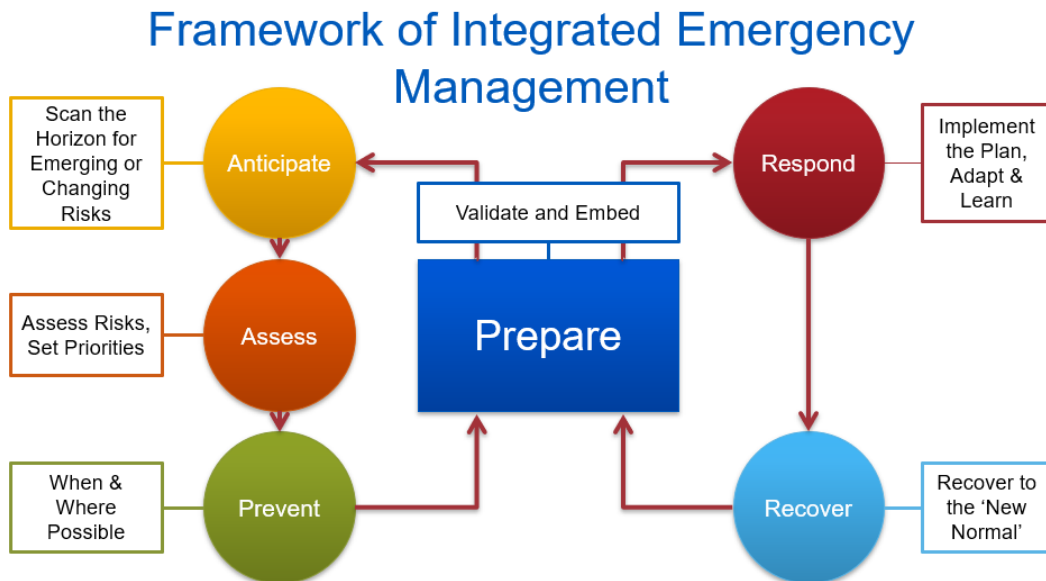
Figure 1: The Integrated Emergency Management (IEM) Cycle as defined for the UK civil protection sector (©Emergency Planning College)

37.   Under the Act, responders are either designated as Category 1 or Category 2.

38.   By their definition as one of the main organisations that will be involved in *most* emergencies at a local level, local authorities (and by default local authority operated Highway Authorities) are designated as Category 1 responders.

39.   The Act places statutory duties on all Cat 1 responders: to cooperate; to share information; to assess risks in their area; to plan for emergencies; to communicate with the public; to ensure their own business continuity and, for local authorities only, to provide business continuity advice to businesses.

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[9] Footnote: Individual LRF areas are, on the whole, defined by the boundaries of Police areas (e.g., Cumbria). Slightly different rules apply in London and the devolved administrations.

40. Category 2 responders are regarded as those organisations that may be involved in *some* emergencies. For this reason, entities such as utilities companies and transport providers are designated as Category 2 responders, and as such they bear the duties to cooperate and to share information with Category 1 responders.

41. The Act also places a duty on Category 1 responders to collaborate, within the LRF, to produce a risk profile for a defined set of hazards and threats that may affect their area and for which emergency plans need to be developed. In order to do this, government has prepared a set of risk scenarios, which are published in Local Risk Management Guidance. Once the risks have been assessed the LRF should then publish these risk assessments in the form of a Community Risk Register (CRR) (see: Leigh, 2013).

42. The CRR is realised as a bi-axial matrix defining a hazard or threat's impact severity on one axis as a 1 (limited) to 5 (catastrophic) scale and its likelihood of occurrence (1 low to 5 high) on the other. Hazards bearing the greatest potential impact and the highest likelihood appear in the top right-hand corner of the matrix and those with the lowest in the bottom left.

43. The intent in creating the CRR is to define the priorities with which the LRF should develop its emergency contingencies (e.g., LRFs may wish to focus attention on managing risks related to high-impact, high-likelihood hazards and threats). Whilst following their assessment process some LRFs may not regard flooding as a 'top-right' hazard, it is unsurprising that Cumbria and West Yorkshire LRFs (for example) have assessed the risk of fluvial flooding as very high (high likelihood x significant impact).

44. A national risk register of civil emergencies has also been prepared and it is notable that coastal, river and surface-water flooding and cold and snow all feature as significant national risks (Cabinet Office, 2017)[10]. It should be remembered, however, that this risk assessment process maps plausible risks over a 5-year window. For this reason, risks related to phenomena such as permanent coastal inundation (i.e., not just coastal flooding) are not assessed as the likelihood of such events occurring over the next 5 years are deemed too low; notwithstanding that climate projections are now suggesting that the likelihood of such phenomena are increasing over longer time periods (e.g., 50-100 years) (UKCP, 2018).

45. Recent Met Office publications should also be considered here as they increasingly reinforce the scientific consensus that extreme-weather events have increased in frequency and magnitude (Met Office, 2018/a), and will increase further in the future (Met Office, 2018/b).

46. The development of a risk register of this type does not simply relate to hazards and threats defined in Local Risk Management Guidance. The

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[10] Footnote: It should be noted that the National Risk Assessment (NRA) methodology was revised at the end of 2019 (e.g., by employing a 2-year risk window). However, due to the time window investigated, this report focusses on the contemporary method and outputs.

highways sector is also familiar with the broader concept of risk assessment and the registration of risks. In its guidance on asset management approaches, UKRLG (2013) provides clear guidance on the risk assessment and management process and encourages practitioners to consider subjecting their processes for assessment under the 2009 ISO standard 31000 (Risk Management) [11].

47.   What the UKRLG guidance lays out, therefore, is a system through which local Highway Authorities can manage their own identified risks: from those related to environmental hazards to those associated with safety, litigation, reputation, contracts, service failure and operations.

48.   In addition to these two risk assessment procedures, local authorities also produce a Corporate Risk Register, which categorises risks dependent on how they may affect the local authority's business model, its future performance or prospects, its solvency or liquidity, or its reputation. In contrast to the CRR developed in accordance with the Civil Contingencies Act, however, the Local Highway Authority and corporate risk registers appear to calculate risks for much more immediate threats, i.e., many risks appear to relate to pressures existing on the timescale of the year quarter; thus they could be considered as bearing much greater urgency than risks faced over the less immediate 5-year window.

49.   Whilst it is important to acknowledge austerity (see next section) and the fact that there are *at least* three relevant and parallel risk-assessment processes carried out by local resilience forums, local highway authorities and local authorities, this review will focus on highway authorities' management of extreme-weather impacts; the risk assessments related to which fall under the aegis of the Local Resilience Forums and their Community Risk Registers.

50.   By examining highway management from this multi-agency coordination perspective, not in a silo but as one sector operating within actually-lived emergency management contexts, this review will seek to identify how resilient some specific highway authorities in the sector have been and, by highlighting examples of notable practice and lessons learned, will suggest some actions the sector should pursue to become more resilient as a whole.

2.3.3 Caveats

51.   At this point it is important to state a caveat. Throughout the review process, participants were forthright in stating that their organisations' resilience had been affected by and continues to be affected by austerity. The review also took place as increasing amounts of planning time were being focussed nationally on managing Brexit-related risks. It was clear that these two factors were understood by participants to be adding to the challenges faced

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[11] Footnote: It should be noted that although the risk matrix adopted by UKRLG (2013: p79) has the likelihood axis inverted, so that 'high-probability x significant-consequence' risks are situated in the bottom-right corner of the grid, the principle is the same.

by the sector. The consensus being that reduced funding was having a negative effect on the sector's capacity to manage all risks.

52. Whilst these concerns were obviously noted, the effects of austerity and Brexit did not fall within the review's parameters of investigation. Therefore, whilst such macro-economic influences should be seen as providing a backdrop for much of the discussion in this report, it has necessarily been left for the reader to decipher and balance (positive and negative) what contribution these influences have made to the experiences, lessons and adaptations discussed.

53. This review does not seek to revisit the recommendations of earlier reports. For example, it will not discuss the efficacy of various chemical treatments for iced roads (Quarmby, 2010), or reemphasise the importance of asset management approaches (Brown et al., 2014). As far as this review is concerned, those reports presented substantive and justified recommendations, which this review does not supersede. Rather, the focus of this report is two-fold. Firstly, to identify any still-persisting unlearned lessons related to the management of extreme-weather events affecting the sector (see: Pollack, 2013). Secondly to identify lessons that have been learned through exploring the lived experiences of those who had to manage a range of high-impact emergencies that occurred between 2015 and 2020.

Plate 1: A flock of local sheep take part in the celebrations to mark the opening of the new stainless steel river crossing at Pooley Bridge, Cumbria in October 2020. The original stone-arch bridge was destroyed by the effects of Storm Desmond in December 2015, with a temporary structure providing connectivity during the intervening period.

Image copyright: @Steven_Barber

3. Key themes

54.   This section will provide context for and discuss key themes that emerged from the discussions with review participants.

3.1 Multi-agency integrated emergency management

55.   In speaking to the review participants, it was clear that the foundations of an effective response during extreme-weather emergencies were defined by the concept of multi-agency working.

56.   Whilst the Civil Contingencies Act (2004) defines responders' duties related to planning for emergencies as the domain of the Local Resilience Forum (LRF), response to manifest hazards and threats is conducted using a slightly different framework. During response, responders will operate using Gold, Silver and Bronze levels of command, control and coordination to manage their own activities, but should also come together to coordinate multi-agency operations, with respective Gold, Silver and Bronze personnel meeting in Strategic (direction), Tactical (solutions) and Operational (delivery) groups (Appx 2).

57.   The report describing Cumbria's recovery from Storm Desmond (Deeming & Otley, 2018) provides a useful illustration of the respective roles of the three-tier multi-agency emergency response hierarchy and is reproduced here (Box 2).

58.   Multi-agency activity is further enabled by responders' adherence to five key principles:

- Co-location
- Communication
- Coordination
- Joint Understanding of Risk
- Shared Situational Awareness

59.   These principles were originally developed as the Joint Emergency Service Interoperability Principles (JESIP) to improve the effectiveness of the emergency services' (i.e., the 'Blue Lights') interoperability at incident scenes. However, their importance in guiding the activities of the much broader partnership of organisations engaged during the response to emergencies has become increasingly obvious to the responder community since the JESIP programme's inception in 2013.

60.   Given the nature of Highway Authorities' involvement in managing extreme-weather related risks, it goes without saying that the sector should be embracing these principles. Accordingly, it was reassuring to find evidence to suggest that engagement with JESIP amongst this review's participating authorities is increasing, even if for some the concept is still surprisingly new.

Box 2: 'Isolated communities' as a simplified illustration of the three principal tiers of Integrated Emergency Management (IEM)

During the height of the Storm Desmond response on 5th December 2015, news started to reach the **Strategic Coordinating Group (SCG)** that communities along the shores of Ullswater were being cut off and isolated from support due to rising lake levels, landslides and road-surface damage. Accordingly, it was important to formulate and activate a plan to reduce risks for these communities.

After deliberating this information, the SCG agreed and communicated a strategic direction that "There will be no isolated communities".

Taking this direction from the SCG, the **Tactical Coordinating Group (TCG)** then interpreted what it meant, in terms of what preventing the isolation of all at-risk communities in the county would need, in terms of solutions (e.g., what assets and activities would be required).

Communicating and developing a plan with the **Operational Coordinating Group (OCG)**, who had deployed personnel to Ullswater, the TCG started to direct water rescue and other resources to the area. These included out-of-county water rescue teams and military vehicles with wading capability. The employment of these assets had been negotiated by the SCG and authorised by other LRFs, and in the case of the military assets, by the Ministry of Defence or by **COBR** itself.

Over the following hours, with everything in place, the integrated response was delivered effectively and ensured that Glenridding, Patterdale and other communities were safely reconnected to support lines, which included the delivery of food and water and the restoration of utilities.

61. Once the response phase has ended a transition occurs whereby the chair of the Strategic Coordinating Group hands over responsibility for the recovery operation to the chair of the Strategic Recovery Coordination Group (SRCG). The SRCG is usually chaired by a senior local authority officer, with the group taking strategic oversight of and setting direction for, the activities of a range of sub-groups (Appx 3). Each of these groups takes responsibility for coordinating recovery activities within their specific sectors (e.g., infrastructure, health and wellbeing). Unlike response, where the emergency services take a leading role, the operation of the SRCG will involve a much broader contingent of organisations, with greater private-sector, voluntary-sector and community-based representation.

62. The first three JESIP principles (co-location, communication and coordination) are relatively straightforward. In effect they simply promote the idea that responders should co-locate, either at the scene (operational) or at a command facility (Strategic/Tactical), in order that they can communicate with each other and coordinate their multi-agency response. The review, therefore, focussed on the final two principles and explored lessons related

to how the highways sector has collaborated in understanding risk and gaining shared situational awareness during extreme-weather events. It also looked at the capabilities of the personnel whose role it is to take part in multi-agency integrated emergency management on behalf of their organisation.

3.1.1 Suitably Qualified, Experienced and Empowered Personnel (SQEEP)

63. Evidence of the effectiveness of the multi-agency approach to extreme-weather impacts on the highways networks during response and recovery was abundant in this review. However, it is also worth mentioning at this stage another crucial factor that appears to further underpin the effectiveness of this approach. That is the concept of Suitably Qualified Experienced and Empowered Personnel (SQEEP).

64. Undoubtedly, personnel sometimes need to make "career-defining decisions"[12] either at the scene of major incidents or in the coordination groups. For example, an account was given by one interviewee of an occasion when a duty officer had to make an out-of-hours decision that would later amount to a cost of £500,000 to the local authority. The decision was correct on this occasion, but the example clearly illustrates that critical decisions during dynamic response operations sometimes need to be made by relatively junior personnel.

65. Indeed, a consistent complaint made during post-incident debriefs focussing on the operation of Tactical and Strategic cells is that organisational representatives who lack the authority to make on-the-spot decisions on their organisation's behalf present real challenges to the effective running of these coordination groups (Deeming & James, 2017).

66. This challenge has also been recognised as problematic where trans-boundary issues are involved, i.e., where organisations' areas of responsibility differ from those of LRF members whose areas match those of the LRF (i.e., usually the county border that defines the local police area). The trans-boundary issue occurs because, for example, utilities companies tend to operate at regional level, which means that wide-area emergencies impacting more than one LRF area present challenges to these companies' abilities to support multiple SCGs/TCGs effectively (e.g., if dial-in SCGs are held at the same time by different LRFs).

67. From this perspective the importance of cross-border and regionally trained and rehearsed mutual aid agreements and coordination across borders (e.g., harmonising gritting routes and activities) becomes obvious. This does not, however, refer only to the operations of neighbouring Highway Authorities, it also relates to collaboration and coordination, by Highway Authorities and other partners (notably the Police) and the operators of the Strategic Road Network (SRN) at the interface between local highways and the motorway/trunk-road networks.

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[12] Footnote: This was stated by several interviewees.

68.   In the review into Cumbria's recovery following Storm Desmond, the authors identified the critical role that SQEEP personnel had played in delivering the recovery activities. Primary amongst these findings was the importance of the role played by the senior managers in the highway authority in setting in place the Authority's recovery strategy. This included the setting up of a non-partisan infrastructure group of Elected Members, which took initial oversight of the programme development. The setting up of this group, whose key focus was on returning Cumbria to an 'open for business' status in the eyes of the public and government, ensured that not only were decisions related to the prioritisation of repairs expedited, but the SRCG's Infrastructure sub-group was given significant responsibilities to carry out key repair projects, because they were trusted to do so.

69.   This included the Highway Authority being given the authority to use NEC3 EEC option E cost-reimbursable contracts to secure contractor capabilities for the most critical repairs (NEC, 2018). In effect this meant that the County Council bore much greater risk than would normally be accepted. That this process was adopted clearly illustrated the Members' Infrastructure Group's confidence in the Highway Authority team's project management capability (see section 3.7.2.1: Cumbria's Infrastructure Recovery Programme).

70.   Another example of SQEEP at the senior level related more directly to interoperability during response. In the midst of the 'Beast from the East' snowfalls in Devon in 2018, the duty Silver for Devon Highways was in the midst of managing significant disruption to the county's networks when he was approached by the Police and asked if assets could be assigned to 'rescue' off-duty staff snow-bound in a hotel. In a situation where the same local authority officer was making concurrent decisions to reopen snow-blocked road links to isolated villages (see section 3.2), the decision to refuse the Police request to divert assets toward the hotel seems obviously correct. However, the fact that the local authority officer was able to make that decision in the face of a direct request should not be discounted. It illustrated clear thinking and prioritisation on the officer's part, in contrast to that of the police, who as lead authority in the response were clearly adopting a reactionary, rather than risk-based, approach to activities.

71.   This finding was mirrored in several discussions with participants from other authorities in the review. Furthermore, all these discussions reinforced the learned point that where SQEEP personnel had been engaged at every tier of the Strategic, Tactical, and Operational response then, communication, coordination, situational awareness, understanding of risk and the effective mitigation of consequences had been enhanced.

72.   This should be seen as validation of the importance of training and exercising in readying personnel at all management levels for their potential roles in delivering integrated emergency management (see section 3.7.1). However, it also indicates the critical value of cultivating trust relationships throughout the organisational hierarchy.

73.   Emergencies create circumstances of inherent uncertainty and, accordingly, good decisions and errors may be made in the heat of the moment by those acting on limited and often contradictory information (MacFarlane & Leigh, 2014). What organisational theory suggests is that an organisational culture

that encourages emergency preparedness and accepts that decisions may be made that are not perfect, but which invests in training to build competence as inclusively as possible, will be more resilient than those that do not (Weick & Sutcliffe, 2007).

74.   From the trust perspective, therefore, it is critically important that duty personnel are confident in two things:

- …that when they have been selected onto the duty rota, they know that they have sufficient professional skills and knowledge to represent their organisation and to make decisions at the appropriate level.

- …that they are confident in knowing that if they were judged to have met the standard required to be placed on the duty rota – therefore increasing the likelihood that critical decisions will need to be made *by them* under conditions of uncertainty – then these decisions will be supported by their line managers.

75.   The SQEEP concept will be further discussed in relation to training in section 3.8.1.

Observation 1: The concept of Suitably Qualified, Experienced and Empowered Personnel (SQEEP) appears to be useful in helping to understand how effectively Local Highway Authorities are able to engage in multi-agency integrated emergency management.

3.1.2 Shared situational awareness (SSA): communicating with partners

76.   As one of the five interoperability principles, shared situational awareness (SSA) is key element of emergency management. Therefore, some of the ways in which Highway Authorities have gained situational awareness of their assets condition during and after extreme-weather events, how they have shared that information with other responders and how they have improved the ways in which they attain SSA as a result are worthy of note.

3.1.2.1 Shared Situational Awareness during response operations

77.   Attaining situational awareness during an extreme-weather event is inherently difficult. If the area impacted is geographically extensive, then this only adds to the difficulty in understanding what is happening.

78.   From this perspective, the importance of adopting a multi-agency approach to collating diverse sources of information into one common operating picture (a "single truth") becomes particularly important.

79.   During extreme-weather events Tactical and Strategic coordinating groups are dependent on a range of information sources. In respect to the forecasting of potential weather impacts, the Met Office, the roads forecasting services and the Flood Forecasting Centre (FFC) provide critical weather and hydrological information and warnings, including the FFC's

daily Flood Guidance Statement. These forms of information allow partners to decide whether escalation, to increase preparedness and/or to initiate a multi-agency response, would be justified. As impacts commence, however, information will flow in from a much more diverse range of sources, such as from operational personnel at impact scenes and from the public via control rooms and, increasingly, via social media.

80.   During the 2015 storms, LRF partners' experiences of the balance between forecasting and warning and live on-scene reporting in providing accurate situational awareness were mixed. In some places the weather warnings were found to be accurate and useful, whereas in others the difficulty in accurately forecasting weather effects at very local scales meant that circumstances on the ground deteriorated much faster than the weather and flood models were predicting.

81.   Two useful examples of such disparities are:

- the situation in Kendal (Cumbria), when by the time a highest 'Red' weather warning had been issued for the area, all main access routes into the town had already been cut off by rising rivers and surface-water flooding.

- the situation in Calderdale, when a member of council staff with experience of the floods in 2012, contacted his Director to say that the river conditions at his location above Hebden Bridge were already objectively worse than they had been in 2012 and that in his opinion a major incident should be declared (see section 3.3.2).

82.   Undoubtedly, best efforts were used by all impacted authorities at the time to understand and respond to weather effects as best they could: saving lives and reducing consequences as a result. These two examples, however, illustrate that attaining shared situational awareness and forming that knowledge into a joint understanding of risk is inherently difficult for responders generally, and specifically indicates a requirement for further consideration by authorities in how they reflect on lessons from this report for themselves.

3.1.2.2 The Multi-Agency Information Cell (MAIC)

83.   As a means to address this challenge, guidance published since 2015 on developing multi-agency shared situational awareness has broadened to introduce a new concept. In 2016 JESIP guidance was issued that encourages the formation of a Multi-Agency Information Cell (MAIC) as a component of the Strategic Coordination Centre (SCC) structure:

> "The Multi-Agency Information Cell, which may come together in either a physical, co-located form, or virtually, should have the capability to source, access, analyse, display and disseminate situational information, drawing on information and expertise from a range of emergency responders, not just one single organization. Both co-located and virtual arrangements for a Multi-Agency Information Cell should make use of ResilienceDirect™ as the common platform, or another suitable system." (JESIP, 2016: p13)

84.   Given the amount of data generated and processed by Highway Authorities' own monitoring technologies (e.g., CCTV, weather stations, control rooms), it is reassuring to note that several authorities are in the active development stages of building an explicit MAIC capability within their local resilience forum/partnership. At a recent meeting to kick off the planning for the COASTEX 20[13] major coastal flooding exercise, I was impressed to see that virtually all participating LRFs had proposed MAIC-related exercise aims and objectives: they all wanted to see how the concept could be usefully tested and improved.

85.   Progress in the deployment of remote-sensing technologies has also been made since 2015, with some Highway Authorities now actively monitoring flood-vulnerable structures using video and differential GPS and defining trigger-points to denote when these structures (e.g., bridges) should be closed and/or subjected to a rigorous post-incident survey.

86.   To further buttress their MAIC capability in relation to social media, some Highway Authorities are also moving toward the development of a Virtual Operations Support Team (VOST) capability. The VOST concept, as it is applied to emergency management and disaster recovery, is a process through which new communication technologies and social media tools are used by VOST teams to lend support to those on-site or in coordination facilities who may otherwise be overwhelmed by the volume of data generated during an emergency. VOSTs can be activated to perform specific functions in support of affected areas, which include[14]:

- Gathering and providing real time information to the public
- Distributing key safety messages during a major incident or emergency
- Countering misinformation
- Providing better situational awareness for incident commanders by gathering geo data, text, pictures, video, or a combination of these media from the public

87.   As a leading proponent of the concept, the Dumfries and Galloway Local Resilience Partnership has now integrated VOST (@DGVOST) as an essential component of the D&G MAIC process. This can be activated as a pre-response whenever the impact of a high-risk hazard is forecast: most recently for Storms Ciara and Dennis in 2020. Other partnerships are also experimenting with the concept.

Observation 2: The development of multi-agency information cell (MAIC) and virtual operations support team (VOST) capabilities by extreme-weather affected local resilience partnerships clearly illustrates good practice in improving information

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[13] Footnote: COASTEX 20 was postponed in March 2020 due to Covid-19
[14] Footnote: Dumfries and Galloway VOST website - https://dgvost.uk/

management processes during emergencies, including highway-network affecting emergencies.

3.1.2.3 ResilienceDirect™ and other "suitable systems"

88.   *ResilienceDirect* (RD) is the current Cabinet Office IT solution to ensure responder partnerships are able to communicate effectively with each other and with higher coordination tiers. RD provides a fully-customisable hierarchy based around 'Communities' that can hold unique content pages, document repositories, or sub-communities. Each such object can be assigned unique security groups and parameters, allowing for both practical fluidity and the strict control of information through the Command and Control networks that Strategic, Tactical and Operational Commanders rely upon during a Major Incident.

89.   Use of RD has increased over the past 3 years, with it now serving over 56,000 people in the resilience sector[15]. However, local authorities still use it to varying degrees and its use does not appear widespread amongst highway authorities.

90.   A core feature of the RD *Collaborate* service is allowing partners to record and share their priorities, actions and rationale in real time. This is a fundamentally important procedure that is encouraged within emergency management doctrine, because it provides an invaluable, contemporaneous, evidence base that can inform any subsequent assessment, investigation or inquiry about the way any particular incident was managed at the time, without introducing the complicating factor of hindsight bias.

91.   As a tool to build situational awareness, or what is referred to as a common-operating picture (COP), RD's effectiveness is highly dependent on the depth to which RD has been integrated into an authorities' procedures and across the wider LRF. Some of the oft-mentioned limitations of RD have been the commitment needed for operator training and the still relative aging and "clunkiness" of the user interface and its counterintuitive functionality.

92.   In relation to managing emergencies on highways, the current RD mapping app also has a relatively limited utility, in that it needs to be updated by an operator rather than it being dynamic by default (e.g., road and bridge closures need to be physically entered onto the system with appropriate icons, lines). The system is also fairly limited in its ability to link to and stream any sort of live footage (e.g., CCTV, drone), however the RD team are now working with AirBox Systems to modernise the mapping component

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[15] Footnote: RD user numbers correct on 29th June 2019. Registrations subsequently spiked to 75k users during the height of the initial Covid-19 response.

and allow integration with some 3rd party applications, e.g., the *What3Words* geo-location App.

93. Such limitations are obviously a concern, because effective emergency management depends on accurate and up to date information and RD is actively promoted as the government's preferred platform for emergency-related multi-agency communication.

94. In relation to interviews for this review, there was a general opinion that whilst RD is useful for some things, the level of technical complexity required to map asset condition in ways that can best support the levels of situational awareness for the RD audience (NB. this will include DfT and COBR during major emergencies), could not yet be readily integrated into the system. In effect RD was suggested as requiring at least "an additional layer" of information on top of that which is currently available. In addition, the Cabinet Office platform is somewhat proprietary in nature, and requests for change are not managed in a fully agile manner, which inevitably extends implementation turn-around time.

95. Whilst Maj-General Cross, in his review of Multi-Agency Flood Plans (Cross, 2018) identified similar issues with RD, this observation, that an additional layer of technical information is required to provide real utility, certainly adds to Cross's concerns about the current system. This is not only because information specific to known-vulnerable infrastructure would be useful to be able to share on a common platform such as RD. It also cuts back to the discussion of awareness, specifically awareness of multi-service 'conduit' assets that sit on Highway Authorities asset inventory, but about which little may actually be known (e.g., Tadcaster Bridge; see section 3.2.1).

96. From this perspective, the general lack of information held by Highway Authorities about which of their assets bear additional elements of critical infrastructure (e.g., key fibre networks) appears to be a problem waiting for a solution, which RD could potentially provide.

97. This is because RD is a secure system requiring authentication and permissions to use. Accordingly, RD would appear to be an ideal venue on which to host detailed layers of information about multi-utility conduit assets of local, or at least of regional or national importance. Having such information available as a national dataset would undoubtedly assist responders with the correct clearance (e.g., the Strategic coordination / Gold command cadre) to efficiently assess risks to those assets and to work toward implementing them into future iterations of both the RD Collaborate and RD Mapping component of the RD service.

98. Whether RD has the capacity to support such functionality currently appears unlikely, but (pending the development of the appropriate datasets) this certainly seems to be a fitting objective for the Cabinet Office RD team and other departments to work toward in later versions of the system.

99.   One option could be for the Cabinet Office and ResilienceDirect team to build on existing collaborations between Highway Authorities and private sector partners, such as Gaist who have the capability to conduct rapid asset-condition surveys, to develop a system that could feed such data directly into RD when required.

100.   In addition, or rather, in parallel to RD, regional operations rooms such as those operated by the resilience partners (e.g., Police), SRN operators and Transport for Greater Manchester have significant monitoring capabilities, including CCTV systems whose signals can be sent directly into the Strategic Coordination Centres if they have the appropriate technology, e.g., the Greater Manchester Police (GMP) Force Command Module. Live feeds such as these and other CCTV systems operated by local authorities obviously provide potentially invaluable information for decision-makers with access to them.

101.   However, in relation to alternatives to RD acting as "suitable systems" for building situational awareness, much to the surprise of the author, one senior Highway Authority officer stated that the first app his team tended to open during an incident likely to involve an element of highways management was the Google™ traffic map. This was because it provides better real-time information on traffic flow than is available via any of his authority's IT systems. This is due to its use of vehicle-borne mobile-device signals and temporary roadworks information, to detect traffic average speed and from that, to identify points of traffic congestion.

Observation 3: ResilienceDirect (RD) is the Government's preferred IT platform for sharing emergency management related information. However, the current system is not yet able to support key additional GIS map layers which identify a number of highways critical information streams, e.g., known-vulnerable structures (and information related to their intervention trigger points), assets containing multiple utilities infrastructures, live traffic data. This is a significant lack of capability. Accordingly, it appears that Local Highway Authorities need to either: 1) work with the Cabinet Office to suitably increase the capability of the RD platform, or 2) continue to develop other contingencies for dynamically sharing their information with partners (including within Strategic Coordination Centres and, trans-boundary, with neighbouring Highway Authorities).

3.1.3 Shared Situational Awareness (SSA): communicating with the public

102.   Whilst the importance of shared situational awareness (SSA) between responder partners when preparing for, during and after extreme-weather events has been discussed above, crisis communication with the public is also inextricably linked to good SSA. It is also, of course, one of the indicators of resilience suggested by Brown et al.'s resilience review.

3.1.3.1 Communicating with the public during extreme weather events

103.   Increasingly, the public are becoming part of the situational-awareness formation process. Social media is now ubiquitous, and the review heard a number of examples given to illustrate how social media has been used to both draw information from and to pass information to the public during extreme-weather events. Social media are, however, still only one group of useful technologies within the crisis-communications inventory.

104.   Using these technologies effectively demands the development of a communications strategy that encourages a flexible approach to public communication, but one which above all else complies with the universal principle, that the message content has to fit both, the needs of the audience and the requirements of the risk communication situation (e.g., motorists being told to use a specific diversion route).

105.   It has long been suggested that the best strategy for crisis communication with the public is to share a consistent and appropriately formatted message across a range of media and via methods and sources that benefit from high levels of public trust (e.g., local radio) (Mileti & Sorenson, 1990). Traditional TV and radio information bulletins can now, however, be supplemented with information posted on a broad selection of social-media platforms (e.g., websites, Twitter™, Facebook™). Communication with motorists travelling on major roads can also be conducted via Variable Message and Matrix Signage assets at the roadside.

106.   This diversity of means available to broadcast messages has been used to great effect to apprise motorists of hazardous road conditions. However, as will be discussed later in relation to the M62 diversion during the Beast from the East, gridlock can still occur. In such circumstances, where stranded motorists' welfare becomes a principal concern, the effective sharing of useful information becomes particularly important.

3.1.3.2 Variable Message and Matrix signage

107.   Plate 2 is used here to illustrate how important it is to maintain a dynamic approach to communications as road conditions and drivers' circumstances change. The image illustrates a matrix board providing a snow warning to motorists on the M80, which is already close to gridlock due to snow.

108.   Traffic Signs Regulations and General Directions, 2016 (Schedule 15) stipulates that Matrix signs can provide "information, *warning, requirement, restriction, prohibition or speed limit*" in relation to information on a temporary hazardous condition. Schedule 16 of the same regulations then sets out the message configurations that can be used on matrix signs. In effect, the information that can be placed on the boards appears to be constrained to strictly specified formats. However, there is some evidence that network operators have innovated during incidents and provided motorists with other types of information in short-message form (e.g., 'Listen to Local Radio Stations').

Plate 2: Gridlocked traffic on the M80 in Scotland during the 'Beast from the East' is informed of a Red Snow Warning. Should a provision be made that these assets could be used to provide information to assist them develop situational awareness (e.g., lo local radio frequencies; traffic-information focussed Twitter accounts)? Source: BBC[16]

109. Therefore, given this apparent willingness to use relatively informal information messages on matrix signs, an assumption can be made that the network operators do apply a flexible approach to message content, rather than feeling strictly bound by the regulations. Accordingly, it would seem appropriate to suggest that exploring message configurations for different message-use contexts (e.g., gridlock) to better assist motorists to gain situational awareness during extreme-weather events should be encouraged. For example, guidance on the use of social media hashtags (which were reportedly successful in generating situational awareness on the M62, see below) might broaden their use, beyond a few innovative operators.

110. A second concern about VM/matrix signs was also mentioned several times. This concern related to the fact that when a motorway or trunk road is closed, for whatever reason, the diversion route agreed with the affected Highway Authority, for all intents and purposes, becomes the motorway. Accordingly, in expressing concern about the effects that diverted traffic has had on their local networks, several interviewees suggested the need for more effective use of VMS signs on the main routes.

111. This included the suggestion that messaging geographically much further away from the point of disruption may facilitate better decision-making by

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[16] Image attribution: BBC News - Gridlocked Traffic on M80: https://www.bbc.co.uk/news/uk-scotland-43222960

motorists. One example given would be that if deteriorating driving conditions were being experienced in Devon, then signage should be suggesting motorists refrain from driving south from as far back as Birmingham (combined with media broadcasts to the same effect). From an evidential perspective, it would be interesting to understand if research has been done, or could be commissioned, to assess whether such suggestions might be valid[17].

Observation 4: The role of VM/Matrix signage during emergencies appears to be an issue that would benefit from focussed research to assess how it can best be used to reduce risks to the travelling public during extreme weather.

3.1.3.3 Internet and Social Media

112.   Apps such as North Yorkshire's interactive road works map[18] and Cumbria Constabulary's Traffic incident map[19] are just two examples of web-based apps developed to use organisations' own data to provide public service travel information. Local highway information is also obviously available to motorists via commercial apps, such as one.network[20] and the Google Traffic-map (see section 3.1.4).

113.   From a proactive traffic-management standpoint, however, interviewees were keen to say how their organisations also used Facebook and Twitter accounts during incidents to share key travel information. In several cases, these outputs were reported to have reduced pressure on more traditional telephony-based helplines significantly.

114.   From this perspective, comparative statistics supplied by Somerset County Council in relation to their use of their Twitter handle (@TravelSomerset) and their more traditional communication technologies are particularly informative.

115.   During the four days of Somerset's management of the Beast from the East their standard telephony-based 'Helpline' number received 25 calls related to snow, two of which came out of hours. This compares to thousands of hits and impressions on the council's social media output, with many of these occurring out of office hours suggesting that the social media content was being used by the public late-night and early morning to inform their travel decision-making.

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[17] Footnote: Para B.7.5.16 of *Well-Managed Highways* suggests that such evidence exists, but no references are provided.
[18] Footnote: Weblink to North Yorkshire CC Roadworks map: https://www.northyorks.gov.uk/roadworks-map
[19] Footnote: Weblink to Cumbria CC Traffic Map: https://www.cumbria.police.uk/Traffic/Traffic.aspx
[20] Footnote: Weblink to One.Network Mapping: https://one.network/

116.　In relation to the M62 snow and wind event, the role of social media was also reported there as a key facilitator in successfully engaging with stranded motorists. With 2,000 people stranded it is perhaps little short of remarkable that Highways England received no complaints. This was partly put down to a social media effect wherein social media usage by those within the gridlock self-regulated and developed a central meme, through to-and-fro messaging between those stuck, that the authorities were doing the best they could.

117.　The combination of respective effects of HE and the Police's visible response activities, in this case, combined with their public-information tweets, which generated public interaction (initially with these tweets and then between vehicles), to develop situational awareness within the gridlock, was described by the authorities as their "saviour from heaven".

3.1.3.4 Communication with the public during recovery

118.　As well as providing increasingly important means through which to communicate with the public during extreme-weather events, social media is now being used to manage the public/s understanding of recovery operations.

119.　Obviously, web-based road works and traffic-incident information apps used by authorities are helpful in providing map-based information. Local authority websites are also used to provide details of complex long-term recovery focussed activity. For example, initial circulations in relation to diversion routes and safety advice have, over time, evolved to focus on more public-engagement type activity, such as providing information about and invitations to participate in public meetings to discuss (e.g.) highway or bridge repair progress and/or options [21].

120.　In relation to the direct aftermath of an extreme event, however, examples of significant successes in providing information to the public were reported to have been achieved through the use of, what were effectively social media platformed public information films.

121.　In both Cumbria and Calderdale, films were used to demonstrate to the public the scale of the challenges faced in terms of infrastructure repair, but also to explain the reasoning that underlay the need for protracted data-collection, analysis and options development that preceded the commencement of major repair works. Good examples of these outputs include Calderdale Council's time-lapse film of the repair to the A646 at Falling Royd[22] and the initial removal of Copley Bridge[23].

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[21] Footnote: Eric Wright Group: Social Media invitation to public consultation in Cumbria: https://twitter.com/EricWrightGroup/status/1065287257056268289
[22] Footnote: Video weblink - A646 Falling Royd Flood Recovery: https://www.youtube.com/watch?v=Ec2DN2OrXwc
[23] Footnote: Video weblink - Copley Bridge Flood Recovery Works https://www.youtube.com/watch?v=DMqIzoKwSY4

122.   In Cumbria the critical importance of the A591 (see Box 2) in providing a central (non-trunk) route through the middle of the county meant that its closure rapidly caused considerable public consternation. Complaints focussed on a broadly held public perception that insufficient progress was being made to reopen the road. However, the repair task faced by the authorities was enormous.

123.   Accordingly, a strategy was developed between the authority's highway managers and its communications team to develop a suite of films to explain these geo-technical and operational challenges to the public. Evidence clearly suggests that the publication of these films on-line[24] effectively stopped public complaints about the speed of the work overnight. Further films were also made to demonstrate progress, for example, on specific repair projects[25]. A film to illustrate bridge surveying under Victoria Bridge in Kendal (whose closure was another source of public frustration) also proved popular and informative, receiving over 23,000 views[26].

124.   Another critical element of public communications during recovery is the role of communication as part of the consultation process. From this perspective, flood affected Highway Authorities have been engaging with the public in relation to a host of recovery-related issues, such as when bridges and roads would be opened and, longer term, whether plans for (e.g.) replacement-bridge designs are in accordance with the wishes of the local communities.

125.   This has not been an easy task, as it has been important to balance the prioritisation of works against the need to minimise the disruptive effect of (e.g.) road closures and repairs against complicating factors such as community events, high-tourism periods (e.g., bank holidays) and environmental phenomena such as fish spawning in rivers.

126.   Faced with prioritising works that need to take such a complex range of factors into account has involved concerted consensus building by the authorities involved, assisted by their partner organisations. However, it appears that in many areas this long-term consultation-based approach has been successful in both helping to manage public expectations, but also in developing the appropriate outcomes for communities.

Observation 5: Local authority and partner agency communication strategies, which encompass and encourage active social media usage have proven that they provide

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[24] Footnote: Video weblink - A591, Understanding the impact: https://www.youtube.com/watch?v=amYwSYgE1go&t=8s
[25] Footnote: Video weblink - Pooley bridge opens: https://www.youtube.com/watch?v=AjTL9bZ3CAk
[26] Footnote: Video weblink - Victoria Bridge, underwater survey: https://www.youtube.com/watch?v=Hcsw_nD88pY&t=153s

both a useful service for the public and an additional information source, which can help responders develop situational awareness during emergencies and recovery.

3.2 The concept of 'stabilisation'

127. Following the impact of Storm Desmond on Cumbria, the critical task of restoring public safety and social continuity, within an *emergency*-dominated landscape of damaged, fragile and destroyed infrastructure, was considerable. Initially, due to the scale of impacts, there was a genuine risk that without intervention, already-damaged infrastructure could fail further. This could have caused previously unconsidered, and potentially larger secondary or tertiary impacts, which could have been argued in retrospect to have been unnecessary or at least likely to have been preventable (Deeming & Burgess, 2017).

128. The scale of the storm's impact on roads, bridges and other infrastructure meant that any rapid recovery, to even a new normal, was guided by four immediate considerations:

    I.   the need to prevent people's exposure to continuing risks of injury.
    II.   the need to prevent further degradation of – and/or enchaining risks accumulating from – damaged assets.
    III. the need to allow planning space in which to develop a combined, social, environmental and economic risks-based approach to ongoing contingency management, and the prioritisation and delivery of repair and reconstruction.
    IV.   the understanding that even with the most intensive civil engineering and project management expertise applied, replacement infrastructure works can take 2 to 3 years to complete: as evidenced by the experiences of Cumbria and Calderdale.

    NB. Point III includes the importance of providing necessary space to consider the options for doing the *right* things well, rather than just doing something, for which there is an often-significant psychological need from the general public and exhausted responders.

129. Whilst the concept of stabilisation does not currently feature within the doctrine of integrated emergency management, participants in both the Cumbria Recovery review and this review have stated their belief in the value of the concept in describing the circumstances they found themselves managing in the short and much longer-term infrastructure recovery activities from December 2015 through to the present.

130. In some situations, the interim provision of sufficient assets to ensure storm-impact stabilisation (e.g., operations teams placing Heras barriers around damaged bridges: Plate 3), undoubtedly reduced risks, prevented further consequences and provided a vital measure of confidence, and space, for the authorities and affected communities to adjust.

131. Due to the scale of the storms' impacts across the county and the increased demand these placed on the authorities and their delivery partners' capabilities and capacities, many such interventions stayed in place for

weeks or months following the storm. This should not, however, be suggested as devaluing the usefulness of the stabilisation descriptor. On the contrary, it helps clarify the different phases of the emergency experienced by the county, by allowing responders to communicate, honestly and openly, to the public the complexity and the projected duration of future recovery efforts.

132. Effective communication with a hazard-affected public exemplifies a type of transparency that builds trust. Thus, the concept of stabilisation is more likely to engage stakeholders with the need for the collaborative co-development of acceptable eventual outcomes (e.g., locally agreeing effective diversion routes in the short term and in the longer term, making decisions over issues such as bridge design).

Plate 3: Bell Bridge on the River Caldrew, south of Carlisle, collapsed in late January 2016, as a result of damage sustained during Storm Desmond a month earlier. These images from July 2017 illustrate the closure (stabilisation) of the bridge pending the implementation of the full reconstruction (recovery) project. Note the information board which has been designed to explain the on-going process to the public.

133. Since 2015, Cumbria has moved from a pre-storm *Normal,* to a post-storm *Fragile* to *Stable* and will be fully recovered to a new normality over the coming years. Stabilisation has been, therefore, a distinct phase within the integrated emergency management cycle (Figure 2).
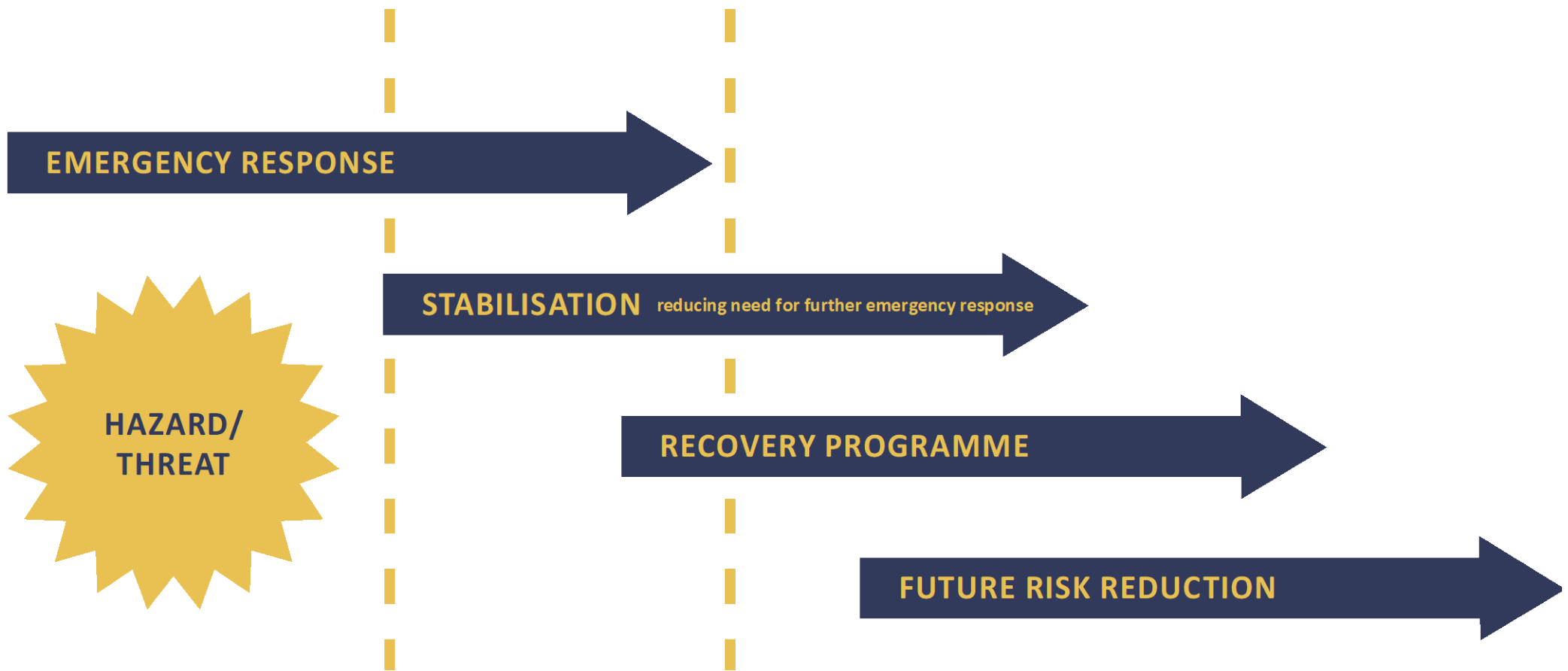
Figure 2: Idealised representation of an overlapping sequence of response, stabilisation and programmed recovery activity, as experienced by Cumbria LRF following Storm Desmond.

Note regarding Figure 2:

This diagram illustrates a simple linear progression, from response through to future risk reduction. However, it should be noted that Cumbria's initial experience was of managing a series of hazard impacts (i.e., a series of storms, one after the other) which introduced a recycling process of response>stabilisation>response, with recovery delayed until the manifesting dangers had passed.

It is also useful to note that extreme-weather effects are not the only hazards to display this type of repetition. The review also heard recollections of the response to the Salisbury poisoning incident. This started with the poisoning of the Skripals on Mar 4th, 2018, but three weeks later, when recovery was coming in train this activity had to be stalled as the same level of CBRN response had to be reactivated on 30th June, when two further victims were affected in Amesbury, 7 miles from the city.

134.   As a result of their experience, Cumbria's authorities are now increasingly promoting and integrating the following definition of stabilisation in their contingency planning processes.

> Stabilisation: The exercise of interim control following an incident in order to increase public safety, mitigate further damage and to reduce the likelihood of secondary impacts occurring.

Observation 6: Stabilisation appears to be a useful concept for Local Highway Authorities to adopt in order to help them to understand and to explain to the public, their intentions, plans and activities following physical damage to highways assets.

3.3 Resilient networks

135.   The identification of a "Resilient network" by each Local Highway Authority was recommended in the Brown review and issued as guidance in *Well-Managed Highways Infrastructure* in 2016.

> A.4.4.1. A 'Resilient Network' should be identified which will receive priority through maintenance and other measures in order to maintain economic activity and access to key services during disruptive events.
>
> - The resilient network is suggested to likely include:
> - those routes crucial to the economic and social life of the local or wider area;
> - take account of repeat events, e.g., flooding;
> - and local factors.
>
> (Well-Managed Highways Infrastructure, 2016: p.28)

136. The guidance goes on to suggest which highways assets should be considered for inclusion in the resilient network, with examples being given down to the scale of minor access routes to individual water-treatment works (because they may require essential chemical deliveries during bad weather).

137. Obviously, as well as schools, factories and commercial centres any Highway Authority's operating area will contain countless third-party assets (such as water treatment works), whose disruption could bear consequences for large numbers of people. Therefore, from a Highway Authority perspective, it is vital that an appropriate risk-management approach is applied to the designation, or not, of such assets as critical infrastructure, if (e.g.) access routes to them are to be justified by their inclusion in the authority's resilient network.

138. However, enabling local business continuity is not the sole responsibility of the Local Highway Authority. The author heard varied accounts of Highway Authorities' responder partners' contingency plans for weather disruption either working or failing. Accounts included that of a local NHS trust whose assumption – during the height of the 'Beast from the East' – was that the Highway Authority would provide assets to clear hospital on-site car parks of snow. This perhaps suggests both an inappropriate assumption made in contingency planning by the trust and/or a failure in communication by the Highway Authority. This is because, whereas access routes *to* hospitals are indeed suggested as needing inclusion in any authority's resilient network[27], and this authority met that requirement, what the Beast from the East exposed were the NHS trust's failure to understand the limits of its Highway Authority's extreme weather capabilities, i.e., clearing hospital car parks obviously requires considerable additional resources, including different types of equipment than those employed to clear roads.

139. Such examples clearly illustrate the need for Highway Authorities to manage the expectations of partners and through communication, encourage them to develop their own capabilities at a very granular level during the planning stages for extreme-weather events (see section 3.8).

140. By contrast the author also heard of a utilities company developing contingency arrangements directly with local farmers in order to ensure their personnel could access critical facilities isolated by weather effects. Contingency arrangements such as these clearly show the value of all partners understanding the capabilities and capacities of their Highway Authorities and that they need to understand and develop their own explicit contingency arrangements for risks to which they are exposed.

Observation 7: Local Highway Authorities need to proactively manage the expectations of their partners in respect to how the highway network will be

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[27] Footnote: see Section 6.3.2 of Well-Managed Highways Infrastructure

managed during emergencies. Partners and businesses in their supply chains should be supported in carrying out their own risk-assessments to identify appropriate (e.g., private sector) contingencies for mitigating the impact of extreme-weather effects on their assets and services[28].

141.   By contrast in other high-risk contexts, the author heard of considerable effort and initiative being applied by Highway Authority personnel to open routes to isolated, vulnerable, communities.

142.   In much the same way as Glenridding is used to illustrate multi-agency mobilisation to reach a community isolated by flooding (Box 1), a Devon Highways officer recalled their experience of needing to adapt operating procedures dynamically, whilst remaining within safe-working parameters, in their effort to plough an access route into Lynton and Lynmouth during the Beast from the East snow fall.

143.   These examples reinforce the importance of Highway Authorities working with their partners to build and maintain a joint understanding of all highway-network related risks, throughout the emergency management cycle. They also illustrate the need to accept that what constitutes a 'resilient network' in the planning stages needs to remain flexible in the face of changing circumstances and unanticipated surprises during an actual event.

144.   In this context, where Highway Authorities reported their need to be able to assess the feasibility of maintaining a resilient network dynamically during extreme weather, this issue of contingency planning becomes critical to multi-agency emergency management. A clear message was that businesses and organisations should not make assumptions about Highway Authorities' ability to support them during extreme weather. They will do their best, but risk-based approaches adopted by Highway Authorities will naturally and quite correctly prioritise higher risks[29]

Observation 8: Extreme-weather effects can manifest in ways that challenge 'resilient network' plans. Effective Local Highway Authorities maintain the flexibility to iteratively reassess risks in order to adjust resilient networks as circumstances require.

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[28] Footnote: The Civil Contingencies Act places a duty on responders (e.g., NHS trusts) to maintain business continuity arrangements for its activities. It also places a duty on local authorities to provide advice and assistance to those undertaking commercial activities in relation to business continuity management.

[29] Footnote: The author was told of an incidence when the Highway Authority Silver had to inform the Police that it really was not a priority for him to divert highways capabilities from the main roads to 'rescue' off-duty hotel staff cut off by snow in an isolated hotel with power and food.

3.3.1 Critical highways infrastructure and close coupling

145.   Assets that are critically important to the continuity of communities, counties, regions or nationally are not, however, only served by the highways network. In many cases the critical asset is borne by the highway itself. There are few better illustrations of the risk from extreme weather acting on a critical piece of infrastructure than that which occurred with the partial collapse of the Tadcaster bridge in North Yorkshire as a direct result of the December 2015 storms. Not only did the failure of the bridge directly impact the community it served, by effectively cutting Tadcaster in half for vehicular traffic, but also utilities carried within the bridge were disrupted, resulting in several regional-scale impacts. The collapse also had direct effects on the response-effort itself, as a result of the damage caused to the Airwave emergency services communications system which was carried within the bridge structure (NYFRS, 2016).

146.   The emergency coordination structures set up by North Yorkshire resilience forum members identified what services the bridge was carrying within hours. However, the fact that the proximate/parallel nature of the exact services damaged within a single structure had not been clearly understood as making it vulnerable to multiple-sector affecting single-point failures prior to the collapse could be seen as a cause for concern in the highways sector specifically (as it is the highways assets that are ultimately the 'hosts' of these other infrastructure components, e.g., gas mains, fibre cabling).

147.   Information on points (bottlenecks) where paralleling of infrastructure occurs is vital for the development of resilient network plans. However, review participants expressed their frustration that progress had not been made in developing a methodology to assist Highway Authorities to better understand, map and monitor these locations.

148.   It was known within the sector that a recommendation had been made to DfT to identify 'single points of failure' within the strategic networks[30]. However, it was understood by review participants that this recommendation had not yet resulted in the release of any data or analysis by DfT. Furthermore, participants shared the opinion that any outputs from such an investigation would be significantly enhanced if they also identified vulnerable paralleled infrastructure assets on a national scale, or at least developed the methodology and provided partners with the impetus to identify these assets for themselves.

149.   At this point it is worth reflecting on how a different project approached this same issue. In 2013 the London Resilience Team conducted an investigation of critical infrastructure (CI) interdependency in London. Ultimately, the project developed a framework which can be used to help

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[30] Footnote: Brown et al. (2014) Recommendation 4: "The DfT should work with researchers, the devolved administrations and the transport industry to further consider whether there are potential 'single points of failure' in the strategic transport networks, which leave parts of the country at risk of having vital economic and social links severed."

understand CI interdependency and the effects that can cascade from infrastructure failure (Hogan, 2013).

150. Participants in that research too, supported a need for responders to know *a priori* where single-point failures could occur on key CI networks. To reflect these concerns the *Anytown* report stated and recommended the following:

> "Strategic decision makers in London (and anecdotally, elsewhere in the UK) have requested a 'map' of Critical National Infrastructure, so that in the event of an incident they can appreciate the impacts of disruption. Utility companies have routinely explained that in addition to inadequately reflecting network complexity (self-healing abilities, etc.) the resultant document would have a security classification which would limit how it could be shared or used. Therefore, whilst network operators have maps of their assets, a combined topographical 'CNI map' is thought not to be possible nor [would it] adequately serve the purpose for which it would be intended. In addition, many Local Resilience Forums are now considering the identification of 'critical local infrastructure' as those assets which, should services be disrupted, would cause significant impact at the local level yet do not meet the criticality scale.
>
> Considering the complexity of displaying CNI, the display of this more locally significant infrastructure would add additional levels of complexity and make any such maps complicated to interpret. The Project Team therefore propose that decision makers should have good general awareness of interdependencies between, and consequences of infrastructure disruption; but that specific knowledge of network distribution be provided at the time of an incident by the most relevant organisation(s)."

(Hogan, 2013: p.18)

151. Returning to this report, what the response to the Tadcaster Bridge failure in 2015 illustrated in this same context, was that the impacts of a simultaneous single-point failure of paralleled infrastructure assets can be mitigated quickly and effectively, regardless of a lack of detailed knowledge about specific networks beforehand. This was achieved in North Yorkshire in two ways:

- Through the rapid activation of system bypasses and redundancy (i.e., 'self-healing') within CI networks by the network managers/owners (e.g., gas supplies being diverted around the affected asset).

- Through the dynamic sharing of situational information and awareness between the Category 1 and the Category 2 responders operating in, or linked directly into, the incident's Strategic and Tactical Coordinating groups, i.e., all partners were able to co-develop shared situational awareness of the developing risk and of the necessary mitigation measures.

Observation 9: Effective prevention and mitigation of single-point failures within paralleled critical infrastructure networks during extreme-weather events (and the cascading risks they present) can be achieved through dynamic information sharing between Category 1 and Category 2 responders. Rather than detailed mapping of potential network complexities and vulnerabilities, what appears to have been critical to resilience partnerships' abilities to manage these risks during major incidents, have been the relationships developed between these organisations during the planning and day-to-day operational management stages. One aspiration that should be taken forward from this point, however, is that despite the challenges presented by the sharing of potentially sensitive data, these partnerships should be seeking to coordinate even more effectively, to develop shared understandings of all vulnerabilities in their integrated systems prior to an event, not just in the heat and confusion of response.

152. Managing expectations in relation to the resilient network is not, however, an issue related only to Highway Authorities' intra-partnership working. Review participants also expressed their concerns over the difficulties they were experiencing in engaging the public with this approach.

153. One such difficulty related to the "last mile" concept. This concept is employed in the transport industry when referring to the final to-the-doorstep access issues related to the delivery of goods, which in haulage terms involves disproportionate time and resource consuming logistics (e.g., small delivery vehicles).

154. Concerns that were expressed about the resilient network went further than this. In some cases, the issue was not public expectations over the last mile, but actually related to the last 100 metres, i.e., the authority had to defend itself against complaints from people whose particular streets were no longer being gritted due to shrinkage of the prioritised networks or, during extreme-events, retrenching to a snow route due to dynamic capacity-overstretch considerations.

155. Whilst communications strategies have been dealt with elsewhere in this report, it is important to acknowledge that these 'last mile' issues have a political component. For example, aggrieved constituents may raise frustrations directly with their Elected Member. Accordingly, this presents another illustration of the importance of Highway Authorities securing strategic-level support and buy-in from senior officers and Members for risk-based decisions related to network prioritisation. Without this, the associated risk increases that those who shout loudest will receive preferential treatment whilst potentially as, or more, vulnerable people do not.

Observation 10: Network prioritisation during extreme weather is an inherently political issue. Local Highway Authorities can face considerable challenges in managing the expectations of the public in relation to this. Accordingly, it is critically important that risk-based management approaches are understood and supported

by suitably trained, experienced and empowered team members in corporate, strategic and elected-member cadres.

156.   A final factor that emerged in respect to Tadcaster bridge during the recovery phase, was the third-party ownership of the land adjacent to the bridge. The difficulty experienced in finalising project arrangements that met the needs and requirements of the landowner and those of the responsible authorities indicated that Brown et al.'s recommendation 7[31], regarding the development of a "landowner code of responsibility", had not yet been developed sufficiently to bypass such barriers to effective project management[32].

3.4 The Strategic Road Network (SRN) local highways interface

3.4.1 Closures and diversions

157.   Management of the interface between the Strategic Roads Network (SRN) and the networks operated by Local Highway Authorities was reported in mixed terms. One key concern was how best to manage SRN disruptions without impacting on the local road networks. Participants expressed concerns that there were still issues with contingency planning for motorway and/or trunk road closures. Instances were mentioned for example, of motorway incidents that had occurred with knock-on effects.

158.   Day-to-day incidents such as road-traffic collisions will mean that roads need to be closed by the Police at short notice. This is inevitable and completely appropriate. However, what the review participants suggested was that during extreme-weather incidents this tendency of the Police to unilaterally close roads without warning, was problematic.

159.   This is because, whilst it may appear to be a justified action if the motorway or trunk road is snarled, the knock-on effect of main road closure is that motorists disperse onto the minor-road network, where they can quickly bring that system to gridlock, or they can expose themselves to greater risk (e.g., flood water). One particular challenge presented by the freight-haulage fleet that was mentioned concerned the occasions when over-height vehicles are diverted off the SRN. Few diversion routes have the capacity to take these vehicles without presenting the   drivers with barriers such as low bridges or significant, and therefore costly, additional

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[31] Footnote: Brown et al., (2014) Recommendation 7: "The Highways Agency, Local Government Association and Network Rail should consider the value of a 'land-owner code of responsibility'. Put simply, this would set out the responsibilities of the transport infrastructure owner and neighbour in terms of maintenance of their respective assets, including right of access. It would need to be tailored for application to roads and railways respectively, given the different legislative regimes that apply."

[32] Footnote: It is interesting to note that the existing Defra guidance for riparian owners contains no information whatsoever about how owners should engage with the authorities in relation to managing infrastructure repair (other than flood defence management) on or adjacent to privately-owned land: https://www.gov.uk/guidance/owning-a-watercourse

mileages. Thus, to avoid such obstacles, drivers tend to park up and wait for the preferred route to reopen. This occurred during the Beast from the East, when the Rochdale and Oldham diversions were effectively brought to a halt by gridlocked heavy traffic diverted off the M62 (part of the Trans-European highway) onto the local highway network.

160.   This closure was caused by a "perfect storm scenario" of snowfall and high winds rather than by an active decision by HE or the Police and it created significant humanitarian-assistance and continuity challenges for all involved in the rescue of stranded motorists (Highways England, 2018). This required coordination from the multi-agency Strategic and Tactical cells at the Police (GMP) force headquarters. In total four rest centres were opened to provide shelter, with staff, including military assets, working long hours in extreme conditions to get the 2,000 people stranded in their vehicles clear and the motorway moving.

161.   Whilst such incidents obviously emphasise the importance of effective crisis communication with the public (see section 3.1.5.1), they also point to the importance of multi-agency collaboration in defining when roads need to be closed. From this perspective, a further example was provided to the author of the precautionary closure, reportedly by the Police, of an A road in north England despite the fact that it was part of the Priority 1 network and was being heavily treated by Local Highway Authority assets. Unfortunately, once closed the beneficial effect of the rolling traffic keeping the surface snow free was removed and the road rapidly become impassable at the same time as diverted motorists were placing themselves at risk by trying to navigate the minor untreated roads onto which they had been forced. By contrast, a wholly positive experience cited, related to HE's decision to keep the M6 open through Cumbria during the Beast from the East. This decision, which was fully supported by partners within the Strategic Coordination Group, was credited as singularly ensuring continuity of critically important oxygen supplies to Carlisle Hospital (Cumbria LRF, 2018).

162.   This issue was not, however, limited to winter weather. Following an RTC (a bridge strike) on the M6 in Lancashire in July 2018 the motorway was closed by police, with no consultation with Highways England and no declaration of a Major Incident. As the closure happened on one of the hottest days of the year arrangements had to be made to provide water for motorists stuck, not just on the motorway but on the main diversion route too, once that dropped to partially-static classification. The Police managed the incident by utilising motorcyclists to ship water to motorists, coupled with local supermarket chains providing supplies. However, it was the contention of Highways England that had a Major Incident been declared more expeditiously by the Police, then strategic-level support would have meant the response being managed more efficiently using welfare elements of the Op CURA contingency plan to assist in supporting stranded or slow-moving motorists (Highways England, 2018).

Observation 11: Responsibility for strategic and resilient-network closures during extreme-weather events should not be borne by a single agency alone. Multi-agency

justification should be sought as soon as practicable, in order that a collaborative risk-based approach can be applied to the decision (e.g., to ensure the safety of motorists is not further compromised by pushing them from the strategic roads onto more vulnerable networks).

3.4.2 Major incident declaration

163.   The reticence of partners to declare a major incident during a response was mentioned more than once in the review. As well as following the M6 bridge strike, the multi-agency debriefing held by Cumbria LRF following the Beast from the East also highlighted that failure to declare the event as a major incident, rather than as a more-ambiguously defined 'unusual incident', early enough. This had meant that some partners had not activated as early as they would have liked to.

164.   It was also suggested that during Storm Eva in 2015, the local authority should not have waited for other partners to declare a major incident in Calderdale, particularly as local authority personnel on the ground clearly understood, and were communicating upward, the fact that they believed the conditions they were witnessing warranted such a declaration.

165.   HM Government guidance on major incident declaration is clear. Local Authorities (and by default Local Highway Authorities) have the authority as a Category 1 responder to declare a major incident if they believe that they are faced with "an event or situation with a range of serious consequences which requires arrangements to be implemented by one or more emergency responder agency" (Cabinet Office, 2013).

166.   Joint doctrine on interoperability also highlights the importance of early declaration:

> "Declaring a major incident is in progress as soon as possible means [pre-determined response] arrangements can be put in place as quickly as possible." (JESIP, 2016: p.8)

Observation 12: Local Authority and Local Highway Authority personnel who deal with extreme weather event preparedness and response need to have sufficient training and support to ensure they have the competence and the confidence required and that they are empowered to declare a major incident, and activate a multi-agency response, when appropriate.

167.   In respect to SRN closures and their knock-on effects on adjacent local highway networks, the review heard that Highways England have acknowledged that they do bear some obligation for ensuring the diversion routes work. In effect, whilst it is the responsibility of the respective Highway Authority to ensure that its SRN-diversion routes remain operable, it has been recognised by Highways England that this responsibility places pressure on Local Highway Authority resources. For example, if additional Highway Authority gritting assets are required to ensure traffic flow on diversion routes is maintained during snow events then these assets will not

be available for use elsewhere on the local network. In light of this, the suggestion expressed to the review, that Highways England are to invest in building capability in its fleet to enable operations on the narrower local diversion routes if required seems an eminently sensible example of partnership working.

Observation 13: It appears that ambiguity exists about Highways England's current attitude toward supporting Local Highway Authorities in the management of designated diversion routes.

3.5 Collaborative working, Mutual Aid and Military Aid

3.5.1 Collaborative working

168. The difficulties faced by Local Highway Authority personnel managing the effects of extreme weather events are considerable. Flood and snowfall-inducing storms tend to be large, so their impacts can be spread over wide geographical areas.

169. Counties and authorities tended to be able to deploy sufficient capabilities and capacities to manage the impacts on their infrastructure internally. For example, the large geographical scale of North Yorkshire, and the operating framework in place that splits Highway Authority operations between districts across the county, meant that impacted districts could call in capacities from other districts without needing to draw in mutual aid assets from other authorities. Likewise, the county's principal contractor could also manage its own service-continuity obligations to the Highway Authority by redeploying assets within the same district structure.

170. However, the scale of the impacts of Storm Desmond on the highway infrastructure in Cumbria bear detailed analysis in relation to the Local Highway Authority's ability to manage its own service continuity. This is because, despite the fact that the county is three-tier, geographically large and with six districts, the impacts of Desmond were so severe that outside assistance rapidly became essential. Table 2 provides detail of the impacts needing to be remediated by the infrastructure recovery group, for which a £120m grant was provided by DfT.

171. This scale of impact, when added to the impacts felt across other sectors and affected communities in the county presented an "unprecedented" recovery challenge. In order to meet this challenge, it was important to accurately appraise the capabilities and capacities required for the task.

172. Due to the level of damage sustained along a 5km stretch of the A591 as it ran beside Thirlmere and the fact that so many other impacts would need attention, concurrently, from the county's finite resources, it was decided that Highways England would be tasked with this repair.

173. As the A591 is not a trunk road, this decision presented institutional challenges to Highways England. Accordingly, the project required high-level coordination by the Department for Transport, between Cumbria

County Council, Highways England and principal contractors. Ultimately, however, enlisting the assistance of Highways England to take on this task provided the vital space for Cumbria Highways to focus its own capabilities in carrying out stabilisation and repair work more effectively across the wider area. Box 3, which is reproduced from Cumbria County Council's Storm Desmond recovery debrief report, uses the A591 repair as a case study of that aspect of the county's return to an 'Open for Business' status.

174. Multi-agency collaboration also occurred in Calderdale, following the damage caused to Elland Bridge by the Storm Eva floods. On this occasion, whilst the bridge repair work was carried out by the Canal and Rivers Trust (because the bridge passed over the Calder and Hebble Navigation), Calderdale Metropolitan Borough Council stepped in to assist financially, with additional engineering assistance accessed by drawing on Environment Agency capabilities through existing water contracts.

175. Neither of these examples of project collaboration had been planned for. However, had Highways England not stepped in to assist with the A591 and had the partnership working not occurred to such effect on the Elland Bridge repair, then the speed of repair to these key assets and the repair of other damaged assets across the wider areas would have been slowed. This would have inevitably extended the knock-on consequences for affected communities.

176. Given these outcomes it was surprising that this review was told repeatedly that no real progress had been made in defining clear collaborative-working arrangements for recovery operations between different organisations and authorities within the sector.

177. It is clear that there do exist a range of often-detailed contracts, where Highway Authorities' and their principal contractors have set out encompassing agreements in respect to the private-sector partner delivering surge capacity and continuity provisions. However, there appears to have been no development of even framework Memoranda of Understanding (MoU) between Highway Authorities and other national network 'owner' agencies (e.g., Highways England), which could add a degree of resilience into plans.

178. Accordingly, yet notwithstanding the apparent inter-agency sensitivities of such operations, the obvious corollary of this, is to wonder whether individual Highway Authorities, or the sector as a whole, should reflect on these examples of successful collaborative delivery and assess whether they should develop and agree similar framework collaboration arrangements of their own for the future.

Table 2: Provisional estimate of road and bridge damage in Cumbria resulting from Storm Desmond (Source: Cumbria County Council, 2016)

Roads	Length of route affected (km)
Strategic routes (strategic A class roads)	62.6

Main distributors (other A class roads)	32.0
Secondary distributors (mainly B class roads)	225.9
Local access roads (mainly unclassified routes)	33.9
Link roads	0.5
Total	354.8

Bridges	
Bridges	
Total affected:	**720**
Damage recorded	**Number**
Minor damage	216
Affected, requiring detailed assessment	504
Of which:	
Significantly damaged	30
Structurally, functionally impaired	42

Observation 14: Given recent examples of effective collaboration between local Highway Authorities and other highways infrastructure 'owners' in repairing extreme-weather damage (e.g., the A591 in Cumbria), it appears strange that no formal mutual-aid based relationship has been proposed by the Department for Transport to develop a framework for managing future critical-repair partnerships.

Box 3: Case study: repairing the A591 – Thirlmere to Dunmail Rise

An abiding illustration of Storm Desmond's impact on Cumbria's infrastructure was provided by the images of the collapse of the A591 at Dunmail and the landslide deposits blocking the road's path alongside Thirlmere. The damage completely closed the A591 and, cut off large parts of north from south Cumbria, resulting in car traffic needing to divert over 40 miles and HGVs to divert 70 miles in order to travel between Grasmere and Keswick.

Image: Landslide deposits block the A591 beside Thirlmere (Cumbria County Council[©])

These significant effects on the community, as well as the image of disruption that the media coverage of the closure was having on national perceptions of Cumbria as a tourist destination, meant that re-opening this road was a principal priority.

The importance of this repair was clearly communicated by the Strategic Recovery Coordination Group (SRCG) to the Ministerial Recovery Group (MRG), who instructed Highways England to carry out the repair. The A591 is not a trunk road, and this broadening of Highways England's remit (i.e., usually the maintenance of designated trunk roads and motorways) was extremely unusual. However, enabling Cumbria County Council Highways to access the additional capabilities available to Highways England for this work was, undoubtedly, a major reason for the project's success.

It is important to note, however, that other factors had made the MRG's instruction of Highways England as primary contractor more straightforward. These factors included Cumbria County Council's existing relationships with Highways England and one of its principal contractors, Mott MacDonald. In effect, the early decision by the Infrastructure Sub-group and SRCG to commission Mott MacDonald to carry out the initial impact assessment on the A591, meant that there was an immediate clarity and mutual trust between the three contractual partners and Government in relation to what the project would involve, what it would cost and how it would be delivered.

Another valuable innovation was the use of drones to assess the damage to the A591. This use of technology sped up the rapid impact assessment process, whilst also reducing the exposure of ground-based surveyors to high risks presented by the landslide debris.

Whilst initial clearance and stabilisation was being undertaken, the importance of the A591's role as a vital community link was emphasised by the fact that local children and young people relied on the road to be able to get to and from school.

The learning from 2009 about the importance of providing temporary rights of way to facilitate travel between disconnected communities (i.e., the 'Barker Crossing' in Workington), the SRCG developed a plan to open a footpath that formed a diversion route around the roadworks, primarily for students traveling via a shuttlebus system to transit the damaged section of road. The path was opened on 5th January, exactly a month after the road was closed.

A second interim solution saw a series of forest roads upgraded on the eastern side of Dunmail Rise. This allowed for a full shuttlebus service to be opened to the public between Grasmere and Keswick. This route opened on 8th February 2016, ultimately carrying 40,000 passengers: partially because of the service becoming a tourist attraction in its own right.

The repaired A591 was finally re-opened by Rory Stewart OBE, MP, on 11th May 2016, ahead of the original schedule.

Throughout the programme of work, Cumbria County Council kept up a high-profile information campaign to keep the public informed about the status of the recovery operation. The challenges and some successful resolutions that affected this campaign will be discussed in the Communications Sub-Group section

Note: An example of drone footage can be found at:
https://www.youtube.com/watch?v=aY5cs3Sl8mI

3.5.2 Mutual Aid and other forms of outside support

179. What there is clear evidence of within some Highway Authorities that have been impacted by extreme weather is a realisation that inter-authority mutual aid may provide critical benefits for them if similar situations are repeated in the future.

180. However, these realisations do not only relate to the pressure placed on Highway Authorities in terms of their capabilities and capacities (e.g., where 'kit' could be borrowed from a neighbour to build capacity). The experience of dealing with wide-area, high-consequence, extreme weather events has also been identified as inflicting severe stress on some local authorities' personnel.

181. It is undoubtedly true that operational staff can face considerable pressure when working in challenging circumstances (e.g., hazardous environments, extended hours).

182. However, ensuring the continuity of service provision through an emergency bears its own pressures (e.g., rota management). Therefore, the pressures placed on managers can also be considerable. At the same time, it is certainly true that Highway Authorities have reported some exceptionally good working relationships with their principal contractors, which have allowed some risk to be shared in key areas. For example, in respect to Highway Authorities being able to pass responsibility for corralling the extra capabilities and capacities needed to carry out survey, project definition and repair works onto their contractors.

183. One example of dynamic collaboration between a Highway Authority responding to an emergency and its private sector partners occurred in 2019 at the Toddbrook Reservoir in Derbyshire. During this high-risk emergency it became clear that pumping equipment had to be positioned very quickly and very close to the dam wall, so that water could be removed from the reservoir to take pressure off the structure. This required the rapid construction of temporary hard standing capable of supporting the equipment. Due to its close working relationships with its local suppliers, the highway authority was able to lead on the acquisition of the vital materials needed, which facilitated the construction of the pads with minimal delay.

184. Refocussing on the role of competent personnel (SQEEP), one unique aspect of highway management needs to be highlighted in relation to mutual aid and, more explicitly, peer support.

185. This is the fact that Highway Authority managers have very specific skill sets, which tend to differ from those of the contractor community. Highway managers, and especially the senior-management cadre, possess knowledge of both the infrastructure they manage (e.g., the technical details of bridge construction), *and* of the bureaucratic processes of local governance.

186. They also bear the responsibility of ensuring these two knowledge bases are used to best effect to ensure that actions taken to reinstate and/or build the resilience of infrastructure is carried out efficiently and effectively. Whereas the Police bear the principal authority to protect life and prevent

damage during emergency response, when it comes to prioritising the repair of damaged infrastructure during recovery, the buck tends to stop with specific senior officers in the local authority.

187. In the period following a significant emergency, this means that the Highway Authority managers bear a dual load of responsibility to develop recovery plans, which both correctly prioritise and enable efficient asset repairs and conform with local authority and government contracting and funding rules and limits. This means that these individuals can be placed under immense pressure.

188. Accordingly, it was suggested that affected local authorities having the ability to call on a cadre of "critical friends", either from neighbouring authorities, or from other regions, could reduce the pressure on key individuals. This critical friendship was described as simply providing a means through which senior managers could have a peer from another authority in the room to double-check the decisions they are making during the most frenetic post-emergency period.

189. The comparison between the collaborative roles of Highways England and the Canal and Rivers Trust partnering with local authorities, discussed in the previous section, and what a critical friend can do are interesting here. This is because a 'critical friend' could not be expected to bring any sort of end-to-end functional capability with them, i.e., they could not take the responsibility to physically complete projects away from the affected Highway Authority.

190. By contrast, the Strategic Road Network operators, Network Rail and other infrastructure 'owners' are more likely to have nationally-distributed supply lines and contractual arrangements to call on. This means that, if asked/tasked, they can step in to assist a Highway Authority by supplying everything needed to complete a project. However, even given their capabilities, in some respects these operators may not be the best people to assist with such work.

191. The A591 fell within the capabilities of Highways England to repair. However, Highway Authorities' expertise and responsibilities tend to range more broadly, from knowing how to build major concrete structures, similar to those on the SRN, to sensitively managing 300yr old bridges: which were termed by one interviewee as the Highway Authorities' "crumbling estate". Such specialist, heritage-focussed, knowledge and skill does not fall within the remit of those operating the SRN, nor does it need to.

192. Accordingly, the 'critical friend' cadre would be purely based on providing decision oversight in relation to the specific responsibilities of Highway Authority officers. This may not seem particularly useful. However, for those officers who have been faced with massive risk and project-management challenges following impacts across the breadth of asset types on their networks – challenges which have required them to work solidly for extended shifts for days and weeks on end – such a backstop was regarded as potentially useful and desirable.

193. As one interviewee stated:

> "I think the lesson would be do not be afraid to pick up the phone to a colleague authority and just ask for that help and be open about what you don't know at the time."

194.   Taking this 'asking for help' perspective, however, it would seem unethical that the continuity of any particular area's local highway network following weather impacts should be dependent on whether or not individual officers personally know others who may be able to assist them.

195.   Therefore, a final point to make on this subject is to reemphasise the acknowledgement that considerable effort has been made by Highway Authorities working with neighbour authorities in training and exercising for cross-border incidents (e.g., between Dumfries and Galloway and Cumbria). However, what the storm series of Desmond, Eva and Frank in December 2015 taught the affected authorities in relation to mutual aid, is that it is no good to expect your neighbour authorities and the officers you know best to be the ones to assist you, because they may be in just as much need of support as you at the crucial time.

196.   The fact that the statement above was made by a senior manager from Cumbria County Council (the authority for the third largest county in England), therefore, should be seen as suggesting that the development of a structured framework for providing all Highway Authorities with post-emergency 'critical friend' support should be considered by the sector.

Observation 15: The nature of contemporary extreme-weather events appears to be leading to a point where emergency mutual aid and professional-networking arrangements need to be developed on a regional or national basis, thus negating the risk of neighbours being unable to aid each other because both have been impacted to their capacity by the same event.

3.5.3 Military Aid to the Civil Authority (MACA)

197.   Guidance for requesting Military Aid to the Civil Authority (MACA) states that there is now a more "forward-leaning" attitude toward providing military support during civil emergencies (Cabinet Office, 2014). Government has also changed the charging arrangements for military assistance, meaning that there are now much lower cost implications for authorities that are granted military assistance during major incident response.

198.   To illustrate this increasing participation, MACA was authorized, for example, during the winter storms of 2015, the Beast from the East (GOV.UK, 2018), the Toddbrook Reservoir incident and Storms Ciara and Dennis. During these incidents military Joint Regional Liaison Officers (JRLO) always worked closely with Strategic Coordinating Groups to define the 'ask' being made of the military. In effect, making sure the most appropriate capability (e.g., bull dozers), capacity (e.g., personnel) or niche assets (e.g., air support) were made available as efficiently as possible as soon as a request was authorised.

199. Support in Cumbria following Storm Desmond included work to identify and record flood-affected communities[33], to clear debris from roads (e.g., the A591) and to assist in the development of briefing materials for COBR meetings. Military personnel also carried out the preliminary (red-amber-green, or RAG-rated) rapid impact assessment of bridges and Army Engineer divers carried out a number of bridge foundation inspections, when river flow conditions allowed.

200. In Lancashire, the UK stand-by air support Chinook helicopter spent several days supporting repair work to flood defences. In 2018 the Chinook was also drawn into service supporting isolated communities in Cumbria during the Beast from the East, whilst concurrently, military personnel were engaged on the ground, providing humanitarian assistance to the motorists stranded on the M62. The Chinook was again highly visible in 2019, as its crew skillfully placed ballast to support the damaged Toddbrook reservoir spillway.

201. It is clear from this variety of operations that the military have become an important asset in terms of responding to major incidents. There are, however, two important caveats that need to be understood in relation to military support.

202. The first is that MOD guidance on MACA requests is very clear that "*Military resources cannot be guaranteed to be available on demand*". The fact that the UK Stand-by Battalion in December 2015 was 42 Brigade, which is situated in the north west, undoubtedly contributed to the relative ease and speed with which it was able to respond to Cumbria. This need not have been the case if the stand-by battalion had been located further away or had already been deployed to another area.

203. This factor alone underpins the importance of local authorities managing contingencies (such as winter-service supplier contracts), in ways that include sufficient business continuity and surge provision, as though military support is not available.

204. What the experience at Toddbrook reservoir (section 3.5.2) also illustrates, is that when highway authorities understand their own local supply chains and activate them effectively, this can reduce the tactical need to default to the military as an option.

205. Secondly, in relation to major recovery projects, it should be noted that any expectation on the part of requesting authorities that the military ought to be regarded as the first call to carry out substantive infrastructure projects, such as bridge or highway repairs, should be discouraged. This position is based on learning from Cumbria.

206. Although, the military did provide the temporary pedestrian-only "Barker Crossing" at Workington following the catastrophic damage to the town's

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[33] Footnote: This assessment developed from the military's initial 'OP. SHAKU District Tracker' spreadsheet, which evolved into the 'Cumbria Ask', the centralised impact assessment which was used to support Cumbria's grant-requests to government.

bridges and the death of PC Bill Barker during the 2009 flood, this was always regarded as a 'one-off' by those directly involved.

207.   Accordingly, when bridges were lost in the county during Storm Desmond the Strategic Recovery Coordinating Group (SRCG) quickly decided that the private sector, rather than the military should provide solutions. Accordingly, Cumbria County Council argued successfully against COBR's initial demand that the military should carry out work on a temporary crossing at Pooley Bridge.

208.   Instead, with the same ethos that underpinned much of the recovery work that was to be conducted under the Cumbria Infrastructure Recovery Programme, this initial stabilisation work was given to a local firm.

209.   An idiom used by an interviewee suggested options should be "as military as necessary, as civilian as possible". From this perspective, it is useful to look at two military capabilities that are being proposed as an important preliminary option to assess whether military intervention is needed.

210.   These options are the Military Assessment Team (MAT) and the Infrastructure Response Force (IRT). These are specialist teams, which can be authorised to deploy by a senior officer in the MOD, i.e., without the need for Lead Government Department authorisation.

211.   The Military Assessment Team (MAT) is a scoping team (not a recce team), who are tasked to assess what military capability may be required, whether the military are suitable for the task and whether they can or cannot carry out the proposed task.

212.   From a highways perspective the MAT is useful, but the Infrastructure Response Force (IRF) should be regarded as a key critical friend and ally by the sector. The IRT is a team of two (1 x Officer, 1 x Other Rank) of Royal Engineers detached from 170 (Infrastructure Support) Engineer Group. This team is stood at readiness with a short 'notice to move' if called upon by any JRLO involved with a major incident.

213.   The IRT is able to provide infrastructure and engineering expertise to the JRLO and other responding agencies, helping them to define what needs to be done and also what specialist capabilities could be accessed for any specific task through 'reaching back' to 170 Engineer Group: whose capabilities are extensive.

214.   Under Joint Doctrine the deployment of either the MAT or IRF are currently zero-cost options for a Strategic Coordinating Group.

3.5.3.1 MACA Severe-Weather Training Days

215.   In order to build its 'forward leaning' relationship with LRFs the military started to hold a series of regional *Severe-Weather Briefing Days* in 2019. The aim of these events was to familiarise LRF partnerships with military capabilities and the process they need to complete to activate MACA during extreme-weather incidents. In October 2019 the first event was hosted in Catterick and the delegation of about 40 people enjoyed a series of presentations, many of which would have interested highway practitioners, due to their focus on engineering and logistics capabilities. Yet only one

local authority was represented in the audience by highway practitioners: all the other guests were emergency planners or blue-light service personnel.

216.   This should be regarded by the sector as a missed opportunity. Put simply, whilst a local authority may regard it as an appropriate division of labour for only emergency planning officers to attend these types of events, these officers do not have the specialist knowledge and competencies that highways professionals possess. If present, more highway practitioners could have engaged with the substance of the presentations and with the military team in ways that built expert relationships.

217.   It would also have encouraged them to think about where the military capabilities could bolster or integrate with those already available to them through their own supply/contract networks. In effect, broader engagement by the sector would have built confidence in the attendees at these events to allow them to argue, within a Tactical Coordinating Group, whether specific military capabilities were needed to deal with an unfolding incident or whether their authority's own capabilities and networks would suffice.

218.   What happened instead, except for that one authority, was that these highly specialist military capabilities were described to people who were much less likely to understand where they would add value to their highway authorities' already available engineering contingencies.

219.   If the sector is to become a more confident partner in delivering integrated emergency management in the future, then these opportunities for highway authority engineers and infrastructure specialists to meet their military peers and "make friends before they need them" should not be passed over.

Observation 16: The military has provided critically important capabilities and capacities to hazard-affected local authorities under existing Military Aid to the Civil Authorities (MACA) arrangements. However, experience has shown that local authorities can clearly illustrate and positively affect their own resilience by developing response and recovery contingencies that do not, and should not need to, include a military component.

> Note: Where conditions do dictate military input, the Joint Regional Liaison Officer, has the option to activate a Military Assessment Team or the Infrastructure Response Force, (currently at zero cost), thus providing Tactical Coordinating Groups access to significant specialist knowledge and reach-back to impressive infrastructure/engineering capabilities.

3.6 The role of Ministerial Groups: COBR, Lead Government Departments and the Ministerial Recovery Group (MRG)

220. The underlying processes and procedures used to recover damaged highway assets and infrastructure are, to an extent, tried and tested[34]. However, certainly in relation to managing the impacts of the winter storms of 2015, the physical and financial magnitude of the infrastructure recovery task faced across some parts of the north of England and into Scotland and Northern Ireland, was seen as definitely benefitting from the additional level of facilitation put in place by the activation of the ministerial Cabinet Office Briefing Room (COBR) and Ministerial Recovery Group (MRG)[35] coordination layers during the response and recovery phases, respectively.

3.6.1 Cabinet Office Briefing Room (COBR)

221. COBR provides national-level support and an element of supra-strategic (i.e., cross LRF area, cross region, cross devolved administration) co-ordination and facilitation of response activities during significant emergencies[36]. Accordingly, in order to develop its own situational awareness Ministers and/or officials seated in COBR require information related to the risks manifesting, the damage occurring and the foreseeable harmful consequences facing all the affected areas. Ideally this information needs to be delivered in as timely, precise, and as accurate a fashion as possible. It is only with such information that COBR can effectively identify and prioritise the types and quantities of assistance needed and to direct it, as appropriate, to the affected areas.

222. The means used to collate this information for COBR is the Common Recognised Information Picture (CRIP). In effect, the CRIP provides:

> "A single, authoritative strategic overview of an emergency or crisis that is developed according to a standard template and is intended for briefing and decision-support purposes." (JESIP, 2017)

223. The evidence suggests, however, that collating the information needed to develop a CRIP is extremely challenging for affected authorities. When road and telecoms connections to affected communities are disrupted, it is very hard for authorities to quantify impacts either precisely or accurately. For example, accurate, resource-intensive, flood-impact surveys take days and weeks not hours to complete.

224. This emphasises the importance of managing the expectations of all partners as to what is realistically achievable with best effort. From this perspective the Environment Agency's method of using its GIS-based Flood

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[34] Footnote: See section 3.8.2 for a discussion of the innovative 'NEC options' approach adopted by Cumbria post-Desmond

[35] Footnote: The MRG is a relatively new institution, which at the time of Storm Desmond had only been activated on three previous occasions (twice for UK flooding and once for the terrorist attack in Sousse, Tunisia).

[36] Footnote: Significant in this sense relates to "Level 2 and Level 3" emergencies as defined in UK Government Concept of Operations (HMG, 2013/b)

Map to rapidly provide best-*estimates* of flood affected properties in areas known to be flooding should be regarded as particularly useful.

225.   This information issue also underlines the key importance of maintaining a structured 'battle rhythm' of briefings, which ensures that shared situational awareness is developed sequentially, through a series of timetabled briefings, with each feeding the most up to date information directly upward to the next level (i.e., Operational > Tactical > Strategic > Ministerial (COBR)), in order that decisions and directions can be cascaded back down.

226.   Here the concept of subsidiarity is key[37]. It is indeed vital that issues requiring ministerial coordination are escalated as effectively as possible to either COBR or the MRG. However, what a 'battle rhythm' of sequential briefings allows is for issues to be vetted and filtered at progressively higher levels to ensure that decisions, and any directions emanating downward from them, are made at the highest level necessary. If the system is working correctly very few decisions should need to be escalated to the ministerial level.

227.   In relation to response and the role of COBR, the processes for activation of Military Aid to the Civil Authorities (MACA), in the form of providing capabilities (e.g., bridge surveying expertise) and capacities (e.g., personnel to assist in debris removal), were seen as well-tested and appropriate.

3.6.2 The role of the Department for Transport (DfT) during response and recovery

228.   The Department for Transport's prompt presence in the impacted areas, its engagement with affected authorities (via particular individuals) and its adjudication of disputes over work programmes were all highly praised. The examples of the rapid offer of funds by DfT to facilitate repairs based on initial impact assessments was also roundly commended. This was because it was clearly identified that in many cases, had the traditional project-based approach to funding been followed, then authorities would have been overwhelmed with bureaucracy and affected communities would have suffered through the inevitable delays such procedures would have introduced into the infrastructure repair process.

229.   So, the lump-sum awards[38] worked. Whether the system adequately reflected a compliance with Brown et al.'s (2014) recommendation[39], for consistent criteria to be developed between Highway Authorities and

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[37] Footnote: Subsidiarity is the principle that "decisions should be taken at the lowest appropriate level, with co-ordination at the highest necessary level. Local responders should be the building block of response for an emergency of any scale." (HMG 2013: p.5)

[38] Footnote: This does not relate to claims against the Bellwin scheme, which is designed to compensate for emergency expenditure on response, but to the DfT lump sums provided for infrastructure repair.

[39] Footnote: Brown, et al., Recommendation 30: Government should consult Local Highway Authorities on a set of criteria to be applied consistently to emergency highway repair funding through the DfT whenever such funding is made available. […]

government for the management of emergency funding, was, however, not clear to interviewees. Accordingly, a level of scepticism remains about whether the same system would be used to equal effect next time[40].

230.   This is an issue that needs to be understood in the broader context that constitutes the sector's expectations regarding the resilience of DfT's own response to major incidents.

231.   The UK Government Concept of Operations for responding to an emergency acknowledges:

> "…most emergencies in the United Kingdom are handled at a local level by the emergency services and by the appropriate local authority or authorities, with no direct involvement by Central Government. However, where the scale or complexity of an incident is such that some degree of Central Government co-ordination or support becomes necessary, a designated Lead Government Department (LGD), or where appropriate, a Devolved Administration department, will be made responsible for the overall management of the Central Government response to the incident." (Cabinet Office, 2004: p.4)

232.   Since 2002, Lead Government Department (LGD) status has been placed on DfT for planning and responding to transport accidents (sea, land, and air), pollution and salvage incidents at sea (through the MCA), the effects of storms and extreme weather on transport (air, rail, roads & ports), and the disruption of supply chains. DfT has also been listed as bearing LGD responsibilities for recovery operations related to pollution incidents, transport accidents and severe weather impacts on transport, unless "wide ranging consequences arise"(Cabinet Office, 2009).

233.   So, whilst the designation of DfT as LGD for responding to the extreme-weather events under review in this report was possible under doctrine, in actuality, responsibility was placed on other departments (namely Defra). Likewise for recovery, during which, due to the complex nature of the impacts being recovered the Government's contribution has tended to be centrally coordinated by the Resilience and Emergencies Division of the Ministry of Housing Communities and Local Government (MHCLG-RED), even though considerable impacts had been inflicted on transport networks.

234.   The fact that DfT has not held LGD status for these incidents has not prevented the department from actively contributing to response and recovery efforts where appropriate. Here particularly, funding for and the coordination of recovery issues related to transport infrastructure have been managed in full accordance with departmental policy responsibilities. For example, DfT took an active role in facilitating the collaborative efforts needed to repair the A591 (Section 3.5.1) and over the period of the review

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[40] Footnote: Observation 27 of this report uses the Cumbria Infrastructure Recovery Programme to illustrate the point about the lack of 'consistent criteria' that is introduced in this section.

has expedited the delivery nationally of emergency repair grants approaching £200 million.

235. What has become evident during this review, however, is that much of DfT's involvement in these incidents has been focussed through a highly respected individual in the department, rather than through a broader departmental emergency management structure.

236. Undeniably, this approach has been successful, in the sense that this individual has received round praise for his tenacious support of impacted authorities. However, this must be seen as a direct challenge to the resilience of the Department's emergency response processes. Without redundancy there is an inevitable risk that a 'single point of failure' may occur. If this occurred during an incident, this could leave the Department racing to obtain situational awareness and, at worst, could leave impacted communities without a key element of support at a critical time.

237. The Cabinet Office guidance on the role of Lead Government Departments (LGD) states:

> "All departments have a responsibility to plan, prepare, train and exercise for handling incidents and emergencies that might occur within their field of responsibility. They must be ready to take on the leading role on behalf of central government in managing the initial response to a crisis, mitigating its immediate effects, and organising the development of a recovery plan." (Cabinet Office, 2008: p.2)

238. Taking a 'lifeline' perspective on the status of the nation's highway infrastructure and the fact that impacts on this infrastructure are projected to increase over coming years, there are clearly now increasing benefits to be accrued by the Department if it invests in a cadre of suitably qualified, experienced and empowered people, who are able to plan, prepare for, and respond to extreme-weather and other emergencies consistently and effectively.

239. Furthermore, by developing a workstream and competency framework that operates, as an umbrella concept, above the traditional focus of weather resilience on 'Winter Service', DfT could guide the sector, using a structured risk-based approach to build resilience against all hazards and threats.

240. Knock effects of doing this would include it becoming easier for authorities to understand the importance of standardising key technical data streams (e.g., impact assessments). Such standardised outputs could be used to complement and not replicate the briefing work of MHCLG-RED during emergencies. This would undoubtedly raise the profile of DfT as a capable Lead Government Department.

241. Having a cross-departmental understanding that such responsibilities exist, underlines the importance of providing personnel at all levels with the emergency management competencies, learning opportunities and peer support that would ensure they are able to respond as the sector would expect.

242. Ideally, such a workstream would be designed to align with the principles of Civil Contingencies Secretariat's own Crisis Management Excellence Programme.

243. Adoption of such a programme would also provide a structure under which to develop major-incident mutual aid arrangements and incident peer support networks, which, using the Salt Cell model, could remove sole responsibility for resilience decision making from DfT and place it within an appropriate forum of engaged sector leaders.

Observation 17: The Department of Transport (DfT) should engage directly with the Civil Contingencies Secretariat to design and put in place a substantive Crisis Management Excellence Programme. This would comprise suitable competency, learning, and peer-support components to ensure consistent delivery of resilience plans and contingencies by a cadre of suitably qualified, experienced, empowered, and respected personnel.

3.6.3 The Ministerial Recovery Group (MRG)

244. A principal challenge identified by interviewees in communicating need to the MRG, related to their concerns about the method used to report requests to ministers. During the recovery from the 2015 -16 winter storms the method used involved affected authorities preparing a "Top-10" infrastructure repair lists for each council. Whilst this approach appeared, on the surface, relatively democratic, the interviewees expressed concerns about it from several perspectives.

245. For some, the method appeared to focus on achieving 'quick wins' (e.g., getting roads open), rather than on facilitating effective processes through which longer term projects to restore other infrastructures could be developed.

246. For others, the rating of impacts across multiple areas led to a perception that significant impacts in one area were being directly compared with, or even displaced from the conversation by, less significant impacts in another (i.e., two 'Number 1' impacts could differ in their projected consequences by orders of magnitude, yet both be regarded as primary concerns)

247. Cumbria and North Yorkshire also reported their frustration that their impacted-infrastructure lists contained hundreds of assets, whose relative importance (even within the county) changed continually. Similarly, other authorities reported that they simply could not complete this task, both due to the scale of the impact to their infrastructure and to the complexity of the infrastructure systems' interconnections. As one contributor stated:

> "The Top-10 approach just doesn't work during big events. Priorities are more dynamic, we had 20 big jobs and 100s of medium and all of them had high socio-economic [vulnerability] scores."

248. Interviewees also suggested the value of not just considering total numbers of assets affected, or the damage status of the "top-ten" single assets, but

also the need to consider the percentage of assets affected that had direct influence on specific communities. The importance of this need to differentiate between total numbers, which bear up-to national scale importance in terms of understanding accumulated impact and potential costs, and percentage figures which bear more specific relevance in terms of informing local infrastructure management decisions (e.g., % of highway assets affected which provide access/egress to specific place-communities) appeared to be significant.

249.   A substantive finding of this review, is that there was a need and appetite within the sector for the development of a Rapid Impact Assessment methodology, which can be adopted to provide a nationally consistent level of data on impacts.

250.   **Note:** Impact in this context does not simply refer to the structural damage to an asset, but also includes an assessment of the consequences of that damage for the community (e.g., long diversions). Accordingly, it is defined:

Impact = Damage x Consequences

Observation 18: It is important for hazard-impacted authorities to present DfT, or in appropriate circumstances the Ministerial Recovery Group, with a coherent 'ask' following emergencies. Therefore, that DfT has provided seed funding for the development of Rapid Impact Assessment (RIA) guidance and a methodology for creating a consistent information picture that provides shared situational awareness and supports the development of repair/funding priorities should be welcomed (x-ref observation 24).

3.7 Democratic institutions and community resilience

3.7.1 The role of elected members

251.   In section 3.4.1 it was seen that the role of the non-partisan infrastructure members' group in Cumbria acted in a vital oversight role for the development of the county's post-Storm Desmond Infrastructure Recovery Programme (IRP).

252.   Given the impacts involved and the scale of the recovery required it was always vital that democratic oversight should be integrated within the deliberation and delivery of solutions for the affected communities. In relation to the members' infrastructure group this happened in the council chambers. However, elected members also provided other critical points of community leadership. From this perspective, members were reported as having been able to facilitate discussions between the authorities and communities, which allowed expectations to be managed, whilst also ensuring that any "cracks in the recovery effort were exposed" and appropriate solutions that took these concerns into account were developed where possible.

253.   Another key role of the elected members during weather events involved councillors using their own local knowledge and social networks to identify

isolated locations and stranded communities and to assist in re-connecting them. This took the form of a liaison role, acting between the council structures linked into the strategic/tactical coordination groups and the communities themselves.

3.7.2 Community Resilience

254.   Community response to emergencies, in the form of neighbours and neighbourhoods rallying together and volunteers converging to provide support during disaster have been documented in the academic literature as predominantly altruistic social phenomena since at least the early twentieth century (Prince, 1920).

255.   Recent experiences of extreme-weather events in the UK have cemented this knowledge through providing numerous examples of affected communities being very active in responding to assist others in peril and/or in reducing impacts where they can (Twigger-Ross et al., 2011). Accordingly, over the last decade the Civil Contingencies Secretariat (CCS) at the Cabinet Office and other bodies have been working to develop guidance for responders on engaging communities (HM Government, 2019/a) and managing spontaneous volunteers (HM Government, 2019/b).

256.   From a highways' perspective, this review has identified at least four types of formalised community-based responses that have been or are currently being developed by local authorities:

- Farmer snow-clearance contracts
- Community rest-centre set up and management capabilities
- Snow warden, "Snow champion" schemes
- Flood warden schemes

257.   Snow-clearance contracts with farmers provide an example of Highway Authorities using their discretion to define formal arrangements to add important capacity to the winter-service fleets. The other types of arrangement tend to be managed by local authority resilience teams and their Local Resilience Forum partners (e.g., the Environment Agency). These have varied amounts of engagement by the Highway Authority, dependent on the relationship between the resilience team and the authority and the identification of specific need for such collaboration (i.e., if there are identified risks involving highways management). To boost the activity of the Local Resilience Forum partnerships in supporting the development of resilience plans by hazard-exposed communities some forums are working with specialist volunteer-sector partners to assist in the process (e.g., Groundwork in Cornwall[41] and Newground in Cumbria and the north west[42]).

258.   From a 'community' perspective, engagement in formal efforts to manage extreme-weather risks can be dependent on a range of drivers. For

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[41] Footnote: Groundwork webpage:
https://www.groundwork.org.uk/Sites/south/pages/communities-prepared-south
[42] Footnote: Newground webpage: http://www.newground.co.uk/services/business-services/flood-risk-and-resilience/

example, public engagement with formal arrangements tends to result from a community's actual experience of a hazard (e.g., flooding).

259. Accordingly, communities may not just want to focus their engagement activities on building local response capability (e.g., assisting in the evacuation of vulnerable households; salting gradients), but may also want to engage in active lobbying for risk reduction (e.g., advocating for a flood defence scheme).

260. From a highways-management perspective, flood and snow warden schemes have started to provide important local capacity, in relation to warning and informing in their localities and in undertaking risk-reduction activities, both of which reduce the workloads of operational staff and enhance their effectiveness.

261. In some areas, community groups are also being given the authority to carry out activities such as closing roads, which have hitherto tended to be the sole preserve of operational highways teams.

262. Road closure could be seen as a contentious issue in respect that, as a public activity, it carries its own risks (e.g., vehicle-pedestrian collision risk). However, some authorities have felt compelled to develop workable solutions that allow this type of activity as a result of local pressure, particularly in relation to flooding.

263. Activities to discourage or prevent drivers from entering flood water are important, because as an activity this is the greatest flood-attributable cause of death on a global scale (Jonkman & Kelman, 2005). However, experience in the UK has also revealed that vehicles driving through flood water near residential properties can increase flood damage through the bow-wave effect. This problem of wading vehicles pushing flood water into properties causes the affected householders significant distress and potential additional costs.

264. Taking elements of both these risk-types into account, local authorities have been working with community groups to develop road-closure procedures that can be set in place safely by group members in response to pre-defined triggers in their community emergency plans. To support this, some Highway Authorities have been providing appropriate training, signage and personal protective equipment (PPE) as part of the arrangement.

265. One persistent challenge to the organisation of activities such as road closure has, however, been the issue of public-liability and employer-employee insurance. There is currently no defined single arrangement that covers resilience groups' insurance requirements nationally. Rather, groups have been encouraged to investigate different ways of dealing with this issue (Box 4).

266. In relation to signage, again the picture is varied. Some community groups aligned with their local councils have access to a stock of road signs which are generally used during (e.g.) fetes and processions and these tend to be rolled out if required for emergency use. Other authorities are, however, being much more proactive in supplying community groups with equipment,

including PPE, signage and lockable chests in which to store it, at or near agreed road-closure points (e.g., Cumbria).

267. In Calderdale, whilst signage has been issued and is kept in stores along the valley (maintained by the council), instructions for community members are explicit in stating that signs should be placed *by* the roadside, so as not to increase risk by having community members operating in the main carriageway during emergencies. Whether instructions such as this will be followed in all circumstances, however, is a question that deserves reflection and the development of a clear understanding of liabilities on both the authorities' and community volunteers' parts.

Box 4: Public Liability Insurance for community resilience activities

In general, government advice for community resilience groups wishing to undertake activities on the highway is to enquire whether the underwriter of their town or parish council's policy would accept such activities under their standard or additional terms. As an illustration of such arrangements, St Blaise Town Council in Cornwall offers its community resilience group cover under the council's policy. Dumfries and Galloway Council, by contrast offer insurance cover to their resilience groups as long as they are also registered as members of the Community Forum.

Local parish, town or district councils do not provide the only options, however, and some groups have made other arrangements. For example, in Cumbria an agreement has recently been finalised whereby Local Resilience Forum validated community resilience groups can get free public-liability insurance for activities including road closure, as part of a Neighbourhood Watch membership arrangement.

Whilst the legality of any road-closure placed by community group members remains slightly ambiguous (e.g., whether a motorist ignoring the closure could be prosecuted), it is apparent that as a measure to control the speed and flow of traffic near flood water such activity is generally acceptable to insurers. However, those companies that do agree to cover such activities insist on the resilience groups' compliance with specific conditions:

- Risk assessments and training of volunteers for road closure related activities must be undertaken by the Local Authority, Local Highway Authority, recorded and refreshed regularly.
- If the plans are activated early/pro-actively by the group (rather than by notification from, for example, the Environment Agency), then the group must notify the appropriate authorities as soon as is reasonably practicable
- Volunteers must wear suitable PPE at all times
- Volunteers are not allowed to enter the water
- In Cumbria's case, the Community Resilience Group must be part of the Neighbourhood Watch Network

268. Another recognised and reasonably well-established role of community resilience groups is assisting in the setting up and management of rest centres. In urban areas the responsibility for setting up and managing rest centres tends to fall on the local authority operating with voluntary-sector partners (e.g., British Red Cross) (HM Government, 2014). However, extreme weather effects can be particularly significant in rural areas. There is, therefore, a need to have rural isolated communities able to activate plans and to shelter stranded motorists, or weather-affected householders (e.g., during power cuts) either with direct local-authority support or autonomously.

269. Of particular note in this regard is the scheme set up to provide rest-centre support to users of the A9 corridor in Scotland. For the 112-mile road between Perth and Inverness the *A9 Trunk Road Plan* provides contingencies for rest centres to be activated along its entire length if conditions dictate. Specifically, for the distance the road travels through Perth and Kinross, the rest-centre operation is conducted by communities along the road, with hotels and restaurants providing the facilities further north, through the Highlands Council area.

270. This collaborative effort adopted between communities, the private sector, BEAR Scotland and local authorities to keep motorists safe was originally conceived to provide contingencies for winter weather. However, community members have also deployed to help manage traffic tailbacks from Road Traffic Collisions, whose effect in this part of Scotland is significant because there are very few diversion routes if the main A9 is blocked.

271. Following severe snow-induced gridlock and the significant risk this caused to stranded motorists on the M80 south of Stirling in 2010 and again, to a lesser extent, in 2018, Police Scotland are now seeking to use the A9 plan as a model for increasing M80 resilience too.

272. Whilst few Highway Authorities have the responsibility for such vulnerable long and linear sections of road in their areas, recent events, including the M62 and M6 stoppages discussed earlier should make those responsible for road-transport resilience consider how well their extreme-weather planning scenarios are linked to their authorities' existing rest-centre plans.

Observation 19: The example of the A9 trunk road plan illustrates the critical importance of Local Highway Authority personnel's collaboration with their own authorities' resilience units to develop efficient working relationships and effective emergency plans.

3.7.3 Extreme weather contingencies: farmers, the "whiteout fleet" and "making friends before you need them"

273. One community-resilience focussed component of the A9 Trunk Road Plan that is already mirrored across the nation in slightly different ways, is the role of farmers in providing additional snow-clearing capacity for Highway Authorities during winter.

274. Agreements with farmers to provide snow-clearance capabilities and capacities differ slightly dependent on authority area. For example, schemes may be managed by the Highway Authority or by its winter-service contractor. Likewise, contracted farmers may be paid to either use their own equipment to clear roads of snow, or the arrangement may include the provision of equipment by the authority/contractor. Either way farmers can provide important additional road-clearance capacity, which allows Highway Authorities and their contractors to focus their assets on their winter service or resilient networks.

275. Whilst adding to the capacity of the frontline fleet, different authorities also invest differently in the additional capabilities and capacities required by their worst-case 'White-out' fleet. Some purchase specialist equipment themselves, whilst others hire capabilities in.

276. In Devon's case, for example, instead of investing in specialist vehicles, the white-out capability is built around the authority's investment in a quantity of the ancillary attachments (e.g., ploughs, blowers), which can be hitched directly onto hired-in vehicles via their 3-point linkage (e.g., tractors, Unimogs). Whilst the attachments obviously need maintenance, the savings made in hiring in rather than owning/maintaining full-specification vehicles have been significant for the authority.

277. Critical to the continuity of this approach, of course, has been the development of contracts and agreements that ensure that suitable vehicles are available when they are required.

278. Such contracts and ways of working clearly illustrate the importance of building relationships with partners specifically to ensure business continuity does not suffer at the most inopportune moment.

279. Whether the responsibility for checking farmers' compliance with contract conditions (e.g., health and safety, equipment maintenance) falls on the Highway Authority or its winter-service contractor depends on the authority involved.

280. So, as part of the network of winter-weather contractors, farmers obviously provide a key element of this winter-service capacity. However, being community based, they also provide the critical local "eyes and ears" and social networks which can both help support Highway Authorities' situational awareness and dynamically bolster their response footprint during extreme weather events (Box 5).

281. What Box 4 clearly illustrates is the importance of ensuring communication routes between strategic/tactical coordination and operational delivery are developed effectively and that they include all partners who will be involved in an extreme-weather response, not just Highway Authority personnel.

During the "Beast from the East" snow and wind event in Cumbria, farmers in the county's eastern fells became concerned that their communities were cut off and to reach them they needed different equipment than was actually available to open the local-road network of lanes between the villages and isolated properties. This was even though at the height of the response operation the local authority had mobilised 84 of its teams and all the snow-clearance assets on their inventory into the area.

Worried by the scale of the challenge in reaching potentially highly vulnerable communities sufficiently quickly, one farmer contacted a local contractor for assistance. The contractor's equipment was designed for quarrying, which made it more capable for the snow clearing task than either the Local Highway Authority's or farmers' assets.

However, the swing shovels and dump trucks available weighed up to 30 tonnes each, so when the farmer then contacted the LHA to ask permission for the contractor to proceed, the duty officer for the LHA was faced with a dilemma. If the equipment was used, then it would undoubtedly be more effective in clearing the snow than the LHA's fleet of gritters and JCBs would be. This was particularly so as the weather conditions had led to the deep drifts changing consistency, from "polystyrene into concrete". However, due to its weight the equipment could cause damage to parts of the minor-road network and other infrastructure that could take months to repair.

Observation 20: Multi-agency planning activities for extreme-weather emergencies should be regarded as opportunities to extend the 'make friends before you need them' mantra to consider potential partners from across the statutory, private, voluntary and community sectors. The goal should always be the integration of all capabilities and capacities that may help to shorten emergencies and reduce harmful consequences.

3.8 Business Continuity Management (BCM), training and exercising

282.   Business continuity management is a duty placed on Category 1 responders by the Civil Contingencies Act. Accordingly, local authorities must make business continuity arrangements that reflect the risks they face.

283.   Obviously, business continuity risks include those related to corporate, sector and community risk register defined hazards and threats (see section 2.3.2), but the focus of the duty defined in the Act is on the third of these risk types.

284.   In respect to emergencies, the Act requires that responders ensure their ordinary functions can be continued through an emergency to the extent required (i.e., to meet all an authority's statutory duties). However, given the

nature of contemporary service delivery and the increasing role of private sector contractors (e.g., in relation to winter service) it is important to also understand that:

> "Organisations should not only look at the resilience of internal structures and processes, but also those of organisations they rely on, or deliver services through."

<div align="right">(Emergency Preparedness, 2012: para 6.4)</div>

285.   Overall, the review found evidence that extreme weather affected Highway Authorities had worked collaboratively and very effectively with their contractors to ensure business continuity. For example, the relationship between North Yorkshire County Council and its highways contractor has already been identified as a good example of a flexible relationship that provides surge capacity between districts as and when required, without the need for approaching neighbouring authorities for mutual aid.

286.   For some authorities, however, the experience of an extreme-weather event has contributed to a re-evaluation of service delivery. For example, since Storm Desmond, Cumbria County Council has brought its highways service arrangements back 'in house'; a decision that required an investment of £7m in vehicles.

287.   This decision was made following a realisation that in-house service delivery offered additional value for the county in respect to allowing a technology-supported risk-based approach to be taken to activities such as gully clearing and winter service. These would not have been as cost effective if contracted to an external supplier. Derbyshire County Council, by contrast, has always retained its own highway service responsibilities.

288.   So, the picture is mixed in relation to whether authorities deliver their own services or whether they contract these responsibilities out. As would be expected in such a diverse sector it is apparent that one size clearly does not fit all.

289.   That being said, concerns were raised in interview in relation to some authorities' relationships with their contractors. For example, it was suggested that despite a focus on building winter-service resilience across the sector since the Quarmby and Brown et al. reviews, some Highway Authorities were still being let down by their suppliers.

290.   Specific reference in this regard was made to the Beast from the East, and concerns that some suppliers had failed to ensure appropriate salt-supply contingencies; thus, placing those authorities in effective contravention of *Well-Managed Highways* guidance. Whilst the author did not speak directly to anyone who had experienced such problems it is hoped that this experience will have caused affected authorities to reassess their contracts.

291.   Given the importance of being able to manage business continuity risks during an emergency cycle, the Act stipulates that training is put in place for all those who would be directly involved in the execution of business continuity arrangements. Given that for local authority personnel such BCM considerations will be inextricably linked to how they direct and deliver effective emergency response and recovery related outcomes, the next

section explores how training and exercising have supported extreme-weather resilience.

3.8.1 Training and exercising

> "All parties involved in a crisis must not only be trained to a high level of proficiency in their given field but must also possess awareness of the other responders. Therefore, training should encompass all aspects of crisis planning, response, recovery, and mitigation."

> (Pollack & Coles, 2015: p.23)

292. A repeating observation that was made during the review was that highways personnel are some of the most experienced operators outside the blue-light services when it comes to dealing with day-to-day emergencies that involve working with other partners in hazardous conditions. The persistent need to respond to (e.g.) road-traffic collisions, diversions and infrastructure failures (wall collapses, embankment damage), means that from the operational teams upward there is a great deal of emergency-management knowledge and expertise within the sector. The sector could be said to contain a high percentage of Suitably Qualified, Experienced and Empowered Personnel (SQEEP).

293. Another observation made, related to the evidence of key partnerships being forged within local authorities between highways managers and resilience units. It was clear that at the tactical and operational levels, effective collaboration between these two teams is bolstering many local authorities' contributions to integrated multi-agency working.

294. It was clear that personnel from Highway Authorities are taking part in training and exercising activities, whether those be table-top exercises or active scenario exercises (e.g., the multi-agency and community flood recovery exercise *#OperationCdale18* took place in Calderdale as this report was being researched)

295. There appears, therefore, to be clear evidence that training, preparedness and contingencies for emergency response are now taken seriously within the Highway Authorities contacted, with 24-hr call-out rotas and contingencies for managers and senior managers being the norm.

296. From a strategic perspective, there also appears to be buy-in at the Senior Management Team level. However, it is apparent that the extensive portfolio responsibilities of some senior Gold/Strategic-level managers, means that during emergencies some tend to rely on the expertise of their tactical/operational highways personnel to manage that aspect of the response, e.g., senior managers may be, to a degree unsurprisingly, more focussed on the humanitarian aspects of the emergency if their portfolio includes child or adult-social care.

297. Whilst entirely understandable it is, however, worth emphasising here the observation that some extreme-weather scenarios bear a high risk to life. Accordingly, the evidence of apparently effective multi-agency collaboration and senior-management buy-in, comes with two caveats related to training:

- Due to the high frequency with which *some* operational staff deal with highways emergencies there appeared to be a belief that additional Integrated Emergency Management focussed training and exercising at the silver/bronze (tactical/operational) level was unnecessary.
- Senior management in some local authorities also appeared not to value incident command training sufficiently to subject themselves to training courses. An oft-cited reason for this was the time needed to complete the Multi-Agency Gold Incident Commander (MAGIC) course.

298. These issues need to be examined separately:

3.8.1.1 Extreme weather contingencies: operational levels of training and health and safety

299. Operational highways personnel deal with 'emergencies' regularly and they are undoubtedly effective in dealing with many causes of disruption that routinely affect the highways network. However, an interesting illustration of the importance of training was made to the review. This related to activity during severe flooding, where it was only identified in a debrief sometime after the event that members of a Highway Authority's operational staff had been trapped in their vehicle, having attempted to wade it through a considerable depth of flood water.

300. This example may seem to illustrate a relatively minor (in the circumstances) and rare infringement of sensible health and safety practice. However, it should also be understood as a possible illustration of personnel operating in a situation where, due to their self-perceived day-to-day competence, they put themselves at unnecessary risk due to a failure to recognise what were actually the much more rarely experienced, and much more dangerous, conditions of a major extreme-weather event.

301. There is some evidence that operational personnel are being increasingly encouraged to participate in JESIP training, to enhance their abilities to understand and contribute to multi-agency collaboration at the scene of emergency operations.

302. However, what the flooded-vehicle example of operational staff finding themselves in danger also illustrates is that weather-hazard training of all operational staff should be recognised as a corporate responsibility, meaning it should be regularly refreshed and assessed.

303. This is not to say that training for extreme weather is straightforward. For example, the review was told about difficulties in maintaining the levels of competency of snowplough and gritter drivers following a series of relatively mild winters. This meant that with the onset of the Beast from the East, drivers were "needing to learn on the job". This is obviously problematic and suggests the need to investigate and/or invest in more innovative training approaches that replicate the necessary factors (e.g., skidding) regardless of season.

304. However, once again if a health and safety approach was taken to identifying and managing the risks of particular personnel operating in conditions beyond their personal experience, then those risks can be

managed to an extent, i.e., in this case this was achieved by ensuring that uplifted-minimum numbers of personnel were working together in crews.

305. Financial constraints and efficiencies, however, have also had an impact on even these sorts of contingencies, with the review being told that streamlined rotas that move from 8 to 12hr shift patterns, mean that fewer personnel tend to be available now than in previous years.

306. Third-party arrangements such as farmer snow-clearance contracts tend to push health and safety considerations and compliance down from the Highway Authority and onto either the authority's winter-service contractor or onto the farmer contractor, sub-contractor. However, as the ultimate client the local authority will always bear an element of vicarious, and nondelegable, responsibility. From this perspective it is useful to take note of an experience in Cumbria during the Beast from the East.

307. As the weather warnings for snowfall continued to escalate, a decision was made by the Highways Gold that all in-house gritter crews would be double crewed for safety. The decision whether or not to double crew is one that is mentioned in Well-Managed Highways (p.128) as bearing on resource planning. However, given the event that unfolded in this instance the decision to place operator safety above simple cost as the principal planning consideration proved insightful.

308. This is because, whilst operating a gritter out on his rural route, a driver climbed out of his cab to carry out a standard equipment adjustment procedure. As he did so he slipped and fell to the ground, badly fracturing his leg. Had this vehicle not been double crewed, with a passenger able to alert their control room and to keep the driver comfortable until the arrival of the Mountain Rescue Team, it is highly likely that this incident would have been fatal.

309. Also, from a health and safety perspective, the senior management cadre's vicarious responsibility for their teams' welfare has been identified as needing to include contingencies such as the supply of appropriate PPE, but also the importance of putting processes in place for monitoring and mitigating causes of work-related stress during response and recovery (e.g., extended-hours working)

> "…even in domestic projects, the impact of stress and exhaustion caused by long hours, atrocious weather and emotional experiences requires both strong and sensitive leadership and self-awareness to protect staff health and wellbeing. It is important for senior staff to lead by example in striking the balance between commitment to the project and the need to take time off and get adequate rest."

> (Major Projects Association, 2018)

Observation 21: Cumbria Local Highway Authority's decision to operate a health-and-safety based approach to asset and personnel management during the 'Beast

from the East' extreme-weather response, should be regarded as an illustration of sound practice.

Observation 22: Under current out-sourcing frameworks Highway Authorities may wish to push the operational risks of managing extreme-weather response away from themselves and toward their contractors and sub-contractors. However, it should not be forgotten that some extreme-weather scenarios bear a high risk to life. Accordingly, Highway Authorities should consider developing contractual conditions with their suppliers to ensure operator health and safety is prioritised.

3.8.1.2 Extreme weather contingencies: training the senior management team for emergencies.

3.8.1.2.1 Training for Response

310. Across the UK there appears to be a range of perceptions in the sector in relation to the value of incident-command and coordination training. In some Highway Authorities senior management team members have completed the three-and-a-half-day Multi-Agency Gold Incident Commanders (MAGIC) course (or the one-and-a-half-day MAGIC-Lite version of the course) and/or the two-day Tactical Emergency Management (TEM) Course. However, in others there appears to be a perception that the courses are either too expensive (financially and/or in time) or unnecessary because individuals feel they have sufficient experience and knowledge to manage without the training.

311. These courses, which are run predominantly by the College of Policing (in partnership with the National Ambulance Resilience Unit and the Fire Service College) and by the Emergency Planning College[43] have been designed to prepare leaders within all Category 1 and 2 responder organisations for the role of strategic and tactical coordination in emergencies. Accordingly, the courses involve classroom input on interoperability and the JESIP principles, understanding capabilities and the importance of decision logging. They also cover the theory of decision-making in conditions of uncertainty and all the courses test learning through the use of challenging scenario-based exercises.

312. During the review the author heard various statements made by those who had undertaken the training. Predominant amongst these, however, were two reflections. The first, by a senior executive faced with dealing with the Salisbury poisoning incident:

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[43] Footnote: The courses can also be delivered, bespoke, directly to local authorities by the providers or in some cases by members of the authorities' own resilience unit.

> "I'd done all the training and the exercises every year which prepared me well and yet still the learning I needed to do in those initial days was daunting"

313. And the second by a senior manager with experience of managing both Storm Desmond and the Beast from the East from a highways' perspective:

> "The most useful thing I found in the [MAGIC] course was the training crystallised for me the mental structure of my role. It made me more confident as a result of developing the shared language and it reaffirmed the things I ought to be worried about."

314. Given the availability of these courses, the blue-light services' promotion of them, the increasingly joint application of the structures, the thinking defined in the course materials (e.g., JESIP) and the fact that local authorities and Local Highway Authorities have been proven by recent extreme-weather events to be key participants in emergency response and recovery, it seems odd that all senior managers (not just the enlightened) are not more actively encouraged to regard attendance on these courses as essential for their personal development.

315. It is also troubling because, as was described in interviews, whilst it is entirely possible for senior executives to be guided through emergencies by their experienced resilience experts, the fact remains, that it is the senior managers who will ultimately bear vicarious responsibility for the outcomes of decisions that are made if those decisions are ever challenged in a court, inquest or inquiry.

316. From this perspective, it is possible that there is a misunderstanding by those looking at the emergency response structure (Appx. 2) that it relates to a system that operates with deference to rank, i.e., the Gold/Strategic levels are regarded as 'in command', ensuring that their subordinates carry out instructions as directed. This is, however, not the correct way to consider this diagram.

317. It is clear from the evidence seen where this system has worked effectively, that its structure is not predicated on 'deference to *rank* or *seniority*' but rather on a shared deference to expertise[44]. This is a useful optic, because taking an expertise perspective encourages an equal expectation to be placed on personnel at all three levels within an organisation (i.e., Gold, Silver, Bronze) that they should have the skills, experience and empowerment commensurate to carry out *their* part of the activity safely, competently and in the best interests of effective teamwork.

318. Thinking specifically in terms of the Gold-level officers who were mentioned during the review as lacking the appropriate training for their role, but who effectively hitched a lift on the competences of their silver-trained juniors, local authorities must realise that this is inappropriate.

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44 Footnote: To understand how 'deference to expertise' can be understood as an important facet of High-Reliability Organisations see: Weick, K. E. and K. M. Sutcliffe (2007)

319.   To underline this point, whilst the comparison between extreme-weather events and the tragedy at Utøya in Norway in 2011 may appear dramatic, Box 6 presents a quotation that clearly illustrates how pre-event commitments to training and exercising can be examined after an event[45].

Box 6: Training and exercises: the key to defendability

"Crises are characterised by unpredictability. Existing plans and experience will never be an exact fit for a scenario. When time is short and many things are happening simultaneously, it is difficult to learn anything new. Accordingly, the very essence of crisis management lies in the preparations, drills, exercises, interaction and ways of thinking. Crisis management per se is a test of how well prepared one is… The ability to acknowledge risk and learn from exercises [in this case] has not been sufficient. The ability to coordinate and work together has been deficient."

Report of the 22 July Commission (Anders Breivik) 13 August 2012
Official Translation p.4

320.   As with other events involving risk to life, it is the Police who will most likely to be chairing the Strategic Coordinating Group during an extreme-weather event. However, this does not mean that responsibility for making decisions falls to the chair alone. The national guidance document 'Emergency Response and Recovery' (2013) makes it clear that decision-making in the SCG is both a collaborative and an accountable endeavour, which requires all members to understand how their organisation's capabilities and capacities can be deployed to best complement the multi-agency response:

> "As a multi-agency group the SCG has collective responsibility for decision-making and implementation. To achieve this the SCG relies on a process of discussion and consensus to reach decisions at strategic level and to ensure that the agreed strategic aim and objectives are implemented at the tactical and operational levels. These discussions, including both decisions taken and not taken or deferred, must be logged for future scrutiny. Effectiveness at strategic level rests upon every member having a clear understanding of the roles, responsibilities and constraints of other participants. The required mutual understanding and trust will be cemented through training and exercising." (Ibid., p.71)

321.   One factor that emerged in relation to making exercise involvement more engaging for the sector, was the use of aims and objectives. Looking at LRF exercise regimes, it is clear that impacts on highways assets are included across the board as components in multi-agency exercise input scripts.

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45 Footnote: The author is grateful to Mark Scoggins (Fisher Scoggins WatersLLP) for his useful advice and reflection which informed this section.

However, the tendency appears to be for this inclusion to be carried out by way of exercise 'injects'. For example, during a multi-agency flood exercise the coordination group will be told that a bridge has failed due to high flows. How the group then adjusts their response around that information is a useful test of incident coordination.
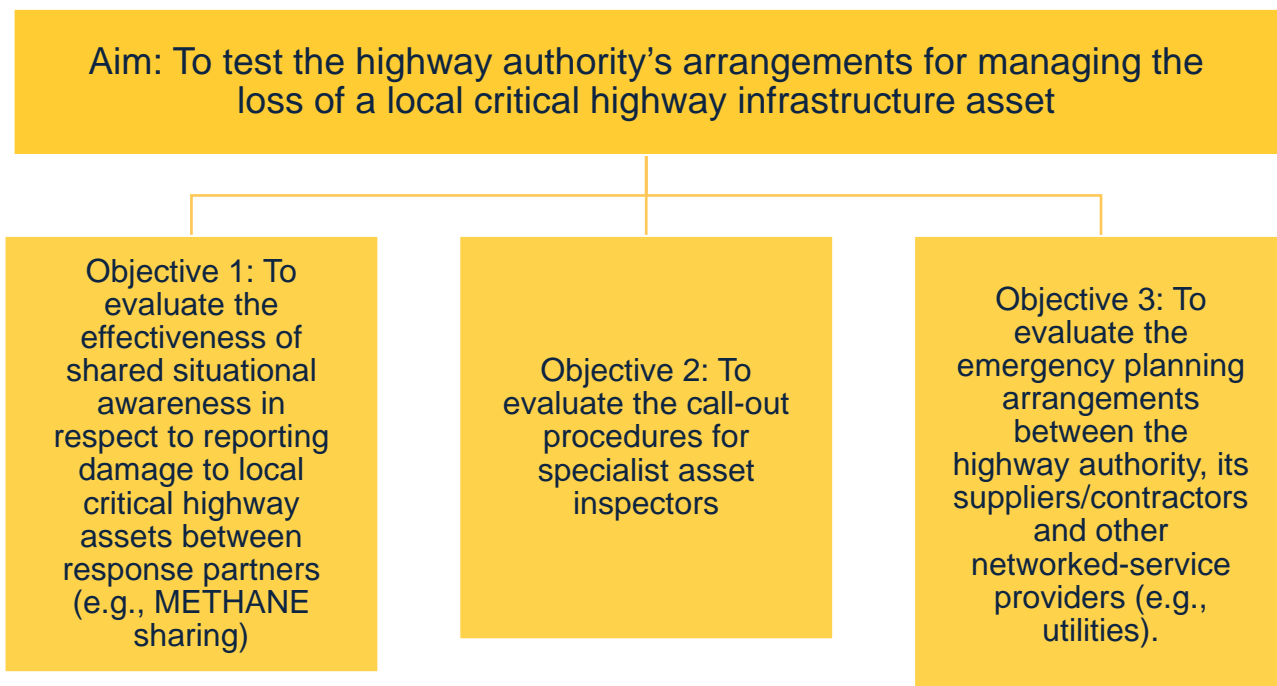
322.   However, without including specific highway-sector focussed aims and objectives in the exercise plans, these injects do not necessarily provide a opportunity for the sector to evaluate itself in a structured way. Writing testable aims and objectives into the exercise plan allows this.

323.   As an example, consider the difference between these two exercise components:

1.   An 'inject' delivered during exercise:

> "14:26hrs: A report has been received that the parapet and half the central arch of Setburn Bridge on the B727 has collapsed, Police are at the scene and the road has been closed."

2.   An Aim and Objectives included from the beginning in exercise plan as set out below:

Aim: To test the highway authority's arrangements for managing the loss of a local critical highway infrastructure asset

Objective 1: To evaluate the effectiveness of shared situational awareness in respect to reporting damage to local critical highway assets between response partners (e.g., METHANE sharing)

Objective 2: To evaluate the call-out procedures for specialist asset inspectors

Objective 3: To evaluate the emergency planning arrangements between the highway authority, its suppliers/contractors and other networked-service providers (e.g., utilities).

324.   This comparison of approaches illustrates two things. Firstly, an inject is a useful trigger to ensure the exercise players engage with a highways-related scenario. Secondly, having aims and objectives focussed on evaluating how highways-related scenarios are managed *adds value to injects* because they provide a substantive framework for the sector to test itself, and its collaboration with partners, within the parameters of the broader exercise.

325.   In summary, the underlying value of structured training and exercising across all tiers of emergency management is that the shared experience of

undertaking these individual and collaborative competency-building activities also reinforces the positive and often-cited '*making friends before you need them*' effect.

326. Using the 'deference to expertise' perspective, however, further illustrates how important it is that all levels of the coordination structure play their role effectively by operating as part of a suitably qualified, experienced and empowered team.

3.8.1.2.2 Training for Recovery

327. One theme that appeared within conversations with those who had undergone incident commander training was that the courses did not sufficiently cover the recovery phase of emergencies. Certainly, for highway managers this appears to be quite a significant deficit, given the likely inevitability of the Highway Authority's involvement in the management of stabilisation and recovery programmes following weather damage.

328. Primary amongst the concerns voiced is that, from a strategic perspective, whilst still being focussed on consequence management, recovery has a 'battle rhythm' that is much slower and more deliberate than that for response. Also, in order to manage this long-term process, recovery requires the coordination of, and the even broader engagement with, a much more inclusive constituency of actors (e.g., the voluntary, private and community sectors) than response does. This complexity means there is a tendency for the 'blue-light' responders to step back once response is over, leaving local authority managers as the lead coordinators across a raft of workstreams, including highways.

329. From this perspective it appears vital that recovery managers are trained and supported to maintain situational awareness and to manage recovery operations as transparently and as inclusively as possible.

330. Such examples do not, however, fit naturally within the current MAGIC-training framework. Accordingly, there appears to be scope for the Local Government Association (LGA), the Association of Directors of Environment, Economy, Planning and Transport (ADEPT) and the Local Government Technical Advisors Group (LGTAG) to explore with providers appropriate ways in which preparedness for recovery could be integrated into training in the future.

331. MHCLG and SOLACE (2018) have recently issued guidance for Chief Executives on preparedness for civil emergencies which includes a recovery element. However, even this guidance does not provide a clear framework for supporting senior executives learning about this subject.

Observation 23: Projections suggest that extreme-weather emergencies may occur with increasing intensity and/or frequency in the future. Preparing personnel for their role during all types of extreme-weather emergency (i.e., not just winter weather) should be regarded as a fundamental component of any authority's continual professional development programme.

Observation 24: Whilst there are useful courses currently available for preparing personnel for multiple respective roles within integrated emergency management, it is apparent that these course materials need to be reviewed to better integrate the needs of responders outside the 'blue light' community.

332.   **Addendum:** In response to an earlier draft of this report, DfT agreed to support the development of a *Professional Diploma in Transport Network Resilience* with the Institute of Highway Engineers (IHE). The course was developed by Dr Hugh Deeming and John Lamb, with its content beta tested with a small group of experienced senior highways officers in January 2020.

333.   Feedback from the beta test was extremely positive, including these two validations from participants (Lamb, 2020):

> "Two weeks after attending the course, I found myself dealing with a real-life situation in the multiagency response to Storm Dennis. Having attended the course, I had a better understanding of the shared language and more confidence in how we should respond as highway managers."

> "The course forges new thinking across councils and supply chains and helps build a national network across highway authorities in terms of mutual aid."

334.   Unfortunately, in March 2020 the onset of the Covid-19 pandemic resulted in the roll out of the full course being postponed until further notice. The course, however, retains DfT backing and will recommence delivery in 2021.

3.8.2 Recovery Programmes

335.   Dealing with extreme-weather effects can mean very different things in terms of what the resultant recovery challenge looks like. The impact of a major snow event can present responders with severe life-risk challenges, but once the snow melts the need for any form of infrastructure-recovery operation may be negligible.

336.   Conversely, major flood-generating storms over the past 20 years have resulted in hundreds of millions of pounds of damage to infrastructure alone. For example, the cumulative cost of road damage and delays following the major floods in 2007, 2013/14 and 2015 has been calculated at £633m (Environment Agency, 2018).

337.   To repair infrastructure damage of this scale takes time, resources and the adoption of effective asset management approaches.

338.   There are many examples of Highway Authorities managing recovery from significant extreme-weather impacts on their networks, but this is not the place to look at them all. Therefore, given the size of the recovery challenges faced by Cumbria's authorities following Storm Desmond and the fact that their programme has now been presented with several industry awards for innovative project management, this section will concentrate on explaining the basic process through which that authority went to develop and deliver the Infrastructure Recovery Programme (IRP).

3.8.2.1 The Cumbria Infrastructure Recovery Programme (IRP)

339. Using Cumbria Highways' stabilisation and recovery of the A591 as an illustration of effective project collaboration and management, Box 2 presented a case study of one of what ultimately became 1,234 individual storm-damage repair projects across the county to illustrate the innovative collaborative working that occurred in the aftermath of Storm Desmond (Figure 3).

340. The sheer scale of the recovery task faced by Cumbria Highways meant that a dynamic approach to programme management needed to be developed quickly.

341. Based on the three principles, of simplicity, proportionality and combining small-step individual behaviour changes into an overall-evolutionary collaborative approach, meant that the IRP has provided a basis for recovery that has undoubtedly proven more effective and successful than its antecedents.

342. From its early stages, three principal factors made the success of this programme more likely:

- the initial comprehensive impact assessment,
- based on the impact assessment, the award of £120m by DfT for the programme
- the close collaborative working relationships between the Local Highway Authority, its contractor, their sub-contractors and the affected communities.
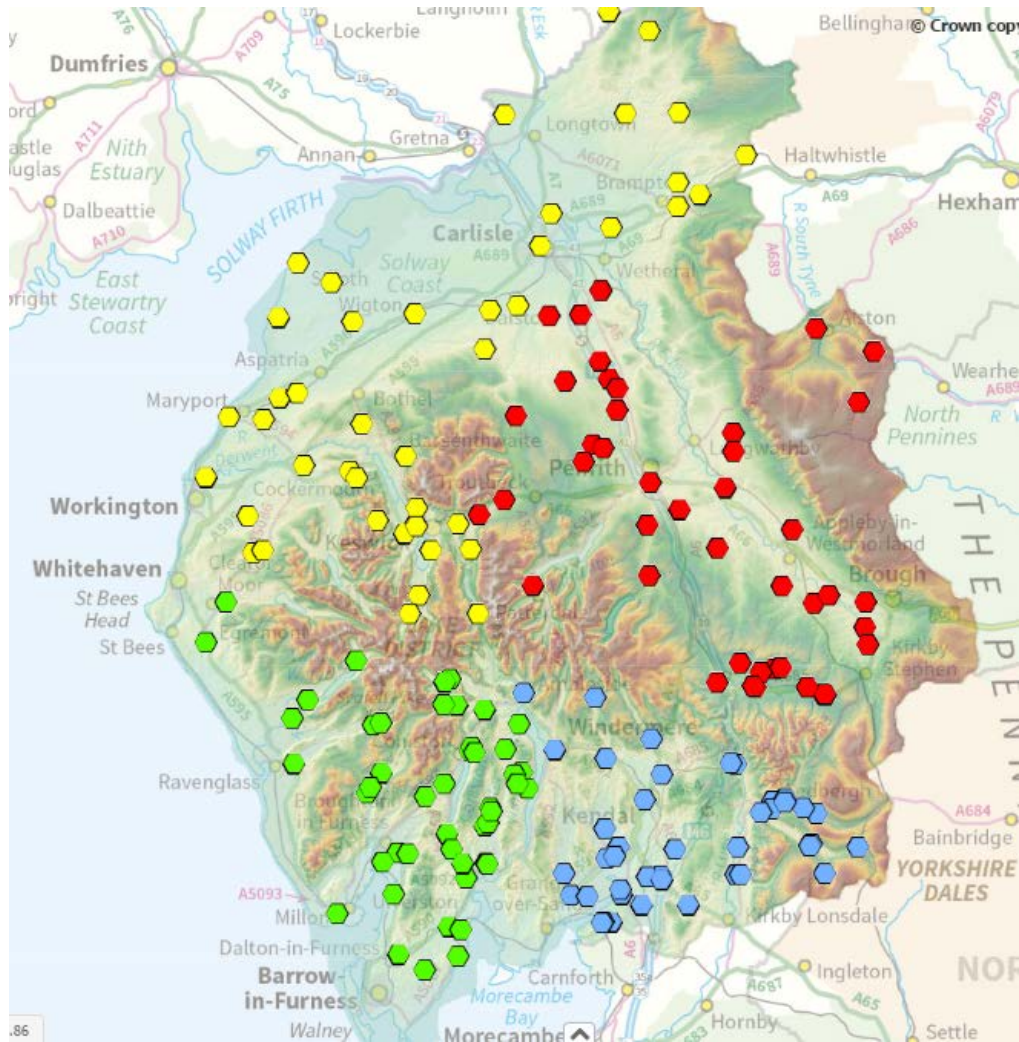
Figure 3: Cumbria's Infrastructure Recovery Programme (CIRP).

Note: The CIRP was specifically created to repair, reinstate and rebuild bridges, highways, slopes and retaining structures that were impacted by Storm Desmond in Dec. 2015. This image illustrates 4 work packages (colours) comprising 180 individual projects.

Image: Cumbria County Council©

343.   From the earliest moments when access to the county became possible it was decided that the impact assessment had to provide a trustworthy estimate of repair costs, which would enable government to rapidly decide on what assistance was necessary.

344.   Accordingly, Cumbria County Council (CCC) contracted Mott MacDonald and Gaist Solutions Ltd., two independent contractors with already proven good working relationships with DfT and government, to carry out the assessment. CCC also actively encouraged the use of the most appropriate technology available to carry out the work. This meant that the assessment was developed using some of the most state-of-the-art technology available, from drones to sonar to the vehicle-mounted system supplied by Gaist

Solutions Ltd. The latter of which provided high-resolution imagery of the complete 2,500km length of Cumbria's Priority 1 and Priority 2 road network.

345.   Cumbria's recovery debrief report describes the process of bridge inspection:

> The risk-based prioritisation of bridge repairs initially involved the Army visiting and visually surveying all bridge assets using a pragmatic 'red, amber, green' categorisation system and logging these inspections into an asset spreadsheet known as the 'Operation SHAKU - District Tracker'. As well as this initial visual inspection, 350 bridges that were recorded in the amber or red categories were then subjected to further expert structural inspection, including by Royal Engineers divers and other specialist capabilities.

> Some bridge inspections were inevitably delayed due to the high river flows presenting too serious a risk to the divers. However, following deliberation between meteorologists, Council Highways and other experts, the inspection of Eamont Bridge in Penrith was accomplished using a Remotely Operated Vehicle (ROV) outside its normal operating parameters, thus posing considerable risk to the equipment and operators.

> If the inspection had not been carried out at that time, further predicted rainfall and the ensuing high river flows would have negated all possibility of an inspection taking place for several weeks. The knock-on consequences of a delayed closure would have been considerable for the town, which was already suffering critical levels of traffic and pedestrian disruption and, therefore, were felt to justify the actions, which fortunately found the bridge to be structurally sound and safe to reopen on 18th December.

> As a result of these experiences and the demonstration of the importance of being able to undertake bridge inspections in hazardous conditions, Cumbria County Council are now working with a consortium to develop a more robust vehicle-mounted surveying system, i.e., BridgeCat (GOV.UK, 2017).

> Due to its simplicity and useful structure the Operation SHAKU – District Tracker spreadsheet quickly evolved into the 'Cumbria Ask', which was the document that ultimately informed CCC's request for government funds and provided the basis for the Infrastructure Recovery Programme.

346.   In relation to the award of the government grant, Cumbria's recovery debrief report explains:

> One of the primary lessons that emerged in relation to the infrastructure damage, and which illustrated something genuinely learned from 2009, concerned finance. As the scale of the physical damage to the county's networks, hubs and public buildings became clear, it was obvious that repair costs would run into many tens of millions of pounds.

In the past, government standard operating procedures had determined that a programme of recovery works needed to be developed on the basis of an impact assessment. However, each project within that had then to be costed individually, with funding needing to be sought on a case-by-case basis – an approach that is enormously expensive in time and planning resources. As a direct result of this regime, the flood damage repairs from 2009 had still been ongoing alongside day-to-day maintenance work into 2015.

However, government thinking shifted following 2009 and other floods (notably the winter floods of 2013/14), and so following Storm Desmond the SRCG and its Infrastructure sub-group were encouraged to collaborate with the Department for Transport (DfT), the Ministerial Recovery Group (MRG) and trusted contractors, in order to agree to the scale and payment of a lump sum. This lump sum was intended to encompass all key elements of the transport infrastructure repair without the need for individual business cases. The bid was successful and £117.7m was awarded to Cumbria County Council's Highways Capital Programme, with an additional £2m revenue grant for initial survey work.

(Deeming & Otley, 2018: p.47)

347. This provision of so much up-front funding clearly reflected the degree of trust that government had developed, both in the SRCG's 'Cumbria Ask' impact-assessment process and in the SRCG's collaborative approach to dealing with other key partners. Importantly, the award of the grant was regarded as a crucial factor in supporting government confidence that plans could be rapidly enacted to bring elements of the county's infrastructure back into operation as quickly as possible. This perception was best illustrated by the comments of two interviewees:

> "Austerity has resulted in a situation where if the business case approach had been necessary [as in 2009], Cumbria County Council would simply not have been able to cope with the repair workload. We couldn't have delivered a tenth of what we could have delivered"

> "I felt the officials in the Department [for Transport] had learned from 2009. We didn't have to negotiate particularly for this approach, the Department were fairly clear from day 1 that what they wanted to do was get the money into the system and get the recovery built and that they would be performance managing us by results not by projects"

348. The primary consideration for the Infrastructure Recovery Programme was public safety. Accordingly, a risk-based approach guided the initial activity to stabilise and/or repair dangerous structures. To expedite this work, the Highway Authority convened a non-partisan Members Infrastructure Group. This group, led by the leader of the Council delegated extraordinary powers to their Chief Executive, but with the cross-party group providing oversight of the process. This enabled senior officers to be confident that they had members' support for decisions they were needing to make, to which were attached considerable cost and risk implications.

349. What also assisted in this early phase of recovery was the use of the NEC3™ project management system. From the initial stabilisation/rapid-recovery programme operations NEC offered options that allowed the work to progress efficiently, with Option E (cost reimbursable contracts) being important in the initial phase, before the programme settled and the more conventional options could be used.

350. The key point to recognise in this is that by using Option E initially, this meant that the council bore much greater risk than was normal. However, the oversight of the Members' Group meant that this accountability was always understood, and the use of trusted contractors and accredited project managers resulted in large parts of the network being returned back to temporary and then permanent functionality within a relatively short space of time.

351. Figure 4 provides an illustration of the progression of the IRP from its stabilisation phase through to its maturity and delivery of multiple packets of projects by the team.

Figure 4: The six stages of delivery for Cumbria's Infrastructure Recovery Project (Source: Cumbria County Council)
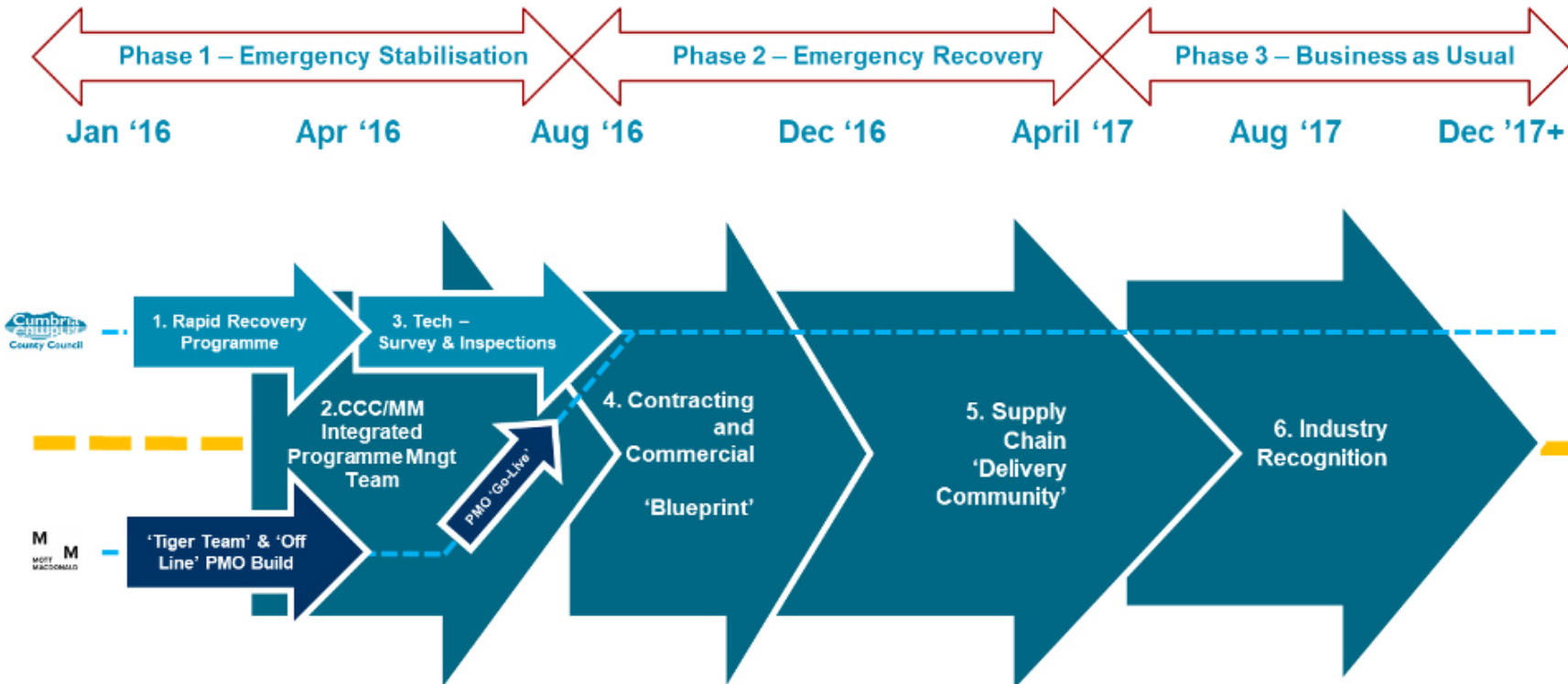
:
1) Rapid Recovery Programme
2) Fully Integrated Programme Management Team
3) Technical assessment (BridgeCAT/GAIST/GIS)
4) Contracting & Commercial 'Blueprint'
5) Supply Chain 'Delivery Community'
6) Industry Recognition

352.   Being able to parcel projects together based on geography, complexity and similarity enhanced the organic growth of supply chains, increased value for money also meant that another key principle of the IRP was easier to adopt. This was that local contractors would be used where possible. Not only did this active inclusion of local expertise help provide security for local businesses, it also meant that communities could really identify with the work. For example, having a locally trusted contractor explain a project timescale to a community, rather than a representative from the council or a multi-national, built trust and local ownership into the process.

353.   Adoption of the principal-contractor>local sub-contractor approach ultimately resulted in 70% of the bridge-repair work being carried out by firms based in the area. Accordingly, the approach should be regarded as bearing relevance for all those faced with planning for recovery in the sector (Mott MacDonald, 2018).

354.   As a result of these factors the IRP team has been the recipient of several national awards for their achievements.

Observation 25: It is notable that the Rapid Impact Assessment (RIA) process used by Cumbria County Council, using trusted independent contractors, technology and 'Cumbria Ask' spreadsheet approach to documentation, has been identified as good practice and used as a case-study by DfT to support the development of consistent Rapid Impact Assessment guidance for the sector (x-ref observation 17).

Observation 26: Cumbria's Infrastructure Recovery Programme presents a clear case study of how careful planning and innovative thinking when recovering from disaster can present genuine opportunities for local growth and for enhancing resilience.

Observation 27: Cumbria's Infrastructure Recovery Programme was made possible by the government lump-sum grant of £120m. However, the process through which this money was awarded, whilst clearly illustrative of good practice, was used because no consistent set of criteria for such applications has yet been developed (contrary to Brown et al.'s recommendation 30).

Whether other Local Highway Authorities have missed out on funding opportunities because they did not use the same structured approach to impact assessment and funding requests as Cumbria is an area of uncertainty. Accordingly, to ensure fairness for those who will be dealing with future emergencies it seems appropriate to repeat Brown et al.'s recommendation that *"Government should consult Local Highway Authorities on a set of criteria to be applied consistently to emergency highway repair funding through the DfT whenever such funding is made available."*

3.9 Corporate memory

355.   Ensuring that personnel engage with a training and exercising regime that develops, tests and maintains competencies over time and which connects throughout the incident management hierarchy provides organisations with important capabilities to manage an emergency when it occurs.

356.   Formally debriefing the way that organisations have managed events, in order to identify what went well, what not so well and what needs to be improved, adds to the body of information, data and knowledge that accumulates to form corporate/organisational memory.

357.   Debriefs, however, tend only to identify lessons (Pollack, 2013). Without a process through which to ensure that the lessons are learned, corporate memory will not evolve and the risk that 'the same mistakes could be repeated' grows.

358.   It is quite clear that all the extreme-weather events examined in this review stimulated comprehensive multi-agency debriefing activities from which numerous recommendations for improvement and examples of notable practice were identified.

359.   Here it is important to identify two local authorities that have gone beyond the standard template and 'task and finish' approach to debriefing, to commission reports that not only reflect the 'what went well/what not so well' detail, but do so in a more narrative format that provides a substantive resource with which to monitor future progress. Perhaps equally importantly, they provide a chronicle of an event, its outcomes, and its lessons identified and learned in ways that are much more likely to retain corporate memory than a spreadsheet-based task list ever will. These substantive review processes were commissioned by Cumbria and Calderdale respectively.

  • Deeming, H. and C. Otley (2018). *A review of recovery processes following Storm Desmond's impacts on Cumbria (5th/6th Dec 2015).* Penrith, UK., A report prepared by HD Research under commission from Cumbria Local Resilience Forum.
  • Calderdale Flood Commission (2016) *Calderdale Flood Commission: Final Report* a report commissioned by Calderdale Council

360.   In discussing past flood events, it was obvious that Calderdale's experience in 2012 and Cumbria's experiences in 2005 and 2009 had all had direct and positive effects on the way the impacts of Storm Desmond and Storm Eva were managed. Likewise, those responding to the Beast from the East made decisions informed by previous experiences of their own and/or from others' lessons learned from them (e.g., as encompassed in the Quarmby and Brown et al. reviews).

361.   However, two factors that challenged the effectiveness of corporate memory if defining response and recovery operations that were repeatedly mentioned were, austerity and staff churn.

362.   Austerity was attributed as a primary cause for authorities now being objectively more resource-challenged when managing emergencies than in the past. Associated with this it was reported that smaller teams with new roles than previously had not been able to draw on corporate memory in ways that helped them manage events. In effect, austerity was reported to have directly impacted on authorities' resilience against extreme-weather events.

363.   What was interesting to hear, therefore, was that faced with these limitations individuals and teams had innovated and developed new ways of working under considerable pressure, which meant that stabilisation activities had been initiated and recovery programmes had been developed and delivered in ways that had drawn considerable praise.

364.   In terms of exemplifying key elements of resilience, which encompass the exercise of adaptive capacity and learning, such successes appear to provide real insights for a highways sector faced with increasing weather-related risks and the resultant requirement to develop contingencies that will deliver stabilisation and recovery programmes in the future.

Observation 28: Building resilience to extreme weather is best understood as a process. Accordingly, it is important that Local Highway Authorities expend effort and resources in consistently striving to learn from their and from others' experiences of emergencies and by instilling these lessons into practice through a process of planning, training, exercising and validation.

4. Report summary

365.   This review has investigated how a number of Local Highway Authorities have managed the impacts of extreme-weather events on their networks. The focus has been on identifying how these Highway Authorities have contributed to the delivery of integrated emergency management, in their capacity as Category 1 responders under the Civil Contingencies Act. In effect the review has explored these Highway Authorities' preparedness, response and recovery activities as part of a multi-agency endeavour, not as an activity that occurs in a silo.

366.   Following a series of interviews and a process of analysis a number of key themes were identified as bearing relevance to Highway Authorities, regarding their resilience to extreme-weather events and more widely, their resilience across a range of hazards and threats.

367.   By focussing on emergency management activities related to the experience of specific events (e.g., Storm Desmond and Eva), it is clear that affected Highway Authorities have been supported by highly capable officers who have adopted, at times, quite innovative approaches to keeping their networks running, or back running following disruption. Such examples include the use of state-of-the-art mapping technologies to create high-definition highway-condition datasets, which have been instrumental in supporting post-event repair grant applications (as well as providing a crucial baseline assessment that will be invaluable in informing future asset management processes).

368.   It is clear that many Highway Authorities can deploy Suitably Qualified, Experienced and Empowered Personnel (SQEEP) across all tiers of the emergency response hierarchy, meaning that the strategic direction, tactical solutions and operational delivery of highways' activities can be and have been integrated effectively with the activities of other responders in highly complex and challenging circumstances.

369.   Note has been taken, however, of the value that focussed training and exercising can have in increasing personnel's capabilities and confidence in dealing with emergencies, especially when those events require levels of initiative and management far beyond those required to manage normal business as usual on a day to day basis (for example, the events that impacted on Cumbria and Calderdale in December 2015, which could objectively be defined as disasters[3]).

370.   The critical importance of shared situational awareness during and following emergencies has been highlighted. It is clear that many Highway Authorities have realised the importance of technology in accessing real-time information on asset condition and deterioration. However, the key role of social media has also been identified as bearing significantly on how Highway Authorities can both push risk information to and pull situational information from the public and professional users of the highway network.

371. Several lines of evidence suggest that the effect of an open and actively implemented social media strategy has been shown to increase situational awareness, to increase safety and to reduce complaints. Taking these findings in an interoperability context, suggests that highways-related social-media streams during emergencies should be integrated directly into an actively supported multi-agency information cell (MAIC).

372. An additional finding regarded the innovative use of social media during recovery. Here customised public communications focussed on explaining and illustrating the complexity of recovery operations were found to have played an important role in providing public reassurance and managing expectations.

373. In relation to managing information between responders, the role of ResilienceDirect™ (RD) was also discussed. Participants found that while potentially useful, the dynamic nature of highways information during emergencies (e.g., traffic flow and congestion monitoring) and the complex nature of task-specific data technologies (e.g., CCTV and dGPS monitoring of assets) were not yet supported for effective integration into RD.

374. This illustrates the importance of MAIC capabilities not being developed purely using generic technologies (e.g., RD, social-media monitoring 'dashboards'). They need to have the ability to interrogate outputs from all systems able to provide real-time information for responder partners during an emergency.

375. The concept of stabilisation was discussed, as was its relevance to Highway Authorities faced with managing damaged assets in a way that provides a buffer of time in which to consider the most resilient recovery options, rather than just the quickest repairs that may simply reproduce an original vulnerability.

376. In relation to Resilient Networks, observations included the need to manage expectations with partners during 'peacetime' as to how Highway Authorities will prioritise their capabilities and capacities during weather emergencies (e.g., partners should be encouraged to make their own continuity arrangements where appropriate).

377. Whilst it was understood that the resilient-network concept supports Highway Authorities prioritisation and management of assets during events, experiences also suggested the need for Local Highway Authority emergency managers to be able to retain a flexible approach to understanding what comprises their resilient network during an emergency. This flexibility needs to be applied through the application of dynamic risk management procedures that are capable of assessing what assets and routes need to be resilient in the face of what might be highly location-specific conditions (e.g., the isolation of villages).

378. The issue of single-point failure of multiple paralleled services was discussed relative to the example of the collapse of Tadcaster Bridge in 2015. Given the physical abutting of critical local, regional and national services across the collapsed bridge, this incident clearly illustrated the vital

importance of Local Resilience Forum partners (Cat 1 and Cat 2) collaborating effectively to develop contingencies for mitigating real-time and potentially cascading effects across diverse networks. From this perspective it is vitally important that Category 2 responders actively engage with their respective Local Resilience Forums' planning processes. This needs to be done, both in order to manage expectations of what is achievable in terms of network resilience (e.g., in developing mutual understandings of networks' self-healing and resilience capabilities) and to ensure the existence of the personal relationships that reduce decision delays during dynamic incidents.

379. Issues related to the importance of declaring a 'Major Incident' drew the observation that as a Category 1 responder, local authorities should actively train and empower their personnel to declare such an incident as circumstances dictate.

380. The review also heard of successful examples of collaboration during recovery. Of particular note were the collaborations that brought about the repair of the A591 in Cumbria and Elland Bridge in Calderdale. Regarding the A591 in particular, without the unprecedented multi-agency approach that was taken to this repair by Highways England, Cumbria's broader recovery would have undoubtedly been significantly delayed.

381. The potential of this type of mutual aid, between agencies as well as between local authorities, appears to offer considerable opportunities for increasing the capability and capacities available for future recovery operations.

382. Another issue related to Local Highway Authority capabilities and capacities focussed on the skillset of Highway Authority officers and the resultant pressure that bearing these skills placed on them during recovery. This led to an observation that a national approach should be taken to exploring ways for mutual aid to include the deployment of 'critical friends' to assist Highway Authority teams during the height of major stabilisation and recovery operations.

383. Also related to assistance during emergencies was the issue of expectation management in regard to the deployment of military aid. It was found that the military have undoubtedly provided crucial support for many operational activities. However, experience now suggests that the sector should accept that major infrastructure repairs following emergencies are much better understood as contingencies to be planned for and integrated into Highway Authorities normal project management and business continuity arrangements. The expressed offer by the military, that the sector develops a relationship with its specialist assessment teams should, however, be seen as providing a clear opportunity for mutually beneficial 'peacetime' partnership building.

384. The discussion of the respective roles of COBR, Lead Government Departments (LGD) and the Ministerial Recovery Group (MRG) found that a Local Highway Authority's access to reliable data and situational awareness were critical in underpinning trusting relationships with these higher tiers.

This is not to suggest that the intensity and frequency of demands for information were appropriate (given the difficulty in anyone having accurate situational awareness during major emergencies). Rather it suggests a need to balance these data requests with the need for a clearer understanding of what is the *best* information to be collating and sharing.

385. In relation to DfT acting as Lead Government Department for highways related incidents[46], examples suggest that their current approach to information management to support decision making is good, but that a standardised approach to impact assessment and recovery-programme costing is still lacking. Thus, it is still difficult for Highway Authorities to develop contingencies and capabilities (e.g., administrative) in advance, because it cannot be known for certain whether previous arrangements and LGD expectations still apply. A suggestion is made which seeks to encourage DfT to develop a resilience planning, training and exercising regime to create a cadre of suitably qualified, experienced and empowered personnel within the Department to deliver this programme in concert with an engaged sector.

386. The importance of the role of Elected Members has also been highlighted, with examples of officers working very effectively with members to ensure emergency response and recovery activities reflect democratic processes and accountability, but also take advantage of these individuals' local knowledge and their ability to act as facilitators to engage local participation and to ensure that (e.g.) repair programmes and schedules are appropriate for the affected communities.

387. Community resilience was found to be a concept understood well across the participating Highway Authorities. Whether arrangements involved farmer contractors and/or flood or snow champions, there appeared to be a broad understanding of the importance of community self-help.

388. The key importance of nurturing strong relationships between Local Highway Authority officers and their resilience units was illustrated with the example of the A9 emergency plan, which has been developed in Scotland to provide a collaborative, community-supported, emergency rest-centre plan for the road's whole 112-mile length.

389. Various approaches were also found in relation to 'white-out' events. Here the 'Beast from the East' response highlighted key issues, from adopting a health and safety focussed approach to operations management, to the importance of understanding all the capabilities a Local Highway Authority has available to it during extreme events. The example of a local company being drafted in to assist the clearance of snow in Cumbria revealed the importance of actively making friends *before* you need them, not just *when* you need them. However, it also reemphasised the importance of Highway

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[46] List of Lead Government Departments: https://www.gov.uk/government/publications/list-of-lead-government-departments-responsibilities-for-planning-response-and-recovery-from-emergencies

Authority officers being suitable qualified, experienced and empowered so as to be aware of the implications (positive and negative) of decisions they make during events that may bear significantly enhanced risk to life (i.e., in this example, balancing the need to reconnect isolated communities against the risk of causing damage to highways infrastructure).

390. The issue of training was continued in a discussion of the Multi-Agency Gold Incident Commanders (MAGIC) and Tactical commanders' courses. It was acknowledged that the current format of the courses may not be entirely appropriate for local authority personnel, particularly as recovery is only covered in minor form. However, arguments were put forward in respect to the importance of multi-agency integrated emergency management being seen as a collaborative endeavour requiring specific and accountable levels of expertise at every tier of coordination.

391. Moving on, to the consideration of how disastrous extreme-weather impacts can be recovered, the example of Cumbria's Infrastructure Recovery programme (IRP) was used to illustrate one innovative recovery collaboration, which was in this case managed through the NEC3 framework.

392. The IRP's progressive use of different NEC3 funding options, its creation of a highly capable management and delivery team based on trust and relationships with key contractors and its insistence on the use of local sub-contractors, makes it clearly recognisable as an example of good practice.

393. The report's final section considers the issue of corporate memory and the importance of learning and remembering not only the lessons of events on your Local Highway Authority, but also what you can learn from the effects of extreme events on others.

5. Conclusion

394. This review has investigated the extreme-weather related experiences of a small selection of local authorities, local Highway Authorities, strategic network operators and others operating in the UK highways sector.

395. The focus has been on exploring events that occurred in the period 2015 – 2020, i.e., the period following the publication of two previous reviews, which each presented substantive recommendations to the sector regarding extreme-weather risk management (i.e., Quarmby and Brown et al.). This review was not conceived to supplant the findings of those reviews, their recommendations remain valid.

396. Rather, the intention was to identify themes within the recent experiences that might indicate additional or complementary areas of learning that would be useful for the sector to acknowledge and reflect on.

397. The review also considered the participants' experiences from a perspective that prioritised the importance of understanding that extreme-weather related integrated emergency management is fundamentally a multi-agency endeavour.

398. In all, nine broad themes were identified and discussed:

- Multi-Agency integrated emergency management;
- The concept of stabilisation;
- Resilient networks;
- The Strategic Road Network (SRN), local highways interface;
- Collaborative working, Mutual Aid and Military Aid;
- The role of Ministerial Groups: COBR, Lead Government Departments and the Ministerial Recovery Group (MRG);
- Democratic institutions and community resilience;
- Business Continuity Management (BCM), training and exercising; and
- Corporate memory.

399. Due to the focussed nature of the review, it was not appropriate to make recommendations as though substantive, whole-of-sector affecting, issues had been identified. Rather a series of observations were made to highlight what appeared to be useful learning points and opportunities accrued by the participating authorities.

400. The review identified numerous examples of good and innovative practice that had been employed by participants to mitigate the risks and consequences of the events they had experienced. There was clear evidence of learning and of an understanding that these extreme events had not been unique. In fact, many participants candidly stated their belief that their experiences had underlined for them the importance of continual vigilance and preparedness given the increasingly convergent projections for escalating extreme-weather risk in the future.

401. This report has identified sector learning from the experiences of a number of highway authorities and underlines the value of collaborative working and the sharing of experiences by those who have recently suffered extreme-weather events. The professional development of key personnel at all levels will ensure they are qualified, experienced and empowered to make crucial decisions as part of an integrated team as and when circumstances dictate.

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7: Observations

Observation 1: The concept of Suitably Qualified, Experienced and Empowered Personnel (SQEEP) appears to be useful in helping to understand how effectively Local Highway Authorities are able to engage in multi-agency integrated emergency management.

Observation 2: The development of multi-agency information cell (MAIC) and virtual operations support team (VOST) capabilities by extreme weather affected local resilience partnerships clearly illustrates good practice in improving information management processes during emergencies

Observation 3: ResilienceDirect (RD) is the Government's preferred IT platform for sharing emergency management related information. However, the current system is not yet able to support key additional GIS map layers which identify a number of highways critical information streams, e.g., known-vulnerable structures (and information related to their intervention trigger points), assets containing multiple utilities infrastructures, live traffic data. This is a significant lack of capability. Accordingly, it appears that Local Highway Authorities need to either: 1) work with the Cabinet Office to suitably increase the capability of the RD platform, or 2) continue to develop other contingencies for dynamically sharing their information with partners (including within Strategic Coordination Centres and, trans-boundary, with neighbouring Highway Authorities).

Observation 4: The role of VM/Matrix signage during emergencies appears to be an issue that would benefit from focussed research to assess how it can best be used to reduce risks to the travelling public during extreme weather.

Observation 5: Local authority and partner agency communication strategies, which encompass and encourage active social media usage have proven that they provide both, a useful service for the public and an additional information source, which can help responders develop situational awareness during emergencies and recovery.

Observation 6: Stabilisation appears to be a useful concept for Local Highway Authorities to adopt in order to help them to understand and to explain to the public, their intentions, plans and activities following physical damage to highways assets.

Observation 7: Local Highway Authorities need to proactively manage the expectations of their partners in respect to how the highway network will be managed during emergencies. Partners should be supported in carrying out their own risk-assessments to identify appropriate (e.g., private sector) contingencies for mitigating the impact of extreme-weather effects on their assets and services.

Observation 8: Extreme-weather effects can manifest in ways that challenge 'resilient network' plans. Effective Local Highway Authorities maintain the flexibility to iteratively reassess risks in order to adjust resilient networks as circumstances require.

Observation 9: Effective prevention and mitigation of single-point failures within paralleled critical infrastructure networks during extreme-weather events (and the cascading risks they present) can be achieved through dynamic information sharing between Category 1 and Category 2 responders. Rather than detailed mapping of

potential network complexities and vulnerabilities, what appears to have been critical to resilience partnerships' abilities to manage these risks during major incidents, have been the relationships developed between these organisations during the planning and day-to-day operational management stages. One aspiration that should be taken forward from this point, however, is that despite the challenges presented by the sharing of potentially sensitive data, these partnerships should be seeking to coordinate even more effectively, to develop shared understandings of all vulnerabilities in their integrated-systems prior to an event, not just in the heat and confusion of response.

Observation 10: Network prioritisation during extreme weather is an inherently political issue. Local Highway Authorities can face considerable challenges in managing the expectations of the public in relation to this. Accordingly, it is critically important that risk-based management approaches are understood and supported by suitably trained, experienced and empowered team members in corporate, strategic and elected-member cadres.

Observation 11: Responsibility for strategic and resilient-network closures during extreme-weather events should not be borne by a single agency alone. Multi-agency justification should be sought as soon as practicable, in order that a collaborative risk-based approach can be applied to the decision (e.g., to ensure the safety of motorists is not further compromised by pushing them from the strategic roads onto more vulnerable networks).

Observation 12: Local Authority and Local Highway Authority personnel who deal with extreme weather event preparedness and response need to have sufficient training and support to ensure they have the competence and the confidence required and that they are empowered to declare a major incident, and activate a multi-agency response, when appropriate.

Observation 13: It appears that ambiguity exists about Highways England's current attitude toward supporting Local Highway Authorities in the management of designated diversion routes.

Observation 14: Given recent examples of effective collaboration between local Highway Authorities and other highways infrastructure 'owners' in repairing extreme-weather damage (e.g., the A591 in Cumbria), it appears strange that no formal mutual-aid based relationship has been proposed by the Department for Transport to develop a framework for managing future critical-repair partnerships.

Observation 15: The nature of contemporary extreme-weather events appears to be leading to a point where emergency mutual aid and professional-networking arrangements need to be developed on a regional or national basis, thus negating the risk of neighbours being unable to aid each other because both have been impacted to their capacity by the same event.

Observation 16: The military has provided critically important capabilities and capacities to hazard-affected local authorities under existing Military Aid to the Civil Authorities (MACA) arrangements. However, experience has shown that local authorities can clearly illustrate and positively affect their own resilience by developing response and recovery contingencies that do not, and should not need to, include a military component.

NB. Where conditions do dictate military input, the Joint Regional Liaison Officer, can activate the Military Assessment Team or Infrastructure Response Force, (currently at zero cost), thus providing Tactical Coordinating Groups access to significant specialist knowledge and reach-back to impressive infrastructure/engineering capabilities.

Observation 17: The Department of Transport (DfT) should engage directly with the Civil Contingencies Secretariat to design and put in place a substantive Crisis Management Excellence Programme. This would comprise suitable competency, learning, and peer-support components to ensure consistent delivery of resilience plans and contingencies by a cadre of suitably qualified, experienced, empowered, and respected personnel.

Observation 18: It is important for hazard-impacted authorities to present DfT, or in extreme circumstances the Ministerial Recovery Group, with a coherent 'ask' following emergencies. Therefore, that DfT has provided seed funding for the development of Rapid Impact Assessment (RIA) guidance and a methodology for creating a consistent information picture that provides shared situational awareness and supports the development of repair/funding priorities should be welcomed (x-ref observation 24).

Observation 19: The example of the A9 trunk road plan illustrates the critical importance of Local Highway Authority personnel's collaboration with their own authorities' resilience units to develop effective working relationships and effective emergency plans.

Observation 20: Multi-agency planning activities for extreme-weather emergencies should be regarded as opportunities to extend the 'make friends before you need them' mantra to consider potential partners from across the statutory, private, voluntary and community sectors. The goal should always be the integration of all capabilities and capacities that may help to shorten emergencies and reduce harmful consequences.

Observation 21: Cumbria Local Highway Authority's decision to operate a health-and-safety based approach to asset and personnel management during the 'Beast from the East' extreme-weather response, should be regarded as an illustration of sound practice.

Observation 22: Under current out-sourcing frameworks Highway Authorities may wish to push the operational risks of managing extreme-weather response away from themselves and toward their contractors and sub-contractors. However, it should not be forgotten that some extreme-weather scenarios bear a high risk to life. Accordingly, Highway Authorities should consider developing contractual conditions with their suppliers to ensure operator health and safety is prioritised.

Observation 23: Projections suggest that extreme-weather emergencies may occur with increasing intensity and/or frequency in the future. Preparing personnel for their role during all types of extreme-weather emergency (i.e., not just winter weather) should be regarded as a fundamental component of any authority's continual professional development programme.

Observation 24: Whilst there are useful courses currently available for preparing personnel for multiple respective roles within integrated emergency management, it is apparent that these course materials need to be reviewed to better integrate the needs of responders outside the 'blue light' community.

Observation 25: It is notable that the Rapid Impact Assessment (RIA) process used by Cumbria County Council, using trusted independent contractors, technology and 'Cumbria Ask' spreadsheet approach to documentation, has been identified as good practice and used as a case-study by DfT to support the development of consistent Rapid Impact Assessment guidance for the sector (x-ref observation 17).

Observation 26: Cumbria's Infrastructure Recovery Programme presents a clear case study of how careful planning and innovative thinking when recovering from disaster can present genuine opportunities for local growth and for enhancing resilience.

Observation 27: Cumbria's Infrastructure Recovery Programme was made possible by the government lump-sum grant of £120m. However, the process through which this money was awarded, whilst clearly illustrative of good practice, was used because no consistent set of criteria for such applications has yet been developed (contrary to Brown et al.'s recommendation 30). Whether other Local Highway Authorities have missed out on funding opportunities because they did not use the same structured approach to impact assessment and funding requests as Cumbria is an area of uncertainty. Accordingly, to ensure fairness for those who will be dealing with future emergencies it seems appropriate to repeat Brown et al.'s recommendation that:

> "Government should consult Local Highway Authorities on a set of criteria to be applied consistently to emergency highway repair funding through the DfT whenever such funding is made available."

Observation 28: Building resilience to extreme weather is best understood as a process. Accordingly, it is important that local Highway Authorities expend effort and resources in consistently striving to learn from their and from others' experiences of emergencies and by instilling these lessons into practice through a process of planning, training, exercising and validation.

8. Appendices

Appendix 1: 'Resilience' working paper: John Lamb (2018)

Resilience

1. Response to extremes events has been a feature of recent years. This includes extreme snow, floods (coastal, river and surface), wind and drought but extreme events also include failure of infrastructure as a result of asset age, sudden deterioration or catastrophic failure (major incident such as accidental or deliberate damage such as fire, explosion, chemical spillage).

2. Local Councils have a critical role to play as the most local body of Government and accountability to local people for maintaining assets, providing access to goods and services and supporting economies.

Role of the Local Government Technical Advisers Group

3. As a national body, TAG provides a broad cross section of contemporary expertise and insight on key issues affecting front line Council service delivery to communities in Borough, County and Metropolitan authorities across the country. Specific technical leadership includes matters across transport, planning, waste and flooding.

Purpose of this paper

4. Recent experiences have underlined the sustained pressures placed on local communities as a result of extreme weather and the impacts on local economies to extreme weather and loss of access to, (or catastrophic failure of) key routes and bridges. Traditional risk assessment and assumptions surrounding 'repeat events' need to be informed by the increased frequency and intensity of events as well as greater consideration given to the impacts of loss of fibre networks and other nationally critical infrastructure.

5. The paper is informed by the £5bn cost of the 2015 flooding from Storm Desmond and Storm Eva but is set against a backdrop of ever harder financial constraints that restrict the ambition of now historic documents on preparedness and incident response. The Pitt Review following the 2007 floods led to over 100 recommendations, but many failed to reach the statute book and those that did since been have been diluted or had inconsistent levels of funding support for their delivery. However, this is not solely about funding, prior to the 2015 floods some Local Councils had failed to produce Flood Risk Management Strategies despite having received DEFRA grants for this purpose. Equally the 'corporate memory' of even recent major incidents has been shown to fail 24-26 months after major events- often based on dated understanding of 'repeat events' or 'lightening never striking the same place twice'.

6. More recently the DfT is expecting more from local Highway Authorities in the development and delivery of asset management planning. However, not all Councils are at the same level of awareness, knowledge base or even understanding of third-party ownership of assets that could be outside their

ownership but essential to local network management (i.e., Canal & Rivers Trust, Network Rail, etc.). Moreover, whilst national departments have benefited from 'Ministerial Recovery Group' and 'Operational Recovery Group' fora, as a sector there has been little formal de-briefing. This Paper seeks to commence a dialogue where all Highway Authorities have a robust and consistent understanding of the risks of extreme events and preparedness that will aide civil response and increase resilience.

Local Authorities and Resilience

7. The Civil Contingencies Act 2004
http://www.legislation.gov.uk/ukpga/2004/36/pdfs/ukpga_20040036_en.pdf is the basis upon which emergency responders' roles and responsibilities are set out. However, for all Highway Authorities there are a myriad duties and responsibilities which demand they work alongside blue light services, as a '4th emergency service' as a result of road collisions, spillages, fallen trees and flooding. Equally the legal duties for winter maintenance has created a body of expertise that proactively manages network, indeed since the severe (snow / ice) winters of 2010 – 2012 there is probably a better preparedness for these kind of weather events.

8. There is however a gap in response / legislation relating to matters of flooding where main rivers may over top and cause significant and long-lasting impacts. The EA is the responsible body for flood prevention, but this in itself cannot protect communities in the manner that is now, arguably, required to protect homes and economies.

9. The type of emergencies for which a local authority would have a duty to respond will be set out in respective emergency plans and risk registers and typically includes flooding and severe weather (storms, heatwave, severe snow and ice), release of chemical and hazardous materials, major transport accidents and terrorist incidents. Local Resilience Forums have a key role in preparedness for events and developing a multi-agency preparedness and response. It is unclear as to how much time and effort by LRF's have been recently spent on extreme weather resilience or contingency in the event of major loss or catastrophic failure of highway assets.

10. The majority of Highway Authorities provide a number of uniformed services, often with freestanding radio and communication systems and fleets. Often there can be more uniformed CEO 's on patrol in local communities than local Police so there are ideal channels that can and should be considered differently. Often representation on LRF's sits within different council functions and it is crucial that learning is extensively disseminated within and across relevant Council Departments. Storm Eva occurred on Boxing Day which meant many council senior officers could not be contacted; equally a public holiday meant that schools and day care facilities that flooded within less than 15 minutes were empty at the time of inundation those averting a major catastrophe. This is a critical learning point.

11. As a Category 1 or Core Responders Councils operate alongside blue light services. In this capacity Councils do not have to wait to declare a major incident. Subsequent review of Boxing Day highlighted the lost opportunity to delay by

nearly 12 hours the formal designation of a 'Major Incident' despite council staff on the ground having already witnessed water levels in excess of the historically devastating floods. A 'group think', allied with loss of blue light telecommunication systems, reduced capacity in emergency planning teams following recent cut backs and a critical absence of key senior staff over the festive period created a delay (however it is equally notable that key staff would have had difficulty in getting into offices).
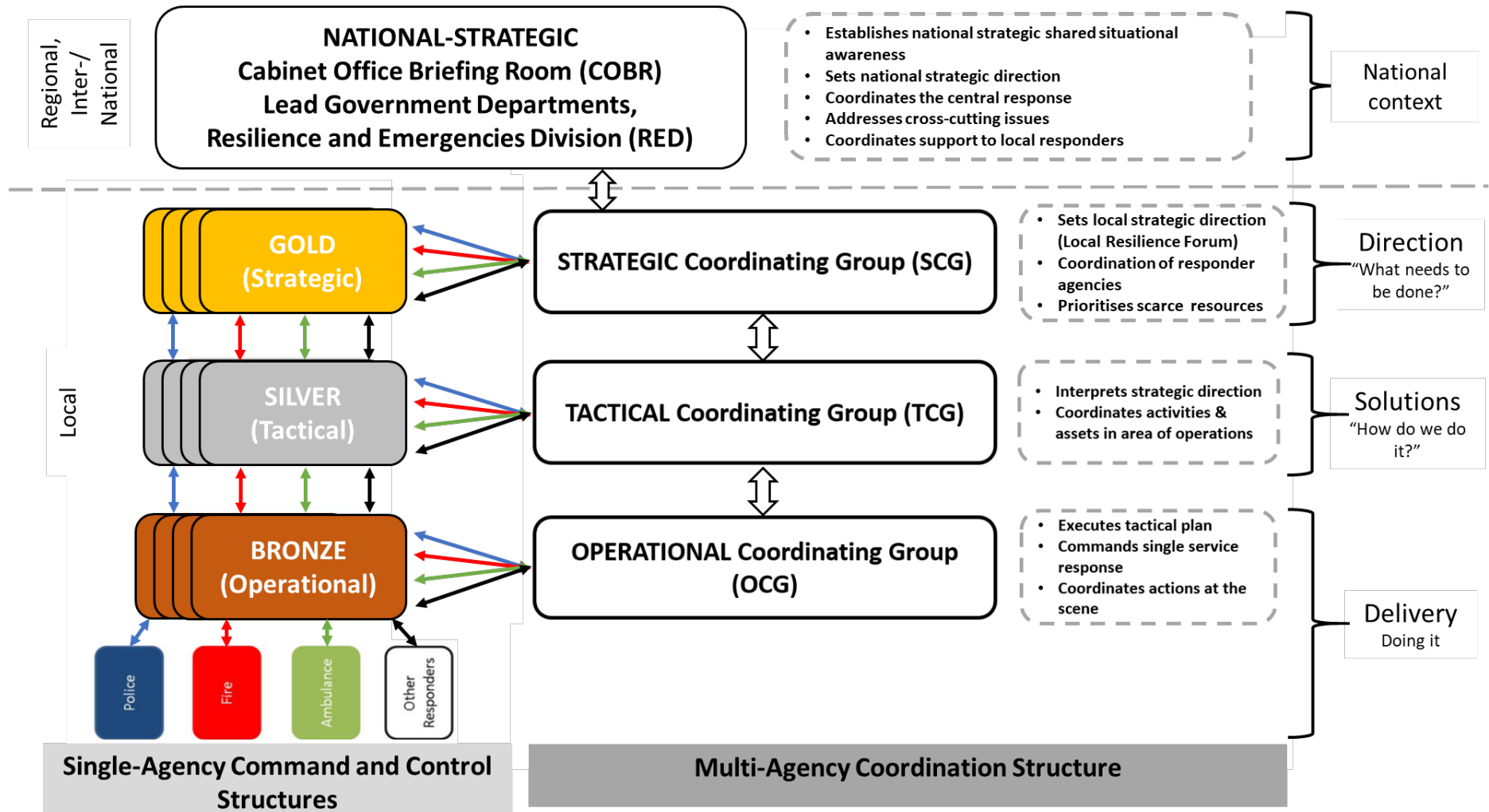
12. It is recognised that it is not possible to fully brief all relevant / potential staff on the myriad eventualities. It is however a central tenet of emergency planning that whilst incidents may vary the rigour and discipline of training will always provide assurance in aspects such as chronological mapping, recording decision made, chains of command and lines of communication across various agencies. It is clear that other than Councils such as Calderdale and Cumbria – who arguably in setting in place the most cutting-edge responses – many senior council staff are ignorant to the severity of events that could transpire in their communities. This could have a major impact on despatching relevant teams to understand the nature of collateral damage which if unchecked could result in far greater costs and community severance.

13. It is notable that Greater Manchester has drawn together into a joint civil contingencies team the former separate entities across most of the City and District Councils. Many Councils are of a quite modest size and it is unclear whether they have the right scale to meet growing expectations – nor is there any understanding of the optimum team size to support a 24 / 7 provision. Tools such as Resilience Direct do provide support but are not consistently used across, and even within, Councils. Moreover, access to these are often are held by 'Gatekeepers' in Councils rather than having this widely available across Council silos.

14. TAG would like to consider how Highway Authorities might develop beyond their winter maintenance expertise into a wider and stronger resilience and preparedness role. In some respects, Councils already provide the only capacity in extreme events. All Ambulances and most fire engines cannot operate over 1 metre of water and therefore event 'basic' response is restricted or no longer possible. Cumbria already has heavy duty cross over vehicles that can maintain lines of communication during emergencies in flood water upto 1.5 metres (with suitable training).

15. Reflecting on the success of DfT leadership on salt stock and response to snow and ice, it is clear that some form of regional centres of excellence should be established across councils. This would certainly involve combined authorities where they exist but could operate on an agreed rota basis across relevant 'Place / Highways Directors. The material, stocks and manpower available in the lead up to and response following a major event need to consider within the context of the DfT salt stocks which solely relate to one type of event). A multi-agency capacity with fire and rescue, EA and water companies would be required but this would at the very least require a stocking up / quartermaster arrangement of special equipment.

16. Linked to this is an expectation of formally documented multi-agency exercises which should also include power, rail, water and gas representatives. This would redress the significant gap that transpired on Boxing Day and the subsequent timely restoration of services to local communities. This would be 'expected' in all regions with critical infrastructure and there should be substantial 'de-briefing' after an event with reps from other areas as observers to consider points of learning. Equally it must never be the 'usual suspects' who get to attend training courses and it is essential that there is distributional leadership. Calderdale Council recently created a be-spoke training programme with a disaster management training company. It is also recognised that some regions consistently witness 'repeat events' – such as coastal flooding – and these present ideal opportunities for staff in other regions to shadow (or even be seconded into) front line teams.

17. TAG recognises that availability of contrasting data feeds, information and issues provides a rich source of intelligence. This certainly did not feature during the 2007 floods but by the 2013 and 2014 floods social media had developed in to a major issue and opportunity. At times some feeds were rich and informative whilst others simply echoed an issue earlier that day which a member of the public or councillor may have personally only just found out about. The art of data capture, triage and management of intelligence is critical in the movement of emergency services staff, alternative routes, and early deployment of experts to reported instances (e.g., failing structures, changing ground conditions, closure of routes).

18. Given the continued turnover of staff and ever-changing roles, functions and duties across local government it is now clear that the corporate memory of previous instances cannot always be guaranteed. Trigger levels for responses to potential different threat levels needs to be better understand. Calderdale Council has recently significantly enhanced its capability in flood response and with this new expertise has come fresh ideas and more contemporary access to cutting edge weather predictions system in excess of typical winter forecasting; this new data and predictive tool is available 24/7 and is being trialled from January 2017. This crucially moves that council into a position where it has demonstrable capability as opposed to Councils who may take a less rigorous approach. TAG is keen to raise Highways Authority capability and capacity to wide ranging incidents through active demonstrations and exercises rather than historic paper-based excises (Cabinet Office best practice). Stoke on Trent was the first UK City to be awarded UN status on preparedness "International Strategy for Disaster Reduction.

19. TAG recognise the need to better understand how new systems and big data can play a bigger role in not just preparedness on the run up to an event (and reduce the risk of 'false alarms') but to use this data to make existing and future communities more resilient. Stress testing of communities to significant and historically unprecedented events demands a new approach. This is especially relevant when considering development within or affecting the capacity of flood plains. The UK yet to grasp in any material way the recent developments around 'Sponge Cities' nor is the balance between 'blue & green infrastructure'.

Next Steps

20. Local Council have responded well when major incidents have occurred, but the response is not uniform and lessons learnt have yet to be consistently disseminated across councils and across sectors.

21. Highway Authorities and wider Emergency Planning Functions need to optimise their response capacity and consider the scale at which critical activities occur. This is likely to result in joint work across traditional geographies.

22. As a sector the relationship between Highway Authorities and the DfT continues to develop but recent weather incidents have shown that good people can be diverted into extensive form filling and updates for myriad other Government departments who risk default to a desk top understanding, paperwork and form filling.

23. TAG wishes to work across the sector to enhance preparation, response and proactive reshaping and safeguarding of critical infrastructure and services. This would be modest investment from Councils and DfT / DCLG but would mitigate the risk of catastrophic and costly failure ('a stitch in time') where early warning signs prior to failure are being missed and resulting in 10 bridge collapses in an average year.

Appendix 2: UK Multi-Agency Coordination Structure (Kerslake, 2018)

Regional, Inter-/National			

NATIONAL-STRATEGIC
Cabinet Office Briefing Room (COBR)
Lead Government Departments,
Resilience and Emergencies Division (RED)

- Establishes national strategic shared situational awareness
- Sets national strategic direction
- Coordinates the central response
- Addresses cross-cutting issues
- Coordinates support to local responders

National context

GOLD (Strategic)

STRATEGIC Coordinating Group (SCG)

- Sets local strategic direction (Local Resilience Forum)
- Coordination of responder agencies
- Prioritises scarce resources

Direction
"What needs to be done?"

SILVER (Tactical)

TACTICAL Coordinating Group (TCG)

- Interprets strategic direction
- Coordinates activities & assets in area of operations

Solutions
"How do we do it?"

BRONZE (Operational)

OPERATIONAL Coordinating Group (OCG)

- Executes tactical plan
- Commands single service response
- Coordinates actions at the scene

Delivery
Doing it

Police | Fire | Ambulance | Other Responders

Local

Single-Agency Command and Control Structures

Multi-Agency Coordination Structure

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Appendix 3: The structure of the Strategic Recovery Coordinating Group (SRCG) adopted by Cumbria LRF following Storm Desmond
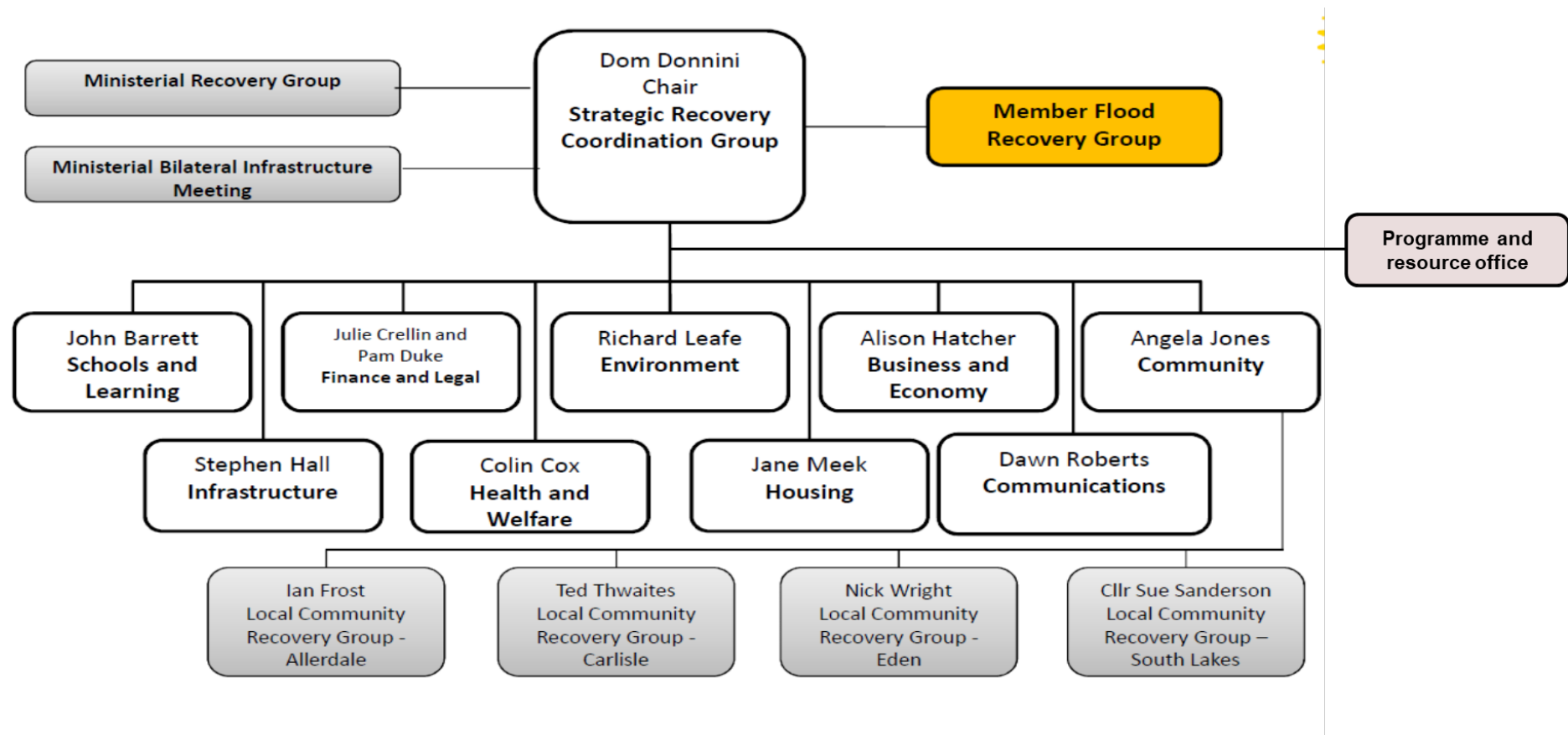
Source: Deeming and Otley (2018)

Appendix 4: Principal project participants

Interviewees	Organisation
Rupert Clubb	ADEPT President / East Sussex County Council
Alyn Jones	Somerset County Council
Barrie Mason	North Yorkshire County Council
Chris Cranston	National Winter Service Research Group (NWSRG) / Devon County Council
Chris Thorpe	Transport for Greater Manchester (TfGM)
Claire Driver	Cumbria County Council
David Laux	Northumberland County Council
Dom Donnini	Cumbria County Council
John Beacroft-Mitchell	Calderdale Council
John Handling	Perth & Kinross Council
Lucy Kennon	Transport for Greater Manchester (TfGM)
Mark Thompson	Calderdale Council
Mark Thomson	Dumfries and Galloway Council
Mike Roberts	North Yorkshire County Council Head of Highways
Neill Bennett	Derbyshire County Council
Parvis Khansari	ADEPT engineering board / Wiltshire County Council
Phil Durnell	Lancashire County Council
Phil Stockford	Highways England
Stephen Hall	Cumbria County Council
Steven Lee	Calderdale Council

Resources/documents/reports

Chris Scott	Sussex Resilience Unit
Dr Kevin Burchell	Communities Prepared National Group
Dominic Browne	Editor Highways Magazine
Tom Knox/Matt Robinson	NYCC Resilience Unit
Max Brodie	Civil Contingencies Secretariat (CCS)

Emergency Preparedness, Response & Recovery:

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extreme-weather emergencies (2015-2020)

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