Thank You

This report could not have been prepared without the contributions of The Leeds City Region Enterprise Partnership, All 10 City Region local authorities, North Yorkshire County Council, The Environment Agency, Yorkshire Water, Canals and River Trust, The West Yorkshire Local Nature Partnership.
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Executive Summary

The 2015 Boxing Day floods were unprecedented in their impact on Leeds City Region in both the extent and severity of the flooding and the damage and devastation that was caused.

In a 24-hour period the equivalent of five-inches of rain fell, 20% more than would be expected for the month of December as a whole. The rain fell on already saturated ground with November and December 2015 being the third and first wettest months respectively for over 100 years. The run-off in to the river system was rapid across the City Region, and the subsequent rise in river levels allowed little time for communities to prepare.

Purpose of this report
As a response to the broad extent and impact of the flooding, and because the greater frequency and severity of future floods are likely due to climate change, the leaders of the West Yorkshire Combined Authority (Combined Authority) commissioned a review of the flooding, to report on:

• the economic impact of the floods on Leeds City Region;
• the lessons learned by and best practice for our emergency response and civil contingency arrangements;
• how recovery from such civil emergencies can be improved in the future; and
• the potential steps that need to be undertaken to improve our resilience and preparedness for the future.

The remit of this report is to better understand the causes and impacts of the flooding; and develop recommendations for action that, when implemented, would reduce the likelihood and impacts of flooding; and enable more effective and joined up response and recovery phases to be put in place across the City Region.

Economic impact
Over 4,000 homes and almost 2,000 businesses were flooded with the economic cost to the City Region being over half a billion pounds, £100 million of which was damage to key infrastructure such as bridges, roads and Yorkshire Water assets.

The result of the rapid rainfall was widespread flooding across the City Region with the main focus of the damage being in:

• The Calder Valley: Todmorden, Hebden Bridge, Mytholmroyd and Sowerby Bridge;
• Leeds: Kirkstall Road and Otley;
• York City Centre; and
• Bradford: Keighley, Bingley, Ilkley and Shipley.

Whilst the scale of the impacts varied, all districts apart from Barnsley suffered damage due to the floods including Tadcaster, Elland, Brighouse, Wakefield, Skipton, Cross Hills, Silsden, Addingham, Ilkley, Collingham and Ulleskelf. The greatest devastation was experienced in the Calder Valley where the steep valleys and narrow valley bottoms along the River Calder provide a natural topography that magnifies the risk and potential damage from flooding.

Infrastructure
Over 100 bridges within the City Region required remedial works due to damage, including bridges at Tadcaster, Elland, Brighouse, Wakefield, Skipton, Cross Hills, Silsden, Addingham, Ilkley, Collingham and Ulleskelf. The greatest devastation was experienced in the Calder Valley where the steep valleys and narrow valley bottoms along the River Calder provide a natural topography that magnifies the risk and potential damage from flooding.

Property
It is estimated that 20,000 properties were saved from flooding due to investments in flood defences since 2010. However, the scale of the problem across the City Region remains significant with over 63,000 residential properties and more than 27,000 non-residential properties still having some degree of flood
Executive Summary

risk. Of these, 7,385 residential properties and 4,698 non-residential properties are at a high risk of flooding.

Human impact
Whilst the flooding brought no loss of life this was not due to the scale of the flooding but more a combination of outstanding emergency work and timing; as the floods happened on a Bank Holiday when schools and businesses were closed and travel at a minimum. Kirkstall Road in Leeds which was devoid of its usual 12,000 commuters for example.

For some communities this was the fifth major flood event in four years, whilst for others it was the first time they had experienced flooding. However, for everyone affected by the flooding it brought a degree of shock and emotional toll with the potential to impact on health and wellbeing.

Emergency response
This report shows that the immediate response to the floods, particularly in the worst hit areas of the Calder Valley, Leeds, York and Bradford were on the whole positive and effective. The emergency services, local authorities and the Environment Agency responded rapidly with the initial emphasis being on public safety. The most vulnerable people were targeted first and then the response broadened to incorporate key infrastructure assets.

Community
It was evident that local communities mobilised quickly and played a key role in helping support the evacuation of the elderly and most vulnerable, erect emergency flood barriers and help in the rapid clean up after the flood waters subsided. The dedication and commitment shown by elected members and help from a broad range of organisations was also invaluable. This included support from water companies across the UK and in places the Army; for example, Yorkshire Water pulled in 1,000 staff and accessed every water pump they could from across the country to deal with the incident.

Regional utility companies including Yorkshire Water, Northern Powergrid and Northern Gas Networks played an important role during and in the immediate aftermath of the floods. They helped to manage the incident and mobilised staff to restore or maintain essential services including power and drinking water supply; and in trying to secure further equipment from mainland Europe.

Lessons learned
Inevitably there are lessons and insights that emerge from the experience, including:

• a need for more structured support for residents and businesses in high flood risk areas to enable them to prepare better to help themselves in times of flooding;
• greater use of flood wardens and flood groups which provide immediate on the ground informed help;
• more effective use of the knowledge and resources within local communities, including a better understanding of key infrastructure, assets and vulnerable groups;
• improvements to communications associated with the emergency response command and control structures and processes in places; and
• improvements to infrastructure resilience preparatory work and how essential works to sewerage facilities and power networks are prioritised in times of flooding.

The West Yorkshire and the North Yorkshire Resilience Forums are responsible for planning and co-ordinating flood responses in their respective areas, and so this learning will need to be incorporated in the reviews of their Local Flood Resilience Plans.

Improvements to recovery
Local authorities play the key role in the provision of leadership, advice and support in the recovery phase. Authorities worked in partnership and offered mutual support in the weeks and months following the flooding to those districts that were most badly affected. This was vital to enabling the recipient
Investing in people, places and business support
Almost 12 months after the floods, households and businesses in several areas are still dealing with the physical damage and associated emotional stress. For some it is about completing the process of rebuild and recovery whilst for others it was and is a question of whether they should remain and live with the risk of a re-occurrence of the flooding. Some local businesses have already moved out of the City Region as a consequence of the floods, so building resilience within our businesses and communities, and investing in people, places and business support as well as infrastructure, is key to enhancing how we deal with and recover as a City Region from future flood events.

Command and control structures
This report finds that although a key attribute of the emergency response phase is the command and control structures that are put in place to allot responsibilities and to guide and structure the activity undertaken, the recovery phase can suffer from the lack of a similar approach. In some places the move from the emergency response phase to the recovery phase happened too early and didn’t include all the necessary agencies, resulting in the transition being less coordinated and effective. In Calderdale and Leeds, council’s responded quickly to put in place a structured approach through their Single Integrated Recovery Plans. This could provide a template through which similar approaches could be developed elsewhere.

Funding
Critically, this report shows that government, local authorities and the Leeds City Region Enterprise Partnership (LEP) were quick to identify additional funding for recovery and repairs to key infrastructure and to put in place support for businesses to continue operating; for example, the LEP’s Business Flood Recovery Fund provided a life-line to support small and medium sized enterprises (SMEs) to clear up, replace machines and equipment, and provide cash flow to enable them to continue operating and paying salaries.

Insurance
Crucial to recovery is also the ability to not only secure the appropriate insurance but also to be able to claim against it. However, due to the known risk of flooding events in some areas many have either been left unable to secure reasonable insurance; which is a situation compounded by the size of premiums, excesses and the potential impact on securing future insurance if a claim is made. This report suggests that a more streamlined and simple claims process is needed to speed up claims and ensure residents and businesses can have the means to return to normality as soon as possible after a flood event.

Improving our resilience and preparedness for future events
It is crucial that the experience of the Boxing Day floods, combined with the knowledge that climate change is likely to worsen the situation, is used to strengthen our strategic approach to the threat of flooding. Local authorities are already acting upon the experience of the Boxing Day floods in terms of their own procedures and responses but it is essential that this knowledge, insight and best practice is shared and rolled out across the City Region.

Implementing consistent planning policies
The local planning system has an important part to play in helping better prepare and mitigate future flood events through local plan policy and implementation. This report finds that although all districts were adopting a sequential approach to flood risk, more consistent planning policies across the City Region would provide greater integration. This would particularly be the case in relation to whole river catchment areas which all transcend multiple districts. This includes developing a strategic approach to sustainable urban drainage systems (SUDS) as implementation is currently hampered by a lack of robust national guidance.

Further investment
Further investment in flood defences and other flood mitigation and adaptation measures will continue to be critical. The recently published Yorkshire Flood Risk Capital Investment Programme incorporates
the announcements for ‘booster’ funding that was made in the 2016 Budget to support additional flood mitigation measures across the City Region. The allocation for the Current Spending Review Period in Leeds City Region is £207 million (2016-21).

However, this report shows that a pipeline of projects remain that could be enhanced and / or be brought forward if further additional funding could be secured from government or other sources; thereby protecting more communities, businesses and homes earlier. It is estimated that a further circa £5 million per annum is needed over the next five years to support this work. In November 2016, the Combined Authority agreed to invest £7.8 million to fund an initial three schemes in Leeds, Mytholmroyd and Skipton to help enable and accelerate delivery of key schemes.

In addition to the funding above, further work is required to understand the full costs and wider considerations of:

- a comprehensive maintenance regime for waterways;
- the risks associated with third party assets;
- natural flood risk management opportunities; and
- upland management, including upstream storage and reservoirs.

**Reservoirs**

Whilst reservoirs could have the potential to play a much greater role as part of whole river catchment management programmes, this report concludes that water companies are constrained in their ability to use these assets as part of a package of flood mitigation measures because their primary role is to ensure that there is adequate water available for public supply. Any proposal to use reservoirs for flood storage would require careful consideration of all related issues and may also require regulatory or legislative changes.

**Prioritisation of resources**

The long-term costs of protecting properties at risk of flooding in the City Region will be in the hundreds of millions of pounds. As public resources are being increasingly stretched, the effective prioritisation of limited resources will be increasingly important. This report recommends the need for stronger collaboration with a range of partners who have a role to play in investing in combined multi-benefit infrastructure schemes that increase the resilience of existing economic activity and enhances our economic growth. This will lead to better long-term strategic thinking and future investments more closely linked to the LEP’s Strategic Economic Plan (SEP).

**Partnership working**

This report concludes that there would be significant benefits in adopting new ways of closer partnership working between the Combined Authority, Environment Agency, local authorities and other partners to join up flood resilience planning and investment with future housing and economic growth and development. This would include a stronger strategic evidence base for infrastructure investment prioritisation linked more closely to economic and housing growth plans as set out in the SEP and local authority plans. This would help realise the benefits more quickly and better align and make best use of funding from all available sources.

Collectively, this greater alignment is already underway by developing a long-term City Region Flood Resilience Delivery and Investment Plan. There could also be opportunities to consider longer term issues through the devolution discussions with government to maximise effective, more integrated arrangements in the future.
Key strategic recommendations
This report identifies the following key strategic recommendations in response to the Boxing Day floods of 2015 and any future flooding:

Economic impacts of flooding
1. The Combined Authority, in partnership with the Environment Agency, local authorities, local resilience forums and other partners, map and undertake a full assessment of the resilience of the critical infrastructure to cope with major future flood events within whole river catchment areas, further developing the approach taken by the National Flood Resilience Review.

2. Develop a City Region Flood Resilience Delivery and Investment Plan drawing together all funding sources to enhance and / or bring forward flood mitigation projects over the next five years and beyond to protect communities and support economic growth and development. This will include setting out the approach to addressing the long-term infrastructure resilience needs across Leeds City Region, including the contribution of green infrastructure.

3. Carry out further work to quantify the indirect economic impacts of flooding in the City Region to better understand infrastructure resilience needs.

Emergency response and recovery
4. Undertake a review, led by the West Yorkshire and North Yorkshire Resilience Forums, of the emergency command structures to identify any potential improvements and ensure they are fit for purpose.

5. Undertake a review, by all 10 City Region local authorities, of their approaches to recovery, including the appropriate time period to move from the response to the recovery phase and prepare / update Single Integrated Recovery Plans referring to the Calderdale Integrated Recovery Plan as an example of good practice.

6. Support people and businesses in high flood risk areas to prepare their own ‘Personal Emergency Plans’ and provide suitable materials, flood boxes and support for future flood events.

7. Increase the number of trained flood wardens across the City Region in preparation for future flood events led by local resilience forums and local authorities.

8. Explore the benefits and practicalities of establishing a single public emergency contact telephone number for the City Region.

9. Build stronger relationships between local resilience forms and local authorities with local media to raise awareness of real time issues and access to emergency help, and embed best practice from social media into emergency plans.

10. Identify best practice and explore the benefits of adopting a consistent definition of critical infrastructure to be protected in the event of floods for the West Yorkshire and North Yorkshire Resilience Forums; for example, hospitals, schools, vulnerable residents, communications infrastructure.

11. Explore the opportunities for a simpler claiming process for individual residents or businesses after flood events with government and the insurance industry.

Planning, risk reduction and mitigation for future events
12. Consistent planning policies and approaches across the City Region developed by the Combined Authority and local authorities to mitigate flooding and improve resilience, including preparing City Region supplementary planning guidance to provide a stronger steer for the adoption of SUDS.

13. Adopt a whole catchment approach to flood risk and resilience and ensure that resources are
made available to promote and instigate natural flood management, identifying best practice and building on what is already being done across the City Region. This should include a focus on the identification and development of funding mechanisms to enable more rapid and expansive progress on natural flood and upland management.

14. Explore with Department for Communities and Local Government (DCLG) and the Combined Authority, the opportunities for updating building control legislation to help deliver greater resilience and resistance to flooding of new buildings and development.

15. Consider extending climate change allowance modelling for fluvial flooding beyond existing scenarios to align with the SEP forecasting timescales and support delivery of longer term Strategic Priority Growth Areas.

16. Convene a strategic working group of local partners reporting to the Combined Authority to share expert advice and good practice, and coordinate actions to deliver these recommendations.

17. Identify resource-sharing opportunities between the Combined Authority and local authorities to ensure the necessary flood and drainage expertise is in place to inform the local planning process across the City Region.

18. Further collaboration between the Combined Authority and Yorkshire Water to identify where reservoirs may better assist with flood risk management as part of a package of measures, without compromising the supply of water to the City Region. This may include amendments sought by the Combined Authority to legislation and regulations to enable water companies to manage their reservoirs to more effectively contribute to reducing the impacts of flooding.

19. Exploration between the Combined Authority, the LEP and government through devolution, the potential long-term opportunities to maximise effective, more integrated arrangements for flood risk management and investment in the future.
Chapter 1
Introduction

The 2015 Boxing Day floods were unprecedented in their impact on Leeds City Region in both the extent and severity of the flooding and the damage and devastation that was caused. Over 4,000 homes and almost 2,000 businesses were flooded with the economic cost to the City Region being over half a billion pounds, £100 million of which was damage to key infrastructure such as bridges, roads and Yorkshire Water assets.

As a response to the broad extent and impact of the flooding and because the greater frequency and severity of future floods are likely inevitable due to climate change, the leaders of the West Yorkshire Combined Authority (Combined Authority) commissioned a review of the flooding, to report on:

• the economic impact of the floods on Leeds City Region;
• the lessons learnt by and best practice for our emergency response and civil contingency arrangements;
• how recovery from such civil emergencies can be improved in the future; and
• the potential steps that need to be undertaken to improve our resilience and preparedness for the future.

The remit of this report is to better understand the causes and impacts of the flooding and develop recommendations for action that, when implemented, would reduce the likelihood and impacts of flooding and enable more effective and joined up response and recovery phases to be put in place across the City Region.

Alan Gay, Deputy Chief Executive, Leeds City Council and Robin Tuddenham, Director of Communities and Service Support, Calderdale Council were asked to lead this work in partnership with the Combined Authority, the LEP and others. A multi-partner working group was established, which comprised of lead officers from all 10 councils in the City Region, the Combined Authority, the LEP, the Environment Agency, Yorkshire Water Services and the Canals and River Trust.

Additional input has come from a wide range of established groups and forums, including the West Yorkshire and North Yorkshire Local Resilience Forums, Leeds City Region officer groups, the West Yorkshire Overview and Scrutiny Committee, the Yorkshire West Local Nature Partnership and the West Yorkshire Flood Risk Partnership.

Further activity will be required to implement the key strategic recommendations outlined throughout the report and take into consideration the significant scale of the challenges that lie ahead.
Chapter Two: The Economic Impact of the Boxing Day Floods

Overview

The scale of the 2015 Boxing Day floods brought a huge financial and economic cost for Leeds City Region – approaching £0.5 billion. The impacts have been felt across communities - households and businesses have been particularly hard hit in terms of damage and loss of property. The flooding has also brought other extensive damage including roads, public infrastructure, public buildings, vehicles and individual’s health.

The focus has been on the direct costs incurred by residents and businesses and due to evidence and time constraints none of the indirect costs (e.g. supply chain impacts) on businesses are included.

The economic analysis has been mainly informed by the data gathered by local authorities and other partners, with some supporting primary research. In establishing the foundations for the findings the analysis draws on the extensive and recent research and evidence base that exists from previous flooding incidents.

Nine of the 10 districts that comprise Leeds City Region were affected by the flooding, with Barnsley being the only district to completely avoid impact from the flooding.

The major direct economic costs that have been incurred across Leeds City Region are detailed below:

<table>
<thead>
<tr>
<th>Impact</th>
<th>Economic cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential properties</td>
<td>£93 million</td>
</tr>
<tr>
<td>Business premises</td>
<td>£162 million</td>
</tr>
<tr>
<td>Temporary accommodation</td>
<td>£19 million</td>
</tr>
<tr>
<td>Motor vehicles</td>
<td>£16 million</td>
</tr>
<tr>
<td>Local authorities and local government infrastructure</td>
<td>£51 million</td>
</tr>
<tr>
<td>Yorkshire Water: infrastructure</td>
<td>£50 million</td>
</tr>
<tr>
<td>Public health and welfare</td>
<td>£10 million</td>
</tr>
<tr>
<td>Other (including agriculture, education, tourism, heritage)</td>
<td>£12 million</td>
</tr>
<tr>
<td>Job loss impact: 10-year period, Leeds manufacturer</td>
<td>£43 million</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>£456 million</strong></td>
</tr>
</tbody>
</table>

Approach

The methodology underpinning the analysis is borrowed from an approach adopted by the Environment Agency and relies heavily on having an accurate number of the number of business premises and households flooded. Whilst the Environment Agency data has provided an insight into the potential impact of the flooding the central role of local authorities in terms of flood response, co-ordination, recovery and support means that they have been used in order to determine the best estimate for the numbers actually flooded.

Supplementing this has been information from the Environment Agency regarding the flood extents, enables analysis of the potential number of properties, businesses and the key infrastructure that was and could be at risk to flooding. These flood extents have been mapped to better understand the actual and potential resulting damage.

Previous work by the Environment Agency has been central to the translation of the number of properties and businesses flooded into a financial and economic cost. This element of the analysis relies heavily on the research, methodology and findings of the Environment Agency’s report into the economic and financial impacts that resulted from the 2013/14 flooding (The Costs and Impacts of the winter 2013 to 2014 Floods, Environment Agency, 2016).

The Environment Agency report identifies and quantifies the different impacts of the flood that result in financial and economic loss. The main source of information was the Association of British Insurers (ABI). ABI provided data from the insurance claims submitted, providing an accurate insight into the resulting damage and financial loss. Whilst this information could not be secured for this report the data used and the findings within it have been used to help inform the approach and quantify the impacts.
Chapter Two: The Economic Impact of the Boxing Day Floods

It should be noted that there are two further economic costs that are not accounted for in the Environment Agency report:

1. The longer-term impacts of the loss of jobs as a result of flooding. This is obviously relevant locally but more relevant nationally where the jobs are lost to the UK. Where such job losses are identified we are able to use the Regional Econometric Model (REM) in order to estimate the net impact in terms of lost GVA. An element of these costs has been included through the example of 93 jobs that have been lost through the closure of a manufacturing plant within Kirkstall, Leeds and the accompanying loss of GVA has been calculated over a 10-year period. The economic argument is strong in this case as the jobs are being lost to the UK not simply moved to a different facility within the UK.

2. The indirect costs on businesses where the impact is felt in the longer-term and is often felt by other companies within the supply chain of effected companies but not directly affected by the flooding themselves. The complex nature of these costs and the need for detailed primary research has meant that it has not been possible to provide an informed estimate of such costs and they have not been included within the report.

The recent work carried out by Leeds University and Calderdale Council focused on the impact of the 2015 floods on the districts SMEs to go into far greater detail regarding the direct and indirect impacts (through primary research incorporating detailed analysis of the indirect impacts that were felt by local business and their supply chains). The report concluded that whilst the direct economic costs incurred by the 1,000 SME firms amounted to almost £50 million, the full economic costs totalled £169 million resulting in an indirect impact to SME businesses within Calderdale of almost £120 million. This provides some insight into the potential scale of the indirect economic impacts across Leeds City Region.

**Number of properties and businesses affected**

The key data gathering exercise has been a questionnaire that was sent to all local authorities whose district was affected by the floods. The questionnaire focused on the impact within each district with regards to residential properties, businesses and infrastructure. The intensive and ongoing involvement of local authorities with regard to the response and recovery from the floods placed them in the best position to provide a detailed view of the number and extent of the flood impacts.

Supporting this was geographic information system (GIS) information from the Environment Agency which was used to determine the flood extent and to identify the number of properties and businesses located within the zone.

There were over 4,000 residential properties flooded alongside almost 2,000 businesses with many more properties impacted by the floodwaters. The impacted properties are a particular issue in Leeds with a significant number of apartment blocks close to the river which were flooded – preventing residents from accessing their apartments but causing no damage to individual residential units.

The location and scale of the flooding for homes and business premises is detailed within the table and maps below:

<table>
<thead>
<tr>
<th>District</th>
<th>Residential premises</th>
<th>Business premises</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Flooded</td>
<td>Flooded</td>
</tr>
<tr>
<td>Bradford</td>
<td>783</td>
<td>189</td>
</tr>
<tr>
<td>Calderdale</td>
<td>2,135</td>
<td>1,021</td>
</tr>
<tr>
<td>Craven</td>
<td>90</td>
<td>24</td>
</tr>
<tr>
<td>Harrogate</td>
<td>160</td>
<td>22</td>
</tr>
<tr>
<td>Kirklees</td>
<td>35</td>
<td>85</td>
</tr>
<tr>
<td>Leeds</td>
<td>298</td>
<td>371</td>
</tr>
<tr>
<td>Selby</td>
<td>93</td>
<td>38</td>
</tr>
<tr>
<td>Wakefield</td>
<td>9</td>
<td>20</td>
</tr>
<tr>
<td>York</td>
<td>453</td>
<td>203</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>4,056</strong></td>
<td><strong>1,973</strong></td>
</tr>
</tbody>
</table>

There is the potential that these numbers could be constrained by the under-reporting of properties being flooded with residents being reluctant to come forward in case it creates additional problems in terms of the cost and limitations attached to insurance cover or an inability to secure insurance at all.
Chapter Two: The Economic Impact of the Boxing Day Floods

Location and Scale of Flood Impact on Residential Properties - Local Authority Data

Location and Scale of Flooding on Businesses - Local Authority Data

Source: ESRI, Local Authorities

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Calderdale suffered by far the greatest amount of damage in terms of the number of both homes and business premises flooded – the impact exaggerated by the narrow valley topography along the Calder Valley. Significant impact is also apparent within the districts of Leeds, Bradford and York. The impact within the district of Selby was largely confined to Tadcaster where the number of properties flooded does not reflect the scale of the impact with the town cut in two following the partial collapse of the bridge over the River Wharfe.

**Economic costs to homes and businesses**

In calculating the cost of damage to buildings the focus has been on the number of homes and premises flooded with the associated economic costs being based on an estimate of the scale of the insurance claims resulting from the damage. This is based on previous research undertaken by the Environment Agency regarding the costs and impacts of the floods of 2013/14 which estimated average economic costs to a flooded business of £82,000 and to a flooded home of £23,000. The original approach acknowledged that the insurance claims represented a financial rather than an economic cost. In order to convert this into an economic cost account was taken of the VAT charged and the replacement of old for new items.

Whilst the actual figures will vary depending on the size and type of the business at this stage it is reasonable, particularly at City Region level, to use the average as a means to estimate the total costs incurred.

The table below details the estimate of the direct economic costs of the damage caused at the district level:

<table>
<thead>
<tr>
<th>District</th>
<th>Residential premises</th>
<th>Business premises</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Flooded</td>
<td>Total cost</td>
</tr>
<tr>
<td>Bradford</td>
<td>783</td>
<td>£18.0 million</td>
</tr>
<tr>
<td>Calderdale</td>
<td>2,135</td>
<td>£49.1 million</td>
</tr>
<tr>
<td>Craven</td>
<td>90</td>
<td>£2.1 million</td>
</tr>
<tr>
<td>Harrogate</td>
<td>160</td>
<td>£3.7 million</td>
</tr>
<tr>
<td>Kirklees</td>
<td>35</td>
<td>£0.8 million</td>
</tr>
<tr>
<td>Leeds</td>
<td>298</td>
<td>£6.8 million</td>
</tr>
<tr>
<td>Selby</td>
<td>93</td>
<td>£2.1 million</td>
</tr>
<tr>
<td>Wakefield</td>
<td>9</td>
<td>£0.2 million</td>
</tr>
<tr>
<td>York</td>
<td>453</td>
<td>£10.4 million</td>
</tr>
<tr>
<td>Total</td>
<td>4,056</td>
<td>£93.3 million</td>
</tr>
</tbody>
</table>

The estimate of the total economic cost of the damages associated with the damage to residential properties amounts to over £93 million whilst the economic damage to business premises amounts to over £162 million. The total for both residential and commercial premises across the City Region amounts to over £255 million.

**Costs of temporary accommodation**

The total estimated costs attributed to temporary accommodation are almost £19 million across the City Region, as set out in the table below:

<table>
<thead>
<tr>
<th>District</th>
<th>Households flooded</th>
<th>Households requiring temporary accommodation</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bradford</td>
<td>783</td>
<td>360</td>
<td>£3.6 million</td>
</tr>
<tr>
<td>Calderdale</td>
<td>2,135</td>
<td>982</td>
<td>£9.8 million</td>
</tr>
<tr>
<td>Craven</td>
<td>90</td>
<td>41</td>
<td>£0.4 million</td>
</tr>
<tr>
<td>Harrogate</td>
<td>160</td>
<td>74</td>
<td>£0.7 million</td>
</tr>
<tr>
<td>Kirklees</td>
<td>35</td>
<td>16</td>
<td>£0.2 million</td>
</tr>
<tr>
<td>Leeds</td>
<td>298</td>
<td>137</td>
<td>£1.4 million</td>
</tr>
<tr>
<td>Selby</td>
<td>93</td>
<td>43</td>
<td>£0.4 million</td>
</tr>
<tr>
<td>Wakefield</td>
<td>9</td>
<td>4</td>
<td>£0.04 million</td>
</tr>
<tr>
<td>York</td>
<td>453</td>
<td>208</td>
<td>£2 million</td>
</tr>
<tr>
<td>Total</td>
<td>4,056</td>
<td>1,866</td>
<td>£18.7 million</td>
</tr>
</tbody>
</table>

Again the largest costs are within Calderdale estimated at almost £10 million, Bradford at over £3.5 million and
York at around £2 million.

The approach to measuring the costs of the flooding mirrors that adopted in the latest Environment Agency report. The lack of direct and detailed information regarding this means that we have used both the proportion of flooded properties where temporary accommodation had been required from the 2013/14 floods as well as the average costs. The analysis of 2013/14 floods resulted in an estimate that 46% of those properties affected by fluvial flooding required temporary accommodation. ABI data was used to determine that the average cost associated with temporary accommodation was £10,000.

Infrastructure impacts
Strategic consideration of the potential damage to key infrastructure such as schools and colleges, electricity substations and cultural facilities.

This shows the scale and vulnerability of some of the City Region’s key infrastructure assets. However, this is not exhaustive as there are large private sector developments that now represent key public infrastructure. Within Leeds this is apparent with the presence of large data hubs and storage facilities – key infrastructure in terms of mobile and data communication and storage. The loss or interruption of the services provided would represent a significant strategic and economic impact.

The impact of flooding within towns and city centres brings obvious additional risks in terms of the scale of the damages and the potential impact on key infrastructure and leisure services. Commercial and retail centres can be seriously affected and the impacts can then be felt in other parts of the city. In the case of York there were wider impacts in terms of tourism visits even for areas and attractions that were not directly impacted by the floods.

Bridges are particularly vulnerable to the impact of flooding, representing key strategic infrastructure and economic resource/driver. Over 100 bridges across the City Region had to be checked for damage following the floods and three bridges in particular were seriously affected; these were Tadcaster Bridge, Tadcaster, Linton Bridge, Leeds and Elland Bridge in Calderdale. All have required significant works that bring with them large capital costs as well as potential additional costs in terms of temporary measures whilst repair works are undertaken. The inconvenience for local people and businesses can be significant, generating large indirect costs as a result of time delays, diversions, cost increases and / or lost business. In Tadcaster for example, the road link connecting both sides of the village will have been cut for over 12-months by the time the bridge has
been fully repaired.

The utility companies will also suffer from huge financial costs and interruption to service. In the case of Yorkshire Water it was severely impacted by the Boxing Day floods with almost 100 separate sites flooded, some of which are still not operational 10 months after the event. A total of 44 sewage treatment works, 46 sewage pumping stations and a smaller number of other asset types were completely flooded across the Yorkshire region, as shown in the map below. These have required extensive refurbishment and repair, and in some cases are undergoing a complete re-build.

In addition the company has incurred significant ongoing clean up and mitigation costs such as the de-silting and jetting of kilometres of sewer, hire costs for high capacity pumps and centrifuges and the transportation of sewage sludge to alternative treatment facilities running to tens of thousands of pounds per week. The total cost of the floods to Yorkshire Water is estimated at around £50 million.

### Aggregated infrastructure costs

The cost identified within the table below does not include the additional indirect costs that would be incurred by businesses and local people and as such the economic costs associated with the damage to infrastructure is likely to significantly greater. The routes affected may also mean that there is a wider impact in terms of associated costs.

<table>
<thead>
<tr>
<th>District</th>
<th>Infrastructure Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bradford</td>
<td>£2.7 million</td>
</tr>
<tr>
<td>Calderdale: including Elland Bridge</td>
<td>£25 million</td>
</tr>
<tr>
<td>Leeds: including Linton Bridge</td>
<td>£9.1 million</td>
</tr>
<tr>
<td>North Yorkshire: Tadcaster Bridge</td>
<td>£3.3 million</td>
</tr>
<tr>
<td>York: including £10 million Foss Barrier</td>
<td>£10.8 million</td>
</tr>
<tr>
<td>Yorkshire Water infrastructure</td>
<td>£50 million</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>£101 million</strong></td>
</tr>
</tbody>
</table>
Motor vehicles
The Environment Agency report into the 2013/14 floods used data provided by ABI in order to estimate the likely scale and cost of the damage to motor vehicles, caravans etc. This found that there was a ratio of 0.86 damaged vehicles to each flooded household with an average economic cost per damaged vehicle of £4,074.

In the case of the Boxing Day floods it is estimated that based on 4,539 residential properties (4,072 flooded and a further 483 affected apartments in the centre of Leeds) that over 3,900 vehicles were damaged resulting in an economic cost of £16 million.

Health costs
It is certain that the flooding would have a significant impact in terms of the health and well-being of people directly and indirectly affected. The Environment Agency report in to the 2014 floods attempted to provide some sense of what the financial and economic scale of this impact might be. Quantifying the health impacts combined original research carried out as part of the 2007 work that was used to determine the number of people affected by illness with research from the Mental Health Foundation used to calculate the economic impact per household. This involved taking account of the numbers that were forecast to develop symptoms whilst also taking into account that some of these would have been likely to occur even without the flooding.

The increased number of households affected by mental illness as a result of the flooding is estimated at almost 1,500 out of total households flooded of 4,056. The economic cost associated with illness is estimated to be £3,200 per year derived from a number of factors including cost of treatment, loss of GDP, NHS savings etc. It is assumed that the costs/benefits will be accrued over a two-year period thereby resulting in an estimate of impact of £6,400 per affected household.

Combining these two figures gives a total cost associated with health impacts across all of the households affected of £9.6 million.

Other costs
It is apparent that there are further economic costs associated with the flooding and these include education, tourism, heritage and agriculture. Based on the 2013/14 Environment Agency report these are likely to account for around 3% of the total costs which would result in an estimated figure of around £12 million.

Longer-term impacts on businesses and districts
There are obviously longer-term impacts on businesses and districts that will impact on them financially and economically. This will include both the impacts of the most recent floods and also the fears and risks associated with potential future incidents of flooding. Businesses will obviously consider whether remaining in their current location is the right thing to or whether it may be more cost (and risk) effective to move location.

Some of these are likely to be alleviated through the development and implementation of new flood defences and measures to limit the impact of future flooding incidents. However, there are a number of potential impacts that should be acknowledged:

- Business and residential insurance: whether businesses can continue and whether they can continue in their current location. Re-location would bring huge additional costs for some businesses especially manufacturing or companies with large amounts of machinery or that require specialist infrastructure / property adaptation. In the case of affected Yorkshire Water some sites insurance premiums have increased 300%.
- Risk management for businesses: businesses will need to build in the elements of inflated risk that come with the history of extensive flooding and the ongoing danger that it will reoccur.
- Impact on long-term investment decisions: significant investment decisions maybe postponed until there is greater clarity over the ability of new flood prevention infrastructure to reduce the chances of similar floods re-occurring.

It is not possible at this stage of the report to estimate what the financial and economic impacts of these longer-term considerations might be, but they will likely be significant.

Whilst councils have worked closely with local businesses to minimise the worst impacts of the floods for some the flooding has had dire consequences. The flooding of a manufacturing factory in Kirkstall, Leeds has directly led to its closure. This has resulted in the loss of 93 highly-skilled manufacturing jobs and, it seems, the transfer of the associated work out of the UK. The economic costs of the loss of this these jobs have been calculated through the REM. This generates an estimate of a loss of GVA estimated at around £4 million per year, totalling £43 million over a 10-year period.
Chapter Two: The Economic Impact of the Boxing Day Floods

Summary
It is apparent that the Boxing Day floods of 2015 came with a huge economic cost to Leeds City Region of approaching £0.5 billion. However, this does not include the indirect cost for businesses and their supply chains such that the total cost is likely to be significantly greater. The recent work carried out within Calderdale, for example, estimates that the scale of these indirect impacts to be almost £120 million for SMEs alone.

The impact on local people and the City Region will also, in some cases, be long-term. The permanent loss of businesses and employment bring such a cost. The potential scale of this is illustrated by the closure of a manufacturing plant in Leeds and the transfer of production abroad. This resulted in the loss of 93-jobs and the economic loss to the city-region over a 10-year period is estimated at over £40 million. Other similar incidences would swell the scale of the impact.

It is apparent that further work on such costs would help provide a more accurate picture of the scale of the impacts.

The flooding also brings with it more intangible impacts and costs such as a further erosion of the ability of residents and businesses to secure adequate insurance, with an increase in the levels of associated risk placing a greater strain on businesses and those living and working within the areas affected.

The LEP Flood Recovery Grants provided significant financial support to a number of those businesses worse affected by the flooding. A key element of this has been helping businesses to improve the flood resilience of their existing premises helping to retain them and their jobs within the City Region. However, such actions really need to form part of a strategic response that looks to both reduce the incidence and scale of future floods whilst also improving the resilience of homes and businesses when flooding occurs. Without such an approach it seems inevitable that some areas will suffer economically as businesses (and residents) find the difficulty, expense and risk too great to remain within certain locations.

Recommendations

1. The Combined Authority, in partnership with the Environment Agency, local authorities, local resilience forums and other partners, map and undertake a full assessment of the resilience of the critical infrastructure to cope with major future flood events within whole river catchment areas, further developing the approach taken by the National Flood Resilience Review.

2. Develop a City Region Flood Resilience Delivery and Investment Plan drawing together all funding sources to enhance and / or bring forward flood mitigation projects over the next five years and beyond to protect communities and support economic growth and development. This will include setting out the approach to addressing the long-term infrastructure resilience needs across Leeds City Region, including the contribution of green infrastructure.

3. Carry out further work to better understand and quantify the indirect economic impacts of flooding in the City Region to better understand infrastructure resilience needs.
Chapter 3
Emergency Response and Civil Contingency Arrangements

Overview
The scale and extent of the floods in the areas worst affected was extraordinary. Within Calderdale one of its senior police officers, with almost 30 years of service, commented that he’d never experienced anything as challenging as this before.

The most important outcome from the whole event is that there were no fatalities and a large amount of credit must go to those organisations and individuals involved in the co-ordination and delivery of the emergency response. These included:

- the emergency services;
- search and rescue teams;
- local authorities;
- flood groups and wardens;
- the military; and
- members of the public.

Special mention should go to the hundreds of members of the public who came forward to offer support and assistance. The achievements of all those involved should be viewed against the backdrop of reduced resources (due to it being a bank holiday) and the extensive calls for resources from other areas.

Whilst event happening on Boxing Day meant that response resources were reduced, it also meant, for example, that the schools which were flooded were empty, and that the usual 12,000 commuters were not on one of the key routes into Leeds City Centre when the adjacent River Aire burst its banks. However, it also meant that many businesses were closed for Christmas and their owners away and so were unable to take early action to minimise loss.

The evidence for this section is taken from a variety of sources from across the city-region, including the Calderdale Flood Commission, notes from the ‘Moving on after the floods’ event held on 18 July 2016, Bradford officer debriefs held in February and the Bradford Council Flooding Scrutiny Review, and the experiences of officers, members and others from across the City Region, particularly Leeds and York.

Structure and process of the emergency response
Within West Yorkshire, as elsewhere, we operate within the context of the Joint Emergency Services Interoperability Programme (JESIP) and its five principles of Co-locate, Communicate, Coordinate, Jointly Understand Risk and Shared Situational Awareness. If the principles are followed then the result should be a jointly agreed working strategy where all parties understand what is going to happen when and by who, this strategy should include:

- **What:** the aims and objectives to be achieved?
- **Who:** police, fire, ambulance and partner organisations?
- **When:** timescales, deadlines and milestones.
- **Where:** what locations?
- **Why:** what is the rationale? Is this consistent with the overall strategic aims and objectives?
- **How:** activity and processes.

Lessons have been learnt from Boxing Day and from subsequent flood exercises which reinforce the need to ensure the right level of awareness and understanding at appropriate levels and that agencies need to ensure they have sufficient knowledge within their organisation.

The generic command structure for major incidents based on the gold, silver, bronze hierarchy and can be applied to the resolution of both spontaneous incidents and planned operations.

- **Gold command = strategic:** this would be initiated for large scale emergencies. Within a local authority this would be the Chief Executive Officer or their nominated deputy. Strategic aspects of the emergency from information supplied from the Silver command level would be considered, from which a policy framework would be implemented to respond to the emergency
- **Silver command = tactical:** this is usually situated near to the emergency scene to enable the swift decision and implementation of actions, staff and resources.
- **Bronze command = operational:** this would usually be the first service(s) on scene i.e. emergency services. The immediate needs of the emergency would dictate the level of response. If necessary this
would be escalated to Silver command level.

**Local resilience forums and the experience of emergency response**

There are two resilience forums operating in Leeds City Region, West Yorkshire and North Yorkshire. These were established in response to the Civil Contingencies Act with a statutory function to ensure partnership agencies plan, prepare and respond to emergency incidents and ensure effective recovery and business continuity arrangements are in place. The police have the lead role in dealing with an emergency incident in most situations, and local authorities usually lead the recovery. All agencies use the joint decision making model, and have established Gold, Silver and Bronze command structures and control rooms. Each area has a Flood Incident Management Plan and local authorities at high risk have developed Reservoir Inundation Plans approved by the Department for Environment, Food and Rural Affairs (DEFRA).

Both resilience forums undertake scenario planning with full exercises on an annual basis. They also produce risk assessments and evaluate risks to each local authority area on a quarterly basis.

The command structures of the resilience forums were severely tested by the timing and scale of the Boxing Day Flooding. The response at all levels was assessed by each resilience forum and through a DCLG debrief for the whole of northern England. Some immediate learning has been addressed such as a more timely and effective mutual aid response across the North, with a new protocol signed by all resilience forums.

In relation to West Yorkshire, enacting the Gold command early was seen as the right decision and helped in ensuring agencies were communicating from an early point. There has been some feedback that at times this felt like a police operation with other organisations supporting, something which the LRF might want to reflect going forward, but which is influenced by the current statutory framework within which all agencies operate. In Calderdale there were pressures coming from West Yorkshire to divert resources elsewhere because the situation on the ground wasn’t fully understood, partly because of communications issues. This was a particular issue for Yorkshire agencies across the region whose resources are stretched across a wide geographical area and where deployment decisions were being made within hours.

The Silver command responders were able to mobilise quickly and acted effectively although there were differing experiences in different parts of the city region. Overall both Gold and Silver command responded to a major incident at a time when resources were depleted and communications were compromised. Individual acts and the initiative shown by local communities was outstanding and reflects a potential to build greater resilience in the future. Revised flood risk plans and further scenario testing need to inform the learning for what will unfortunately be the likely further flood events in the future. This includes embedding relationships that have now improved on the ground following the Boxing Day flooding and the measures taken to reduce risk. The work of utility companies is particularly commendable in this regard. Further work is required to ensure reservoir management and collaboration with key partners such as Yorkshire Water.

The issue of when to call a major incident is a common one, with concerns that standing-up too early may result in resources being stretched when they are really needed. However, whilst there are some fears of ‘crying wolf’ there was agreement that early multi-agency communication is essential, and the need to ‘stand-up early’ with an expectation that there might ultimately be ‘stand-down’ and no further action required.

- Leeds City Council suggested that there needs to be a clearer understanding about the circumstances in which formal Gold and Silver level command structures need to be activated.
- Concerns were expressed in York over the length of time taken before all partners were permanently present in the control room, this led to difficulties in easily sharing information between agencies as the event rapidly escalated.
- Within Calderdale health services ran their own Silver Command, which didn’t align fully with the broader Silver Command, although it has to be recognised that it served a different purpose.
- Bradford officers, in their debrief, felt that there were effective lines of communication during the council’s Gold command, but key staff for Gold and council communications were Calderdale residents and were directly affected by the floods there, impacting on the council’s initial response.
- In York concerns have been expressed over the silver control room. It is four years since the room has been used, it is a training room for Police control staff in its day to day usage and is very cramped with little desk space owing to the presence of multiple computer screens on each desk, none of which the attending agencies could utilise. There was also no access to the printers in the building as these were on the Police network. All agencies made the most of the room but its inadequacies will have hampered response.

Additional issues were identified at a DCLG flooding workshop included:

- reluctance to declare the event as a major incident;
• difficulties contacting / activating the right people;
• volume and frequency of ever changing warnings impacting on their effectiveness;
• inconsistent assessment, interpretation and communication of actions from Met Office / Environment Agency warnings; and
• better cross-border collaboration and enactment of mutual aid.

There is a recognition that to undertake ‘recovery’ in parallel with ‘response’ is very resource intensive. The initial recovery phase is the biggest challenge as communities want to get back on their feet quickly. A sudden and early handover from the police-led Strategic Co-ordination Group (SCG) to the local authority-led Recovery Group is felt to be unhelpful as the Recovery Group requires all partners to remain engaged. A longer transfer period is preferable with the SCG kept in place to enable local authorities to fully equip themselves for the recovery task. In York, the police and the army continued to take part in the multi-agency recovery group meetings for a number of weeks, this helped to give a wider overview of the issues that remained from the immediate response phase of the event.

The command structures that were integrated appeared to generally work well. However, practical concerns such as simply being able to travel to incidents or having the necessary communications in place to understand what was happening are key to being able to manage the event and react appropriately.

Evidence to the Calderdale Flood Commission from a police Superintendent:
“The role of the police is to co-ordinate the emergency services – lead colleagues being the fire and rescue service. The Special Operations Room, Silver command opened on Boxing Day - all agencies were represented. Calls were received via various channels and prioritised by professionals carrying out risk assessments and then actions decided. The priorities centred on saving lives. At the same time Gold command opened in Wakefield – all agencies represented there as well. There was close liaison with the ambulance service and air ambulance.

“We were dealing with many trapped people. There were also a number of non-urgent calls stacked up. Resources were at a minimum due to the Bank Holiday. We had re-deployed officers from other areas due to cancelled football matches but they were unable to move around due to the flooding. Also Gold command had concerns about other areas in Leeds, Bradford and Keighley.”

Role of communities and elected members
In Calderdale, as in other areas, communities and elected members played a vital role during the emergency period and beyond. Road closures had meant that the emergency services were unable to access certain areas and a failure of the communications and power infrastructure meant that it was impossible for the authorities to provide clear leadership. In instances such as this members of the community and elected members filled the breach – providing emergency help and assistance to neighbours and friends and often assuming a leadership role helping to co-ordinate and manage intervention.

Clear and up-to-date communication is obviously vital in emergency situations yet Calderdale’s Flood Commission heard many times that people involved in the situation didn’t know what was happening. Whilst the emergency services were rightly focussed on the emergency response there needs to be a review of how information can be delivered in a timely and concise way to people. Social media played an important part in disseminating information and enabling communication and there is the obvious potential that this could be harnessed further and its effectiveness improved. Clear communication would also serve to reduce the need to devote resources to responding to information requests, something which all areas experienced.

The communications issues across York were severe, the city centre telephone exchange was inundated and further difficulties were experienced due to the impacts upon Vodafone infrastructure in Leeds. All responders suffered a protracted period where only a limited number of phone lines were available. The wider impacts upon the city centre during one of the busiest shopping periods of the year meant that many ATM’s could not be used and card payments taken. This was further compounded as almost all road links into the south east of the city were severed due to the flooding of the River Foss and its tributaries.

From a Calderdale Councillor:
“On the day of the floods I was contacted by someone who was stuck on a first floor – I contacted the services – nothing happened. I spoke to a mobile unit in Mytholmroyd who were unaware of this emergency. It seems it was very disjointed between what was happening on the ground and Silver / Gold command. I was there all day - the lack of emergency service vehicles was apparent.”
The community: Kirkstall Road

Kirkstall Road in Leeds was one of many examples of community spirit, from volunteers helping to clean up the Kirkstall Bridge Inn to Open Source Arts setting up a Kirkstall Flood Clean-up – Action Room page on Facebook to co-ordinate the clean-up in the area.

Volunteers from across West Yorkshire came to help, with more than 700 people signing up in less than 24 hours following appeals on social media. Open Source Arts’ base in Kirkstall Road acted as the central point for volunteers, a drop off point for donations and resource, plus acting as a food and recoup space. The volunteer zone there had hot drinks, seating, access to computers and facilities to help feed people.

The coordinated approach saw council members, officers, skilled tradespeople and volunteers supporting the 250 businesses and more than 1,000 properties in the area impacted.

The West Yorkshire Overview and Scrutiny Committee found that there was:

“...confusion for the public as to which agency they should ask for help, and confusion with agencies themselves as to whether something was their responsibility or not (which) could be avoided if a policy was adopted whereby whichever agency was on the scene dealt with the emergency, with a reconciliation as to cost coming later. Yorkshire Water offered to host a single contact telephone number at their LOOP call centre.”

At public meetings in York many residents admitted that they had received the Environment Agency warnings but had ignored them and then criticised the Council for not sending staff to physically knock on their doors and tell them to evacuate. In some cases people claimed they had ignored the warnings because ‘we always get them...’ This perception is inaccurate. The severe flood warnings for the Foss had never previously been issued since the barrier had been in place. Many communities behind the barrier had not flooded since 1982. The retained knowledge of what to do in an event was therefore very low; this may be further compounded by the opt-out setup for flood warnings with many receiving warnings for the first time with little supporting information to inform them of what the warnings mean.

Flood wardens

The flood groups and flood wardens established in some communities in Calderdale post-2012 worked well, but there are not enough of them and they are geographically restricted. This is also recognised in Leeds, where it’s recommended that more local flood groups be established, building on the experience in Garforth.

This is echoed in Bradford, along with the need for defined flood hubs communities are also being encouraged to identify space to store the appropriate emergency equipment/resources for use by the community. The Council is working with the Environment Agency to ensure active flood wardens are included in emergency and flood plans.

The West Yorkshire Overview and Scrutiny Committee found that:

“The role of flood wardens had proven to be invaluable during the incident and a review of this resource, which was not equal across the districts, together with greater preparedness and use of shared data via social media networks would be beneficial.”

Calderdale’s Flood Commission made a number of findings and subsequent recommendations around emergency planning and preparedness, and the need for communities and individuals to also prepare for future flood events. Examples included the preparation and use of personal flood plans and flood boxes to protect important documents, improvements to flood hubs and increased recruitment of flood wardens. Bradford’s recent scrutiny review made similar recommendations and there is merit in rolling out community flood resilience capacity building in other areas.

It is imperative that each local authority area defines and understands its critical infrastructure and that this is part of risk assessment and management in response to a flood event. Each flood hub and key sites need permanent access to this information, and its effectiveness needs to be tested. Calderdale undertook a flood exercise in October to assess their mapping and response to a further flooding event.

Emergency response: Yorkshire Water

Yorkshire Water is responsible for the supply of clean water and collection and treatment of sewage for Leeds City Region. The company had been in escalation for much of December due to the ongoing wet weather but had stood down on Christmas Eve as weather forecasts became less concerning and in order to allow staff to have Christmas at home. By the morning of Boxing Day when the Met Office issued the red weather warning, alarms
had started to arrive at Yorkshire Water’s command centre in Bradford indicating that key sites were flooding. The company incident management process was instigated and senior staff called in to manage the event and liaise with the emergency services and other utilities. The Environment Agency requested that Yorkshire Water implement their flood plans in York, Malton, Brawby, and Boroughbridge as well as assisting in managing the floods in Leeds.

By the afternoon of Boxing Day at least 34 sewage treatment works were flooded and discharging straight to rivers, so waivers were secured from the Environment Agency. These waivers are issued in recognition of the fact that not only is the site inaccessible and therefore inoperable but the environmental impact is limited due to the extremely high volumes of river water diluting the effluent.

Calder Valley Incinerator was also flooded, staff evacuated and the high voltage power to the site shut down. A significant number of customer calls were received to the customer contact centre and additional staff were mobilised to deal with the call volumes. Mutual aid was also invoked, calling on resources from other water companies elsewhere in the country. By the 27th of December, tankers, jetters and staff from Wessex Water, Northumbrian, Welsh and Severn Trent Water started arriving at the Bradford depot to assist with the situation.

Over the 27th and 28th December, river levels started to drop. Yorkshire Water continued efforts to get enough staff into the call centre, get staff out to sites to assess the damage and assess what needed to be done. The inspection of reservoirs was prioritised along with drinking water sites and the largest and most critical pumping stations in areas affected. Hired-in pumps and generators were mobilised and water and sewage transported away from affected pumps and works to alternative sites for treatment.

Welfare centres were set up with hot food available 24/7, drinks and showers for staff and those directly affected by the flooding. Two mobile service centres in Todmorden with staff on hand providing bottled water and advice and support. In conjunction with public health bodies, communications were issued about managing risks from flood water and providing assurances about the safety of drinking water supply.

A critical issue faced during the event was gaining visibility of what was happening on the ground at Yorkshire Water sites. Access was restricted by flood waters to many sites, and there was uncertainty whether sites were safe to enter due to flood waters and electrical equipment, along with contamination from sewage and other health and safety hazards.

It was necessary to make sure that staff on-call had adequate rest and sleep time, and could access welfare facilities. Additional resources were drafted in to the call centre to manage the large number of incoming customer calls. There were some issues around managing the large number of contractors and mutual aid providers – co-ordinating jobs and making sure info was shared and available. The loss of the BT servers in Leeds and York caused severe communications issues but was fortunately resolved fairly rapidly.

The scale of the event is apparent in that 1,000 Yorkshire Water staff were involved in the incident working alongside staff from other water companies, the police, Environment Agency and local authorities. Every available pump and generator that the company could secure in the UK was deployed and the potential to fly more in from Europe was considered.

However, the response to the flooding also generated other issues. Yorkshire Water were forced to tanker sewage from sewage pumping stations to prevent flooding to homes. However, this meant that there were articulated lorry movements up and down certain streets 10-12 times a day and through the night. A Yorkshire Water tanker driver was assaulted by a member of the public and an emergency pump was switched off by a local resident because it was too noisy. As a result security had to be put in place to secure generators and pumps.

**Emergency incident and flood response plans: next steps**

There is broad agreement that the SCG model works well (subject to the right membership including seniority/trained participants and a good/well-trained Chair who keeps the meeting strategic, succinct and avoids being drawn into operational detail), but there is an ongoing need for regular training for SCG members.

The use of Resilience Direct (an online resource for emergency planning) is felt to be good in the response phase, but further work is needed on ensuring its use by all partners to make best use of it. Resilience Direct buy-in should improve with further development and improvement of the mapping facility. It is recognised that use of Resilience Direct is variable, but it is ready to use in response to a major incident, and further training to local areas is being provided.
With the scale of flood risk within the City Region it is imperative that all districts are aware of their own flood risks and have in place their approach of how the response would be managed. Crucial to this are well developed Flood Risk Management Strategies. Not all local authorities currently have formally approved strategies in place, although all do now have drafts in the process of securing approval. This is a further area where local authorities can undertake shared learning and have complimentary approaches that reflect the obvious pan-district nature of flood risk.

Flood Risk Management Strategies should inform and guide the response to the threat of flooding. However, with limited guidance and structure to develop a strategy – the Local Government Association (LGA) have developed a framework to assist Lead Local Flood Authorities (LLFAs) but ultimately the formal requirements for a strategy in the Act are minimal – content and consistency across the strategies varies widely. However, it is apparent that the range and scope of strategies across the country still varies with some, if not many, being a very high level assessment of flood risk issues that don’t really drive any resultant response. Content and consistency are crucial if the impact and effectiveness of the strategies is to be optimised.

As mentioned in the introduction, the Committee have looked at the economic impacts of the winter floods and the ongoing activities to respond collectively to the flood resilience issues. Members discussed the investment commitments to respond and prepare for floods and the approach to addressing prevention. They stressed the need to invest in the future for resilient systems and testing of infrastructure and land management at river heads.

It was considered that the experience of the Boxing Day 2015 floods was that the aftermath was more difficult to deal with than events happening during the flood itself. Some of their specific points have been included elsewhere in this chapter, but it’s worth highlighting the following individually:

- A resilience framework should be developed across the catchment areas for flood plains to examine infrastructure at risk and resource to deal with it. More focus was needed on commercial premises and the knock-on effect on business in general if communication infrastructure was disabled, as had been the case.
- A spike in blocked drains and sewer pipes should be anticipated a few days after flooding events occurred;
- Utility companies across the country were a valuable and helpful resource that could be called upon at very short notice to provide resource and equipment with the necessary experience to deal with incidents – more should be done to explore setting up ways of working to make the best use of this capacity.
- Work with insurers to adopt a collective loss adjustment approach so that each individual resident or business did not necessarily need to go through the loss adjustment process.
- There is potential for reservoirs and other water industry assets to be used as part of a mitigation strategy to reduce the speed of flow of upland waters, but this has to be balanced with the statutory duty to provide a clean water supply and other considerations such as reservoir safety and operational requirements. Further work is underway with Yorkshire Water, the Environment Agency and local authorities to ensure an effective plan is in place / to identify whether this may be an appropriate future option, once the issues have been fully considered.
- Harmonisation of flood plain data and planning authority development plans would help ensure development was resilient to flood risk.

Summary
This report shows that the immediate response to the floods, particularly in the worst hit areas of the Calder Valley, Leeds, York and Bradford was on the whole positive and effective. The emergency services, local authorities and the Environment Agency responded rapidly with the initial emphasis being on public safety with the most vulnerable people targeted first and then broadened to incorporate key infrastructure assets.

The actions of the local communities affected was inspiring, helping support the evacuation of the elderly and most vulnerable, erect emergency flood barriers and help in the rapid clean up after the flood waters subsided. The dedication and commitment shown by elected members and help from a broad range of organisations was also invaluable including support from water companies across the UK and in places the Army; for example, Yorkshire Water pulled in 1,000 staff and accessed every water pump they could from across the country to deal with the incident.

Regional utility companies including Yorkshire Water, Northern Powergrid and Northern Gas Networks played an important role both during and in the immediate aftermath of the floods by helping to manage the incident and mobilising staff to restore or maintain essential services including power and drinking water supply; and were
in the process of trying to secure further equipment from mainland Europe.

Inevitably there are lessons and insights that emerge from the experience:
- there is a need for more structured support for residents and businesses in high flood risk areas to enable them to prepare better to help themselves in times of flooding;
- the greater use of flood wardens and flood groups which provide immediate on the ground informed help;
- more effective use of the knowledge and resources within local communities is required, including a better understanding of key infrastructure, assets and vulnerable groups;
- improvements should be made to communications associated with the emergency response command and control structures and processes in places; and
- improvements to infrastructure resilience preparatory work and how essential works to sewerage facilities and power networks should be prioritised in times of flooding.

The West Yorkshire and the North Yorkshire Resilience Forums are responsible for planning and co-ordinating flood responses in their respective areas, and so this learning will need to be incorporated into their respective Flood Resilience Plans.

**Recommendations**

1. Undertake a review, led by the West Yorkshire and North Yorkshire Resilience Forums, of the emergency command structures to identify any potential improvements and ensure they are fit for purpose.

2. Support people and businesses in high flood risk areas to prepare their own ‘Personal Emergency Plans’ and provide suitable materials, flood boxes and support for future flood events.

3. Increase the number of trained flood wardens across the City Region in preparation for future flood events led by local resilience forums and local authorities.

4. Explore the benefits and practicalities of establishing a single public emergency contact telephone number for the City Region.
Chapter 4
Enhancing Recovery From Civil Emergencies

Overview
Much of the attention around civil emergencies focuses on the event itself and the response of the emergency services and the other agencies involved. The emergency response phase involves a number of different agencies with clear and pre-determined roles underpinned by a process that reflects principles of command and control. However, once events such as flooding have passed it is the communities, residents and businesses left behind who face an often long and protracted process of recovery. It is generally the respective local authority that is generally charged with leading and co-ordinating this recovery phase.

The experience of recovery from the Boxing Day floods as well as previous flooding on residents by residents and businesses is likely to be a key factor in terms of whether they feel they would be able to recover and get through future flood events.

As demonstrated in this report, the costs of flooding and the subsequent recovery are hugely expensive. Councils and other agencies can help but there is a reliance on the availability of adequate and affordable insurance to enable residents and businesses to be able to undertake the necessary building works and adaptations and to be able to replace the possessions and equipment lost.

Improving the ability to recover from instances such as flooding requires a multi-agency approach but it needs to start from attempts to limit the need and extent of recovery through measures to, wherever possible, avoid flooding and make communities, homes, businesses and infrastructure more resilient when flooding does occur.

Enhancing recovery to civil emergencies
Once the emergency situation has passed then the recovery phase begins. As the emergency services withdraw from the event it is local authorities that step in to co-ordinate and manage the recovery phase. A decline in staffing and financial resources available to local authorities is likely to have an effect on their ability to respond to such events.

At a more granular level the recovery phase is driven by those affected by the flooding – including homeowners, businesses, utility companies, public sector organisations and perhaps most importantly the community. The Boxing Day floods highlighted the importance of community resilience and including the community in establishing recovery priorities. It is important for early prioritisation of priorities – to establish a mix of 'quick-wins' and longer-term goals.

Communities can and do also help themselves as can be seen in the case studies within this chapter. Much fantastic work has been done through communities harnessing social media to come together as one to help their own communities and individual members of it. Challenges lay ahead in terms of understanding how this can be used to nurture and sustain the groups that have emerged and learn from the activity and roles they successfully undertook.

Building resilience within communities, investing in people and place as well as infrastructure, is key to enhancing recovery. There will be flooding again. Much of our City Region was developed historically because of the presence of water; we grew as a water-based economy. It is crucial to ensure that, as far as possible, the impacts of future floods are minimised and recovery from them is quicker. This means enhanced flood prevention systems as well as flood protection. It may also lead to conversations around place-shaping and neighbourhood planning.

Residential and business properties need to be made more flood resilient and ways to support and encourage those responsible should be explored. Existing measures, such as Property Level Protection grants are helpful as is the support of the LEP and Community Foundations and some insurance companies will now pay out to protect rather than just repair but this is not universal.

Businesses also have ongoing support needs beyond property protection. Ensuring a business can continue to operate in a location is important not just for that business, but also for its employees and the upstream and downstream supply chain businesses. Businesses help to ‘balance’ economies and are an obvious indicator of the health of a city, town or area. They can act as an attractor for new businesses enabling economic growth and inward investment.
Chapter Four: Enhancing Recovery from Civil Emergencies

Health is an area which the Calderdale Flood Commission identified as an element sometimes overlooked in recovery planning. The traumatic impact of flooding on the emotional wellbeing of people must be recognised as being important and with an ongoing need for support.

**Case study: The River Aire care and the Kirkstall regeneration initiative**

Established in response to the large amount of litter and debris that was left strewn across river banks and in trees as a result of the Boxing Day flood event, an informal group met to start organising a series of volunteer days to clean up the river banks. The initiative is now supported by the Environment Agency, Network Rail, Leeds City Council, Bradford Council, the Aire Rivers Trust, Yorkshire Wildlife Trust, the River Stewardship Company and Groundwork, amongst others. Clean up events continue to be held and a long-term approach to river stewardship along this beautiful river is developing.

Yorkshire Voluntary Flood Support: Bradford

“This all started on Facebook, Boxing Day 2015, when my husband Daniel posted his business card in order to offer immediate help to those who were being flooded at the time. There were a few ‘negative’ comments, but then Vicki, whom I’d never spoken to before, asked if I’d be interested to join forces and start a Facebook group where anyone - those who were flooded, volunteers, and tradesmen - could use the same space to get together to help each other help those who had been flooded. Things have gone from strength to strength at a pace since then!!

We had a lovely chat and both worked out really quickly that we had a lot in common, Vicki suggested setting up a group where traders could offer their help all in one place, I agreed it was a brilliant idea and it started from there. We had no idea what was going to unfold over the coming months. Within a matter of hours we had masses of people coming forward offering items to those affected including services from traders, we started up a spreadsheet and tried to organise volunteers to collect the items donated and distribute to those in need. Within a week the page became so busy that a friend of mine Andy offered his help and we asked him to come on board. We were thrilled when he agreed.

Since then we have secured on a short-term basis two places for storage and a garage. We have collected items from as far afield as Wakefield and Halifax, and local from Baildon, Guiseley and Ilkley etc. We have helped 24 families to get new homes. We are now planning on spreading the area we are working by offering our services to those who have been affected by any natural disasters. We have applied to become a charity and opening a bank account.

I can’t believe how far we have come in the last few months and what we intend to achieve in the near future, it’s just amazing. I have met some of the most amazing people along the way, some of which I know will be friends for life.

*It has been a pleasure to write this and share my story, I believe we can all achieve things bigger than our expectations if we all put a little work and effort in and the three of us have proved this.*

**Key activities and achievements over the last 12 months**

Since the Boxing Day floods, significant investment and activity has taken place across Leeds City Region to better protect those communities most at risk of flooding. This work has been carried out in partnership with the Environment Agency, all 10 local authorities, utility companies and communities.

Across Yorkshire, much of which has been undertaken in the Leeds City Region:

- more than 600 repair projects have been completed costing in the region of £27 million;
- over 17,000 tonnes of gravel have been removed from river channels;
- 111,483 person hours have been employed to repair damaged flood defences; and
- 10.5 km of flood banks have been repaired.

In Leeds City Region specifically this includes:

**Calderdale**

In Calderdale there is a total budget of over £60 million for flood risk management which includes the £35 million announced by the government in March 2016 to investigate and progress work to reduce flooding to 1600 homes and businesses including Mytholmroyd and Hebden Bridge.

A major scheme to reduce flood risk in Mytholmroyd is at an advanced stage of design and 2017 will see work on site. Design work is also progressing for Hebden Bridge with work also expected to start in 2017.
In Autumn 2016, the Environment Agency launched the Calderdale Flood Action Plan that was developed with the Calderdale Flood Partnership Board. This document sets out action that will see thousands of homes and businesses in the Calder Valley better protected, as well as longer term strategies that will involve local organisations and communities collaborating to develop better ways of managing rivers and the land.

As well as investment in flood alleviation schemes, the past 12 months has seen deployment of £9 million to repair flood defences and remove debris and £25 million to repair roads and bridges. Furthermore, Yorkshire Water has committed £36.3 million to repair, reinstate and protect water treatment assets in Calderdale.

Leeds
In Leeds, much work has gone into repairing and restoring the significant damage caused by the Boxing Day floods. An initial £1.8 million was secured from government to repair damaged flood defences across Leeds as well as £4.5 million from the Department of Transport to restore Linton Bridge. A further £3.8m was invested to repair damage along the River Aire, including phase one of the Leeds Flood Alleviation Scheme and the government also committed £35 million to fund the phase two scheme, initially providing £35 million between now and 2021. The government has committed to following up with further funding for the scheme.

The Environment Agency carried out a scoping study that was completed earlier this year, which sets out potential options to reduce flood risk to Leeds City Centre and Kirkstall Road. Government also approved £175,000 funding to develop options for the reduction of flood risk at Otley, Collingham and Tadcaster. The Environment Agency is also creating a new Wharfe Flood Partnership to coordinate investment and enable partners to work effectively across the catchment areas to manage and reduce flood risk, and to support the development of a scheme in Otley following the government’s commitment of £2 million in the 2016 Autumn Statement.

Work on phase two is now progressing: Leeds City Council has recently awarded a contract for a feasibility study and initial design stage of phase two of the Flood Alleviation Scheme. The Environment Agency is working in partnership with Leeds City Council to produce a full business case which will establish the appropriate standard of protection, looking at how this can be achieved, what it will cost and how long it will take to deliver. The primary aim of the second phase is to reduce the risk of flooding from the River Aire in Leeds, including the areas of Kirkstall Road and Stourton.

The Environment Agency has also supported a stewardship and clean-up programme working closely with partners such as Team Kirkstall Regeneration Hub, the River Stewardship Company and Groundwork to deliver a programme of volunteer-led clean-up days in the Kirkstall and city centre areas of Leeds.

A flood information centre opened in Kirkstall on 1 December 2016. Set up by Open Source Arts and Kirkstall Regeneration Hub but also including Leeds City Council and the Environment Agency. The Hub will provide flood information and advice to local residents and businesses.

Bradford
Across the district of Bradford many homes and businesses were affected by the floods including Keighley, Bingley, Shipley, Baildon, Apperley Bridge, Addingham, Ilkley and Menston. 400 homes were evacuated across these towns and a number of road bridges were hit by floating debris and as a consequence were closed. Throughout the district, the Environment Agency checked over 140 structures, repairing 18 as emergency work.

£1.7 million has been spent in Bradford as part of the flood recovery programme to repair damaged defences since the flooding in December 2015 and the Environment Agency is currently undertaking 15 initial flood defence assessments in the area. To inform these, a series of drop-in sessions were arranged over the summer to engage and involve local communities. This included taking the Environment Agency’s Incident Command Unit vehicle out into the affected communities and door-knocking to engage with those who were most severely affected.

The Combined Authority has worked in partnership with Bradford Council and the Environment Agency to secure £850,000 of local levy funding for the Bradford Flood Programme which will be used to commission options appraisals and develop community resilience and stewardship projects.

York
Within York, the Environment Agency’s focus has been on progressing upgrades to the River Foss Barrier as
well as producing a plan to better protect over 2,000 properties in the city over the next five years. They are also working on the development of a long-term plan to reduce flooding to York, embracing a number of upland water management measures and fully engaging the public and partners in the planning and delivery of this work.

The works on the River Foss Barrier are estimated to cost £17 million, with £10 million of direct government funding and £7 million from a recovery budget. Eight new pumps have been installed, giving a current pumping capacity of approximately 40 cubic metres per second (equivalent to the flow down the River Foss on Boxing Day). Planning permission for this work has now been granted by the City of York Council and the Environment Agency are proceeding with the permanent works to the Barrier. These works will include an additional storey to the building to house sensitive equipment and improve the power supply to the pumps. This will increase the potential pumping capacity to 50 cubic metres per second by next winter. The Barrier is fully operational and has so far been used five times since the winter 2015 floods to protect York. Most recently on 22-23 November 2016.

An existing allocation in the medium-term plan of £15 million was increased by a further £45 million to develop projects across the city that will reduce the risk of flooding to an additional 2,000 homes.

**Standardising our approach to recovery**

The severity and extent of the damage caused by the floods within the Calder Valley meant that a structured approach to flood recovery would be required if recovery was to progress effectively. This led to the development of a Calderdale a Single Integrated Recovery Plan.

The plan brings together all elements of the recovery effort under key themes: Community, Business, Infrastructure, Media and Public Affairs and Prepare. The importance of the plan was recognised in the speed with which it was in place with the plan being approved by the cabinet at its meeting on 11 January 2016.

It is a dynamic document with accountability to the cross-party Flood Steering Group. It is reviewed on a weekly basis by the corporate leadership team and updated regularly to drive the Council’s response following the impact of Storm Eva.

The plan is based on a number of principles:

- Provide leadership and co-ordination to the recovery activity in the impacted areas within Calderdale.
- Minimise disruption to Calderdale’s infrastructure and ensure effective business continuity.
- Maintain public confidence and provide reassurance for residents, businesses and members of the public to engage with recovery services through the provision of locality hubs in the impacted areas and targeted community support.
- Work in partnership with other agencies in order to ensure that flood victims are supported and their welfare needs are provided for.
- Support business growth and recovery and return to normality.
- Ensure effective communication of our recovery plan and support future investment into Calderdale
- Deliver enhanced resilience to future flooding events and immediate learning of key lessons for all agencies.

A similar approach was adopted in York. Whilst they didn’t have a formal printed plan, a recovery group was set up consisting of internal and external officers. This group met twice-weekly initially, then weekly and ultimately fortnightly. The minutes of each meeting identified required actions which were then followed up on at subsequent meetings and as such constituted the recovery plan. In all other aspects the approach was identical to that of Calderdale.

Leeds City Council developed a city-wide Strategic Recovery Plan. This has been developed with local communities, volunteers, and partners and incorporates the response to a range of recovery actions. Most activity, including support to communities and businesses affected, infrastructure repairs, ensuring effective communications and developing future resilience plans have continued for a significant period, and are now either completed or have been incorporated into business as usual projects and work. Like Calderdale, Leeds City Council’s Strategic Recovery Plan is divided into five sections: Community, Business, Infrastructure, Media and Communications, and Prepare. The plan includes a range of actions under these headings with a named person responsible for each action and a timeframe within which it should be completed.

Within Leeds there has been a significant focus on identifying the learning that emerges from the flooding and the response and a number of recommendations have already been made in terms of improvements going
forward. These include improvements to the emergency handbook, promotion of flood groups, consideration of how social media could be used more effectively and the mapping of key infrastructure within the city.

**Identifying critical infrastructure**

Discussions with partners during the commission of this report indicated the importance of identifying and maintaining up-to-date registers of critical infrastructure such as schools, hospitals, bridges, and energy and communications assets, which are priorities for assistance or protection in times of floods. However, the discussions also indicated that there is not consistency across the City Region in how critical infrastructure is defined and therefore, what assets are included and what level of protection is given to each type.

The Environmental Audit Committee commented in May 2016 that: ‘nationally significant infrastructure [see below] is not currently protected to a consistent standard. Infrastructure companies should be mandated to report their target resilience level, why this target is appropriate and what progress they are making with it.’

The definition of what is critical infrastructure or sub-regionally significant infrastructure is something that continues to be the subject of much debate and generates a wide range of views.

Indeed, whilst the Centre for the Protection of National Infrastructure (CPNI) has 13 categories for the national infrastructure, it notes that there are elements of infrastructure, the loss or compromise of which would have a major detrimental impact on the availability or integrity of essential services, leading to severe economic or social consequences or to loss of life. These ‘critical’ assets make up the Nation’s Critical National Infrastructure (CNI) and are referred to individually as ‘infrastructure assets’. Infrastructure assets may be physical, for example sites, installations or pieces of equipment, or logical, for example information networks and systems.

The 13 national sectors identified by the CPNI are:

1. Communications
2. Transport
3. Chemicals
4. Emergency services
5. Water
6. Space
7. Energy
8. Defence
9. Government
10. Financial services
11. Civil nuclear
12. Health
13. Food

Infrastructure is categorised according to its value or ‘criticality’ and the impact of its loss. This categorisation is done using the Government’s ‘criticality scale’, which assigns categories for different degrees of severity of impact. In determining this the criticality scale employs three impact dimensions: impact on delivery of the nation’s essential services; economic impact (arising from loss of essential service) and impact on life (arising from loss of essential service). There are some cross-sector themes such as technology wherein there may be infrastructure which supports the delivery of essential services across a number of sectors.

What is clear from the above is that there could be benefits in developing a consistent approach to both defining critical infrastructure and setting out a standardised approach to critical infrastructure protection. The local resilience forums are best placed to seek to achieve this through coordinated activity and sharing of knowledge and learning in revising their Integrated Flood Recovery Plans.

**Insurance**

Business insurance, or the lack of, is still a major ongoing issue, especially for SMEs. Whilst the introduction of flood re-insurance scheme Flood Re has provided significant support for households no similar schemes have been put in place for business. Community Foundation for Calderdale has launched two schemes which offer some matched funding protection, but they are not insurance schemes.

A report from the University of Leeds, Calderdale Council and Upper Calder Valley Renaissance, entitled ‘Economic Impact Assessment of the Boxing Day Floods (2015) on SMEs in the Borough of Calderdale’ was published in April 2016. It surveyed 150 businesses in the aftermath of the flood and found that three out of five of the surveyed businesses had at least one type of insurance. Nevertheless, around 14% had an insurance
excess that was so high it has not been worth submitting a claim. Many people affected in 2012 didn’t have flood insurance, and it was from then that future insurance cover became a serious concern. Often post-2012 insurance cover for SMEs was simply unaffordable.

The main reasons stated for insurance being unaffordable were what businesses considered excessive or very high premiums. The average insurance quote which was not affordable for 7.1% of the surveyed businesses was £7,576 (excluding one firm which stated that the quote was around £1,000,000).

An insight into the issues faced by some anonymised firms from the Calderdale impact assessment is provided in the case studies below (survey work from February 2016):

**Company A: Manufacturing, up to 30 employees**
Already paying £5 million in insurance, this company’s premises were totally under water. All production equipment was put out of action. This firm predicted weeks of lost production whilst machinery is repaired or replaced. The management are confident they will recover but concerned about further flood risks and the increased cost of insurance premiums. They are looking at the LEP’s flood recovery funding.

**Company D: Textiles, up to 20 employees**
This firm was severely flooded and was unable to get flooding insurance since the 2012 flooding. Management are confident they can recover but expect to have to lay-off staff or make redundancies. Stock losses were around £200,000. There are serious concerns about future flooding due to the firm’s proximity to river.

**Company E: Manufacturing, up to 100 employees**
This firm was severely flooded with serious damage to machinery. The premises suffered structural damage. The management resolved to adapt and were back in production by the end of January.
Insured damages amounted to around £1 million. However, as with others in Calderdale, there is concern that becoming uninsured or having to meet much higher premiums may become the critical success factor in long-term recovery and sustainability of this business. The total element of their uninsured losses amounts to around £120,000.

**Company G: Manufacturing, up to 80 employees**
Their site was completely flooded with all production machinery lost and administration departments destroyed. Machinery is a specialist type and will take six months plus to replace. This time the insurers will pay but as this could be several millions, this is another firm which is seriously concerned about getting insurance cover for flooding. They already fear losing clients to competitors during the period of recovery. At the moment they are looking at minimal job losses. The management are seeking to apply for flood recovering funding from the LEP.

**Company J: Food processing, up to 100 employees**
This firm’s site is currently out of use and their insurance claim will run to several million pounds. Some production has been moved out of Calderdale and the management are considering the long-term viability of staying in Calderdale.

In September 2016 DEFRA published the Property Flood Resilience Action Plan. In the ‘Embedding resilience in small businesses’ section, the task group looking at this it stated:
*"The commercial world can play a valuable role in helping to improve small businesses’ resilience to flooding, through the insurance, loss adjusting, property and financial industries. There is a need to better recognise and reward the increased resilience and reduction in risk, thus creating greater awareness and a market for property level resilience."

*"Many of the benefits would apply to the household market too, which would complement the efforts of Flood Re to help householders at high risk transition to risk-reflective prices by 2039."

*"In May 2016, the British Insurance Brokers’ Association (BIBA) undertook a survey of its members to understand more of the role of flood resilience, resistance and property-level protection for small businesses in flood risk areas. This sought to evaluate its current effect on premiums, deductibles (such as excesses), and the availability of cover. The survey has identified broker interest in flood resilience. This will inform how we take forward work with actors in this sector."

The task group has committed to a number of actions, including:

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• To establish a working party of insurers and brokers to explore how underwriters and brokers are assessing the impact of different types of flood resilience measures on SMEs. It will consider how this might influence the decisions that small businesses take to invest in certain areas; the direct financial benefits of such measures; how to improve insurance underwriters’ and brokers’ understanding of the reduced risk exposure; and to improve the availability of competitive quotes that incentivise small businesses to take action.

• Compile a ‘health check’ for small businesses. This will check whether adequate insurance cover is in place, assess benefits of flood resilient measures and determine the overall cost benefit to the business. It will then explore if insurers could use their purchasing power to leverage deals on appropriate flood resilient products for SMEs.

Grants and support
Grants formed a significant role both financially and psychologically in terms of the response to the Boxing Day floods. In order to try and offset some of the impacts of the flooding grants were available to both residents and businesses affected by the flooding.

For households there were three separate means of financial support that were provided through local councils:

1. Household Recovery Grants: these are grants of up to £500 and are intended to help with costs such as temporary accommodation.
2. Household Flood Resilience Grants: these are of a value of up to £5000 and help to improve a properties resilience to flooding – making them better prepared if instances of flooding re-occur.
3. Council Tax Relief: households are exempt from paying their council tax for a specified period.

It is apparent that the support available is relatively limited but it does provide a route to help households. The resilience grants provide an opportunity for households to provide themselves with some long-term resilience and additional protection from future flood incidents.

For businesses support was accessible through four different grants and several schemes were initiated across those districts affected by the flooding:

1. Flood Recovery/Relief Grant: administered by the each of the district local authorities and was used to help businesses with the initial clean-up costs associated with the flooding. These grants had a value of up to £2,500.
2. Flood Resilience Grant: intended to help businesses in terms of physical improvements to their facilities to make their premises more resilient to future instances of flooding. The grants were administered by the respective local authority and grants are of a value of up to £5,000.
3. LEP Flood Recovery Fund: this grant-based fund for businesses affected by the flood has now approved grants worth £2 million to 43 businesses with almost £1 million worth of applications from another 19 businesses in the pipeline. This funding is providing support towards the cost of replacing or repairing capital equipment damaged as a result of the floods, and has provided a financial lifeline to local businesses over this difficult early period. It has ensured that businesses have sufficient capacity to maintain operations and service contracts and suppliers. The aim of the fund has been to safeguard jobs within local businesses that may otherwise have been lost as a result of the flooding.
4. Business Rate Relief: relief from business rates was provided to a large number of the businesses flooded with around 800 businesses across Leeds City Region benefitting from this relief.

The driving force behind the take-up of grants for both households and businesses were the individual district councils whose officers had an ongoing role in terms of the provision of support and being a continued point of contact.

Applications for assistance are still being received by some local authorities 10 months after the flooding. Information is still being collated from councils on the number of businesses that have benefitted from financial support. The latest position on the take-up of grants by businesses are detailed below:

<table>
<thead>
<tr>
<th>District</th>
<th>Flood Recovery / Relief Grant</th>
<th>Flood Resilience Grant</th>
<th>LEP Flood Recovery Fund*</th>
<th>Business Rate Relief</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bradford</td>
<td>71</td>
<td>15</td>
<td>4</td>
<td>108</td>
</tr>
<tr>
<td>Calderdale</td>
<td>945</td>
<td>133</td>
<td>31</td>
<td>666</td>
</tr>
<tr>
<td>Craven</td>
<td>-</td>
<td>12</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Harrogate</td>
<td>-</td>
<td>36</td>
<td>0</td>
<td>-</td>
</tr>
</tbody>
</table>
Summary

Local authorities play the key role in the provision of leadership, advice and support in the recovery phase. Authorities worked in partnership and offered mutual support in the weeks and months following the flooding to those districts that were most badly affected. This was vital to enabling the recipient authorities to effectively cope with the demands of residents and businesses.

Almost 12 months after the floods, households and businesses in several areas are still dealing with the physical damage and associated emotional stress. For some it is about completing the process of rebuild and recovery whilst for others it was and is a question of whether they should remain and live with the risk of a re-occurrence of the flooding. Some local businesses have already moved out of the City Region as a consequence of the floods, so building resilience within our businesses and communities, and investing in people, places and business support as well as infrastructure, is key to enhancing how we deal with and recover as a City Region from future flood events.

This report finds that although a key attribute of the emergency response phase is the command and control structures that are put in place to allot responsibilities and to guide and structure the activity undertaken, the recovery phase can suffer from the lack of a similar approach. In some places the move from the emergency response phase to the recovery phase happened too early and didn’t include all the necessary agencies, resulting in the transition being less coordinated and effective. In Calderdale and Leeds, council’s responded quickly to put in place a structured approach through their Single Integrated Recovery Plans. This could provide a template through which similar approaches could be developed elsewhere.

Critically, this report shows that government, local authorities and the LEP were quick to identify additional funding for recovery and repairs to key infrastructure and to put in place to support businesses to continue operating; for example, the LEP’s Business Flood Recovery Fund provided a life-line to support SMEs to clear up, replace machines and equipment, and provide cash flow to enable them to continue operating and paying salaries.

Crucial to recovery is also the ability to not only secure the appropriate insurance but also to be able to claim against it. However, due to the known risk of flooding events in some areas many have either been left unable to secure reasonable insurance; which is a situation compounded by the size of premiums, excesses and the potential impact on securing future insurance if a claim is made. This report suggests that a more streamlined and simple claims process is needed to speed-up claims and ensure residents and businesses can have the means to return to normality as soon as possible after a flood event.

Recommendations

1. Undertake a review, by all 10 City Region local authorities, of their approaches to recovery, including the appropriate time period to move from the response to the recovery phase and prepare / update Single Integrated Recovery Plans referring to the Calderdale Integrated Recovery Plan as an example of good practice.

2. Build stronger relationships between local resilience forms and local authorities with local media to raise awareness of real time issues and access to emergency help, and embed best practice from social media into emergency plans.

3. Identify best practice and explore the benefits of adopting a consistent definition of critical infrastructure to be protected in the event of floods for the West Yorkshire and North Yorkshire Resilience Forums; for example, hospitals, schools, vulnerable residents, communications infrastructure.

4. Explore the opportunities for a simpler claiming process for individual residents or businesses after flood events with government and the insurance industry.
Chapter 5
The Impact of Climate Change

Overview
Climate change represents the single greatest threat in terms of increased frequency and severity of flooding in the Leeds City Region.

According to the national Climate Change Risk Assessment 2017:
“The greatest direct climate change-related threats for the UK are large increases in flood risk and exposure to high temperatures and heatwaves […] A warmer atmosphere can hold more moisture, leading to heavier rainfall and more frequent flooding, including outside of recognised flood risk areas […] Projected sea level rise of 50-100 centimetres by 2100 will exacerbate flood risks and accelerate the process of coastal change for exposed communities”

This means that although our summers will be warmer and broadly drier we will face an increased risk of intense rainfall which could lead to flash-flooding. Winters will be milder and wetter with an associated risk of higher river flows causing flooding from rivers.

The Intergovernmental Panel on Climate Change
The Intergovernmental Panel on Climate Change (IPCC) is the international body for assessing the science related to climate change. Established in 1998 by the World Meteorological Organisation and the United Nations Environment Programme, the IPCC publishes assessments of the latest climate science, impacts and future risks. The latest IPCC report unequivocally states that the global climate is changing and greenhouse gas emissions from human activity are the dominant cause, and that the impacts include: more frequent and severe flooding due to changes in rainfall patterns and rising sea levels, greater risk of drought, and widespread impacts on natural systems, habitats and species. Many of these impacts are already being observed across the globe and across our City Region.

The UK Climate Impacts Programme
At a national scale, the UK Climate Impacts Programme (UKCIP) has provided detailed climate projections for the UK since 2000. The latest set of projections from UKCIP are known as UKCP09 and provide projections at a regional scale for each decade up to the end of the century for three different emissions scenarios (high, medium and low). A selection of projected changes both for Leeds and for Yorkshire are shown below:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Baseline (1961-1990)</th>
<th>2050s</th>
<th>2080s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual average temperature in Yorkshire</td>
<td>9.1</td>
<td>11.4</td>
<td>12.4</td>
</tr>
<tr>
<td>Annual maximum temperature in Leeds</td>
<td>27.6</td>
<td>31.5</td>
<td>32.3</td>
</tr>
<tr>
<td>Annual average daily minimum temperature in Yorkshire</td>
<td>5.2</td>
<td>7.6</td>
<td>8.6</td>
</tr>
<tr>
<td>Summer average daily precipitation in Yorkshire</td>
<td>1.75mm</td>
<td>-19% (1.42mm)</td>
<td>-23% (1.35mm)</td>
</tr>
<tr>
<td>Winter average daily precipitation in Yorkshire</td>
<td>1.66mm</td>
<td>+11% (1.84mm)</td>
<td>+15% (1.91mm)</td>
</tr>
<tr>
<td>Annual number of heavy rain days (more than 25mm per day) in Leeds</td>
<td>2</td>
<td>7</td>
<td>9</td>
</tr>
<tr>
<td>Annual number of dry spells (5+ days with no rain-fall) in Leeds</td>
<td>12</td>
<td>15</td>
<td>18</td>
</tr>
<tr>
<td>Sea level rise at Immingham</td>
<td>7091mm (1990)</td>
<td>7312mm</td>
<td>7458mm*</td>
</tr>
</tbody>
</table>

*This equates to a sea level rise of 36.7cms at Immingham by 2080.

The table confirms that temperatures in both summer and winter will rise, but summers will be drier overall and winters will be wetter, with average daily rainfall in winter rising by around 15% by 2080. This will have significant impact on the frequency and severity of flood events in Leeds City Region.
The Committee on Climate Change
As well as the information provided by UKCIP, the UK also benefits from an independent Committee on Climate Change (CCC) and its Adaptation Sub Committee (ASC). These committees were established by the Climate Change Act 2008 and play a statutory role in providing impartial scientific advice and scrutiny to government about climate change. In fulfilling this role, the ASC have recently commissioned four research projects to inform the second national climate change risk assessment, including a study of future flood risk which has not reported.

The flood risk study considered projections of future flood risk for the UK. It found that significant additional investment and adaptation action will be needed to counter the increase in UK flood risk projected under a two degree Celsius rise in global mean temperatures.\(^2\) It also finds that even the most ambitious adaptation scenarios will be unable to avoid the large increase in UK flood risk implied by a four degree Celsius rise in global temperatures. Key impacts will be felt around our coast as sea levels rise, particularly the low-lying land around the Humber estuary, which may have knock on effects to the flows of rivers discharging into the Humber in times of a flood, which could impact areas within the City Region upstream.

The table below shows the projected increases in the number of properties at risk from flooding today and in the 2080s in the Yorkshire region. The projections assume a continuation of existing adaptation policies and do not include population growth.

<table>
<thead>
<tr>
<th></th>
<th>Expected annual damages</th>
<th>Number of properties at &gt; 1 in 75 risk</th>
<th>Number of properties in deprived areas at a &gt; 1 in 75 risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Present day</td>
<td>£32 million</td>
<td>87,000</td>
<td>18,000</td>
</tr>
<tr>
<td>2080s: two degree rise</td>
<td>£44 million</td>
<td>130,000</td>
<td>26,000</td>
</tr>
<tr>
<td>2080s: four degree rise</td>
<td>£80 million</td>
<td>170,000</td>
<td>33,000</td>
</tr>
</tbody>
</table>

This report concludes that expected annual damages to properties from flooding are projected to increase fourfold by 2080 across Yorkshire and that such increases could occur as early as the 2020s. The report also finds an increased risk of flooding to critical infrastructure such as electricity sub-stations, railway lines and hospitals, as well as to the most productive agricultural land and to internationally important protected habitats.

Continuing current adaptation activity could offset between 30-50% of the projected increase in future damages under a two degree rise (note: the projections do not include population growth). These activities include maintaining defences, managed realignment on the coast, catchment management and urban run-off management through SUDs. The analysis highlights that the most significant contribution to reducing risk is achieved through a whole system approach to adaptation, which requires action by a broad range of stakeholders, from national level down to individual households and businesses.

The UK Climate Change Risk Assessment 2017 (synthesis report published July 2016)
The Climate Change Act requires the government to compile its assessment of the risks and opportunities arising for the UK from climate change every five years. The first UK Climate Change Risk Assessment (CCRA) was presented to Parliament by the Government in January 2012. The government commissioned the ASC to produce an Evidence Report to inform the second Climate Change Risk Assessment (CCRA2) due in January 2017.

In its summary of urgent climate change risks for the United Kingdom it identifies flooding and coastal change risks to communities, businesses and infrastructure as having ‘HIGH MAGNITUDE NOW’ with a high confidence, ‘HIGH MAGNITUDE IN FUTURE’ also with high confidence, and states ‘MORE ACTION NEEDED’ [note: emphasis as shown in the CCRA].

protection for some communities will be possible whilst others will face the prospect of significantly increased risks. This will affect property values, business revenues and in extreme cases the viability of communities. Risks to communities and local economies are closely linked to the resilience of local infrastructure, in particular energy, transportation and communications systems. Warming of four degrees Celsius or more implies inevitable increases in flood risk across all UK regions even in the most ambitious adaptation scenarios considered.”

Studies suggest flood events, like the event of autumn 2000 (Pall et al., 2011), and extremely wet winters like the winter of 2013/14 (Shaller et al., 2016), have become more likely. This is consistent with the increasing moisture levels that a warmer atmosphere can hold. There is some evidence that heavily moisture-laden air currents (atmospheric rivers), linked with the flooding in England in November 2009 and December 2015, are more likely to form and can hold more moisture with climate change (Lavers et al., 2013).

This report also identifies priorities for further action and research:

• **Residual risks:** even with current investment plans the residual risk of flooding will remain high across the UK. Improved flood defences will not be possible or affordable in every area, and with climate change a greater disparity in risk between protected and non-protected areas may emerge. Some individual coastal communities are vulnerable to coastal erosion and sea level rise. More action is needed to support communities facing increasing risks, especially in areas where formal flood defences are unlikely and long term viability is at risk.

• **Urban water management:** climate change is expected to lead to significant increases in heavy rainfall, with sewers in many urban areas already at or over capacity. More action is needed protect individual properties whilst also beginning to redesign urban landscapes (such as through the use of sustainable drainage approaches) to be able to cope with more intense patterns of rainfall.

• **People and communities:** as well as residential homes and other buildings, a significant number of hospitals and other care facilities are located in exposed areas. The evidence suggests that the long term health and wellbeing impacts of flood events are considerable and more research is needed to assess and understand how best to manage these.

• **Infrastructure:** electricity sub-stations, road and rail networks, water treatments works, ports and airports, and fixed line and mobile communications assets, are all exposed to increasing flood risks. Further work is needed to assess and address vulnerabilities, including as a result of interdependencies between networks. This includes the risk of sewer failure and consequential flooding.

• **Agricultural production:** strategic choices need to be made about the value of protecting agricultural production in flood risk areas when this could further increase run-off rates, silt deposition in rivers, and downstream flood risk.

• **Business:** companies operating in flood risk areas are exposed to direct damages to buildings and assets, and indirect impacts on sales, production, supply chains and reputations. Businesses not directly at risk but located in affected towns may suffer knock-on impacts from disrupted infrastructure and custom being postponed or lost to competitors elsewhere.

Climate models are becoming more locally specific enabling a stronger understanding of estimated local impacts. Latest MET office modelling suggests that there could be a five-fold increase in the number of events exceeding 28 mm of rain in one hour than in our current climate with a subsequent increase in flood risk. Whilst research is ongoing, a number of academics have concluded that current guidance about how to account for changes in daily or sub-daily rainfall are likely to underestimate how rainfall intensity will increase in the future.

Furthermore, extreme-event analysis by the University of Oxford has indicated that Storm Desmond in December 2015 is 40% more likely to re-occur. A follow-up study also showed climate change had increased the odds of such a wet December in the UK by 50-75%.

**National flood resilience review and extreme flood outlines**

A national review was initiated in January 2016 to assess how the country can be better protected from future flooding and extreme weather events such as during December 2015. This review was chaired by the then Chancellor of the Duchy of Lancaster with a team including Cabinet Office, DEFRA, the Environment Agency, the Met Office and the government’s Chief Scientist.

The review examined how the government understands the risks of river and coastal flooding from extreme weather over the next 10 years. It also assessed the resilience of key local infrastructure (such as energy, water, transport and communications), and identified ways to protect it better; and improved how it is able to respond to flood incidents with new temporary flood defences.
The report reflected that:
“Describing flood risk in traditional terms such as a ‘1% chance of flooding’ or ‘1 in a 100 year risk’ is not helpful because it is so likely to be misinterpreted, as these terms describe the flood risk at a specific location. They do not describe the chance of one of these events happening somewhere in the country or region in a given year – which is much greater. Nor do they describe the impact on people and on the economy when events that have previously been regarded as very unlikely do something happen.”

Working with the Met Office and the Environment Agency, new plausible extreme rainfall scenarios were developed (recent extreme events plus substantial uplifts of between 20% and 30%) and tested using the existing detailed flood models. The models suggest that even this plausible extreme flooding remains overwhelmingly within the areas and depths defined by the current Environment Agency extreme flood outlines. This provides significant confidence that the extreme flood outlines constitute a good representation of plausible severe fluvial (and tidal) flooding.

**Climate change allowances**

National Planning Practice Guidance refers planners, developers and advisors to the Environment Agency guidance on considering climate change in flood risk assessments (FRAs).

This guidance can be used for planning applications, local plans, neighbourhood plans and other projects. It provides climate change allowances for peak river flow, peak rainfall, sea level rise, wind speed and wave height. The allowances contained within the guidance were revised to reflect the latest climate projections in UKCP09 and wider flood risk research published since 2009.

The main changes are to the peak river flow allowances. These allowances are now provided for each river basin district rather than a single national allowance of 20%, based on UKCP02. A range of allowances are provided based on different probabilities for each epoch, rather than a single allowance for each epoch. It advises on what allowances to use for assessment based on vulnerability classification, flood zone and development lifetime. The allowances for the upper end of the range are significantly higher than previous single national allowance – these allowances would apply to essential infrastructure, highly vulnerable development in flood zone two and more vulnerable development, such as housing, in flood zone three. The peak river flow allowances for the Humber are outlined in the table below:

<table>
<thead>
<tr>
<th></th>
<th>Total potential change anticipated for 2020s (2015-39)</th>
<th>Total potential change anticipated for 2050s (2040-2069)</th>
<th>Total potential change anticipated for the 2080s (2070-2115)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Old NPPF allowance (England) for comparison</strong></td>
<td>10% (1990-2025)</td>
<td>20% (2025-2115)</td>
<td>20%</td>
</tr>
<tr>
<td><strong>HUMBER</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Upper end</strong></td>
<td>20%</td>
<td>30%</td>
<td>50%</td>
</tr>
<tr>
<td><strong>Higher central</strong></td>
<td>15%</td>
<td>20%</td>
<td>30%</td>
</tr>
<tr>
<td><strong>Central</strong></td>
<td>10%</td>
<td>15%</td>
<td>20%</td>
</tr>
</tbody>
</table>

It is apparent that following the February 2016 climate change allowances, there is now a lack of readily
available flood data for the new scenarios. This means that the onus is placed on developers to produce this information, to demonstrate the impact of climate change and the mitigation that will be required. There is the potential that this will result in significant costs and delays to developers. Previously, the flood data required to demonstrate the impact of the single national climate change allowance could be readily obtained from the Environment Agency. The introduction of the new allowances renders this flood data out dated.

The availability of updated flood data, taking the form of new modelling or re-runs of existing models to include the climate change allowances, would be a hugely valuable output that would help speed and smooth the planning process. This should be carried out across multiple local authorities in conjunction with the Environment Agency, perhaps best delivered by appointing framework consultants project managed by the Environment Agency, with outputs shared with the parties.

Summary
Climate change is happening, the earth is warming and the impact on Leeds City Region will mean that our summers will become drier whilst our winters will become wetter increasing the risk and severity of flooding. There will need to be greater intelligence gathered and analysis carried out in terms of how these changes will impact on the City Region and a large degree of uncertainty will need to be factored into any modelling/analysis.

This places a greater emphasis on the interventions that reduce the risks of flooding and that add to the resilience of our homes, businesses and infrastructure. The increase in flood risk in terms of the number of premises susceptible to flooding will increase and this could rise significantly depending on where new developments take place in the future. It is apparent that consideration of this risk will become an increasingly important aspect in terms of where and how development can and should proceed in to the future.

Recommendations
1. Consider extending climate change allowance modelling for fluvial flooding beyond existing scenarios to align with the SEP forecasting timescales and support delivery of longer term Strategic Priority Growth Areas.
Chapter 6
Upland Management

Overview
Upland management represents an important tool in terms of reducing exposure to flood risk. It incorporates a range of approaches and interventions that seek to harness and maintain the landscape in order to slow the run-off of water. The approach has the potential to have a significant impact in terms of both upper and lower catchments, slowing the rainwater run-off serves to help alleviate flash flooding in upper catchments whilst potentially reducing the level of peak flow in lower catchments as the rain waters travel down river.

Current position
The peaty uplands in Leeds City Region provide significant climate regulation. The peaty soils generally have a carbon content of between 20% and 50%. They also have high levels of carbon storage associated with the large expanses of blanket bog, for example 25,000 hectares in the South Pennine Moors. The existing woodlands also perform a role in the sequestration and storage of carbon, slowing the flow of water, and enhanced biodiversity. Unfortunately, the tree cover in the Leeds City Region is only approximately 5.2%, based on the Forestry Commissions National Inventory of Woodland and Trees. Good coverage that would help with climate regulation and coverage is in the order of 20-30%.

The peaty plateau soils of the South Pennines and Yorkshire Dales are at risk of gullying / haggling where surface vegetation is damaged or lost from overgrazing or burning of from wind and water erosion where the soil is bare. The blanket bog soils are also vulnerable to occasional mass flow events, such as those that occurred following the Boxing Day floods. Drainage through historic gripping has also resulted in increased oxidation of carbon and soil wastage.

A number of upland projects such as the Environmental Stewardship Scheme, Yorkshire Water’s site of special scientific interest (SSSI) recovery project, Yorkshire Peat Partnership and MoorLIFE programme are having notable success in restoring degraded peat soils by reducing the impacts of compaction, reducing the risk of wildfire, maintaining permanent pasture, increasing tree cover and establishing wetland habitats where the focus has been around biodiversity and carbon loss.

In addition a number of tree planting and woodland creation initiatives through projects like The Source, White Rose Forest and the Yorkshire Dales Millennium Trust have delivered small scale tree planting and woodland creation within the upland catchments.

There are, however, significant gaps in the capacity to deliver the opportunities which require investment and management which would directly reduce the impacts of flooding and improve catchment resilience against climate change.

Leeds City Region green infrastructure strategy refresh
Following the flooding events of December 2016, the LEP requested a refresh of the green infrastructure strategy and delivery plan by the LEP’s Green Economy Panel, alongside developing an investment framework for green infrastructure interventions that would help to mitigate flood risk. The Green Economy Panel is working closely with the Yorkshire West Local Nature Partnership to deliver the project that will produce three outcomes:

1. A stakeholder map of actors who have a delivery role to play in green infrastructure.
2. A refreshed green infrastructure strategy.
3. A delivery plan for green infrastructure interventions that will also help to reduce flood risk.

The approach being adopted for this work is based on whole river catchments and so requires full collaboration across areas both within and outside the City Region. The strategy and delivery plan once completed will be key in identifying investment by the Combined Authority and the LEP to maintain and deliver green infrastructure and ensure its ongoing contribution to flood risk reduction.

Leeds City Region Natural Flood Management Task Group
Under the strategic leadership of the West Yorkshire Local Nature Partnership executive board, the White Rose Forest partnership has, in collaboration with the Aire and Calder catchment Partnership and the Environment Agency, established a Leeds City Region Natural Flood Management Task Group.

This working group helps to co-ordinate and develop the necessary mechanisms with a wide-range of partners
to ensure strategic delivery of natural flood management as part of the Green Infrastructure Strategy refresh and its subsequent investment plan for reducing flood risk.

The task group’s key aims to date are:

- Work with developers and investors to provide the planning context and necessary guidance alongside design ‘toolkits’, ensuring we integrate green infrastructure into all new developments.
- Clarify and refine the different modelling and mapping processes to identify priority areas for natural flood management investment and align these processes with suitable funding opportunities, for example the Woodland Trust and Countryside Stewardship.
- Develop a comprehensive package, of design ‘toolkits’, training and marketing, for working with landowners in target areas to scale up the Woodland for Water activity already under way across the City Region.
- Review how natural flood management can be incorporated fully into a revised farming subsidy system as part of a reform of agricultural policy.

Land management pilot
The White Rose Forest partnership have begun working with Yorkshire Water a strategic collaboration to incorporate natural flood management into Yorkshire Water’s business case and begin a programme of delivery across the City Region. All natural flood management interventions provide multiple benefits and, depending on how the schemes are delivered, they can provide community engagement opportunities, training and apprenticeship opportunities around managing woodlands sustainably. Other benefits, depending on the intervention, can also include reduced sediment run-off, resulting in improved land productivity for farmers, habitat restoration and creation, improved tourism and carbon storage.

However, there remains issues establishing the priorities for initiatives such as natural flood management and ensuring that there are sufficient resources available to be able to develop and deliver such projects.

Role of reservoirs in managing flood risks
Reservoirs could play a vital role in helping to manage flood risk. They can serve to reduce flows in rivers downstream if flows out of them during flood conditions are less than (slower) than flows in.

Altering reservoir operation could reduce flood risk, but other measures, such as flood walls along a river, or flood proofing of individual properties, would often be needed as well to make a big enough difference.

The top water level of a reservoir would need to be lowered, or ‘drawn down’, before a major storm arrives in order for a reservoir to attenuate flood flows as much as possible, which can take several days. Additionally reservoirs can reduce flood risk without reducing storage volume by raising the level of the dam spillway and holding water down below this new dam crest level. Reservoirs are needed to maintain a consistent supply of water and protect against drought risk. If storage is reduced in one place, an increase somewhere else may be required. In the past valves and pipes were not always designed to lower the top water level of a reservoir in a controlled way and maintain it below full and changing this could be expensive and difficult. Many reservoirs have dams with a clay core and it is important that this core does not dry out too much due to water levels being low for long periods.

There would also be some potential, with significant alteration works, to use of disused reservoirs which could be brought back into use to reduce flood risk downstream.

However, whilst water companies could have a role to play in helping to manage flood risk they do not have a legislative or regulatory role in terms of aspects relating to flooding. There is a potential conflict between the water companies taking steps to help reduce flood risk, for example by reducing the water levels in some reservoirs, and the legislative requirement placed on them to supply clean drinking water. Therefore without a specific requirement it is difficult for water companies to prioritise flood mitigation above simply maintaining high levels of water reserves within their reservoirs. A change to legislation or regulation may be required to enable water companies to better support flood mitigation.

The role of land management
There is also the potential to hold water ‘upstream’ in the peaty soils of the South Pennines and the Yorkshire Dales which feed into the upper catchments of the main rivers running through the City Region. The conservation of this environment also is hugely important due to the significant volumes of greenhouse gases stored within them.
Bare and eroded areas of peat need to be re-vegetated and managed to protect and expand areas of active blanket bog. In addition, any activities that might damage peaty soils should be avoided for example, creating tracks, planting trees, soil compaction and unsustainable burning regimes. On free draining soils, measures could be taken to improve carbon sequestration by increasing organic matter inputs and by reducing the frequency/extent of cultivation and maintaining or establishing permanent pasture and wetland. It is important to ensure that the existing woodlands are in good management for adapting to climate change impacts. The area of woodland cover could be expanded to increase woodland cover in cloughs and alongside areas of wetland within the flood plains.

It is important that the peaty soils retain water in situ, have good vegetative cover and are not overgrazed or subject to unsustainable management. Opportunities should be centred on those which can restore the natural hydrology of peatland habitats and the re-establishment of peat bog plants, such as Sphagnum to increase water retention in some locations and mitigate the severity of flood events. There is also a need to address risks of poaching and compaction on soils to improve soil structure and aid water infiltration. Improving the management and control of flood waters will benefit the many urban areas and settlements downstream.

There is also a need to ensure that all areas of blanket bog are under good environmental management, improving the habitat’s ability to actively sequestrate CO2 from the atmosphere, while retaining significant volumes of greenhouse gases in storage.

Accelerating the restoration of bare and eroded peatland habitats with the onset of climate change and the potential increase in flood risk should also be considered. This should be in combination of encouraging sustainable grazing regimes and combatting wildfire risk, seeking opportunities for permanent grassland and wet pastures, as well as creating new woodland.

It is crucial that there is a strategic approach to tree and woodland planting across the City Region, utilising the White Rose Forest Joint Venture Agreement supported by the Green Infrastructure Strategy refresh, the Calderdale Plan and the Upper Aire Catchment Network.

The benefits of managing woodlands and increasing woodland cover for improving flood resilience has been well demonstrated through various projects such as ‘Slowing the Flow’ in Pickering and its implementation of the natural flood management approach. The challenge would be to scaling up such a project within the Aire, Calder and Wharfe catchments.

Woodland cover could be expanded to increase riparian woodland in cloughs and alongside areas of wetland within the floodplains.

It is important to ensure that the existing woodlands are in good management for adapting to climate change impacts and providing long-term environmental benefits in accordance to the UK Forestry Standard.

**The Countryside Stewardship Scheme**

The new Countryside Stewardship Scheme launched by DEFRA in 2015 is a voluntary scheme for landowners and farmers to enter. It is competitive and based on delivery of local area priorities.

The priorities for Calder, Aire, Wharfe catchments include:

- moorland management;
- flood risk management; and
- woodland planting.

The extent to which the scheme can deliver large scale integrated peat restoration projects and landscape scale improvements associated with flood risk is limited. It can in combination with landscape wider focused initiatives, such as MoorLIFE, provide a useful mechanism through its base incentives to develop further sustainable farming management, which can build upon good land management practices. It is a useful tool and can be a starting point for further landscape scale initiatives but by itself it will not resolve the full tasks associated with flood impacts or their remedies.

**Investment in upland management for flood risk reduction and carbon capture**

Following the flooding on Boxing Day, the LEP Board and the Green Economy Panel have both agreed that the scale and nature of the event highlighted the importance of a strategic approach to upland management.

In response, the Local Nature Partnerships have developed a strategic proposal that would enable the LEP to
support the delivery of strategic landscape scale interventions. The proposal complements the almost £200 million planned capital investment to reduce the flood risk in the villages, towns and cities of the City Region between now and 2021. The details of this are summarised below:

- The development of a strategic approach in the Aire, Calder, Colne, Holme and Wharfe catchments, including interventions with key landowners, will be targeted to provide maximum benefits and will include a range of ‘quick win’ demonstration schemes.
- It is important that the LEP and York, North Yorkshire and East Riding LEP work collaboratively on the Swale, Ure, Nidd and Ouse catchments to help reduce the risk of flooding in the City of York.
- In the Yorkshire Dales National Park and Nidderdale Area of Outstanding Natural Beauty restoration of natural drainage across 4,500 hectares of peatland, creation of 300 hectares of new native woodland and localised run-off attenuation measures are proposed.

In the long-term these interventions will realise a reduction in sub-catchment flood peaks of up to between 5 and 10%, contributing significantly to climate change resilience and providing other multiple benefits: from increased tourism, environmental resilience and dramatically improved carbon storage. There will be an additional net benefit of at least £16 million over 40 years for avoided carbon emissions and carbon sequestration.

Summary
Upland management has a key role to play in terms of both flood management and carbon storage.

The natural environment, its soils and plants, naturally performs these tasks holding both water and carbon. Upland management includes re-establishing or supporting these environments; enabling the soils and landscapes return to what they were alongside the introduction of appropriate plants and trees. The White Rose Forest Partnership and the Countryside Stewardship Scheme provide some insight into interventions could be structured and delivered.

Upland management is crucial in term of the development and implementation of a whole-catchment approach. It focuses on where the river waters and actually come from. Potential interventions are not limited to natural elements and reservoirs and other means of structures to retain / slow water may also have a role to play.

It is important that political commitment and engagement at a Leeds City Region level continues in support of the natural flood management programmes, recognising their positive impact on economic growth. Opportunities to restore upland peatlands and to increase woodland cover within the catchments which either are part of or, have an effect on, the Leeds City Region are actively sought, developed and funded.

**Recommendations**
The recommendations that reflect the issues raised within this section are largely reflected within the other sections of this document, notably within the next chapter.
Chapter Seven: Planning, Risk Reduction and Future Investment

Overview
There is a widespread view by the leaders of the Combined Authority, the Combined Authority Scrutiny Committee and other partners that there is a need for a much stronger whole river catchment and multi-partner approach to flood risk reduction and management.

Many partners have a role to play in managing water, a critical natural resource, in a way that reduces the likelihood of both flooding and water shortages. It is important that all partners work together across organisational and political boundaries to make this happen. However, as was also stated in the recently published National Flood Resilience Review, integrated catchment management will not reduce the likelihood of flooding overnight.

Therefore, it is important that we maximise the benefits that all investments can provide in reducing the impacts when extreme weather events do occur. Further it will be important that all the mechanisms available are utilised and all potential funding sources are drawn on to ensure that a more coordinated and effective approach to long term flood mitigation and management is adopted.

Green infrastructure has a potentially greater role to play in flood risk mitigation and management, particularly in upland areas and downstream to slow water run-off and as storage to minimise the effects of floods. The ‘Green Streets’ approach, adopted by the Combined Authority and developed in partnership with the West Yorkshire Local Nature Partnership, demonstrated the multiple benefits of embedding green infrastructure principles and design into future capital schemes. These principles need to be translated into holistic multi-beneficiary schemes, from flood risk through to housing, transport, communications and utility networks to improve the resilience of the City Region.

This will provide a fundamental building block to enable the good growth ambition outlined in the SEP to be realised.

Local planning policy
The planning system plays a critical role in ensuring that future flood resilience is built into long-term physical planning. Local plans set out the policies and strategies to integrate flood risk development needs that enable and support economic, housing and other development to take place in a coordinated and integrated manner.

The DEFRA partnership funding approach for flood risk reduction and mitigation schemes does not allocate funding on the basis of future development. Flood Defence Grant in Aid (FDGiA) can be secured to alleviate existing flood risk to properties, businesses (if built before January 2013) and infrastructure. In this way, it can provide a key ‘seed’ contribution enabling partners to collaborate and develop co-designed flood risk reduction schemes that also support development activity. It is important to highlight that benefits for development need to be paid for from other funding sources, such as developer contributions, Combined Authority and LEP growth programmes, and related utility companies such as Yorkshire Water and Northern Gas Networks.

The Environmental Audit Committee report, ‘Flooding Cooperation across Government’, published in May 2016 encourages local authorities to develop joint local plans that properly take account of flood risk management.

The report also states that: “despite sustainable urban drainage systems being widely acknowledged to be an efficient way of dealing with surface water, successive governments have been reluctant to mandate them as the default option in new developments.”

National Planning Policy Framework requirements
National planning policy related to flood risk and mitigation is set out in the National Planning Policy Framework (NPPF) and related policy guidance. The key elements of national planning policy specifies that:

- Local plans should be supported by a strategic flood risk assessment (SFRA) and develop policies to manage flood risk from all sources.
- Local plans should apply a sequential, risk-based approach to the location of development.
- New development should be planned to avoid increased vulnerability to the range of impacts arising from climate change.
- When new development is brought forward in areas which are vulnerable, care should be taken to ensure that risks can be managed through suitable adaptation measures, including through the planning of green infrastructure.
• Inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk, but where development is necessary, making it safe without increasing flood risk elsewhere and through the provision of infrastructure (including flood risk).

Local planning policies
A review of the flood risk and related policies and strategies set out in local plans across the City Region has been undertaken and a summary for each district local plan is set out in the table below:

<table>
<thead>
<tr>
<th>District</th>
<th>Document (Date)</th>
<th>Policy coverage (Policy ref)</th>
</tr>
</thead>
</table>
| Bradford | Core Strategy (February 2014) | • Seeks to avoid increasing flood risk, and manage land and river catchments for flood mitigation (SC1).  
• Recognises the sub-regional driver to provide greater resilience to climate change as part of approach to green infrastructure (SC6).  
• Aspiration to project and enhance river corridors and support flood reduction within various site/area based policies (e.g. WD1).  
• Application of a sequential approach, directing development to areas of lowest flood risk (EN7)  
• Requirement for all sources of flooding to be addressed and that proposals do not increase flood risk elsewhere (EN7).  
• Requirement for new development to minimise run-off (greenfield sites should be no greater than existing greenfield overall rates) (EN7).  
• SFRA (Level 1) completed. |
| Calderdale | Potential Sites and Aspects of the Local Plan (November 2015) | • New development should take into account climate change and be directed to areas of lowest flood risk (TB25).  
• Development should manage surface water replicating natural water flows and decrease runoff using SUDS and green infrastructure (TB25)  
• Enhancement of green infrastructure to minimise flood risk, limit surface water runoff and provide/protect flood storage areas and deliver SUDS (TP11).  
• SFRA completed. |
| Craven | Craven Local Plan (April 2016) | • New development to avoid areas of highest flood risk (ENV6).  
• New development should safeguard waterways and benefit the local environment by incorporating SUDS where possible (ENV6).  
• All SUDS or other systems should be economically maintained for the lifetime of the development (ENV6).  
• New development should maintain adequate and easy access to water courses and flood defences to enable management and maintenance (ENV6).  
• New development should enhance the natural capacity (via soils, vegetation, floodplains, wetlands and habitats) to reduce flood risk (ENV6)  
• New development will minimise the risk of surface water flooding via adequate foul/surface water disposal and maximise opportunities for attenuation and long term storage.  
• SFRA completed. |
<table>
<thead>
<tr>
<th>District</th>
<th>Document (Date)</th>
<th>Policy coverage (Policy ref)</th>
</tr>
</thead>
</table>
| Harrogate | Harrogate Core Strategy (February 2009) | - The risk of climate change and environmental damage will be reduced through management of flood risk (EQ1).  
- SFRA completed. |
|          | Harrogate District Local Plan (2001) | |
| Kirklees | Kirklees Local Plan (November 2015) | - Requires buildings to be resilient and resistant to flood risk (DLP25).  
- New development should take into account climate change and be directed to areas of lowest flood risk (DLP28).  
- Proposals for building over culverts / canalisation of water courses not encouraged (DLP28).  
- Support for delivery of SUDS to achieve greenfield run-off rates on greenfield sites; minimum 30% reduction in runoff on brownfield sites where previous surface water connections from site can be proven (DLP28).  
- Developments including water bodies, should normally be retained and include a future management plan for the lifetime of the development (DLP30). |
| Leeds    | Leeds Core Strategy (November 2014) | - Comprehensive management of flood risk issues via delivery of the Leeds Flood Alleviation Scheme and other mitigation measures (SP3).  
- New development to avoid areas of flood risk (SP6, EN5).  
- Encouraging the removal of existing culverts where practicable (EN5).  
- Reduction in the speed and volume of surface water run-off as part of new build developments and making provision for space for flood water in high flood risk areas (EN5).  
- SFRA completed. |
| Selby    | Selby District Core Strategy Local Plan (October 2013) | - New development will be directed to towns and sustainable villages having regard to particular environmental and flood risk constraints (SP2).  
- New development to be directed to areas of lowest flood risk (SP2).  
- As part of the site allocations process the council will (SP15):  
  - ensure development is avoided in areas of flood risk where possible;  
  - support sustainable flood management measures such as water storage areas; and biodiversity and amenity improvements;  
  - ensure development proposals respond to land characteristics and minimise risk of erosion, subsidence and instability; and  
  - ensure water efficient design and SUDS to promote groundwater recharge.  
- SFRA completed. |
### Districts and Policies

<table>
<thead>
<tr>
<th>District</th>
<th>Document (Date)</th>
<th>Policy coverage (Policy ref)</th>
</tr>
</thead>
</table>
| Wakefield | Wakefield Core Strategy (2009) | - New development should take into account climate change and be directed to areas of lowest flood risk and take into account climate change (CS1, CS13).  
- Development should manage flood risk though SUDS and positive land management (CS13).  
- SFRA completed. |
| York | York Local Plan (2005) | - Presumption against development (except essential infrastructure) within the functional floodplain (GS15a).  
- Proposed for development on PDL will only be supported where there is no net loss in floodplain storage and flood risk is not increased elsewhere (GP15a).  
- SuDS encouraged to mimic natural drainage on all developments to reduce surface water runoff (GP15a).  
- Discharge from new development should not exceed the capacity of existing / proposed receiving sewers and watercourses. Long term run-off from development sites should always be less than the level of pre development rainfall run-off (GP15a).  
- The provision and maintenance of flood mitigation and defined measures will be sought from the developer (GP15a).  
- SFRA completed (2013). |

The key points arising from this report are:

- There is general consistency across local plan policy and applying the sequential approach to minimising development in high flood risk areas across all districts.
- All local planning authorities have completed SFRA to inform the preparation of the local plans. It is important to highlight that these might need to be updated in order to reflect new modelling and policy changes such as the new climate change allowances.
- There are some variations in the level of detail in the policies across the various local plans, some of which will be due to particular local issues and circumstances with others being due to the timing of local plans and the evolving understanding of flood risks following flood events, and wider policy changes and understanding. These variations include in relation to references to:
  - the strategic importance of considering long term climate change impacts;
  - consideration of the impacts of development elsewhere within water catchments;
  - the role of green infrastructure in reducing surface run off;
  - ensuring buildings are resilient and resistant to flood risk; and
  - ensuring SUDS are maintained over their lifetime.
- There is a consensus view amongst local planners in the City Region that national SUDS guidance is inadequate and doesn’t provide the strategic and detailed steer to support planners to implement the SUDS principles.
- A consistent standard of emergency flood response, for example the provision of safe access and egress routes to a particular standard, would better allow planners and the Environment Agency to influence this issue. Currently local authority emergency planners often lack the resources to be able to provide bespoke advice for each development.
- Consider whether there could be even greater alignment of planning policies and approaches across districts, particularly in relation to detailed policy implementation and delivery.
- Pursue the development of a supplementary planning document across Leeds City Region to enable the application of flood policy locally.
- There also needs to be more regulation in place to allow the building control process to enforce standards that could mitigate the impact of flood events on buildings in areas of flood risk. Part of this could be compliance checks of whether development has been built in accordance with planning conditions requiring flood risk mitigation measures.
- There is an increasing problem of staffing resources within local authorities across the City Region, particularly in relation to drainage experts that is hampering expert advice and support input to the planning process, slowing the decision making process.
- A potential issue of alignment with climate change allowances and the implications of these in terms
of flood modelling, with a potential gap between the scenarios being run by the Environment Agency in relation to flood risk priorities, compared to local economic growth spatial priorities. This could have potential implications for the evidence base for the City Region Integrated Infrastructure Investment Framework.

- Following the February 2016 climate change allowance there is now a lack of readily available flood data for the new scenarios. This means the onus must be placed on developers to produce this information. This has the potential to incur significant cost and delay on developers. Previously, developers could readily attain flood data for climate change allowance from the Environment Agency, but their information is now out-of-date. Undertaking new modelling for the City Region could be helpful to better understand the latest situation and ensure the necessary data is readily available to developers so as to speed up the planning process.

Recent Investment in Flood Defences

Since 2010, a total of £102.5 million has been invested in reducing flood risk across the City Region. This investment comprises £63.8 million flood defence grant in aid, £24.3 million central government accelerated growth funding, £2.8 million from local levy and £11.5 million from other contributions. The breakdown of this investment by the lead local flood authority areas in Leeds City Region is presented in table below:

<table>
<thead>
<tr>
<th>Lead local flood authority</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barnsley</td>
<td>£1.2 million</td>
</tr>
<tr>
<td>Bradford</td>
<td>£81,000</td>
</tr>
<tr>
<td>Calderdale</td>
<td>£16.7 million</td>
</tr>
<tr>
<td>Kirklees</td>
<td>£1.1 million</td>
</tr>
<tr>
<td>Leeds</td>
<td>£37.9 million</td>
</tr>
<tr>
<td>North Yorkshire*</td>
<td>£25.5 million</td>
</tr>
<tr>
<td>Wakefield</td>
<td>£13.9 million</td>
</tr>
<tr>
<td>York</td>
<td>£5.9 million</td>
</tr>
<tr>
<td><strong>Grand Total</strong></td>
<td><strong>£102.5 million</strong></td>
</tr>
</tbody>
</table>

*Note: the North Yorkshire figure only includes those North Yorkshire districts within Leeds City Region, namely Selby, Harrogate and Craven.

The diagram below illustrates where the investments are located:
Between 2,645 and 2,795 properties were protected from flooding during the 2015 Boxing Day flood event as a result of these existing defences.

Taking the average of these high and low figures, equates to 2,720 properties. Assuming that all of these properties would have been flooded without the additional defences, it is possible to estimate the likely economic cost that would have been incurred had these measures not been in place. Assuming that the split between residential and business properties is the same as within the Boxing Day floods (70% residential and 30% business) then this equates to 1,904 domestic properties and 816 business premises. The average economic damage incurred in the 2013/14 floods has been estimated at £23,000 per residential property and £82,000 per business premises flooded.

These figures generate an estimate of £44 million in terms of damages to domestic property averted and £66 million in terms of business premises. Generating a total of £110 million in terms of damage to property alone. All other direct costs would increase this figure to approximately £180 million, and accounting for the indirect impacts on business it would rise further.

**Existing flood risk within Leeds City Region**

The above evidence shows that even on the basis of a single flood incident, investing in flood mitigation measures to protect homes and businesses from flooding prevents huge financial and economic costs, which is greater than the original investment. The potential scale of some flooding events mean that the avoidance of a single event could almost payback the total investment and, taking into account that flood incidents re-occur means that these significant economic costs are averted time and time again, providing an even stronger value for money case for flood mitigation investment.

Whilst large numbers of properties have better flood protection through measures already implemented there remains a large number of properties still at risk of flooding. It is estimated that within the City Region there are around 12,000 residential and commercial properties that are at a high risk of flooding with 90,000 properties at some risk of flooding.

The 2015 National Flood Risk Assessment (NaFRA) shows the change of flooding from rivers (and the sea). The assessment is used to inform the public of their risk, assess current risk taking into account the flood defences and structures, and support investment decisions. It uses three categories of flood risk likelihood which indicate the chance of flooding in any given year. The definitions of which are explained in the table below:

<table>
<thead>
<tr>
<th>NaFRA category</th>
<th>Likelihood</th>
</tr>
</thead>
<tbody>
<tr>
<td>High risk</td>
<td>Greater than or equal to 1 in 30 (3.3%) chance in any given year</td>
</tr>
<tr>
<td>Medium risk</td>
<td>Less than 1 in 30 (3.3%) but greater than or equal to 1 in 100 (1%) chance in any given year</td>
</tr>
<tr>
<td>Low risk</td>
<td>Less than 1 in 100 (1%) but greater than or equal to 1 in 1000 (0.1%) in any given year</td>
</tr>
</tbody>
</table>

The model used to generate the NaFRA takes into account defences and the chance that they can fail or be overtopped.

The table below shows the estimated amount of buildings at risk of fluvial flooding for each of the local authorities within Leeds City Region. These have been sub-divided based on the NaFRA dataset to display the numbers of buildings at high, medium and low risk.

The figures have been sub-categorised into residential and non-residential buildings to help give a feel of the different impacts that would be felt in each area.
Chapter Seven: Planning, Risk Reduction and Future Investment

The scale of the challenge is therefore still very significant. The cost and time involved in seeking to protect every property within the City Region would be prohibitive, into the hundreds of millions of pounds. Even if funds were available, the scale of the intervention would mean that it would take 10-20+ years to build out and, in the meantime, communities will continue to be affected by flooding. As public resources are being increasingly stretched, the effective prioritisation of limited resources will be increasingly important. There is therefore a need collectively to prioritise interventions based around the limited resources available and seek more cost effective innovative interventions that can have a positive impact on resilience including green infrastructure, land management, and better use of reservoirs.

Further work is also required to understand the full costs and wider considerations of:

- a comprehensive maintenance regime for waterways;
- the risks associated with third party assets;
- natural flood risk management opportunities; and
- upland management, including upstream storage and reservoirs.

The City Region green infrastructure strategy and delivery plan is currently being developed and will include setting out the proposed strategic approach, principles and priority investments to maximise the contribution of green infrastructure to flood risk mitigation and alleviation. The plan will report by Spring 2017.

Reservoirs could have the potential to play a much greater role as part of whole river catchment management programmes, although discussions with Yorkshire Water, local authorities and other partner suggest that water companies are constrained in their ability to use these assets as part of a package of flood mitigation measures because their primary role is to ensure that there is adequate water available for public supply. Any proposal to use reservoirs for flood storage would require careful consideration of all related issues and may also require regulatory or legislative changes to enable water companies to more strongly support the use of their reservoirs to better contribute to flood prevention.

Planning investment and future investment needs

Shortly after the Boxing Day flood event funding was provided to restore assets to their pre-existing standard, ahead of winter 2016.

In the 2016 Budget, the chancellor announced £700 million for investment in flood risk reduction capital schemes nationally to be administered by DEFRA, the Environment Agency and the Regional Flood and Coastal Committees. Some of this ‘booster funding’ was specifically allocated to communities that were impacted by the Boxing Day floods; their funding for the City Region amounted to £73 million.

The table below provides a summary of the sources of investment in flood risk reduction in Leeds City Region for the current spending review period up to 2020/21. The figures are for all districts within Leeds City Region and have been taken from the programme published in August 2016.

<table>
<thead>
<tr>
<th>Flood defence grant in aid</th>
<th>Booster funding</th>
<th>Local levy</th>
<th>Public contributions</th>
<th>Private contributions</th>
<th>Other Environment Agency recovery</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>£87 million</td>
<td>£73 million</td>
<td>£4 million</td>
<td>£17 million</td>
<td>£5.2 million</td>
<td>£22 million</td>
<td>£208 million</td>
</tr>
</tbody>
</table>

In the spring of 2016 the government announced a third round of Growth Deal funding with a £1.8 billion pot to be allocated to Local Enterprise Partnerships through competitive bidding. There are a number of flood risk schemes in the Environment Agency’s capital programme that have yet to secure all of the funding contributions required to bring them forward for delivery. Within its Growth Deal Three bid the LEP has
developed an ‘Economic Resilience Programme’ which contains a number of projects aiming to reduce flood risk. The programme has been developed with partners including the Combined Authority, all 10 district local authorities, the Environment Agency, Yorkshire Water, the Homes and Communities Agency, and the Local Nature Partnerships.

The programme identifies a number of key projects where all their funding requirements have not been currently identified, and include a natural flood management programme scheme within the catchment area of the Aire and Calder rivers. These schemes include:

- Mytholmroyd flood alleviation.
- Brighouse and Clifton flood alleviation.
- Wyke Beck Valley / Aire Valley Enterprise Zone integrated infrastructure.
- Kirkstall Road, Leeds.
- Canal Road Corridor, Bradford.
- Castleford flood alleviation.
- Leeds Road Corridor, Kirklees.
- Growing resilience: the Leeds City Region natural flood management programme.

Together these and other schemes could be enhanced and/or brought forward if further funding is secured from government or other sources, thereby protecting more communities, businesses and homes earlier. It is estimated that a further £5 million per annum is needed over the next five years to support this work. As a start in this respect, the Combined Authority has recently agreed to invest £7.8 million to fund an initial three schemes in Leeds, Mytholmroyd and Skipton to help enable and accelerate delivery of these key schemes. However, further funding will be required to progress the remaining pipeline schemes.

Summary
It is crucial that the experience of the Boxing Day floods, combined with the knowledge that climate change is likely to worsen the situation, is used to strengthen our strategic approach to the threat of flooding. Local authorities are already acting upon the experience of the Boxing Day floods in terms of their own procedures and responses but it is essential that this knowledge, insight and best practice is shared and rolled out across the City Region.

The local planning system has an important part to play in helping better prepare and mitigate future flood events through local plan policy and implementation. Although all districts are adopting a sequential approach to flood risk, more consistent planning policies across the City Region would provide greater integration, particularly in relation to whole river catchment areas which all transcend multiple districts. This includes developing a strategic approach to SUDS as implementation is current hampered by a lack of robust national guidance.

Further investment in flood defences and other flood mitigation and adaptation measures will continue to be critical. Positive action is already underway and the recently published Yorkshire flood risk capital investment programme incorporates the announcements for booster funding that was made in the 2016 Budget to support additional flood mitigation measures across the City Region.

However, there remains a pipeline of projects that could be enhanced and/or be brought forward if further additional funding of £5 million per annum over the next five years could be secured from government or other sources. The £7.8 million investment by the Combined Authority will help support three initial schemes to be delivered and protect more communities, businesses and homes earlier.

In addition, further work is required to understand the full costs and wider considerations of a comprehensive maintenance regime for waterways; the risks associated with third party assets; natural flood risk management opportunities; and upland management, including upstream storage and reservoirs. The latter may also require regulatory or legislative changes if reservoirs are to play a much stronger role in flood mitigation.

The long-term costs of protecting properties at risk of flooding in the City Region will be in the hundreds of millions of pounds. As public resources are being increasingly stretched, the effective prioritisation of limited resources will be increasingly important. What is needed therefore is stronger partnership working to co-invest in multi-benefit infrastructure schemes that increase the resilience of existing economic activity and enhances our economic growth. This will lead to better long-term strategic thinking and future investments more closely linked to the SEP.

There would be significant benefits in adopting new ways of closer partnership working between the Combined
Authority, the Environment Agency, local authorities and other partners to join up flood resilience planning and investment with future housing and economic growth and development. This would include a stronger strategic evidence base for infrastructure investment prioritisation linked more closely to economic and housing growth plans as set out in the SEP and district local plans. This would help realise the benefits more quickly and better align and make best use of funding from all available sources.

Collectively, this greater alignment is already underway by developing a long-term City Region Flood Resilience Delivery and Investment Plan. There could also be opportunities to consider longer term issues through the devolution discussions with government to maximise effective, more integrated arrangements in the future.

**Recommendations**

1. Consistent planning policies and approaches across the City Region developed by the Combined Authority and local authorities to mitigate flooding and improve resilience, including preparing City Region supplementary planning guidance to provide a stronger steer for the adoption of SUDS.

2. Adopt a whole catchment approach to flood risk and resilience and ensure that resources are made available to promote and instigate natural flood management, identifying best practice and building on what is already being done across the City Region. This should include a focus on the identification and development of funding mechanisms to enable more rapid and expansive progress on natural flood and upland management.

3. Explore with DCLG and the Combined Authority, the opportunities for updating building control legislation to help deliver greater resilience and resistance to flooding of new buildings and development.

4. Consider extending climate change allowance modelling for fluvial flooding beyond existing scenarios to align with the SEP forecasting timescales and support delivery of longer term Strategic Priority Growth Areas.

5. Convene a strategic working group of local partners reporting to the Combined Authority to share expert advice and good practice, and coordinate actions to deliver these recommendations.

6. Identify resource-sharing opportunities between the Combined Authority and local authorities to ensure the necessary flood and drainage expertise is in place to inform the local planning process across the City Region.

7. Further collaboration between the Combined Authority and Yorkshire Water to identify where reservoirs may better assist with flood risk management as part of a package of measures, without compromising the supply of water to the City Region. This may include amendments sought by the Combined Authority to legislation and regulations to enable water companies to manage their reservoirs to more effectively contribute to reducing the impacts of flooding.

8. Exploration between the Combined Authority, the LEP and government through devolution, the potential long-term opportunities to maximise effective, more integrated arrangements for flood risk management and investment in the future.
Chapter 8
Governance, Resources and Collaboration on Flood Risk Management Across Leeds City Region

Overview
There are numerous organisations and bodies involved in flood risk management at both a national and local level. Varying responsibilities include:

- planning for reducing flood risk and the severity of floods in the future;
- responding to flood events; and
- investing in flood mitigation and adaptation.

The Environment Agency is a key organisation with a national role to help identify both flood risks and the infrastructure required to mitigate flood risk, as well as administrating government investment in flood defences and other flood mitigation and adaptation measures. The Environment Agency works closely with local authorities, elected members and partners, particularly through regional and sub-regional committees, in identifying investment priorities.

Local authorities and local partnerships, including the Combined Authority, play a leading role through their local planning responsibilities and the development of a range of strategic and local delivery plans including catchment management plans. This role also includes helping to identify the necessary infrastructure and measures to reduce future flood risk.

Similarly, all of the emergency services play a vital role in liaison with local authorities, the Environment Agency, utility companies, and local communities in responding to flood events.

The diagram below sets out the broad governance framework for the current arrangements to be governed under the responsibility of the Combined Authority and / or LEP:

**Responsibilities for flood risk management and investment**
The main bodies and agencies responsible for flood related activity are:

- **DEFRA** has overall national responsibility for policy on flood and coastal erosion risk management nationally, and provides funding for flood risk management authorities through grants to the Environment Agency and local authorities.
- **DCLG** has a key role to play through its involvement in the local planning authorities and the need to ensure that flood risk is appropriately taken into account in the planning process. DCLG also has a responsibility for Building Regulations.
• **Environment Agency** has strategic and operational responsibilities for managing the risk of flooding from main rivers, reservoirs, estuaries and the sea. Its role includes managing risks through strategic plans; providing evidence and advice to inform government policy; working collaboratively to support the development of risk management skills and capacity; and providing a framework to support local delivery. The Environment Agency convenes and supports local partnership committees and sub-committees including the Yorkshire Regional Flood and Coastal Committee and both the West Yorkshire and North Yorkshire Flood Risk Partnerships.

• **The Yorkshire Regional Flood and Coastal Committee** is responsible for the capital investment in flood risk reduction including Leeds City Region. The Committee was established by the Environment Agency under the Flood and Water Management Act 2010 that brings together members appointed by LLFAs and independent members with relevant experience for three purposes:
  1. to ensure there are coherent plans for identifying, communicating and managing flood and coastal erosion risks across catchments and shorelines;
  2. to encourage efficient, targeted and risk-based investment in flood and coastal erosion risk management that represents value for money and benefits local communities; and
  3. to provide a link between the Environment Agency, LLFAs, other risk management authorities, and other relevant bodies to build understanding of flood and coastal erosion risks in its area.

• **Flood Risk Partnerships** support the Yorkshire Regional Flood and Coastal Committee by developing propositions for investment within their respective area, and for overseeing progress with local scheme delivery.

• **The programming and investment sub-group** provide a due diligence function supporting and advising the Yorkshire Regional Flood and Coastal Committee of scheme financing.

• **Lead local flood authorities** are responsible for developing, maintaining and applying a strategy for local flood risk management in their areas and for maintaining a register of flood risk assets. They also have lead responsibility for managing the risk of flooding from surface water, groundwater and ordinary watercourses. Under the Flood and Water Management Act 2010 all risk management authorities mentioned above have a duty to co-operate with each other and to share data. A key theme of the Sir Michael Pitt’s review of the country’s flood defences in 2008 was for flood risk management authorities to work in partnership to deliver flood risk management better to the benefit of their communities.

• **Local authorities** are key partners in planning local flood risk management and can carry out flood risk management works on minor watercourses, working with lead local flood authorities and others, including through taking decisions on development in their area which ensure that risks are effectively managed. District and unitary councils in coastal areas also act as coastal erosion risk management authorities.

• **Internal drainage boards**, which are independent public bodies responsible for water level management in low lying areas, also play an important role in the areas they cover, working in partnership with other authorities to actively manage and reduce the risk of flooding.

• **Highway authorities** are responsible for providing and managing highway drainage and roadside ditches, and must ensure that road projects do not increase flood risk.

• **Water and sewerage companies** are responsible for managing the risks of flooding from water and foul or combined sewer systems providing drainage from buildings and yards.

• **The Combined Authority and the LEP** have until the last 12 months had only a minimal role in flood mitigation, management and investment. Following the Boxing Day floods they have provided grant funding to support businesses to recover from the flooding and have instigated this report. Recently they have also agreed to fund flood mitigation capital schemes and have established a senior officer multi-agency flood resilience group to oversee delivery of the recommendations outlined in this report. There are a range of officer groups including the local nature partnerships that will feed in ideas and investment propositions to the Combined Authority including through the City Region Green Economy Panel, which is an advisory body to the LEP.

**Local authority governance approaches for flood activity**

Following the Boxing Day floods Leeds, Calderdale and Bradford reviewed their internal governance regarding flood risk and established similar multi-partner governance models for flood risk, tailored to their specific needs.

• In **Calderdale** the existing partnership that was formed in response to the 2012 floods was revisited and now there are four operational groups that report into a Flood Recovery and Resilience Steering Group chaired by the Council Leader. The groups are: Flood Damage Repair Group; Flood Prevention and Investment Group; Natural Flood Management Group and Community Resilience Group.

• In **Leeds** the pre-existing governance for the current phase of the Leeds Flood Alleviation Scheme has been developed further to enable a catchment approach to be taken for the second phase, ensure innovative approaches are fully explored, and that there is a strategic view of flood risk investment
The supporting groups include a broad range of partners and local stakeholders, and the overseeing board is chaired by the Director of City Development.

- In Bradford a new strategic partnership approach is being developed. Led jointly by the Assistant Director for Planning, Transportation and Highways for Bradford Council and the Area Flood Risk Manager for the Environment Agency, the Bradford Flood Programme Board has four supporting groups: Investment and Programme Group; Resilience and Community Engagement Group; Data and Knowledge Group; and the Strategic Priority Area Shipley Canal Road Corridor Group.

- City of York Council and North Yorkshire County Council work closely together on all flood risk issues, and this work is overseen by the North Yorkshire Flood Risk Partnership and through close officer relations across all partner organisations. Work to deliver direct improvements to York’s flood defences and a commitment to prepare a long-term vision, over 100 years, for the River Ouse catchment will identify, reinforce and develop formal governance needs. The long-term vision will be available for a consultation phase by the end of the current financial year.

Closer working and integration of policy and investment

At a strategic level, all infrastructure investments have their own governance processes, with varying scales of public accountability. The challenge faced is how to work effectively across these processes to align funding, develop joint schemes and ultimately deliver key outcomes in priority areas.

The LEP included an economic resilience programme within their bid for Local Growth Deal three funding. The process of developing this bid, across organisations highlighted the importance of a chief officer level group which could provide an integrated view of both transport, drainage and flood risk across the City Region.

It is therefore proposed to expand this existing group, expanding its representation to include the Environment Agency and others to oversee the delivery of the recommendations of this report. This group develop such schemes in partnership and share best practice. Consideration could also be given to establishing a wider stakeholder forum to provide a wider sounding board on emerging proposition for policy and investment. It would help improve the resilience within each district through shared learning and potentially shared resources, and also enable complex and multi-faceted schemes to be developed effectively and efficiently for whole river catchment areas which cross district and political boundaries.

Scheme development and collaboration

It is acknowledged at various points within this report that it is critical that any approach to managing flood risk or flood prevention is not constrained by administrative or other boundaries.

The analysis at the whole catchment area is critical in terms of understanding the causes and effects of flooding and in identifying the opportunities for a successful intervention in order to prevent, reduce or mitigate. Aligned to this needs to be a process that enables decisions and strategies to be joined-up and complimentary. Significant steps forward have been taken by the Environment Agency in terms of the development of an investment mapping tool which has been developed in partnership with several West Yorkshire districts.

This will help to weave together planned activities in different areas and will produce four outcomes:

1. a strategic scoping document;
2. a schematic map;
3. risks and opportunities for the area, including flood risk data; and
4. a timeline/plan.

This suite of documents enables all partners to understand and agree the roles that they have to play in a given location to both reduce flood risk and support other aspirations as identified in the local plan or SEP. It enables partners to identify where they need to work collaboratively on shared schemes, or align activities to maximise benefits and economic impact, and it supports the ‘Green Streets’ approach.

It is critical that, together, activity remains focussed on identifying and delivering the key projects that will reduce future flood risk, particularly in high risk areas. This includes delivering flood reduction schemes; leveraging in investment for further schemes and measures; and joining activity across the groups.

Summary

At a regional level the organisational and governance framework for flood risk management is complex. What is apparent within the City Region is that significant steps forward are being taken by the Combined Authority, the local authorities and the Environment Agency. Effective decision making is crucial if there is to be quick and effective measures that can positively impact on flood risk management.
There is the potential to better integrate activities of the various organisations and bodies in the future, particularly in relation to future policy, planning and co-investment opportunities. There is therefore the need for stronger collaboration with a range of partners who have a role to play in investing in combined multi-benefit infrastructure schemes that increase the resilience of existing economic activity and enhances our economic growth. This will lead to better long-term strategic thinking and future investments more closely linked to the SEP.

There would be significant benefits in adopting new ways of closer partnership working between the Combined Authority, Environment Agency, the local authorities and other partners to join up flood resilience planning and investment with future housing and economic growth and development. This would include a stronger strategic evidence base for infrastructure investment prioritisation linked more closely to economic and housing growth plans as set out in the SEP and district local plans. This would help realise the benefits more quickly and better align and make best use of funding from all available sources.

Collectively, this greater alignment is already underway by developing a long-term City Region Flood Resilience Delivery and Investment Plan. There could also be opportunities to consider longer term issues through the devolution discussions with Government to maximise effective, more integrated arrangements in the future.

**Recommendations**

1. Convene a strategic working group of local partners reporting to the Combined Authority to share expert advice and good practice, and coordinate actions to deliver these recommendations.

2. Exploration between the Combined Authority, the LEP and government through devolution, the potential long-term opportunities to maximise effective, more integrated arrangements for flood risk management and investment in the future.
Appendices
Appendix 1

Overview
The pattern of flood inundation which directly resulted from the Boxing Day 2015 floods in Leeds City Region (and beyond) affected many of the City Region’s main population centres, impacting both residential and business properties.

The map below shows the extent and bounds of the confirmed flood inundations extents across Leeds City Region, it also plots the distribution of key public infrastructure assets within those extents relative to the clustering of businesses also within the extent bounds.

The businesses shown have been mapped from a list of all businesses located within the flood extents and designed to show the spatial pattern of business location within the flood boundaries, as the map shows the density of businesses was most pronounced in Bradford, Calderdale, York and Leeds, with more disbursed business distribution in Selby.

![Infrastructure within December 2015 Flood Extents](image)

Source: Environment Agency, Leeds City Region local authorities and the Combined Authority (August 2016).

Flood extents
Flood extents have been provided by the Environment Agency. Other data has been used to calculate the number of businesses that are located within the flood extents but this does not mean that all of these businesses would have suffered from flooding. The table below analyses the number of these business as a function of all businesses in each respective local authority area. This effectively shows the severity of the flooding in terms of total number of businesses within an area.

<table>
<thead>
<tr>
<th>District</th>
<th>Within flood extent</th>
<th>Total business base</th>
<th>Percentage of businesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Halifax</td>
<td>892</td>
<td>11645</td>
<td></td>
</tr>
<tr>
<td>Todmorden</td>
<td>200</td>
<td>748</td>
<td></td>
</tr>
<tr>
<td>Calderdale</td>
<td>1092</td>
<td>12393</td>
<td>8.8%</td>
</tr>
<tr>
<td>Kirklees (Wake)</td>
<td>46</td>
<td>6742</td>
<td></td>
</tr>
<tr>
<td>Kirklees</td>
<td>20</td>
<td>13326</td>
<td></td>
</tr>
<tr>
<td>Kirklees</td>
<td>66</td>
<td>20068</td>
<td>0.003%</td>
</tr>
<tr>
<td>York</td>
<td>305</td>
<td>11631</td>
<td>2.6%</td>
</tr>
<tr>
<td>Leeds</td>
<td>1153</td>
<td>45507</td>
<td>2.5%</td>
</tr>
<tr>
<td>Bradford</td>
<td>121</td>
<td>23541</td>
<td>0.5%</td>
</tr>
</tbody>
</table>
The greatest proportionate effect is visible in Calderdale where 8.8% of all business in the district fall within the flood zone extent with York and Leeds both having around 2.5% of their total number of businesses falling within the flood extent.

**Leeds: flood extent and direct economic impact**

The map above shows the local level distribution of businesses by size within the Leeds flood extent. Leeds has the highest number of larger business falling within the flood extents of any local authority within Leeds City Region.

**Headline impact**
- Number of businesses falling within flood extent: 1,153
- Number businesses reported as flooded: 371
- Direct economic impacts include:
  - Business impacts: £30 million
  - Residential damages: £6.8 million
  - Temporary accommodation costs: £1.4 million
  - Infrastructure damages: £9.1 million
- Number of households directly flooded: 298
- Households requiring temporary accommodation: 137
York: flood extent and direct economic impact

The map above shows the local level distribution of within the York flood extent. Our research shows that up to 67% of businesses in York within the flood extent were actually flooded; this is amongst the highest proportions in Leeds City Region.

Headline impact

- Number of businesses falling within flood extent: 305
- Number businesses reported as flooded: 203
- Direct economic impacts include:
  - Business impacts: £17 million
  - Residential damages: £10.4 million
  - Temporary accommodation costs: £2.0 million
  - Infrastructure damages: £10.8 million
- Number of households directly flooded: 453
- Households requiring temporary accommodation: 208
Calderdale: flood extent and direct economic impact

The map above shows the local level distribution of businesses by size within the Calderdale flood extent and highlights that business of all sizes were affected by the floods in the district. It should be noted that Calderdale and Kirklees had the highest number of mainline rail stations that fell within the confirmed flood extents.

Our analysis has confirmed that Calderdale had the highest proportionate business impact of any local area in the City Region, with up 8.8% of the districts business lying within the flood extent and 7.5% of businesses in the district who were actually flooded.

Headline impact

- Number of businesses falling within flood extent: 1,093
- Number businesses reported as flooded: 1,021
- Direct economic impacts include:
  - Business impacts: £83.7 million
  - Residential damages: £49.1 million
  - Temporary accommodation costs: £9.8 million
  - Infrastructure damage: approximately £25 million
- Number of households directly flooded: 2,135
- Households requiring temporary accommodation: 982
Bradford: flood extent and direct economic impact

The map above shows the local level distribution of businesses by size within the Bradford flood extent.

**Headline impact**

- Number of businesses falling within flood extent: 121
- Number businesses reported as flooded: 189
- Direct economic impacts including:
  - Business impacts: £15.5 million
  - Residential damages: £18.0 million
  - Temporary accommodation costs: £3.6 million
  - Infrastructure damages: £2.5 million
- Number of households directly flooded: 783
- Households requiring temporary accommodation: 360
Summary of impacts

**Leeds**

It was a one in 200-300 year event in Leeds based on the Armley gauge on the River Aire. The flooding was centred on the commercial and industrial area in Kirkstall and the commercial area to the south of Leeds Station in Leeds City Centre. An estimate of 678 commercial and 2683 residential properties were affected in Leeds. £10 million of infrastructure damage was caused in the city. In Leeds City Centre, 13 electricity distribution substations flooded affecting supplies to 368 customers. 110 water assets (pumping stations and sewage treatment works) were affected.

The flooding caused multiple road closures in the city, including the A65 Kirkstall Road: a major transport route into the city. On a normal weekday, 27,000 workers would have been affected in Leeds with no rail/road exit through this route out of the city. Leeds Station was open as normal on Sunday 27 December but the line to the Leeds North West electrified network (serving Bradford Forster Square, Shipley, Ilkley and Skipton, among other stations) was closed due to the flooding at Kirkstall.

**Calderdale**

Figures collected by Calderdale Council from their community hubs indicated that 2,781 homes and 1,008 businesses were affected. The economic impact on SMEs was estimated to have cost £47 million with indirect costs totalling £170 million. The Council estimated that 70% to 80% of businesses had been affected. Businesses affected range from manufacturing companies to guesthouses and other small businesses. In Calderdale and the west Yorkshire Dales 19 electricity distribution substations flooded, affecting 7,800. In addition to this a number of schools, roads and bridges were also affected, causing widespread disruption. This included the A646 in Mytholmroyd which was damaged with substantial stabilisation to the hillside being required along with a new road. Midgley Road in Mytholmroyd was also subject to a landslip. Unlike previous floods, communities further down the valley including Sowerby Bridge, Elland and Brighouse were also badly affected. Copley Bridge, in Sowerby totally collapsed affecting access to 4 residential properties and a historic church. The canal bridge in Elland collapsed deeming the road impassable. There was also a partial collapse of a major road bridge linking Elland with Halifax and Brighouse. This structure now requires demolition with a new build required.

The number of businesses that were affected by the Calder included: 294 in Hebden Bridge; 185 in Todmorden; 155 in Sowerby Bridge; 100 in Mytholmroyd; 77 in Brighouse, and 34 in Elland.

**Tadcaster**

79 properties (36 homes and 43 businesses in the town centre) and the bridge were affected from the Boxing Day 2015 floods. Flooding occurred from surface water and the sewer system before the river overtopped the flood defences on both banks of the river. It was in excess of a 1 in 100 year event in the town, which has defences with a 1 in 25 year standard of protection. The road bridge at Tadcaster collapsed at approximately 5pm on Tuesday 29 December 2015. This caused disruption to the transport networks and a gas leak.

**Kirklees**

In Kirklees 15 residential premises flooded and 35 business premises flooded, predominantly in Mirfield. The flooding here was fluvial and cut off Granny Lane and Calder View.

**Wakefield**

In Wakefield, gardens adjacent to the Oakenshaw Beck, which is a tributary of the River Calder, flooded on 26th of December in the Agbrigg area of Wakefield. The industrial/commercial area at Horbury Bridge flooded including half of the main road.

**Bradford and Upper Aire**

Bradford suffered its worst flood event in the last 30-40 years. 350 domestic properties and 50 businesses were affected in the city of Bradford.

840 homes and 170 businesses were affected, including Keighley, Bingley, Shipley, Baildon, Apperley Bridge, Addingham, Ilkley and Menston.

**Earby, Pendle**

42 residential and 20 commercial properties flooded from river, surface water and sewer flooding.

**Otley**

It was a one in 100 year event in the Lower Wharfe, Otley and further downstream. Approximately 50 domestic properties flooded on Bridge Avenue and Farnley Lane.
Collingham
12-14 properties flooded on The Avenue. There was flood water in the street for three days until it was pumped out by the Fire Service. There was also some river bank erosion and a bank slip nearby.

Other areas were nearly affected, including Mill Beck Green, which is at risk from Mill Beck. Although it didn’t flood, the watercourse was bank full.

Linton
Linton Bridge was damaged and one domestic property flooded. The bridge was closed to all users on 27 December 2015 causing a diversion of four miles for vehicles and there was no available diversion for pedestrians. Leeds City Council estimate a cost of £4.3 million and 12 months to repair the structure.

Wetherby
Riverside apartments flooded.

Thorpe Arch Mill
12-14 residential properties in an old converted mill and two properties in Bridge Farm flooded.

Boston Spa
Three properties flooded in Boston Spa.

Kirkby Wharfe
Six residential properties flooded.

Ulleskelf
16 residential properties were affected, mainly in the west side of village. There are some flood defences in Ulleskelf with a 1/50 standard of protection. Approximately 30 properties were protected on the East side of the village.

Church Fenton
Four residential properties flooded here, and many nearby communities were cut off due to rural roads flooding. The B1223 was cut off, sporadically from November 2015 through to January 2016.

Bolton Percy
One property flooded and two communities in the area were cut off for several weeks.

York
Around 600 properties flooded in York from the Ouse and Foss (411 residential properties and 190 businesses). Areas affected include Huntington Road, Fulford, Bishopthorpe, and Naburn.

River Derwent
Malton and Norton had the highest groundwater levels ever recorded. Five properties flooded and Environment Agency pumps were deployed.

River Nidd
Knaresborough was affected, including two caravan sites just outside the town and an industrial estate flooded.

It was a one in 100 year event on the Nidd. Harrogate suffered mostly localised surface water flooding. A handful of properties flooded from River Crimple. The A59 at Kex Gill between Harrogate and Skipton re-opened on 27 February 2016 following a landslip caused by the heavy rain.

River Ure
Boroughbridge and Milby Island flooded prior to Boxing Day, but the flooding still occurred within the ‘winter floods’ period. About eight to 10 properties flooded.