

A Local Climate Impacts Profile for Leeds

2002 - 2008

CONTENTS

	Page
1. Introduction	3
1.1 The need to adapt to climate change	3
1.2 Introduction to LCLIP	3
1.3 Leeds Climate Change Strategy	4
1.4 Meteorological data for Leeds	4
1.5 Climatic fluctuations recorded in Leeds 1985-2009	5
2. Record of Past Weather Events	6
2.1 Categories of weather event	6
2.2 Magnitude of impact	7
2.3 Record of severe weather	9
Weather events in 2002	9
Weather events in 2003	16
Weather events in 2004	20
Weather events in 2005	27
Weather events in 2006	32
Weather events in 2007	45
Weather events in 2008	55
2.4 Summary of events	66
3. Council records of the impact of severe weather	68
3.1 Leeds City Council	68
3.2 Environment Agency Floodline	68
4. Service summary	70
4.1 Transport	70
4.2 Residential property	72
4.3 Utilities and infrastructure	73
4.4 Leisure (sports, events, training)	74
4.5 Emergency services	75
4.6 Commercial / retail	76
4.7 Waste collection	77
4.8 Health	77
4.9 Education	78
5. Future climate change	79
5.1 Yorkshire and Humber climate change adaptation study	79
5.2 UK climate projections 2009	80
6. Past and potential future weather impacts in Leeds	81
6.1 Higher temperatures	81
i. Summary of impacts of recent weather events on Leeds	81
ii. Potential / future impacts	81
iii. Actions already taken	82
iv. Potential / future actions	83

	Page	
6.2	Reduction in annual rainfall and an increase in dry spells	84
	i. Summary of impacts of recent weather events on Leeds	84
	ii. Potential / future impacts	85
	iii. Actions already taken	85
	iv. Potential / future actions	86
6.3	Greater seasonality of rainfall and an increase in extreme rainfall events	86
	i. Summary of impacts of recent weather events on Leeds	86
	ii. Potential / future impacts	87
	iii. Actions already taken	87
	iv. Potential / future actions	89
6.4	Marginal increase in winter average wind speed	90
	i. Summary of impacts of recent weather events on Leeds	91
	ii. Potential / future impacts	91
	iii. Actions already taken	91
	iv. Potential / future actions	92
7.	Severe weather and management of national indicators	93
8.	Next Steps	98
8.1	Flood Visualisation Model	98
8.2	UKCP09 Weather Generator Case Studies	98
9.	Conclusion	99
10.	References	100
 Appendices		
A.	Examples of actions arising from the Water Asset Management Group	100

1. INTRODUCTION

1.1 The need to adapt to climate change

There is an accepted scientific consensus that the global climate is warming rapidly as a result of human activity. Regardless of how much we reduce our CO₂ emissions there will be some degree of unavoidable climate change. The persistence of greenhouse gases in the atmosphere is expected to result in a time lag of 30-40 years as the extra heat already trapped in the oceans will only slowly be released over several decades, regardless of future emissions (UKCIP, 2009).

Although it is important to limit the extent to which climate change occurs by reducing greenhouse gas emissions, measures will also need to be taken to enable adjust to the impacts brought about by the changing climate.

1.2 Introduction to LCLIP

The Local Climate Impacts Profile (LCLIP) aims to identify the threats and opportunities presented by climate change in Leeds. The LCLIP does not assume that the weather events which have occurred in recent years are as a result of climate change. However, climate models widely predict more extremes in future weather and by examining the impacts of recent severe weather in Leeds and the way in which communities and authorities have responded, we can start to identify those areas in Leeds most vulnerable to the weather patterns expected as a result of climate change, and identify what lessons could be learned for the future. The way in which Leeds is affected by climate change will also depend on local characteristics – for example how badly a community is affected by flooding will depend on how hilly the area is, how adequate the drainage systems are; whether there is previous experience of dealing with flooding; and how well prepared people are (UKCIP, date unknown).

The concept of the LCLIP has been developed by the United Kingdom Climate Impacts Programme (UKCIP) and has the following aims:

- Provide a database of local severe weather events, highlighting their impacts and consequences;
- Record actions taken in response to current local climate impacts and the effectiveness of these actions.
- Provide information to encourage councils and other organisations to change their current policies and decision-making criteria which are generally short term;
- Raise awareness of local climate impacts, their consequences and adaptation responses;
- Assist in the development of local adaptation responses to the expected local climate conditions.
- Make the longer term data presented in the UKCIP02 climate scenarios more relevant to the local area.

1.3 Leeds Climate Change Strategy

The Leeds Climate Change Strategy: Vision for Action was published by the Leeds Initiative in July 2009 and considers key issues that need to be addressed in the short term so that we can mitigate and adapt to climate change effectively. The Strategy identifies several priorities for action on adaptation. These are:

- To work with the Environment Agency and others to develop and deliver an appropriate flood defence scheme to protect Leeds city centre.
- To work with partners across Leeds to deliver National Indicator 188 ('planning to adapt to climate change') to identify key climate risks and priority actions (concentrating on health and social care; transport and utilities; the domestic and non-domestic built environment and; green infrastructure).
- To develop and trial a methodology for detailed vulnerability mapping of key climate risks across the city.

1.4 Meteorological data for Leeds.

The meteorological data included throughout the LCLIP comes from two sources: the former official Met Office station in Leeds and Leeds City Council's own automatic weather station. The Council's weather station was originally established to provide data for air quality modelling, and was set up following Met Office guidance on location and specification of equipment.

Weather data was collected from the national Met Office station in Leeds city centre from 1986 until it closed in 2000. Any data referred to in the LCLIP in that period will be sourced from Met Office data.

This data has been substituted in this report for subsequent years (1997-2000) by data from Leeds City Council's own weather station. This station is also situated in Leeds City Centre, although at a different location. The data from each site will be affected to some degree by local factors and cannot be considered to be a thoroughly accurate, continuous record, but is included here to provide some context for the weather events considered in the LCLIP. The Leeds City Council weather station provides real time weather data for the following parameters:

- Wind speed and direction at 12 and 32 metre heights.
- Solar radiation (3 metres), relative humidity (2 metres) and rainfall (ground level) .
- Temperature at 8 metre height, and temperature difference at 2 and 24 metres.

Due to technical problems with the temperature probes at certain times over the LCLIP period, any temperature data referred to in this report will refer to the temperature at 8 metres. The standard height for temperature measurement is 1.5 metres and so it is possible that the 8 metre data could slightly under-represent the exact temperature.

1.5 Climatic fluctuations recorded in Leeds 1985-2008

As mentioned above, the two different meteorological datasets available for the LCLIP period have been combined, and although merging meteorological data in this way is not scientifically robust, the information has been extremely useful in raising awareness that our local climate appears to be changing. It is recognised that at least a 30-year period of continuous data is needed to reflect trends in climate change, however the following climatic fluctuations have been observed for 25 years in central Leeds - all of which are consistent with climate change projections:

- seasonal warming, greatest for autumn & winter;
- increasing frequency of wet months (>165% mean monthly rainfall);
- no change in frequency of dry months;
- tendency for more intense, short-period, rainfall events;
- decreasing frequency of air frost and snowfall and;
- increasing frequency of winter gales.

2. RECORD OF PAST WEATHER EVENTS

This section documents a selection of past severe weather events affecting Leeds from 2002 to 2008. Most of the events included were identified through a search of local media (the Yorkshire Post, Yorkshire Evening Post and the BBC Leeds website), and further information into the impacts of these weather events and the response was sought from officers involved with the event within Leeds City Council. This is not a fully comprehensive record of weather events, but it will hopefully capture those events that had a largest impact on the local area, and describe how the community was affected by, responded to and can learn from severe weather events in the future.

2.1 Categories of weather event

For each event the predominant weather conditions were identified and categorised into one or more of the following:



Strong winds



Flooding



Heavy rain (where it is the intensity of the downpour that causes problems rather than surface water flooding).



Lightning strike



Wintry conditions



Heat

2.2 Magnitude of impact

Each weather event includes a score for 'magnitude of impact'. This score was allocated based on a methodology developed in the 1960s in a study looking at the level of disruption caused by heavy snowfall (Rooney, 1967). In this study, as with the LCLIP, public records and media articles were studied for seven US cities and evidence of disruption as a result of snow and ice were identified, and followed up with interviews with individuals involved. This methodology has been modified to make it more suitable to other weather types and is included in table 1.

Table 1 gives examples of the type of impact we might expect to see for each level of disruption. Each weather event identified for Leeds was judged against these typical impacts and allocated to the level of disruption to which it best fit. These scorings are included in the following accounts of weather events, and were used as a measure of the level of disruption resulting from each event.

Those events identified as the most disruptive events (1st order: 'highly disruptive') have been highlighted in red in the subsequent section describing each event.

Table 1: Hierarchy of disruption (based on Rooney, 1967)

Sector	1st order (highly disruptive)	2nd order (disruptive)	3rd order (inconvenience)	4th order (nuisance)
Health	Deaths reported as a result of the weather event.	Increase in hospital admissions as a result of the weather event. Interventions to prevent health impacts implemented.	Health advice / warnings provided in media.	Any media mention.
Housing	Large scale / long term evacuation of homes necessary as a result of the weather event. Emergency accommodation made available to residents unable to use their homes.	Some (short-term) evacuation of homes necessary. Temporary emergency accommodation provided.	Sand bags or other precautionary measures to protect housing implemented. Warnings/advice regarding potential disruption provided to residents.	Any media mention.
Retail trade	Extensive closure of retail establishments.	Noticeable drop in number of shoppers in CBD. Reported decreased sales.	Minor impact.	Any media mention.
Events	Civic events, cultural and athletic events cancelled or postponed.	Major and minor events postponed. Outdoor activities moved indoors.	Minor events postponed.	Any media mention.
Manufacturing	Factory shutdowns and cutback in production.	Moderate worker absenteeism.	Any absenteeism attributable to weather event.	Any media mention.
Construction	Major impact on indoor and outdoor operations.	Major impact on outdoor operations. Moderate indoor cutbacks.	Minor effect on outdoor activities.	Any media mention.
Power supply	Widespread power failure.	Moderate power failure.	Minor difficulties.	Any media mention.
Schools	Numerous city and urban schools closed due to the weather.	Closure of some/rural schools due to the weather.	Reduced attendance in schools.	Any media mention.
Highway	Roads officially closed. Few vehicles travelling on city streets. Vehicles stuck/abandoned on roads. Drivers advised not to travel.	Accidents widespread across city roads. Decline in number of vehicles using roads / several key routes impassable. Difficult driving conditions warning on local radio/TV.	Above average level of accidents in the city. Traffic movement slowed / some roads impassable.	Any media mention. Traffic movement slowed.
Rail	Cancellation or severe delays of many train services, and provision of rail replacement services.	Delays to a number of rail services, and provision of rail replacement services.	Some delays to services as a result of adverse weather.	Minor disruption to rail services as a result of the weather.
Air	Airport closure	Some cancellations due to weather event. Widespread delays due to weather event.	Some delays as a direct result of weather event.	

2.3 Record of recent severe weather

WEATHER EVENTS IN 2002

Date:	28th January 2002
Type of Event:	STRONG WINDS
Magnitude of impact:	4 th order (nuisance)
Description of event:	According to the BBC web site, gales reaching 65 mph were recorded in Leeds. Four people were killed across the north of England as a result of the gales, including one in York, but no serious injuries were reported in Leeds.
Local media reports:	BBC News: "Freak gales kill four" (www.bbc.co.uk/news , 28 January, 2002)
Area affected:	Region-wide
Sectors affected:	Not specified for Leeds
Key impacts:	None specified



Date: 11th February 2002

Type of Event: FLOODING



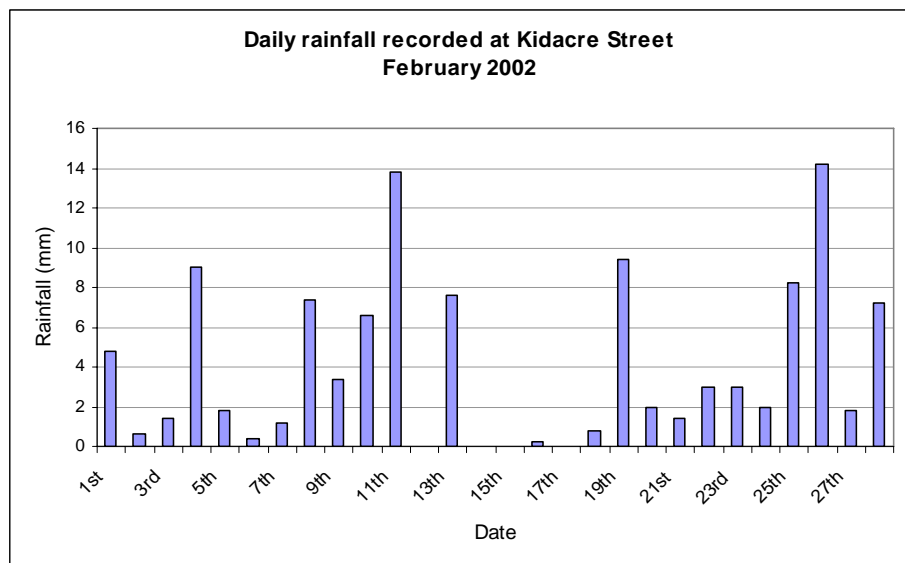
Magnitude of impact: 3rd order (inconvenience)

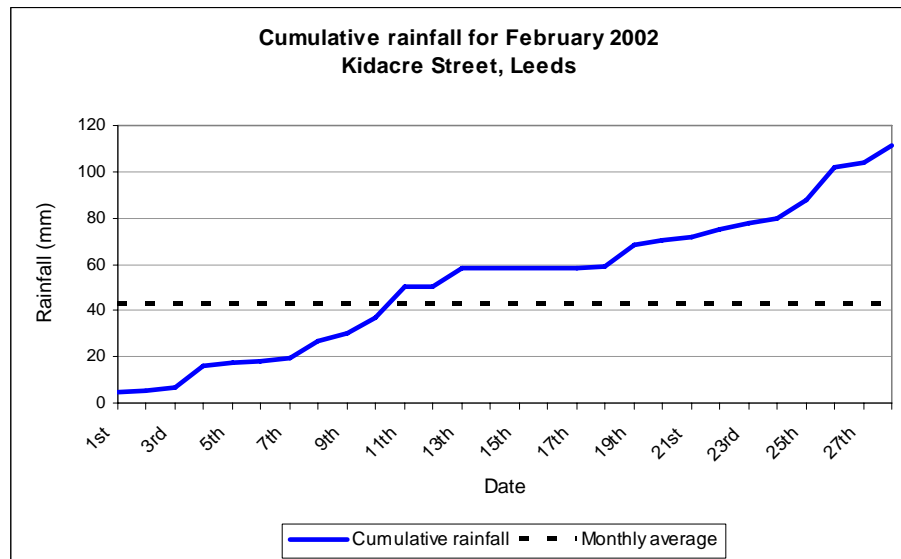
Description of event: The River Wharfe in West Yorkshire was put under the highest alert at two places – Ilkley and Otley. The River Wharfe in Otley, Leeds rose 3m above normal levels. Residents in the town put down sandbags to protect their homes and some roads were impassable. Sixteen houses flooded in Castley Lane, Pool-in-Wharfedale. Sections of the A658 between Otley and Pool-in-Wharfedale and Ilkley Road in Otley remained closed into the following day.

In Otley, the only bridge across the river was closed for several hours from about 10.30 a.m. on the 11th February as water levels rose and swallowed up parts of Farnley Lane and Bridge Street. The town's cattle market was left under water and residents at the bottom of Farnley Lane were stranded. Motorists were left with no way across the river till mid-afternoon. Police diverted traffic away the bridge but with flooding at both Ilkley and Pool-in-Wharfedale commuters from Bradford and Leeds faced long diversions along the river.

West Yorkshire Police closed the A659 into Otley and further flood warnings were issued for 42 locations throughout Yorkshire, and follow two weeks of extensive damage caused by storms and persistent rain in the region.

No calls were made to Leeds City Council to report flooding incidents.





Local media reports: *Britain back on flood alert* (www.bbc.co.uk/news, 11th February 2002)
Forced out by floods (Telegraph and Argus, 12th February 2002)

Area affected: Otley

Sectors affected: Transport – some roads impassable
Residential – risk of flooding to properties

Key impacts: Roads closed
Sandbags deployed to residents

Date: 22nd February 2002

Type of Event: STRONG WINDS

Magnitude of impact: 2nd order (disruptive)



Description of event: Snow and strong westerly winds affected Northern England and Scotland on the 22nd February. Railway lines between England and Scotland were closed due to damaged power lines for a time during the day, although it is not clear whether this disruption specifically affected Leeds.

Motorways in the north of England were also affected by delays after lorries toppled over in high winds, and a number of train services were affected by blocked lines. Again, the extent of disruption in Leeds itself is unknown.

Local media reports: *Britain back in winter's grip* (www.bbc.co.uk/news, 22nd February 2002)

Area affected: Region-wide

Sectors affected: Transport
Infrastructure (power lines damaged)

Key impacts: Rail lines closed.
Motorways closed due to toppled lorries.
Power lines damaged.

Date: 30th July – 2nd August 2002

Type of Event: HEAVY RAIN AND FLOODING



Magnitude of impact: 3rd order (inconvenience)

Description of event: Between the 30th July and 2nd August 121.2 mm rain was recorded at the Leeds City Council weather station. Almost 52 mm of this fell in just one day on the 30th July – well above the average monthly total in Leeds for both July (45.6 mm) and August (50.5 mm). The Council's Land Drainage Team received 25 calls reporting flooding incidents during this period, 16 of which were received on the 2nd August.



Leeds' Headingley cricket ground was waterlogged (photo taken from BBC website: Summer floods hit north).

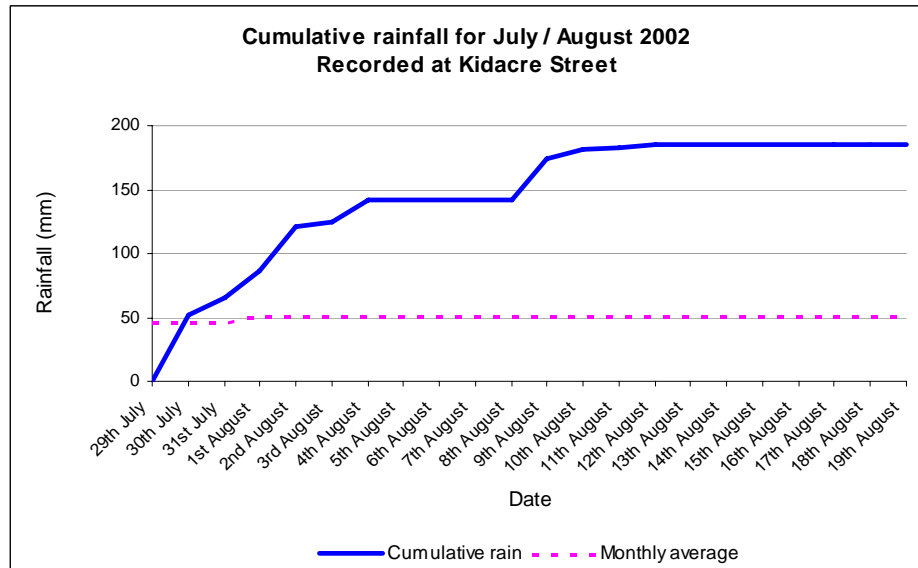
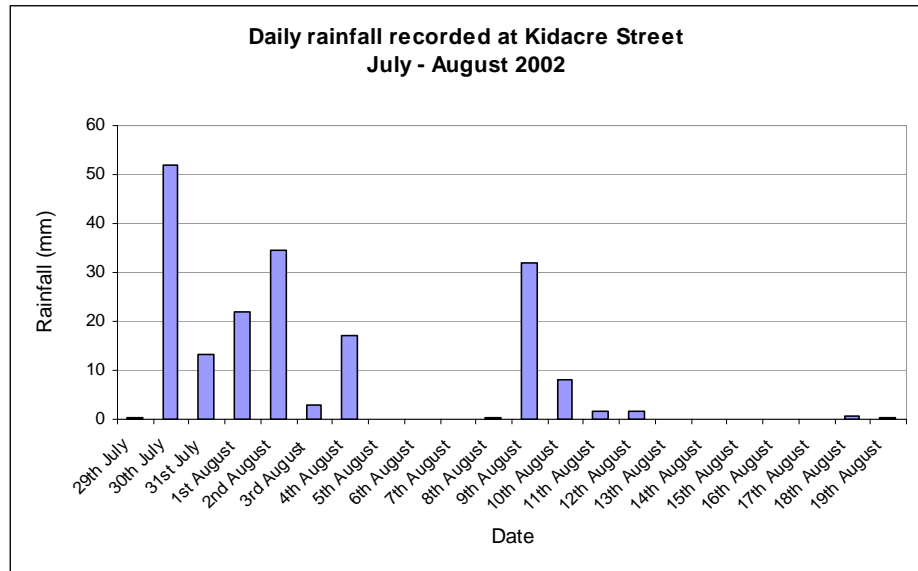
Flooding and heavy rain has caused disruption across the north of England. The semi-final of cricket's Cheltenham & Gloucester Trophy between Yorkshire and Surrey was washed out at Headingley in Leeds.

Rail services between Harrogate and Leeds were also affected by severe flooding.

Commuters in Leeds suffered after floods in the Ardsley Tunnel area affected rail routes to Wakefield. Southbound trains from Leeds were also subject to delays and cancellations as a result of the flooding on the line.

A series of thunderstorms and prolonged heavy rain over the course of the week caused disruption in Leeds.

According to the Yorkshire Post, Leeds received 61.8 mm (2.5 in) of rain over four days, compared to a monthly average for July of 48 mm (1.8 in). The volume of water falling in a very short space of time simply overwhelmed storm drains in the city which are designed to cope with heavy rain, but not a torrent. The River Aire reached the second highest level in some 35 years, exceeded only by the high water in November 2000 which flooded parts of the city centre.



Local media reports: *Flooding hits the north* (BBC website, Wednesday 31st July 2002 www.bbc.co.uk/news)
Summer floods hit North (BBC website, Friday 2nd August 2002 www.bbc.co.uk/news)
Where did our summers go?(Article 20th August 2002)

Area affected: Region-wide / all Leeds

Sectors affected: Sporting events
Transport

Key impacts: Semi-final of cricket's Cheltenham & Gloucester Trophy cancelled.
River Aire reaches second highest level in 35 years.
Rail lines flooded.

Date: 28th October 2002

Type of Event: STRONG WINDS



Magnitude of impact: 3rd order (inconvenience)

Description of event: Gale force winds left a trail of destruction across the UK and north west Europe. Six people died in the UK, and winds of up to 90 mph wreaked havoc on roads and railways as trees fell, power lines came down and cars overturned.

On the east coast trains between Kings Cross and Doncaster were suspended because of high winds, debris on the line and damage to the infrastructure, with services also suspended between Leeds and Doncaster.

Local media reports: *Gales wreak havoc* (BBC web site)

Area affected: Nationwide

Sectors affected: Transport
Infrastructure

Key impacts: Rail services suspended
Road disruption
Power lines down

Date: 30th – 31st December 2002

Type of Event: FLOODING



Magnitude of impact: 2nd order (disruptive)

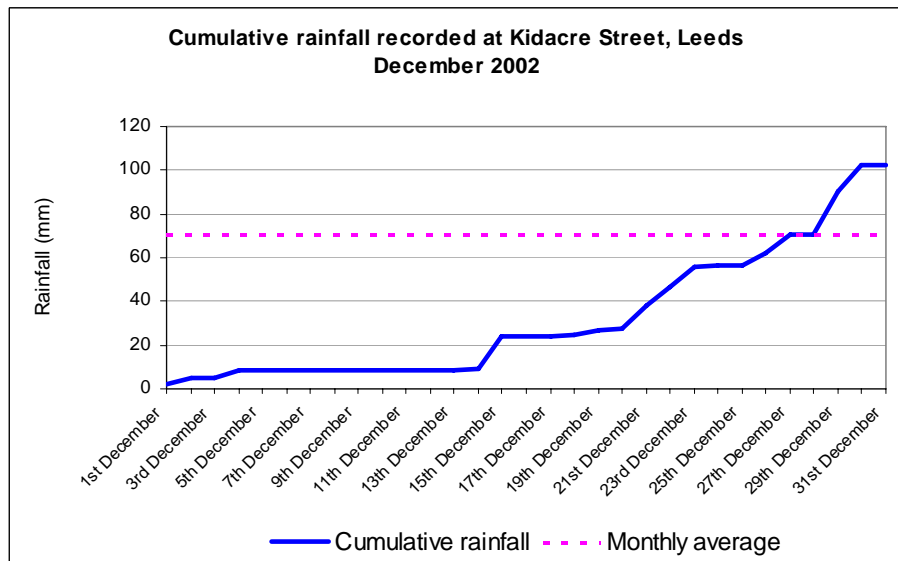
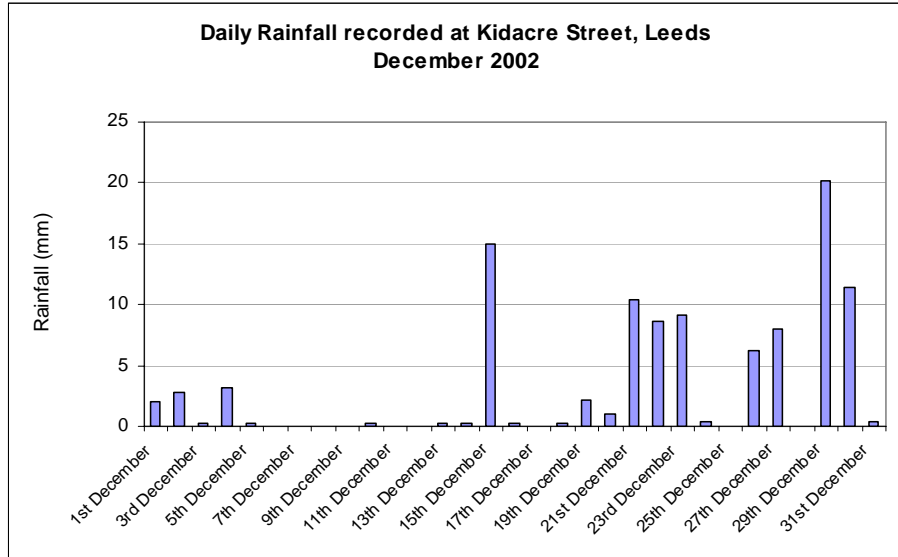
Description of event: In 12 hours overnight on the 29th-30th December, an inch of rain fell on Leeds - equivalent to a third of the average total rainfall for December. Eighteen flood warnings were put in place around Yorkshire, with Kirkstall Road in Leeds pinpointed as a potential trouble spot. Other areas in Leeds were also affected, including Otley, Garforth and Beeston.

Firefighters and Yorkshire Water officials were called out to Southleigh Road in Beeston when waste drains burst. An overflowing beck put pressure on the underground system, forcing several manhole covers to shoot off.

Crews from Garforth were called to a home in Ariel View, Micklefield at around 11 pm after water draining from a field began pouring under the house's foundations. The Cross Pipes pub in Westgate, Otley, also suffered minor flood damage after its cellar began to fill with water. Flood warnings were given for several rivers including the River Aire.

Barnsdale Road between Castleford and Leeds closed temporarily when the River Aire burst it's banks.

Six calls were received by Leeds City Council reporting flooding incidents on December 30th.



Local media reports: *Flooding threat to Yorks homes* (Yorkshire Evening Post, 30th December 2002)
Flood alerts issued as downpours swamp Yorkshire, (Yorkshire Post, 31st December 2002)

Area affected: All Leeds, but particularly Kirkstall Road, Otley, Garforth and Beeston.

Sectors affected: Transport
 Infrastructure

Key impacts: Rail services suspended
 Road disruption
 Power lines down

WEATHER EVENTS IN 2003

Date: 4th February 2003
Type of Event: WINTRY CONDITIONS



Magnitude of impact: 3rd order (inconvenience)

Description of event: The whole of February was exceptionally cold with daily minimum temperatures struggling to limb above the long term average, and the majority of days falling below it.

On the 4th February the M1 was closed near Sheffield as a result of a series of accidents in which snow was considered to contribute, and was likely to have had a knock-on effect on M1 traffic near Leeds. Local road networks were reported to be heavily congested as a result of the M1 closure and snowy conditions.

Local media reports: *Snow brings M1 chaos as drivers feel crunch* (Yorkshire Post, 4th February 2003)

Area affected: Region-wide

Sectors affected: Transport

Key impacts: Motorway closure / congestion
Local road congestion

Date: 13th April 2003

Type of Event: WIND DAMAGE



Magnitude of impact: 4th order (nuisance)

Description of event: Mini-tornado hits antiques fair at Wetherby racecourse. No damage was reported.

Local media reports: *Mini tornado ruffles fair* (Yorkshire Post, 13th April 2003).

Area affected: Wetherby

Sectors affected: Events

Key impacts: No significant impact

Date: 22nd June 2003

Type of Event: LIGHTNING STRIKE



Magnitude of impact: 3rd order (inconvenience)

Description of event: Officials at the Met Office said West and North Yorkshire bore the brunt of the region's dramatic thunderstorms yesterday. West Yorkshire Fire Service said it received a number of calls about fires being sparked and alarms being triggered by the storms. Bradford, Leeds and Wakefield were the first to be affected before the thunderstorm moved north.

Local media reports: *Thunderstorms keep region's firefighters busy* (Yorkshire Post, 22nd June 2003)

Area affected: Region-wide

Sectors affected: Residential
Emergency services

Key impacts: House fires
Alarms triggered

Date: 12th – 13th July 2003

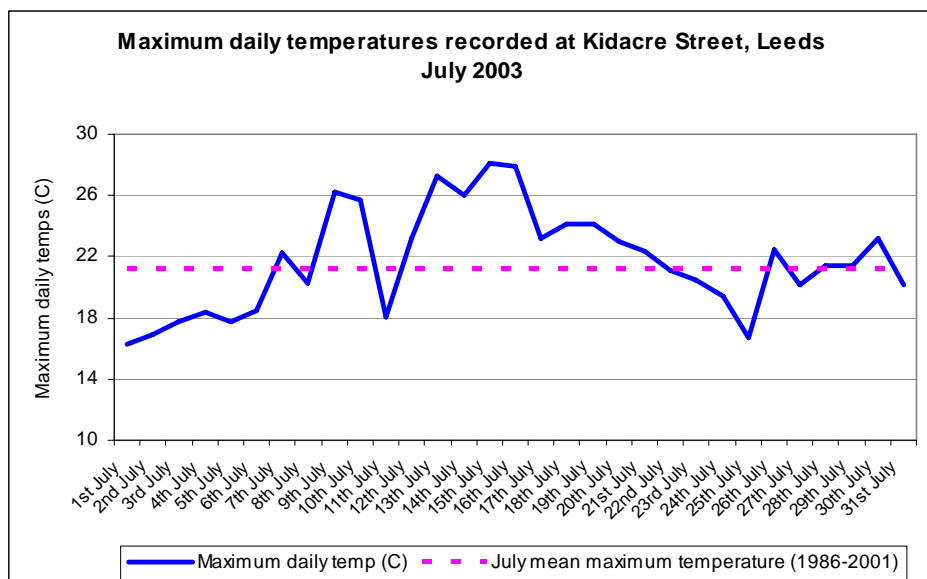
Type of Event: HEAT



Magnitude of impact: 4th order (nuisance)

Description of event: Yorkshire became one of the hottest regions in Britain as a heatwave swept the country. Leeds was officially the hottest place in the north of England as temperatures reached 29°C.

A maximum temperature exceeding 28°C was recorded by Leeds City Council's met mast at Kidacre Street – as indicated in the graph below.



Local media reports: *Yorks enjoys a dip with its Sunday roast* (Yorkshire Evening Post, 14th July 2003)

Area affected: All Leeds.

Sectors affected: None specified.

Key impacts: None specified.

Date: 3rd – 9th August 2003

Type of Event: HEAT

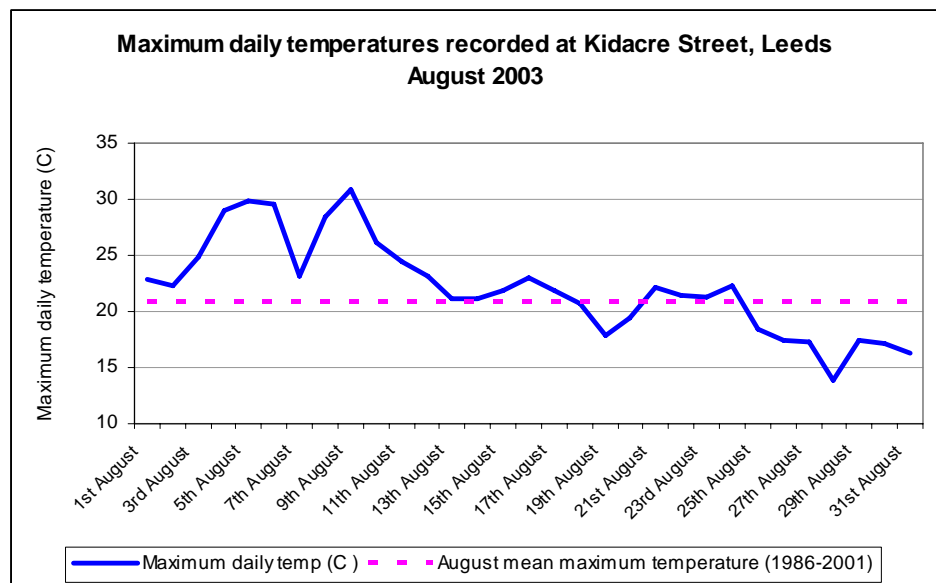


Magnitude of impact: 4th order (nuisance)

Description of event: Temperatures reached up to 30°C in Yorkshire on the 3rd August as people took to beaches, parks, beer gardens and festivals. Leeds was predicted to be at it's warmest for 13 years and the city was the hottest place in the county on the 3rd August with temperatures topping the 27°C mark. The high temperature continued for the next couple of days, and Leeds was expected to break all records before Saturday (9th August). Domonic Woollatt from the Met Office said: "It is going to be pretty hot and sunny for the whole week. It could reach 33°C during the middle of the week and maybe even 34°C". Although temperatures did not quite reach this level, maximum daily temperatures for the first part of the month were well above average (see graph below).

Bosses at the Richmond Ice Cream factory in Cross Gates, Leeds were celebrating record sales of the company's Fab lolly.

The heatwave has been good news for the county's tourist trade with thousands of holiday makers heading for the Yorkshire coast.



Local media reports: *Here comes the sun and it'll be a record* (Yorkshire Evening Post, 4th August 2003)
99 degrees.....we're sizzling in the sun (Yorkshire Evening Post, 5th August 2003)

Area affected: All Leeds.

Sectors affected: Tourism.
Ice cream sales.

Key impacts: Increased participation in outdoor events / tourism.
Boom in sales from ice cream factory.

WEATHER EVENTS IN 2004

Date: 2nd January 2004

Type of Event: WINTRY CONDITIONS



Magnitude of impact: 3rd order (inconvenience)

Description of event: Thousands of homes across Yorkshire greeted 2004 in the dark and cold after overhead electricity cables fell victim to extreme weather. In Leeds city centre about 9000 people braved freezing temperatures at a successful New Year party in Millennium Square, but hundreds of people had to walk home after Leeds bus services were affected by snow.

Several roads were affected by snow and icy conditions in Yorkshire, including the M62 and other routes across the Pennines.

Local media reports: *2004 starts in dark for thousands* (Yorkshire Post, 2nd January 2004)

Area affected: Region-wide

Sectors affected: Transport
Utilities (electricity)

Key impacts: Cancellation of bus services
Poor road conditions
Power cable failure

Date: 28th January 2004

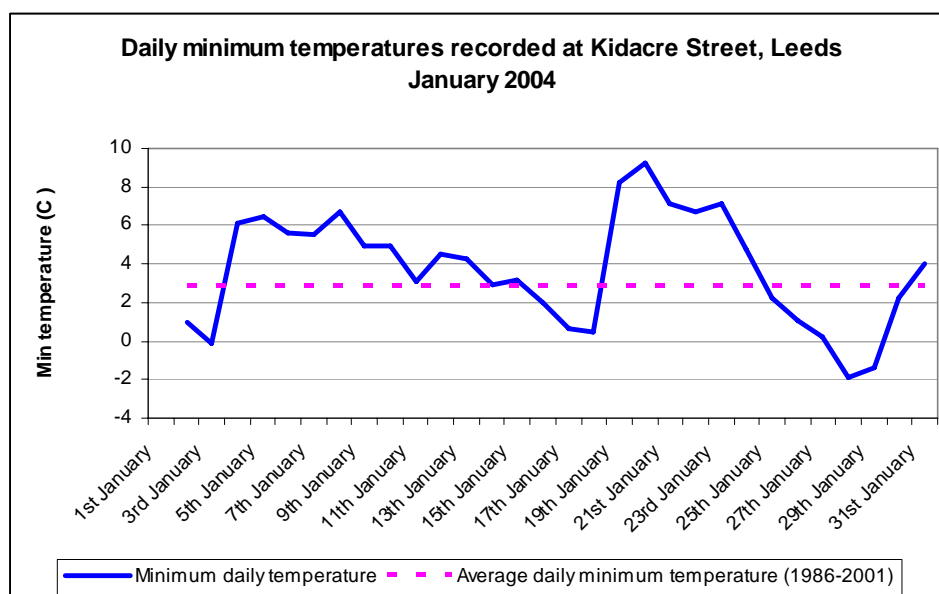
Type of Event: WINTRY CONDITIONS



Magnitude of impact: 3rd order (inconvenience)

Description of event: Yorkshire was braced for further snow as a second weather front moved south from Scotland bringing strong winds and freezing temperatures. The temperature was expected to hover around freezing throughout the day on 28th January before dropping to -2°C overnight.

The AA said it was preparing for a breakdown rate of up to 20,000 a day (compared to the usual 12,000) and an extra 20% of patrols were put on standby. British Gas is predicting that the plummeting temperatures could trigger more than 20,000 emergency calls a day. Rail and bus operators across Yorkshire are hoping to continue to run normal services but are monitoring the weather in case contingency plans have to be implemented. A Network Rail spokesman said: "We have a national weather strategy manager and we are having regular meetings about the weather." Leeds-Bradford Airport last night said it was fully prepared and a normal timetable would operate unless conditions seriously deteriorated."



Local media reports: *More snow as Yorkshire faces icy blast* (Yorkshire Post, 28th January 2004)

Area affected: Region-wide

Sectors affected: Transport
Utilities (electricity)

Key impacts: Extra breakdown recovery patrols put on.
Expected increase in emergency gas call outs.

Date: 20th March 2004

Type of Event: WIND DAMAGE



Magnitude of impact: 3rd order (inconvenience)

Description of event: Winds gusting up to 70 mph damaged properties across the region and falling trees brought down power lines, leaving about 15,000 homes without electricity. West Yorkshire Fire and Rescue Services said they had been called out to survey a number of dangerous structures, including reports of glass panes being blown loose at the Albion Shopping Plaza in the centre of Leeds. Part of the city centre was sealed off on the afternoon of Saturday 20th March after a plank was blown from the roof of the Boots store. Part of Albion Street was closed but no-one was hurt.

West Yorkshire Fire Service took 50 weather-related calls from the public during Saturday, mostly about fallen trees and damage to property. The wind was so severe on the M62 that that a blown-over heavy goods vehicle had to be left for five hours because it was too early to right it. The M1 link with the A1 in east Leeds was blocked after a two-car smash in bad weather at lunchtime and emergency services reported five people injured at the scene.

Local media reports: BBC News: *Weather causes transport havoc* (www.bbc.co.uk/news, 20th March 2004)
More bad weather on the way (Yorkshire Post, 22nd March 2004).

Area affected: Region-wide
Leeds

Sectors affected: Transport
Utilities
Commercial / retail
Emergency services
Health

Key impacts: Power lines down.
Roads blocked by trees and overturned lorries.
Parts of city centre closed because of dangerous buildings / structures.
Road traffic accidents.
High level of emergency services callouts.

Date: August 2004

Type of Event: FLOODING



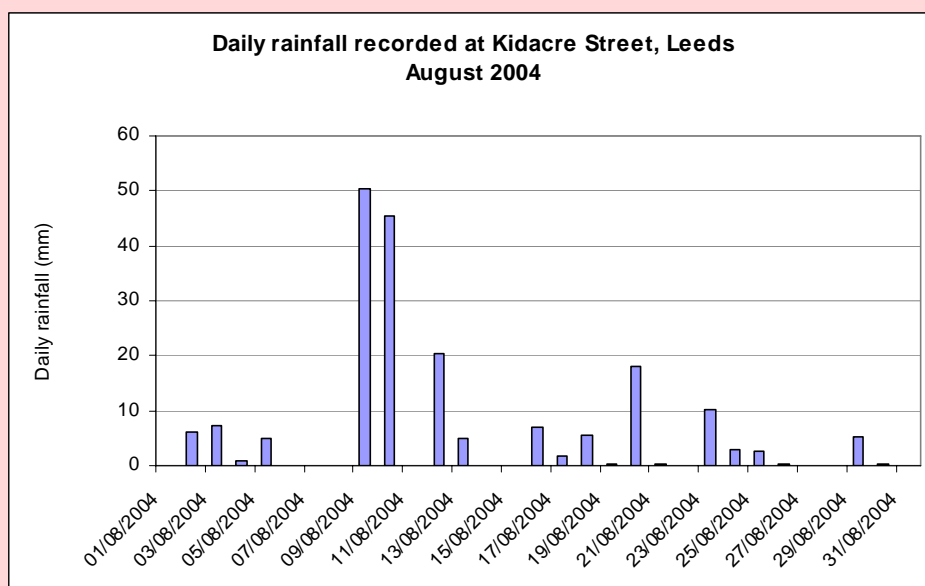
Magnitude of impact: 1st order (highly disruptive)

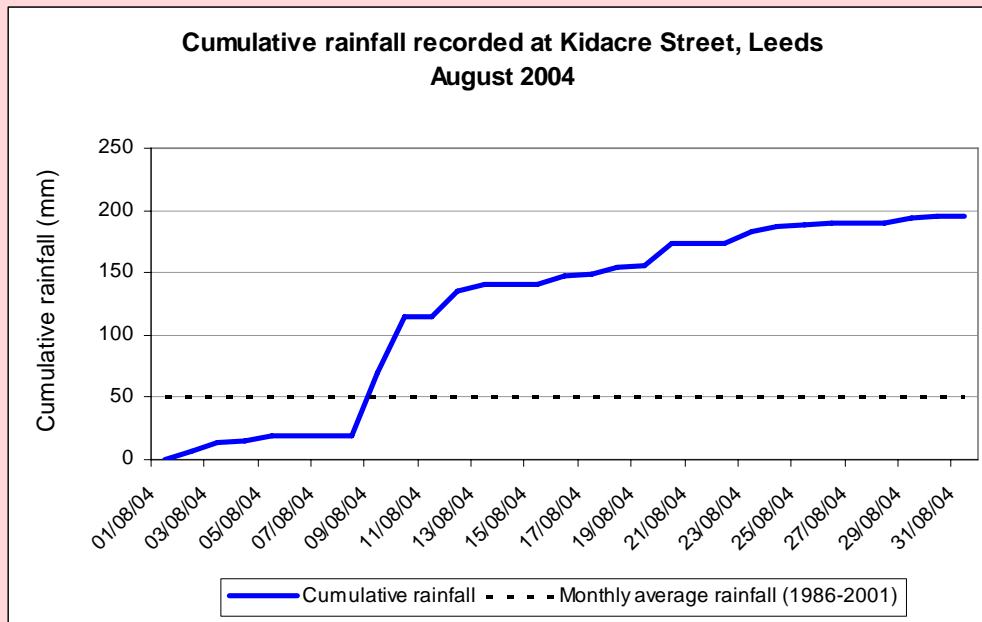
Description of event: In August 2004 several areas of the city, primarily in the east of Leeds, experienced significant flooding due to an unusually intense rainfall and the inability of the drainage system to cope with the increased volumes of water. Dozens of houses flooded internally on the Dunhill Estate in Halton as a result of Wyke Beck flooding. The rainfall was extremely intense and historical records show that this level of rainfall equates to a 1 in 100 year storm event - well above current national guidelines for storm sewer design.

Storms occurring between the 9th and the 11th August saturated the ground. As a result the further extreme rainfall on the 12th generated high levels of surface run-off from both highways and land. High levels of flow in Wyke Beck during the August 2004 storm impeded the flow discharging from the combined sewer overflow pipe and resulted in flows backing up the pipework and into the storage tank (Yorkshire Water, date unknown).

The Leeds City Council met station recorded 50.4 mm rain at Kidacre Street in the city centre on the 9th August and 45.5 mm rain on the 10th (see graphs below).

Five calls reporting flooding incidents were logged by LCC Land Drainage team on the 9th and 10th August. Another 32 calls were made to LCC Land Drainage service to report flooding incidents around Leeds on the 12th August, and a further 5 calls were received on the 13th.





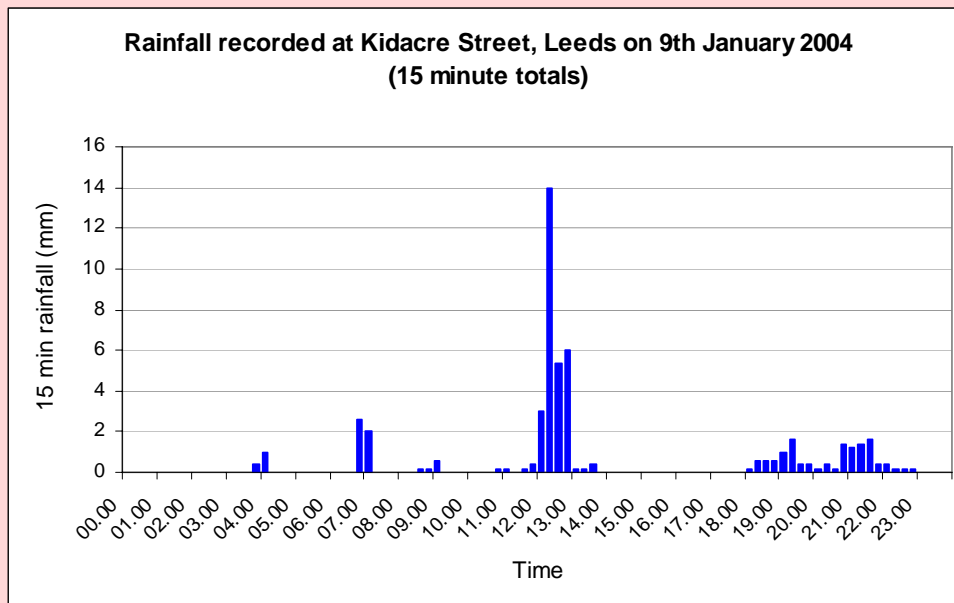
WHAT THE PAPER'S SAID... Yorkshire Post, 10th August 2004

FLOODING CAUSES MISERY ON ROADS AND RAILWAYS

On the 9th August in West Yorkshire between 25 and 35 mm rain (~2 in) fell in the space of a couple of hours. The heavy rain saw homes in Knottingley, Ferrybridge and Leeds suffer flood damage. In the eastbound tunnel near the Armley gyratory on Leeds Inner Ring Road, rising waters lifted a man's car and left him stranded. The man was rescued by fire crews and was not hurt. Evening commuters faced grid lock on all major routes for many hours. The flooding pushed up a manhole cover and on the inner ring road, forcing a section to be closed and causing long tailbacks. An AA spokeswoman said: "Unfortunately, it's such a major route that something as simple as that can have a real knock-on effect."

In the city centre, in the space of 10 minutes so much rain fell that Westgate, near Leeds Magistrates Court, was under five inches of water. Some city centre stores were forced to close their doors for a time because of flooding. At Russell and Bromley in Commercial Street, staff had to buy 30 buckets to try and clear up rain water which came through the roof. Severe flooding also affected Scott Hall Road in north Leeds and a handful of homes near King Lane roundabout.

Hundreds of rail passengers were also delayed by floods affecting several key lines in Yorkshire. Trains on the York-Harrogate-Leeds line were delayed by 40 minutes due to water on the track at Pannal.



A rainfall intensity of 2.5mm in 15 minutes is normally sufficient to cause local flooding, therefore intensities up to 14mm over 15 minutes, as recorded in the graph above, were exceptional with drainage systems unable to cope.

WHAT THE PAPER'S SAID... Yorkshire Evening Post, 13th August 2004

FLOOD, SWEAT AND TEARS

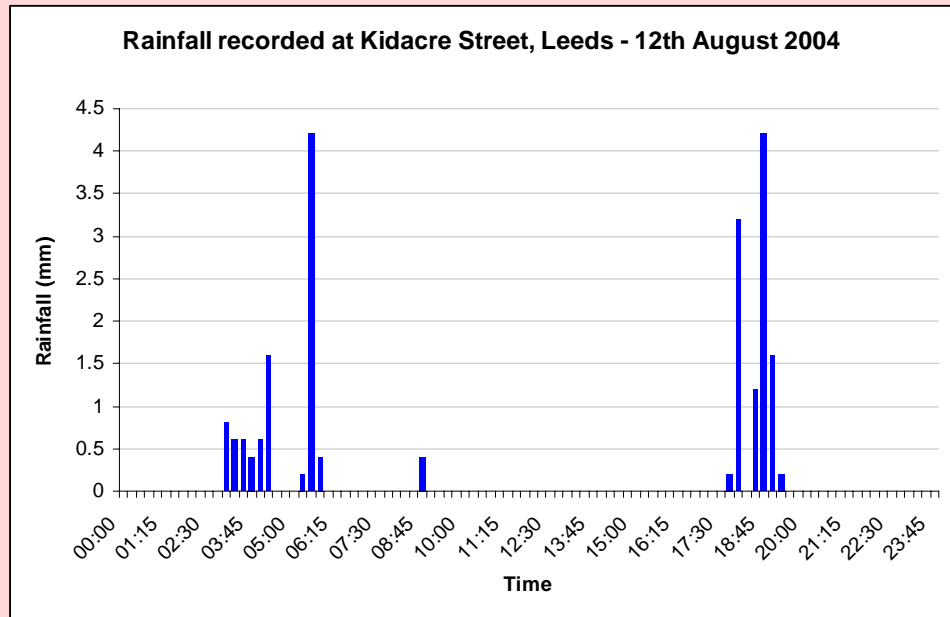
People across Yorkshire were cursing the great British summer again after flooding wreaked fresh havoc across West Yorkshire on the evening of the 12th August. Some places saw as much as 60mm of rain falling in a single hour – two-thirds as much as would normally be expected during the whole of August.

At the height of the problems around 5000 properties – including 1300 in Cross Gates, Leeds – were left without electricity for part of the day. West Yorkshire fire service said its resources had been stretched to the limit as it tackled the “unprecedented” number of flooding incidents. In the three and a half hours up to 8.30 pm yesterday, the brigade received 500 flood-related calls. Standing water on the M1 near Leeds forced the closure of lanes in both directions from junction 45 at Stourton to junction 47 at Aberford.

One of the worst affected areas was Horsforth in Leeds. Water began pouring into gardens on Fairfax View at around 6.30pm from an adjacent field where a stream is thought to have burst its banks. Within an hour they were totally submerged, with a five-foot-high dry wall even being swept away in the torrent. At nearby Trinity and All Saints college fire crews spent two hours pumping water from the canteen, while Scotland Lane and Low Lane were both closed. Train services between Leeds and Harrogate were disrupted by flooding on the line at Horsforth, forcing rail bosses to lay on replacement buses.

Elsewhere in Leeds, residents in Skelwith Walk, Cross Gates, had to be helped from the first floor of their houses after water levels downstairs rose waist high. More than 100 people in Dunhill Rise, Halton, were evacuated from their flood-hit homes by fire crews at around 7.15pm.

The LCC weather station measured 20mm rainfall throughout the day, although most of this fell in two intense bouts of rain (see graph below).



Local media reports: *Flooding causes misery on roads and railways* (Yorkshire Post, 10th August 2004)
Flood, sweat and tears (Yorkshire Evening Post, 13th August 2004)
Trains running again after floods (BBC web site, 13th August 2004, www.bbc.co.uk/news)

Area affected: Region-wide
 Halton, Knottingley, Cross Gates, city centre, Armley, Stourton, Aberford, Horsforth

Sectors affected: Residential
 Commercial/retail
 Transport
 Utilities

Key impacts: Residents evacuated from their homes
 Major road network flooded (including Leeds Inner Ring Road and M1)
 City centre shops flooded
 Rail lines flooded
 Electricity supply failure (including 1300 homes in Cross Gates).

WEATHER EVENTS IN 2005

Date: 1st January 2005

Type of Event: WINTRY CONDITIONS



Magnitude of impact: 4th order (nuisance)

Description of event: Gales, blizzards and torrential rain ripped across Britain at the weekend. Hail buffeted parts of Leeds, and across West Yorkshire police said the severe weather had caused “general havoc”.

Local media reports: *Gales bring death and destruction* (Yorkshire Post, 3rd January 2005)

Area affected: Region-wide

Sectors affected: None specified

Key impacts: None specified

Date: 7th - 9th January 2005

Type of Event: FLOODING AND WIND DAMAGE



Magnitude of impact: 3rd order (inconvenience)

Description of event: A small number of residents were evacuated when the River Wharfe burst its banks and flooded the A65 at Ilkley and Otley on Friday night. As gales lashed the region, fire and rescue services dealt with hundreds of calls relating to damaged roofs, streetlights and fallen trees. Communities across North, West and East Yorkshire experienced power cuts, leaving thousands of homes still without electricity.

A maximum 10-minute average wind speed of 60.6 mph (classified as a gale) was recorded by the Leeds City Council met mast on Kidacre Street on the 8th January. A gale is defined as a mean 10 minute gust over 39mph, therefore a 10 min mean gust of 60mph can be considered a significant storm. Gales were also recorded on the 7th, 10th, 11th and 12th January.

Local media reports: *Flood relief pumps ‘working wrong way’ says ex-mayor* (Yorkshire Post, 10th January 2005)

Area affected: Otley / region wide

Sectors affected: Residential
Utilities
Highways maintenance
Forestry

Key impacts: Damage to properties
Fallen trees
Damaged streetlights
Power cuts

Date: 20th January 2005

Type of Event: WIND DAMAGE



Magnitude of impact: 3rd order (inconvenience)

Description of event: High winds over the last 24 hours uprooted trees and debris strewn across the region. Gusts up to 50 mph were recorded.

Local media reports: *Flood relief pumps 'working wrong way' says ex-mayor* (Yorkshire Post, 21st January 2005)

Area affected: Region wide / all Leeds

Sectors affected: Forestry

Key impacts: Fallen trees
Other debris scattered around region

Date: 24th February 2005

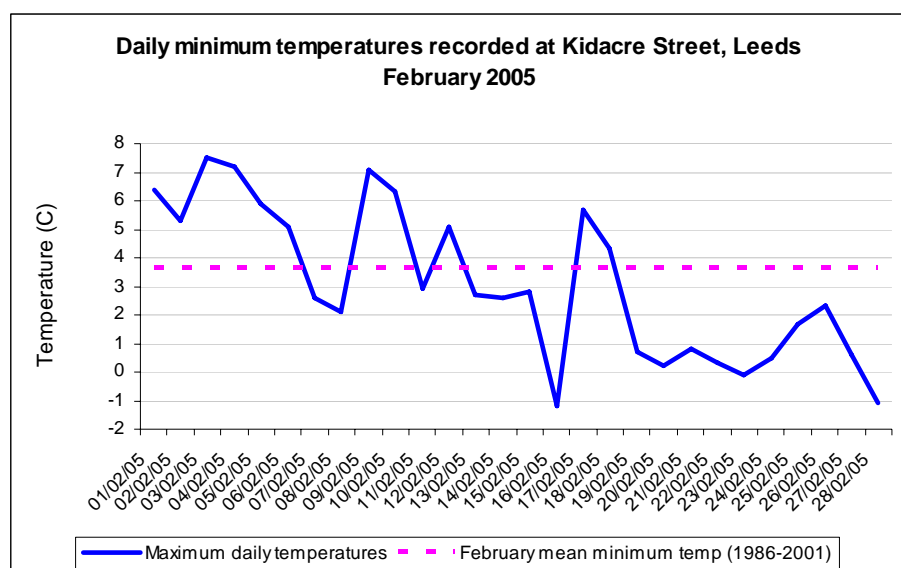
Type of Event: WINTRY CONDITIONS



Magnitude of impact: 4th order (nuisance)

Description of event: Leeds City Council said it reluctantly decided to close all its outdoor sports pitches due to snow and icy conditions. Up to 40 gritters were on duty across Leeds as wintry conditions continued to take hold.

Main access roads were being gritted from 6pm and again from 4am each morning. Well used secondary routes were also being targeted. Nine schools in Leeds closed on Thursday because of snow. Residents were warned that refuse collections could be hit.



Local media reports: *Today expected to be worst yet as cold spell tightens* (Yorkshire Post, 24th February 2005)

Cold snap goes on with further risk of snow (Yorkshire Post, 26th February 2005)

Area affected: All Leeds

Sectors affected: Sports and leisure facilities
Highways Maintenance
Waste collection
Education

Key impacts: Sports pitches closed
40 gritters out on roads
9 schools closed
Potential disruption to refuse collection

Date: 3rd May 2005

Type of Event: FLOODING

Magnitude of impact: 1st order (highly disruptive)



Description of event:

In May 2005 several areas of the city, primarily in the east of Leeds, experienced significant flooding due to unusually intense rainfall and the inability of the drainage system to cope with the increased volumes of water. This flooding affected the same areas as the previous floods in August 2004.



Initial data from the Environment Agency suggest that a tenth of the annual average rainfall for Leeds fell in a two hour period. The storm that hit the Wykebeck Valley Road area of Leeds was estimated to be a 1 in 300 year event - significantly greater than the August 2004 storm intensity and well above the current national guidelines for storm sewer design.

15 calls were made to the LCC Land Drainage Team on 3rd May reporting flooding incidents.

WHAT THE PAPER'S SAID... Yorkshire Post, 4th May 2005

HEAVY RAIN BRINGS CHAOS

Torrential rain brought chaos to Leeds yesterday [3rd May]. People in Wykebeck Valley Road found their houses flooded again, for the second time in less than a year.

St. Nicholas Primary School was knee deep in water and had to be closed.

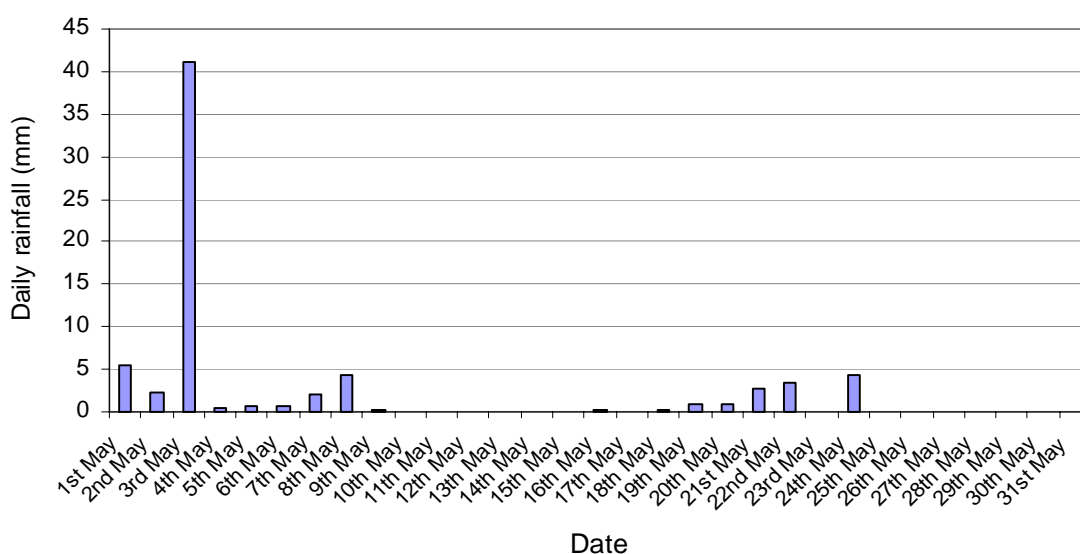
Yorkshire Water said it was too early to tell if the cause of the flooding was the same as last summer, then exacerbated by blocked drains caused by fly tipping. Alternative accommodation and help with the clear up were offered by Yorkshire Water.

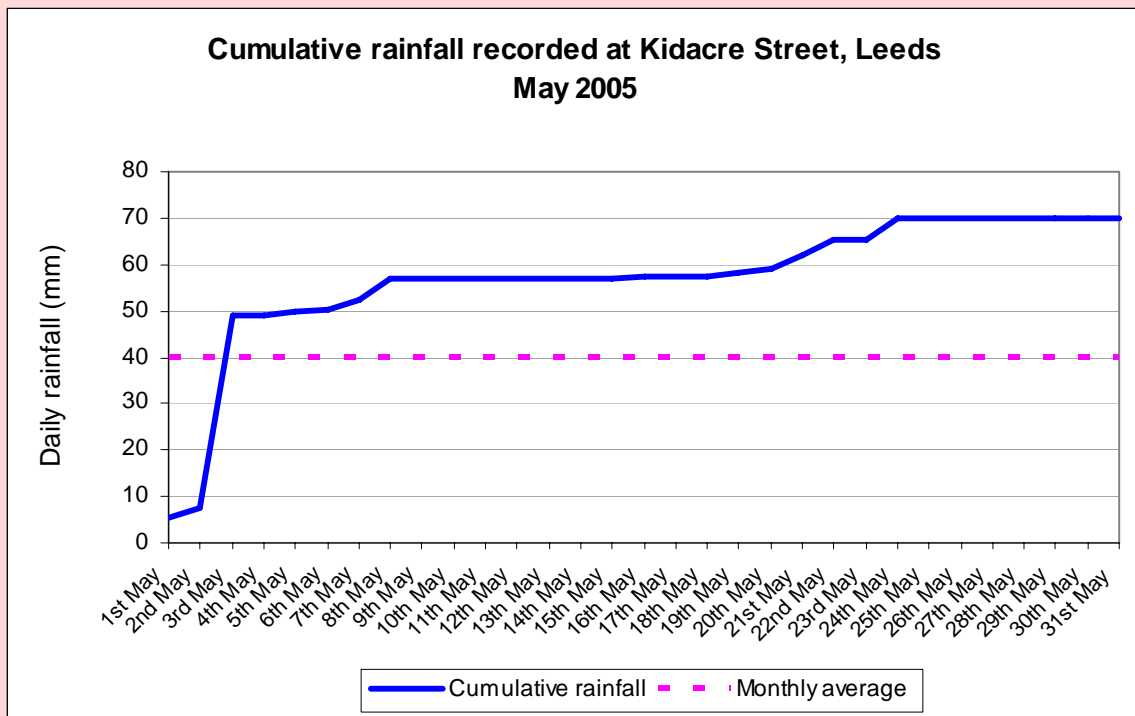
In Leeds City Station shops were affected and many of them closed for most of the day because of water seeping through ceiling and air vents.

Hail and heavy downpours made driving conditions particularly hazardous, and just outside the city centre at Millshaw cars had all but disappeared under water following flash flooding.

West Yorkshire Fire Service received 150 calls for help and was still pumping out homes in Morley and Oakwood last night.

Daily rainfall recorded at KidacreStreet, Leeds
May 2005





Local media reports: *Heavy rain brings chaos* (Yorkshire Post, 4th May 2005)

Area affected: Region-wide
East Leeds
Millshaw
Halton
Morley
Oakwood

Sectors affected: Transport
Retail
Residential

Key impacts: Roads and car parks flooded
Shops in city centre inundated
School flooded
Homes flooded (for the second time in 2 years)

WEATHER EVENTS IN 2006

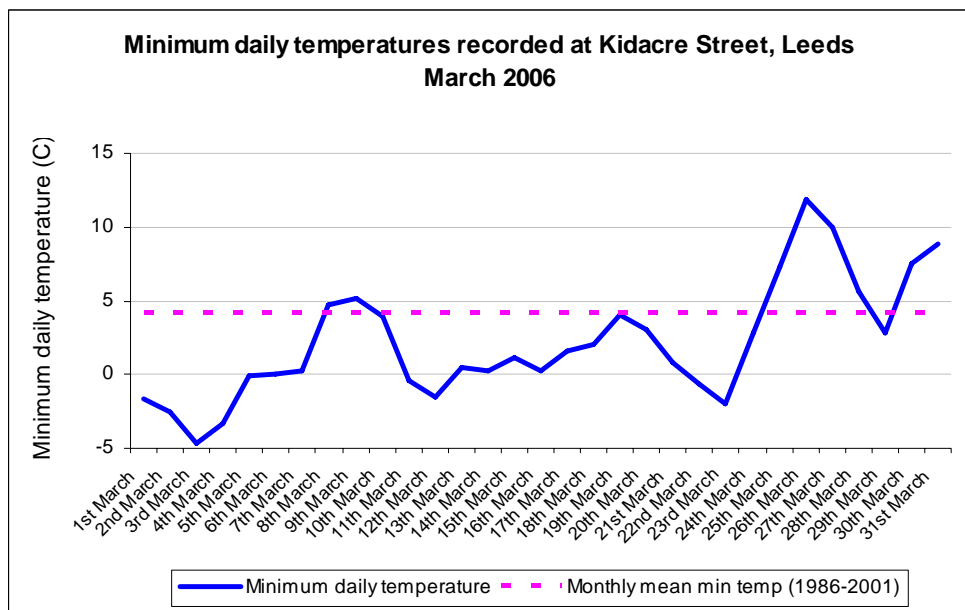
Date: 4th March 2006

Type of Event: WINTRY CONDITIONS



Magnitude of impact: 4th order (nuisance)

Description of event: A minimum temperature of -4.7C was recorded by the Leeds City Council met mast on Kidacre Street on the 3rd March. This site is located in the city centre, which suggests that even colder temperatures could have been experienced in more rural areas.



Local media reports: *Yorkshire hit by heavy snow showers* (Yorkshire Post, 4th March 2006)

Area affected: Region wide / all Leeds

Sectors affected: Transport

Key impacts: Traffic disrupted

Date: 2nd July 2006

Type of Event: FLOODING + LIGHTNING STRIKE



Magnitude of impact: 3rd order (inconvenience)

Description of event:

WHAT THE PAPER'S SAID... Yorkshire Post, 4th July 2007

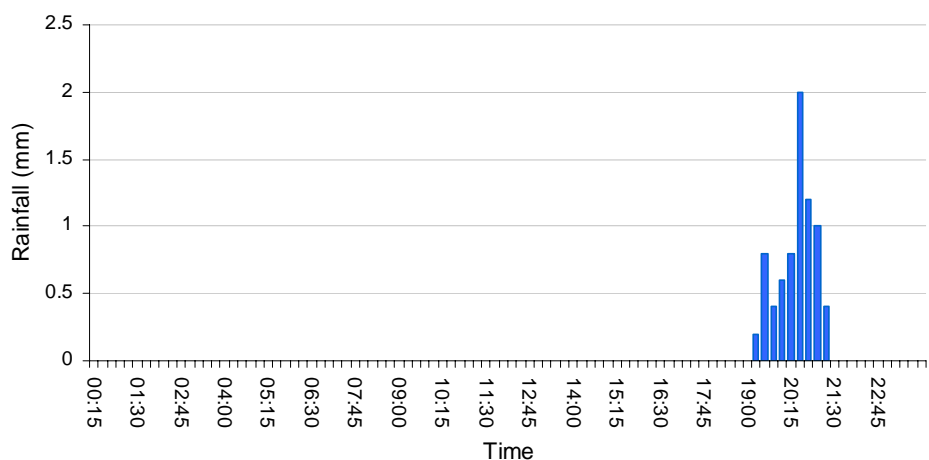
COUNTING THE COST OF STORM MISERY

Yorkshire was picking up the pieces yesterday after flash floods and thunder storms hit the region at the weekend (2nd). It was a case of the storm before the calm on Sunday evening as heavy rain hit West, South and North Yorkshire. The downpour gave way to bright sunshine as temperatures in Yorkshire hovered around the 30°C mark yesterday.

Fire crews in West Yorkshire received about 330 call outs in five hours on Sunday night, mostly from the Hebden Bridge and Todmorden area.

The roof of a house in Iverson Drive, Cookridge, Leeds was blown apart at 8.30 pm by a bolt of lightning, causing a fire and the collapse of the house.

Rainfall recorded at Kidacre Street, Leeds on 2nd July 2006
(15 minute totals)



Local media reports: *Counting the cost of storm misery* (Yorkshire Post, 4th July 2006)

Area affected: Region wide; lightning strikes in Cookridge

Sectors affected: Transport
Residential property

Key impacts: Flash flooding
Collapse of house in Cookridge as a result of lightning strike.

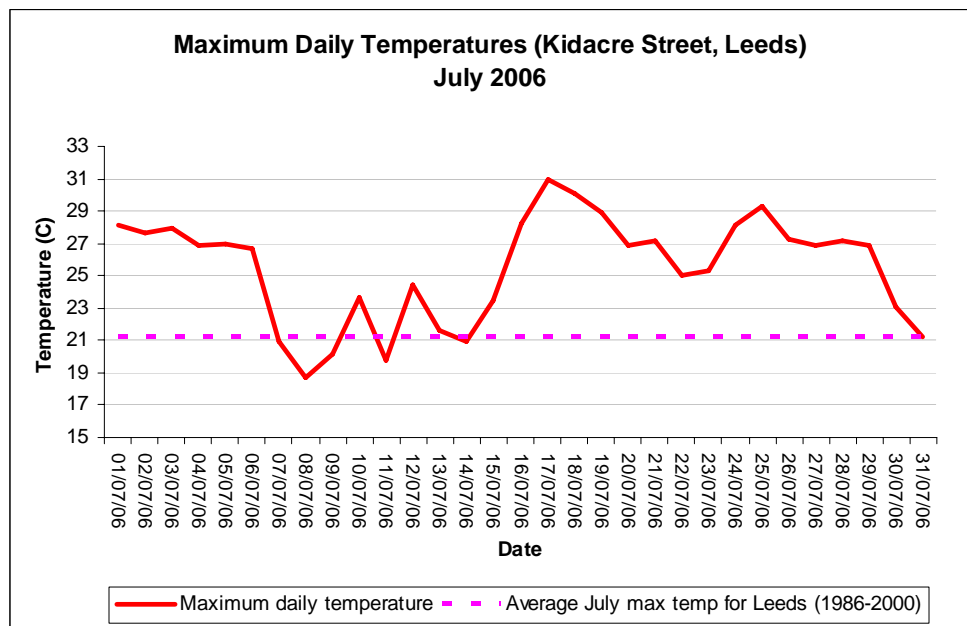
Date: 17th – 31st July 2006

Type of Event: HEAT

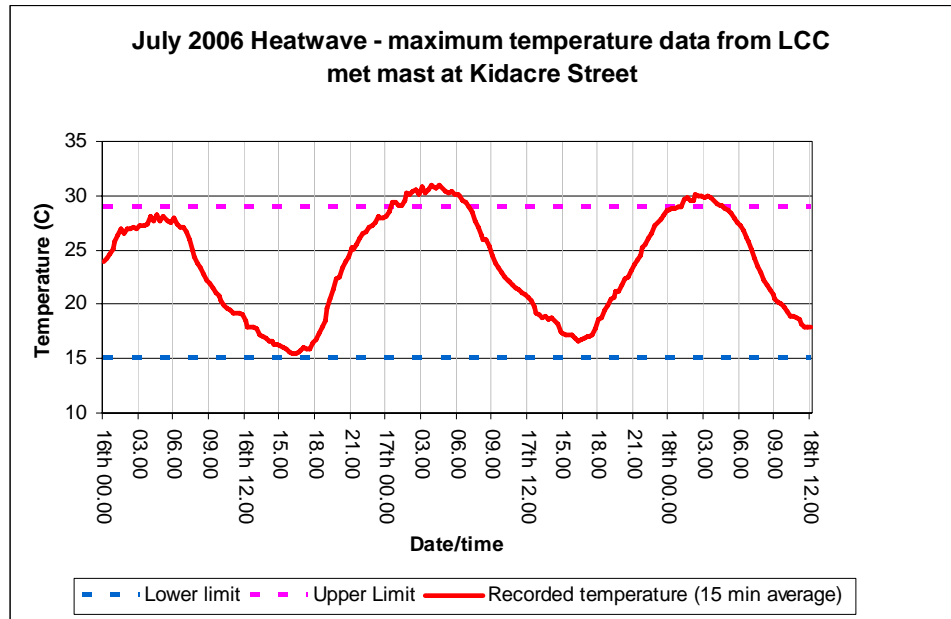


Magnitude of impact: 3rd order (inconvenience)

Description of event: A maximum temperature of 31°C was recorded at the Leeds City Council weather station at Kidacre Street on the 17th July.



A heatwave is declared under the Leeds Heatwave Plan when the day-time temperature reaches 29°C and the night-time temperature does not fall below 15°C. As can be seen in the graph below this occurred on the 17th – 18th July 2006 and a heatwave was officially declared in Leeds.



WHAT THE PAPER'S SAID... Yorkshire Post, 18th July 2006

SIZZLING NATION NOW BRACED FOR ITS HOTTEST EVER JULY

Sunworshippers can expect another 48 hours of record breaking temperatures before thunderstorms sweep across the country.

Yesterday's highest temperature in Yorkshire was 32°C (90F) at Linton-on-Ouse (near York), beating highs in Mediterranean holiday destinations including the Canaries and the French Riviera. Higher temperatures across the region are expected today, but it will be refreshingly cooler on the coast.

WHAT THE PAPER'S SAID... Yorkshire Evening Post, 19th July 2006

**YORKSHIRE SIZZLES IN THE SUN
AS TEMPERATURES SOAR**

Today could be the hottest day since records began. In Leeds, thermometers are expected to hit 30°C (86F) – about 10°C above the average for July. Workers were having to drink large amounts of water to keep hydrated.

Meanwhile, speed restrictions were introduced on several stretches of West Yorkshire's rail network yesterday (18th July) amid fears the heat could cause the tracks to buckle.

Doctors have urged people to be sensible by drinking plenty and taking care not to overheat.

WHAT THE PAPER'S SAID... Yorkshire Evening Post, 26th July 2006

**ENJOY THE SUN – BUT PROTECT
YOUR CHILDREN**

The Met Office recently declared a level three alert, just one step down from an emergency being declared.

In Leeds temperatures have regularly been hitting the high 20s in Celsius, with 30°C reached on a number of occasions last week.

The NHS has offered advice for keeping children and babies cool during a sweltering summer.

WHAT THE PAPER'S SAID... Yorkshire Evening Post, 26th July 2006

**THUNDER TO SIGNAL
EASING OF HEATWAVE**

Thundery showers are expected to hit Yorkshire today as the exceptionally hot weather of the last two weeks begins to cool down.

In Yorkshire temperatures are expected to reach 28°C inland while tomorrow they will only climb to 26°C.

WHAT THE PAPER'S SAID... Yorkshire Evening Post, 27th July 2006

**EXODUS TO BEAT HEATWAVE
AS STORM HITS HOME**

Britons are fleeing abroad to escape the heatwave in a twist on the usual holiday story amid predictions July will be the hottest month since records began. Holiday companies report a rise in foreign bookings, with people reckoning they can cope with hot but less humid spots such as the Greek Islands and Turkey.

The weather has been bad news for retailers, keeping people out of the shops, but power firms have been asked to generate more electricity following a surge in demand as air conditioning is used. Centrica's gas-fired South Humber plant was switched on unexpectedly.

WHAT THE PAPER'S SAID... Yorkshire Evening Post, 31st July 2006

**WEATHER SET TO RETURN TO
MORE USUAL SUMMER**

End of the heatwave. In Leeds the temperature is predicted to be 22°C today and similar tomorrow.

Area affected: Region-wide

Sectors affected: Transport
Health
Utilities
Retail

Key impacts: Speed restrictions on rail lines due to fear of tracks buckling
Public health advice for dealing with hot weather conditions issued in local media.
Fall in the number of people going shopping
Rise in foreign travel as people seek to escape heat
Additional electricity generation required as a result in surge in air conditioning units

Date: 17th August 2006
Type of Event: HEAVY RAIN + FLOODING



Magnitude of impact: 3rd order (inconvenience)

Description of event: Heavy rain caused rush hour chaos in West Yorkshire as a key route was partially flooded. Motorists on the A58(M) Inner Ring Road in Leeds suffered severe tailbacks for several miles after one of the lanes leading towards the M62 flooded just before 5 pm. Congestion spread to other areas of the city as motorists looked for alternative routes.

Local media reports: *Downpour brings rush-hour chaos for drivers* (Yorkshire Post, 18th August 2006)

Area affected: Inner Ring Road

Sectors affected: Transport

Key impacts: Lane flooded on the Inner Ring Road at peak time, causing severe tailbacks and congestion elsewhere in the city.

Date: 23rd August 2006

Type of Event: HEAVY RAIN



Magnitude of impact: 4th order (nuisance)

Description of event: Heavy rain caused havoc across the country yesterday. Fire crews in West Yorkshire received more than 100 calls, with Wakefield being particularly badly affected. Police said there were also problems for motorists on Aberford Road.

14 calls were recorded by LCC Land Drainage team reporting incidents of flooding on the 23rd August.

Local media reports: *Torrential rain sparks flood chaos* (Yorkshire Post, 24th August 2006).

Area affected: Region wide / Aberford Road

Sectors affected: Transport

Key impacts: Difficult driving conditions as a result of heavy rain and flooding.

Date: 14th September 2006

Type of Event: WIND DAMAGE + LIGHTNING STRIKE



Magnitude of impact: 1st order (highly disruptive)

Description of event: Lightning strikes, ferocious winds and torrential rain caused widespread damage and sparked chaos on the region's roads yesterday. The Met Office had reports of the weather producing "mini-tornados" in and around Leeds.



Photo courtesy of
www.bbc.co.uk/leeds

Businesses and three schools in Leeds (Guiselley High School, Hunslet Moor Primary School and South Leeds High School) were closed after a series of mini-tornados battered buildings, trees and rail signals.

23 calls were recorded by LCC Land Drainage team reporting incidents of flooding on the 14th August.

A report from Leeds City Council's Peace and Emergency Planning department reported the following impacts:

Property damage – Harehills and East End Park

The worst affected property damage in Harehills were in the Seaforth, Berkeley, Strathmore, Cowper, Compton, Clifton and Brown Hill areas. Around 200 properties were affected.

By the morning of 16th September all emergency repairs on council and private properties affected by storm damage in the Harehills and East End Park areas were complete (e.g. sheeting on damaged roofs to ensure they are weatherproof; and removing debris).



Floods at Leeds United's Elland Road stadium
(Yorkshire Evening Post)

Residents in the properties affected by the storms were offered to be re-housed as necessary. Due to the speed of the emergency repairs this service was not needed. The resident of one property with serious damage arranged his own temporary accommodation.

Forestry damage

Parks and Countryside attended over 40 sites affected by the storms, with an initial estimate of 300-500 trees damaged.

Flooding

A limited number of flooding incidents were reported to PEPU and Land Drainage, including individual property flooding in Guiseley, Weetwood, West Ardsley, Wortley, Yeadon, Bramley and Churwell. In the main the flooding experienced was not from watercourses (i.e. becks and culverts) but from highway and sewer flooding.

Schools

There was flooding and other weather-related damage to over 20 schools across the city.

WHAT THE PAPER'S SAID... Yorkshire Post, 14th September 2006

TORNADO TERROR

Heavy lifting gear was brought into position to move fallen trees which blocked the A61 between Leeds and Harrogate after a series of storms battered the region.

A series of "mini-tornados" damaged homes and businesses in several areas of Leeds, while a lightning strike damaged rail signals and brought train services around the city to a halt, causing chaos for commuters.

WHAT THE PAPER'S SAID... Yorkshire Evening Post, 15th September 2006

TERROR STORMS HIT LEEDS

A terror tornado ripped through Leeds yesterday, causing thousands of pounds worth of damage.

Shops were shut due to flooding, snapped trees and roads riddled with water, and the fire service received a record number of calls. One man was taken to hospital after being hit by a falling tree, and the Council carried out repairs to more than 300 homes.

There was havoc across the city when a tornado hurtled across the north and east of Leeds at around 3pm. East End Park and Harehills was strewn with branches leaves and trees which had been lifted out of the ground by the fierce weather.

Harehills Children's Centre narrowly escaped being hit after a series of trees clattered to the ground in the park outside.

Karen McIntosh, 42, was sitting in her home on Ecclesburn Avenue, East Leeds, when one of the windows was twisted off its hinges.

WHAT THE PAPER'S SAID... Yorkshire Post, 15th September 2006

HUGE STORMS LEAVE BEHIND TRAIL OF TERROR

Firefighters in West Yorkshire took 90 weather related calls in the space of just half an hour as a massive storm shook the region. A Fire Service spokeswoman said it was the highest number of calls for help taken in such a short period of time by any fire brigade in 20 years.

In the most serious incident a man was reported to have been struck by a falling tree in Compton Road, Harehills.

North Leeds appears to have taken the brunt of the weather which struck at about 3pm on the 14th September. High winds left metal shutters covering shop windows twisted out of shape and uprooted trees in the Roundhay area of the city. More trees were felled in Shadwell and Harehills by a mixture of wind and lightning strikes leaving several streets blocked. The owners of dozens of homes and businesses were left counting the cost after the winds damaged roofs, windows and chimneys.

Ranjit Dhanjan of Cowper Mount in Harehills discovered part of his home's roof lying in the road as he returned from his pet shop around the corner. He found his young children screaming in the family car which had been surrounded by the remains of the wooden guttering. Mr. Dhanjan said: "If I had come round the corner a little earlier the whole roof would have hit me. I was very, very lucky."

High winds also hit homes near East End Park. Lawrence Wilson saw a tree fall on top of his car at the height of the storm. He said: "I've seen a tornado before and so I told my son to go around and shut the windows as otherwise they would have been ripped out. I was battling with the back door trying to close it for two or three minutes."

One lightning strike damaged railway signalling equipment and led Network Rail to stop all services in and out of Leeds for 90 minutes and cancellations. Fallen trees led to the closure of the A61 between Leeds and Harrogate until staff from the nearby Harewood Estate cleared the branches away.

At the height of the storm customers at the B&Q store at the Junction One Retail Park in Leeds were asked to leave as water poured in through the roof. Duty Manager Jeremy Bellis said: "The water's come through the roof. The centre of the roof has leaked all the way along so obviously the roof channel has not been able to take the volume of water."

A Met Office spokesman said several parts of Yorkshire had seen more than half an inch of rain fall in the space of an hour – four times more than the amount which is considered a heavy downpour.

Local media reports:	<p><i>Tornado terror: Ferocious storms leave trail of damage in region</i> (Yorkshire Post, 14th September 2006).</p> <p><i>Huge storms leave behind trail of havoc</i> (Yorkshire Post, 14th September 2006).</p> <p><i>Terror storm hits Leeds</i> (Yorkshire Evening Post, 15th September 2006).</p> <p><i>Clean up after deluge</i> (Yorkshire Post, 16th September 2006).</p>
Area affected:	<p>Region-wide / All Leeds Particularly East and North Leeds</p>
Sectors affected:	<p>Transport Residential property Utilities and infrastructure Leisure Emergency services Commercial / retail Waste collection Health Education</p>
Key impacts:	<p>Significant wind damage to residential property. 300-500 trees fallen or damaged. Flooding to schools and residential and business properties. Blocked roads. Rail delays - signal damage. Record number of emergency calls. Member of public hospitalised after being hit by falling tree.</p>

Date: 25th October 2006

Type of Event: HEAVY RAIN

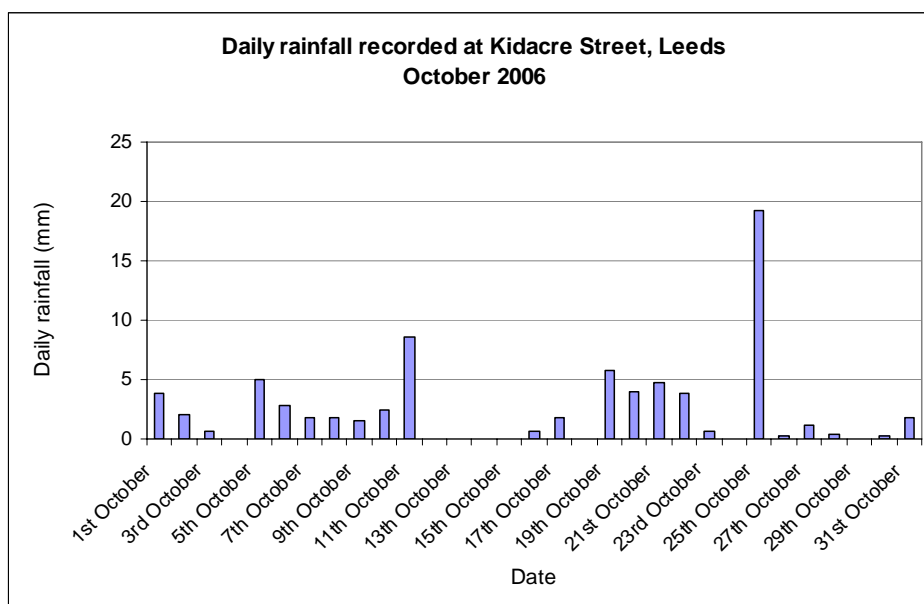


Magnitude of impact: 4th order (nuisance)

Description of event: Non-stop rain brought flooding to several parts of Yorkshire yesterday.

The Highways Agency said there had been ‘horrendous’ congestion on the region’s roads throughout the day, and that traffic had practically ground to a halt in parts of Leeds during the evening rush hour.

The M621, M62 and main arterial routes into and out of the city were particularly badly affected. A spokesman said: “We can’t even give any particular reason for it, apart from perhaps the weather. There haven’t been any major accidents but traffic has certainly been particularly bad today.”



Local media reports: *Flooding brings chaos to region’s roads* (Yorkshire Post, 26th October 2006)

Area affected: Region wide / all Leeds

Sectors affected: Transport

Key impacts: Difficult driving conditions as a result of heavy rain and flooding.

Date: 3rd December 2006
Type of Event: STRONG WINDS AND HEAVY RAIN



Magnitude of impact: 3rd order (inconvenience)

Description of event:

WHAT THE PAPER'S SAID... Yorkshire Post, 4th December 2006

STORM RIPS ROOF OFF FAMILIES' FLATS

Several families were today homeless after strong winds tore the roof from their homes. A loud bang was the first residents knew of the storm which yesterday ripped the flat tarmac roofing off four adjoining apartments on High Street in Kippax, near Leeds. After running out of their homes, they discovered parts of the roof hanging precariously over their front doors, while indoors rain began pouring through ceilings. Severe water logging meant water also leaked through to ground floor shops below.

Single mums Kathy Parker, 23, and Nikki Jones, 25, spoke of the terrifying ordeal. Nikki said: "It was scary as hell. We were all screaming and crying. The kids were going hysterical. We didn't know what we should be doing – whether it was safer to be outside or in. It was like the ceilings were going to cave in. It was like a hurricane. It was awful."

Kathy, who lives in an end flat, was the first to be hit. She said: "I heard this almighty bang and went outside to find the roof hanging off". This was the second time in just over a year that the roof was blown off the flats. A similar incident happened in January 2005. Today Kathy, Nikki and their neighbours were all without electricity. Damaged furniture has been cleared. Personal belongings like clothes had been bagged and moved to friends' and relatives' homes. Firemen from the Garforth station made the roof as safe as they could, but with more rain and winds forecast over the next few days it is not certain that the rest of the roof will stay on.

A maximum 10-minute average wind speed of 47.8 mph was recorded on December 3rd by the Leeds City Council weather station on Kidacre Street, which is classed as gale force.

Local media reports: *Storm rips roof off families' flats* (Yorkshire Post, 4th December 2006)

Area affected: Kippax

Sectors affected: Residential property
Commercial / retail

Key impacts: Roof blown off flats.
Ground floor shops flooded as water leaked through from inundated flats.

WEATHER EVENTS IN 2007


Date:	18th January 2007
Type of Event:	WIND DAMAGE + FLOODING
Magnitude of impact:	1 st order (highly disruptive) 
Description of event:	<p>Leeds City Council Peace and Emergency Planning team reported the following on this incident:</p> <p>Large parts of the Yorkshire and Humber region experienced severe winds on 18th January 2007. These winds were described as a 1 in 25-30 event.</p> <p>The worst of the weather was concentrated in a three hour period between 13.00-16.00. Mean wind speeds were in excess of 30 knots (35 mph) across most of the region for this period with some areas and higher elevations experiencing mean wind speeds of up to 60 knots (70 mph). Gusts were recorded from 45 knots (50 mph) up to 86 knots (100 mph) in the worst hit areas.</p> <p>The winds, compounded by localised flooding in several parts of the region, caused widespread but low level disruption, particularly to the transport network. As a result of speed restrictions, damage to overhead lines, fallen trees and debris rail disruption was region wide.</p> <p>Several sections of motorway were closed due to incidents often involving high sided vehicles. Local road networks were affected by fallen trees and debris and damage to traffic and street lighting. Several road closures were also necessitated by fallen scaffold or structural damage to adjacent buildings.</p> <p>18 calls were recorded by LCC Land Drainage team reporting incidents of flooding on the 18th January.</p>



Photo courtesy of www.bbc.co.uk/leeds

WHAT THE PAPER'S SAID... Yorkshire Post, 19th January 2006

KILLER STORMS WREAK HAVOC

100 mph gusts and heavy downpours brought transport chaos, damaged buildings, left 50,000 electricity customers in Yorkshire and the North East without power and closed major attractions.

Leeds Bradford Airport was closed for part of the day. One quarter of trains from Yorkshire to London were cancelled as a result of precautionary speed limits on some of the lines. There was chaos at Leeds railway station as dozens of local services were cancelled leaving thousands of passengers facing delays.

The A1, M1, M62, M18 and many arterial roads were all in chaos after lorries were blown over. Many smaller roads were hit by flooding, fallen trees and other debris. Double decker buses were withdrawn from some West Yorkshire routes.

Leeds City Council cancelled sporting events on its pitches because they are waterlogged.

West Yorkshire fire crews attended incidents in Rodley and Drighlington (in Leeds) after the gable ends of two homes were blown down. Pupils were also told to stay from Ilkley Grammar and Knottingley High, where part of the roof was blown off by the gales.




WHAT THE PAPER'S SAID... Yorkshire Post, 19th January 2006

REGION LASHED BY KILLER GUSTS THAT TOPPLED LORRIES LIKE TOYS

On the A1 yesterday [18th] motorists sat in their cars for up to 8 hours as they were caught in traffic tailbacks caused by an overturned lorry south of the M62. Robert Wilkinson from Shadwell, Leeds, whose son was caught in the traffic shortly after 11.30 am said: "I think people would be quite forgiving of delays of half an hour or an hour, but 8 hours is just ridiculous. People were cold, hungry and completely left in the dark about what was going on."

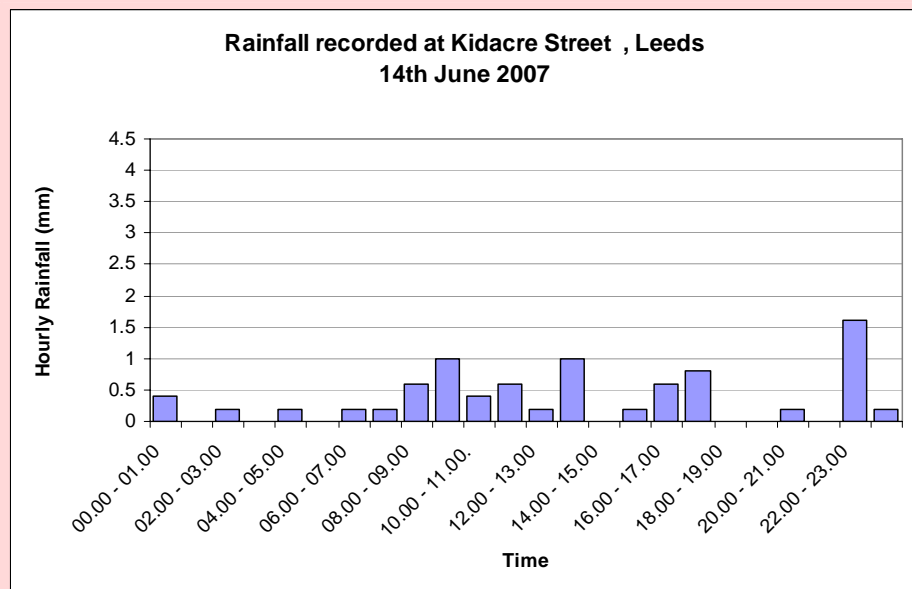
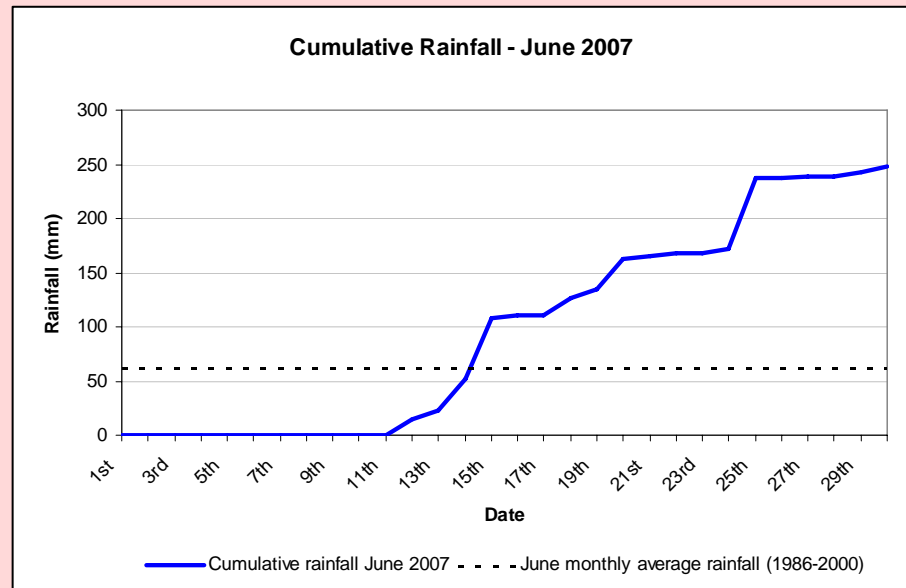
Even in low lying areas, such as Farsley on the outskirts of Leeds, the winds raced up to 77 mph, but on higher ground they were almost touching 100 mph. '

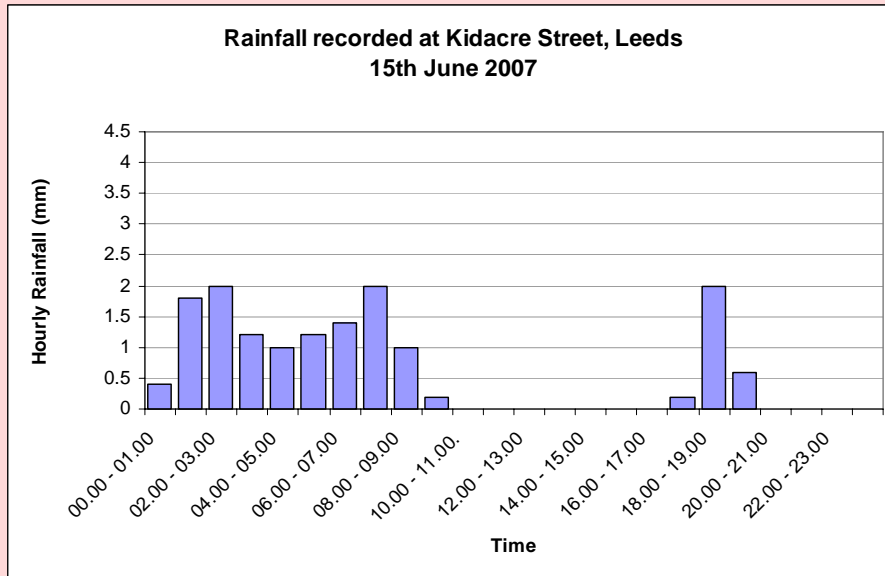
Local media reports:	<i>Killer storms wreak havoc</i> (Yorkshire Post, 19 th January 2007) <i>Region lashed by killer gusts that toppled lorries like toys</i> (Yorkshire Post, 19 th January 2007)
Area affected:	Region-wide All Leeds
Sectors affected:	Transport Commercial / retail Utilities and infrastructure Leisure / sport Residential
Key impacts:	Rail delays (speed restrictions; fallen trees/debris on lines) Roads blocked by trees, fallen trees, street lamps, etc. Sections of motorway closed due to blown over lorries Localised flooding Structural damage to buildings Sporting events cancelled. Electricity cuts – power lines down

Date:	June 2007
Type of Event:	HEAVY RAINFALL + FLOODING  
Magnitude of impact:	1 st order (highly disruptive)
Description of event:	<p>A number of flooding incidents were experienced in Leeds throughout June as a result of severe rainfall over a period of several weeks. This rainfall culminated in the most significant widespread flooding in Leeds in recent history. Between the 15th and 25th June the Environment Agency issued three flood watches, ten flood warnings and three severe flood warnings in and around the city of Leeds.</p> <p>Another factor attributing to the flooding in Leeds was saturation of land due to prolonged heavy rainfall. As is shown in the graph of cumulative rainfall below, 250 mm rain was recorded at Kidacre Street, Leeds in June – almost five times the monthly average.</p> <p>The Council's Land Drainage service logged 345 calls reporting flooding incidents in June 2007, 257 of which were received on a single day on June 25th.</p> <p>According to the Council's Land Drainage service, the level of flooding experienced in Leeds in June 2007 had not been seen in the city for almost 40 years. Internal flooding of buildings in Leeds is historically very unusual in Leeds.</p>
	 <p>Photo courtesy of www.bbc.co.uk/leeds</p>

June 14th - 15th

The first episode of flooding occurred following intense rainfall over a 48 hour period – on the 14th and 15th June over 100 mm was recorded at Farnley, Leeds. This gave rise to widespread flooding across the city. It is clear that this downpour contributed to the ground becoming saturated and set the scene for the flooding incidents that occurred 10 days later. According to the Environment Agency, approximately 250 houses and 50 businesses were flooded in Leeds during June 2007 (www.environment-agency.gov.uk).





WHAT THE PAPER'S SAID... Yorkshire Post, 15th June 2007

**FLOOD HAVOC AS DOWNPOUR SWAMPS
YORKSHIRE**

Torrential rain swamped Yorkshire on Friday 15th June. The region was one of the worst affected in the country as it was overwhelmed by more than 100 incidents of flooding, and West Yorkshire faced some of the worst flooding.

As a month's worth of rain fell in only 6 hours, water rose like a tide, leaving hundreds of people across the region stranded in their homes and cars. Allerton Bywater was badly hit, with firefighters forced to rescue residents from their homes by boat while two occupants of a truck stranded in Barnsdale Road (Allerton Bywater) were airlifted to safety by RAF helicopter.

Stretches of the A1 were closed until 8 pm because of the weather, which also affected the region's rail network – with several services operated by Virgin and Northern Rail in West and South Yorkshire suspended.

Bingley was reportedly the wettest place in the country after 71 mm of rain fell in 24 hours.

WHAT THE PAPER'S SAID... Yorkshire Post, 16th June 2007

DISRUPTION AFTER DELUGE STRETCHES 999 SERVICES TO THEIR LIMITS

Torrential rain caused severe disruption across West Yorkshire as rivers threatened to burst their banks and roads became waterways. Emergency services were stretched to their limits across the county yesterday, as the West Yorkshire Fire and Rescue Service fielded 400 calls relating to flooding between 7 am and 4 pm.

Traffic was bumper to bumper on central Leeds and thousands of rail users were left stranded. Platforms at Leeds City Station were closed because of signal failure and the Ilkley to Leeds line was flooded, causing major delays.

Today's Otley carnival has been cancelled because of the weather and Thwaites Mill in Leeds was closed because of flooding.

Two motorists were rescued from their cars in Barnsdale Road, Allerton Bywater, by firecrews shortly before 2 pm.

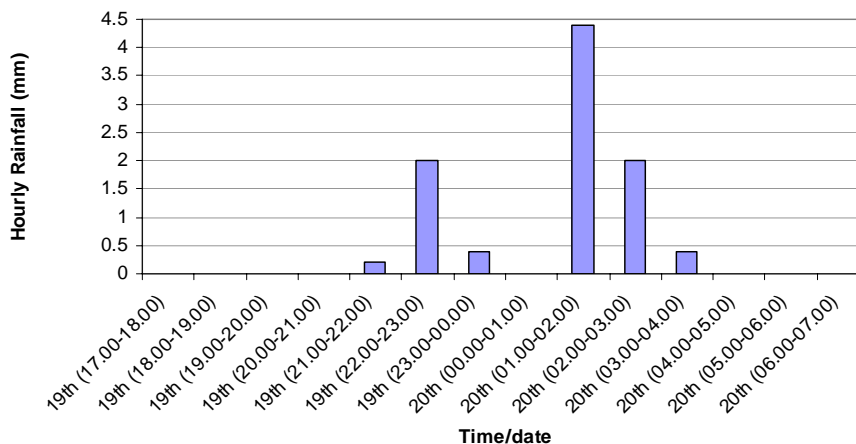
19th - 20th June



Photo courtesy of
www.bbc.co.uk/leeds

The second bout of intense rainfall fell overnight during a lightning storm on the 19th – 20th June, closing train lines between London and Harrogate and causing flooding in the city centre, Halton, Pudsey and Methley.

Rainfall recorded at Kidacre Street, Leeds
Overnight 19th-20th



WHAT THE PAPER'S SAID... Yorkshire Post, 20th June 2007

HOMES FLOODED IN HEAVY RAIN

Heavy rain across West Yorkshire. In Castleford (near Leeds) crews were called to the Green Lane area where high water had trapped employees inside the building. Firefighters used high volume pumps to clear out the excess water.

Across the region train services were crippled by delays and cancellations this morning after rail lines were flooded. In Leeds a series of roads were sealed off early this morning as clogged drains caused flooding. Train operators reported a string of cancellations and delays. GNER said trains from Leeds to London Kings Cross were cancelled this morning.

Traffic was also at a standstill. Scott Hall Road in Leeds was sealed off earlier this morning due to floods but was reopened just before rush hour traffic. Police reported flooding problems in Horsforth, Newmarket Lane, Methley and Northern Street on Leeds city centre.

The deluge came just days after Yorkshire was plunged into chaos with torrential rain. Parts of Allerton Bywater and Castleford were flooded by more than 4 feet of water.

June 25th

The most serious flooding in Leeds followed an unprecedented rainfall on Monday 25th June 2007, resulting in widespread flooding across the Leeds district. It was reported that northern England experienced the wettest June since records began. Over 153 mm fell in the north with around 100 mm of this falling in just over 24 hours. The vast majority of flooding incidents (houses, businesses and roads) were due to the significant level of surface run off or surcharging of the drainage system, highlighting the inability of the ground and the drainage infrastructure to cope with the extreme volumes of water.

In addition to excess runoff, there were also a number of incidents arising from watercourses overtopping their banks to cause major damage. Approximately 100 houses in the Leeds district were affected this way, including:

- In Halton, over 50 houses were affected by flooding from Wyke Beck for the third time in five years.
- In Collingham around 30 domestic properties were flooded by the Collingham Beck.
- A number of properties flooded in Wortley from the Wortley Beck.
- A wide swathe of Springhead Park in Rothwell was flooded by the River Dolphin, inundating the depot to 4 ft and flooding the aviary causing the death of 80 birds.



Photo courtesy of
www.bbc.co.uk/leeds



East Street Leeds, 25 June 2007

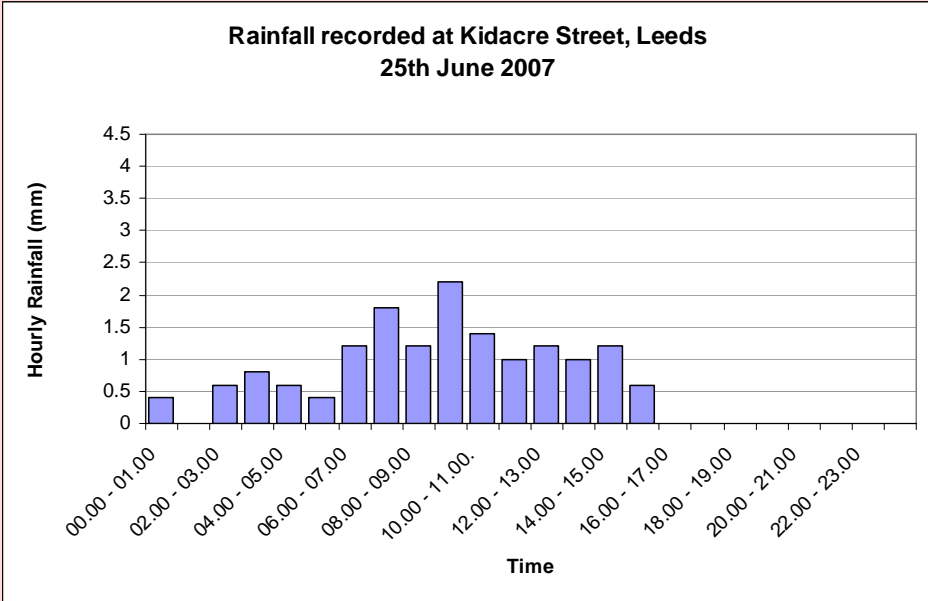
- Meanwood Beck overtopped its banks, flooding Millside Nursing Home; a number of residential properties at Monkbridge Terrace and Mill Pond Close; businesses at Meanwood Close and Meanwood Valley Farm.
- Sheepscar Beck at Mabgate overtopped and inundated businesses in the Mushroom Street area to around 4 feet.
- In Kippax around 12 houses in Ramsden Street were flooded by an unnamed watercourse.

Nine primary schools and four high schools in Leeds also had to be closed after being affected by flooding.

There was also major concern on the 25th June that the River Aire may breach its bank along Kirkstall Road, throughout the city centre and further downstream at Mickletown, potentially causing widespread and long term damage to homes and businesses.

A report was produced by the Council's City Development department and the Corporate Leadership Team to assess the impact of the June floods and the Council's response. The report concluded that the Council responded well to incidents, for example deployment of staff; distribution of sandbags, airbrick covers, floorboards and skips where required; preventative and reactive maintenance work at identified problem spots on watercourses; assessment of structural safety of buildings and bridges, gully cleansing in vulnerable places.

Environmental Health Officers were deployed to flooded areas to give advice on the dangers of flood water and how to clean up when waters subside. Rest centres were also set up at Fearnville Leisure Centre, Gipton (for residents choosing to leave their homes to be sheltered and fed) and at Leeds Town Hall (for stranded commuters).



WHAT THE PAPER'S SAID... Yorkshire Evening Post, 26th June 2007

LEEDS – “WORST FLOODS EVER”

A massive clean-up operation was underway after Leeds was hit by the worst floods in its recorded history. A massive 61 mm of rain fell in just nine hours in some areas of the city, causing millions of pounds of damage to flooded homes, schools and businesses.

Dozens of trains were cancelled and roads were gridlocked as the city tried to cope with the torrential downpour, the heaviest on a single day for 50 years.

Many areas saw six weeks worth of rain in just 24 hours yesterday [25th June] making this the wettest June ever – and possible the wettest month since Met Office records began in 1882. The exceptional weather conditions saw sustained torrential rainfall during a short period leading to flooding across Leeds. Amongst the worst affected areas were the Dunhill Estate in East Leeds where many properties were flooded from the Wyke Beck. A number of other properties experienced localised flooding across the city.

Emergency rest centres were set up at Leeds Town Hall in the city and the Fearnville Leisure Centre to accommodate people who had been stranded. Officers were planning to visit areas of the city known to have been affected by flooding to help residents and businesses recover. This will cover advice on issues such as temporary housing needs, hygiene and clean-up, clearing blocked gullies to make roads safe.

There were three severe flood warnings in place on the River Aire in Leeds city centre last night, threatening businesses including Capita, KPMG and the Royal Armouries at Clarence Dock. At Brewery Wharf, the River Aire flooded the walkway and there were fears nearby flats could be affected by the rapidly rising water levels.

Eyewitness Sarah Millett, 23, is a resident at Brewery Wharf and she said she couldn't believe it when she returned home from work to find the river so high: "I was really shocked, the water was halfway up the trees so you couldn't get anywhere near the path. You could swim down it but you couldn't walk down it. I'm surprised none of the garages have been flooded. People on The Calls must be getting worried because it was really high on that side, almost touching the windows."

Commuters at Leeds train station were left stranded as dozens of trains were cancelled and the station closed as a result of the massive downpour. Throughout the afternoon, many trains suffered severe delays, with no services operating at all between Leeds and Harrogate, Huddersfield and Sheffield. There were also no GNER services running between Leeds and London after flooding in five places on the busy line. Many more trains were heavily delayed and, with no replacement buses, British Transport Police were advising people not to travel unless absolutely necessary. As the rush hour reached its peak, Leeds train station was closed by the Transport Police.



Photo courtesy of www.bbc.co.uk/leeds

Across the region, major roads remained gridlocked for hours, parts of the M1, A1, M62 and A63 being completely submerged. A series of railway stations, including Sheffield and Leeds, were closed and hundreds of bus services were cancelled.

Dozens of people were evacuated from Leeds city centre to two emergency shelters after the River Aire broke its banks. Five control operators in West Yorkshire dealt with 200 calls an hour, and five schools were closed in Leeds.

As a result of the floods in June 2007 Leeds City Council incurred direct costs estimated at £1,588,383 in response to the flooding. These are subject to a claim under Government's Bellwin scheme and are detailed in the table below. In addition to the cost to Leeds City Council of £8,750,000 for residential damage, a further 4250 properties made some form of insurance claim including damage to sheds, garages, etc. (Leeds City Council, 2007(a)).

Local media reports:	<p><i>Flood havoc as downpour swamps Yorkshire</i> (Yorkshire Post, 15th June 2007).</p> <p><i>Disruption after deluge stretches 999 services to their limits</i> (Yorkshire Post, 16th June 2007).</p> <p><i>Homes flooded in heavy rain</i> (Yorkshire Post, 20th June 2007).</p> <p><i>Hundreds stranded as raging storm floods claim two lives</i> (Yorkshire Post, 25th June 2007).</p> <p><i>Leeds – “worst floods ever”</i> (Yorkshire Evening Post, 26th June 2007).</p>
Area affected:	All Leeds
Sectors affected:	<ul style="list-style-type: none"> Transport Residential property Leisure (sports, events, tourism) Emergency services Commercial / retail Education
Key impacts:	<ul style="list-style-type: none"> Businesses flooded and employees stranded Widespread residential flooding (estimated 250 homes in Leeds throughout June) Roads flooded – roads closed; motorists stranded Significant flooding of rail lines Leeds Rail Station closed for one afternoon Museums closed; parks flooded and local events cancelled Number of schools closed Rest centres set up in Leeds Town Hall (for stranded commuters) and Fearnville Leisure Centre (for residential flood victims) High levels of emergency calls (200 / hour in West Yorkshire on 25th June. Over £1.5 million cost to Leeds City Council in response to flooding

WEATHER EVENTS IN 2008

Date: 4th January 2008

Type of Event: WINTRY CONDITIONS



Magnitude of impact: 4th order (nuisance)

Description of event: Heavy snow and freezing winds brought havoc to the region's roads yesterday. Yorkshire and Humber was one of the worst affected areas in Britain as icy weather swept across large parts of the country. Although problems were mainly confined to north Yorkshire snow showers were recorded in Leeds.

Local media reports: "Snow chaos on Yorkshire roads" (Yorkshire Post, 4 January, 2008)

Area affected: Region-wide

Sectors affected: Transport

Key impacts: None specified for Leeds

Date: 21st January 2008

Type of Event: FLOODING



Magnitude of impact: 2nd order (disruptive)

Description of event: The Environment Agency issued two severe flood warnings for the River Aire in Leeds City Centre at the Clarence Dock area around the Armouries, and near The Calls. The river level in Leeds city centre peaked at a height that was 0.25 metres below that of summer 2007, and did in fact breach its banks at one point in the city centre.

WHAT THE PAPER'S SAID... Yorkshire Evening Post, 21st January 2008

LEEDS FLOODING: RIVER AIRE BURSTS BANKS

Leeds traffic was thrown into chaos on the afternoon of the 21st January when the River Aire burst its banks. The river gushed over its barriers close to Leeds Dam and Crown Point Bridge in the city centre.

Roads including Marsh Street, East Street and Neptune Street have been closed by West Yorkshire Police as a safety measure. Close by flood warnings were still in place along Sovereign Street to Leeds Bridge with businesses such as Capita and KPMG warned to be on their guard. Other nearby businesses and properties affected included the Royal Armouries and the University's riverside hall of residence at Clarence Dock.

Commuters were reporting severe delays due to the floods, with one Farsley man saying it had taken more than an hour to reach the city centre. The congestion was expected to get even worse with rush hour approaching.

Earlier a Leeds businessman watched in horror as water swallowed up his riverside bar after floods ravaged the city centre. The Aire Bar on The Calls was among businesses, residents and roads battered by rising rainwater on Monday after Leeds was given severe flood warnings. The rising river was knee deep on the bar's terrace by lunchtime and police urged staff to evacuate customers. Chris Howard, owner of the Aire Bar, criticised the council for not supplying sand bags immediately despite several requests. "It's eight inches up against the windows and they will only take so much pressure. We were hit twice last year and we lost about £30,000. Consequently we no longer have flood insurance because no-one will touch us. We pay our business rates for stuff like this. They were well aware and they would not give them out until we were higher risk. When I have got water coming in and they are saying you need to wait three or four hours because of prioritising, I am not sure how much more priority we can be."

Mr. Howard is now threatening legal action over the way the situation has been handled by the council.

The Royal Armouries closed at 3 pm after the flood warnings. A spokeswoman said: "From that time we will be moving some artefacts as a precaution but the main exhibits are on the second, third and fourth floors."

A council spokesman said: "We have been working closely with people at risk of flooding for several days but have had to prioritise who receives sandbags so the most vulnerable and needy are protected. We proactively work with local businesses to ensure contingency plans are in place for situations like this and would encourage anyone with questions on how best to protect their premises to contact us for advice and information."

LEEDS FLOODING LATEST

Flood duty officers have been monitoring rainfall levels while police were forced to close off roads across Leeds and Wakefield which had been hard hit by flooding. Cars were abandoned around the Bramhope area after roads were flooded, fire crews have said.

According to one reader the Meanwood Beck had curst its banks and was slowly threatening properties in Monk Bridge Terrace, Highbury Lane, Monk Bridge Road and Mill Pond Lane. Tenants on these roads feared repeat damage of that which occurred the previous June.

Homes in Garforth's Grange Avenue were today at risk of being flooded by water running off Glebelands playing fields. Local councillor Mark Dobson was helping with the distribution of sandbags to residents on the street, which was hit by last summer's floods.

At least one property on nearby Swillington Lane was also reported to have been flooded out.

Old Otley Road leading to Leeds Bradford Airport was flooded at the junction with Moor Road, prompting police to seal odd the road at 11 am.

Train services were also affected and diversions were in place while traffic jams gripped the M1 and M62 during this morning's rush hour. Train services were affected between Leeds and Manchester Victoria, and services on the Leeds-Harrogate route were suspended with trains only able to run between Harrogate and York. Services between Leeds and Sheffield were also subject to diversions and a reduced service.

A number of roads were also affected by flooding, including the A65 Leeds Road (closed both ways between Knott Lane and Horsforth); the B6135 was closed at Drighlington and; Otley Old Road was closed both ways at Bramhope.

- Local media reports:** *"Severe flood warning for Leeds and Wakefield"* (Yorkshire Evening Post, 21 January, 2008)
 "Leeds flooding: River Aire bursts banks" (Yorkshire Evening Post, 21 January 2008)
 "Leeds flooding latest" (Yorkshire Evening Post, 21 January 2008)
 "Flood risk eases but rail network still crippled" (Yorkshire Post, 21 January 2008)
- Area affected:** All Leeds
 City centre
- Sectors affected:** Transport
 Commercial / retail
 Residential
- Key impacts:** Local roads closed
 Businesses flooded in city centre
 Royal Armouries closed because of flood risk
 Residential flooding
 Train delays / diversions

Date: 23rd January 2008

Type of Event: HEAVY RAIN



Magnitude of impact: 3rd order (inconvenience)

Description of event: Traffic was almost at a standstill on the M1 and the M62 because of heavy rainfall. Rail services also suffered continued disruption as the heavy rain and flooding affected signalling circuits and caused major problems with stability on at least one rail embankment between Elland and Brighouse, a route which also serves Leeds. Train services between Leeds and Shipley were also affected; and the Trans-Pennine service between Leeds and Manchester was closed for a time while divers worked to establish the safety of a rail bridge.

Officers from the Environment Agency said they were particularly concerned with the River Aire after rainfall totals of 30-50 mm were forecast for the day.

Local media reports: *“Another crawl to work: Bus passengers rescued by boat”* (Yorkshire Post, 23 January 2008).
“Rail services in Yorkshire still face flood disruption” (Yorkshire Post, 24th January 2008).

Area affected: Region-wide

Sectors affected: Transport

Key impacts: Commuter congestion
Rail delays

Date: 25th January 2008

Type of Event: STRONG WINDS



Magnitude of impact: 1st order (highly disruptive)

Description of event: Storm force winds were responsible for toppling lorries on motorways and causing widespread flight cancellations. Gust of wind measuring 70 mph battered the region with high sided lorries particularly vulnerable.

Maximum 10-minute average wind speeds of 45 mph, 48 mph and 49 mph were recorded on January 25th, 26th and 27th (respectively) by the Leeds City Council weather station on Kidacre Street. Any 10-minute average above 39 mph is classed as gale force.

West Yorkshire Police said the first lorry was overturned on the northbound M1 and 11 am at junction 40. Twenty minutes later at junction 39 a wagon lost its ladders in the severe cross winds.

At 12.30 pm a lorry overturned near junction 39 of the southbound M1, and at 1 pm police requested the closure of the Aire and Calder Bridge at junction 30 of the M62 near Rothwell after a lorry almost had its roof ripped off.

High winds prevented planes from taking off and landing at Leeds Bradford International Airport on the afternoon of the 25th. Inbound flights were diverted to Doncaster, Manchester and Teeside, while departures were either cancelled or passengers were taken by bus to unaffected airports. The wind became too severe shortly after noon. A Leeds Bradford Airport spokesman told the Yorkshire Post: "Disruption to flights at LBA today is due to unusually high cross winds. In severe weather conditions it is the captains decision to take the most appropriate course of action."

Elsewhere in Leeds, engineers advised people to evacuate the area in Marshall Street, Holbeck at 1.03 pm following reports of an unsafe chimney. Later in the afternoon, Neville Street and Victoria Road in the city centre were closed to traffic because of debris blown in by the wind. The roads were expected to remain closed for the rest of Friday.

The high winds forced the closure of the Icecube skating rink in Millennium Square in Leeds at lunchtime, along with an outdoor photography exhibition 'Celebrating Leeds' in Victoria Gardens.

A woman with two small children was also reported to have been hit by a falling sign in Crown Point Road, Hunslet, Leeds, suffering an injury to her legs.

Local media reports:	<i>"New weather chaos as storms hit Yorkshire"</i> (Yorkshire Post, 25 January, 2008)
Area affected:	Region-wide
Sectors affected:	Transport Commercial / retail Leisure Health
Key impacts:	Overtuned lorries Flight cancellations and diversions Areas of city evacuated due to unsafe structures Closure of ice skating rink and outdoor photography exhibition Member of public injured by sign falling in high winds

Date: 31st January 2008

Type of Event: STRONG WINDS



Magnitude of impact: 2nd order (disruptive)

Description of event:

WHAT THE PAPER'S SAID... Yorkshire Post, 31st January 2008

FREAK WEATHER BATTERS LEEDS

Freak weather conditions battered the region again today causing chaos as winds reached speeds of up to 70 mph. Sleet, hail and rain bounced down from around 4 am causing road accidents, traffic jams and flight delays.

A string of planes were delayed or cancelled at Leeds Bradford International Airport because of strong winds.

The A1(M) at Wetherby was closed for an hour after palettes fell off a lorry and damaged three passing cars. No-one was injured in the accident at 8 am but the northbound carriageway was closed while the site was cleared, causing severe delays at rush hour.

West Yorkshire Police issued a severe weather warning advising drivers and pedestrians to take extra care.

Local media reports: *"Freak weather batters Leeds"* (Yorkshire Evening Post, 31 January, 2008)

Area affected: Leeds
Region-wide

Sectors affected: Transport

Key impacts: Road traffic accidents and delays
Delayed and cancelled flights
Police issued weather warning for drivers and pedestrians

Date: 27th February 2008

Type of Event: STRONG WINDS



Magnitude of impact: 2nd order (disruptive)

Description of event: The M1 was closed southbound for several hours at junction 40 after a northbound lorry overturned and was blown across the carriageway to block all three lanes. The closure, shortly after 4 pm, caused chaos as the rush hour traffic ground to halt. The lorry driver suffered minor injuries.

In Leeds a customer at a car dealership had a narrow escape after a corrugated iron roof blew off and crashed down onto a sales plot at Kelvic Industrial Business Park, Burton Street, Beeston. Several cars at Yorkshire Fleet Indoor Car Sales and neighbouring Corner Cars were damaged. YFI sales executive Mick Adams told the Yorkshire Post: "Someone was looking at the cars at the time and he's very lucky it missed him or he would have been seriously injured."

Local media reports: *"Chaos on roads as 70 mph winds batter the region"* (Yorkshire Post, 27 February, 2008)

Area affected: Leeds
Region-wide

Sectors affected: Transport
Commercial / retail

Key impacts: Motorway closed because of overturned lorries
Roof blown off car dealership damaging cars and narrowly missing customers

Date: 22nd March 2008

Type of Event: WINTRY CONDITIONS



Magnitude of impact: 3rd order (inconvenience)

Description of event: Air travellers were affected by the wintry Easter weather as snow hit flights at Leeds Bradford International Airport. Several flights were delayed and others were cancelled on the 21st and 22nd March.

Local media reports: *"Easter flights hit by weather"* (Yorkshire Evening Post, 22 March, 2008)

Area affected: Leeds

Sectors affected: Transport

Key impacts: Flights delayed or cancelled

Date: 10th June 2008

Type of Event: HEAT



Magnitude of impact: 3rd order (inconvenience)

Description of event: Rail passengers faced severe delays after hot weather damaged signalling equipment near York. Travellers were delayed for as long as two hours in some cases after problems struck at 3.50 pm, and severe delays continued to hamper trains into the evening as a result of the backlog of services. Rail passengers in Leeds would have been affected by disruption to both local services and services on the East Coast Mainline.

Local media reports: *"Rail delays as hot weather hits signals"* (Yorkshire Post, 10 June, 2008)

Area affected: Leeds

Sectors affected: Transport

Key impacts: Severe rail delays

Date: 4th September 2008

Type of Event: HEAVY RAINFALL



Magnitude of impact: 4th order (nuisance)

Description of event:

WHAT THE PAPER'S SAID... Yorkshire Post, 5th September 2008

**THREAT OF FLOODS AS TORRENTIAL
DOWNPOURS LASH REGION**

Huge swathes of Yorkshire face flood warnings this weekend as torrential downpours threatened to burst river banks. More than an inch of rain fell yesterday, a months rainfall in 36 hours, much of it on the Pennine catchments in North and West Yorkshire. Although nowhere in Yorkshire had seen significant flooding so far, Environment Agency officials were said they were worried that rising water levels in the Dales, combined with the continued blanket of rain expected overnight, could see Yorkshire towns flood.

The normally porous ground in Yorkshire was saturated from a summer of rainfall and rain could not sink in, so the whole region was at risk from surface water flooding.

Local media reports: *“Threat of floods as torrential downpours lash region”* (Yorkshire Post, 5 September 2008)

Area affected: Region-wide

Sectors affected: None specified

Key impacts: Flood risk

Date: 2nd – 4th December 2008

Type of Event: WINTRY CONDITIONS



Magnitude of impact: 1st order (highly disruptive)

Description of event: A cold snap led to several days of ice and heavy snowfall, with widespread impacts across Leeds and beyond.

In 2nd December as much as 20 cm of snow fell and up to 15,000 homes in the North East and Yorkshire lost power. Trans-Pennine routes were affected as drivers were warned of hazardous driving conditions on the M62 at Rishworth Moor, and heavy snowfall caused problems on Woodhead Pass and Snake Pass.

Pool Bank and Old Pool Bank in north Leeds were also closed on the morning of the 2nd December and there were long delays on the A65 from Ilkley into Leeds, with blockages at Guiseley and Yeadon.

Council chiefs said 30 gritters had covered the primary road network which includes all the main routes within Leeds. Passengers at Leeds Bradford Airport faced delays as heavy snow fell on the runway. Most trains were running, but buses between Harrogate and Leeds were cancelled, and delays were reported in many parts of the district.

All school buses were cancelled in Leeds, and 54 schools were listed as being closed because of snow.

Further heavy snowfall overnight on 4th December in parts of West Yorkshire caused a number of transport problems in Leeds. The poor weather conditions also led to a limited refuse collection service in Leeds. Street cleansing staff were engaged in gritting of priority routes, working in close consultation with officers in the Highways Department. Other ancillary services will operate as weather conditions allow.

78 schools and nurseries were closed in Leeds.

WHAT THE PAPER'S SAID... Yorkshire Post, 4th December 2008

LEEDS SCHOOLS CLOSE AFTER HEAVY SNOWFALL

Parts of West Yorkshire were in danger of coming to a standstill today following heavy overnight snowfall. Thousands of school children were told to remain at home as more than a dozen schools in Leeds alone closed.

Some commuters reported spending nearly an hour and a half driving into Leeds from places such as Normanton and Birstall. The AA warned motorists to take extra care in the difficult conditions.

Leeds Bradford International Airport was also badly affected by snowfall on the runway. Several morning in-bound flights were cancelled; and many flights out of the airport were either axed or subject to delays.

West Yorkshire's passenger transport authority, Metro, warned of widespread disruption to bus services with many being restricted to main roads. It said some rural and high level routes were hazardous while others were impassable. All school bus services in Leeds were cancelled. Many services offered by First in Leeds were running up to an hour late.

Leeds North West MP Greg Mulholland also branded the council's response to the cold snap as "inadequate". A spokesperson for the council however said that gritting has been carried out where necessary on Leeds' main roads each morning and evening since winter started to bite, and efforts were being made to cover the city's secondary roads. She said: "Our gritting teams are prepared and ready to deal with the expected wintry weather conditions in order to keep the city of Leeds moving."

Local media reports:	<i>"After the struggle to work... another cold snap on the way"</i> (Yorkshire Post, 2 December 2008) <i>"Leeds schools close after heavy snow fall"</i> (Yorkshire Evening Post, 4 December 2008) <i>"Snowfall brings chaos to region"</i> (Yorkshire Post, 5 th December 2008)
Area affected:	All Leeds Region-wide
Sectors affected:	Transport Utilities and infrastructure Waste collection Education
Key impacts:	Transport disruption – hazardous driving conditions Flight delays Bus cancellations Widespread school closures

Date: 7th December 2008

Type of Event: WINTRY CONDITIONS



Magnitude of impact: 2nd order (disruptive)

Description of event:

WHAT THE PAPER'S SAID... Yorkshire Post, 7th December 2008

BABY INJURED AS AMBULANCE OVERTURNS ON MOTORWAY

A baby was today injured when an ambulance overturned on ice on the M62. The infant was being taken from Preston to Leeds when the ambulance skidded and overturned at the junction with the M621.

The baby was taken in another ambulance to Leeds General Infirmary where the condition of the child is not known, but a police spokesman described the incident as "serious".

Police said there were a number of minor accidents on the stretch of motorway prior to the ambulance overturning at 8.43 am.

The female driver of a Toyota Corolla was involved in an accident with a VW Passat and moments later a Nissan Micra crashed into the central barrier. While police were en route to the scene, near junction 27, the ambulance skidded and overturned at the same location. A spokesman added: "It is believed ice on the roadway was a primary contributory factor. The ambulance crew were said to be shocked by the accident but otherwise unhurt. No-one else was injured.

The junction remains closed while investigations continue. Roads in the region were left treacherous after a heavy frost saw temperatures plunge below freezing.












































Local media reports: *"Baby injured as ambulance overturns on motorway"* (Yorkshire Post, 7 December 2008)

Area affected: All Leeds
Region-wide

Sectors affected: Transport

Key impacts: Road accidents on icy motorways

2.4 Summary of events

Season:	2002	2003	2004	2005	2006	2007	2008	
Winter (Dec-Feb)	 30-31 Dec	 4 Feb	 2 Jan	 1 Jan		 18 Jan	 4 Jan	 21 Jan
	 28 Jan		 28 Jan	  7-9 Jan			 23 Jan	 25 Jan
	 11 Feb			 20 Jan			 31 Jan	 27 Feb
	 22 Feb			 24 Feb			 2-4 Dec	 7 Dec
Spring (Mar-May)		 13 Apr	 20 Mar	 3 May	 4 Mar		 22 Mar	
Summer (Jun-Aug)	  30 Jul-2 Aug	 22 Jun	 August		  2 Jul	 June	 10 Jun	
		 12-13 Jul			 17-31 Jul		 4 Sep	
		 3-9 Aug			  17 Aug			
Autumn (Sep-Nov)	 28 Oct				 14 Sep			
					 26 Oct			



Strong winds



Flooding



Heavy rain



Lightning strike



Wintry conditions



Heat



1st order event (highly disruptive)



2nd order event (disruptive)



3rd order event (inconvenience)



4th order event (nuisance)

The chart on the previous page summarises the record of weather events according to the season or the year in which they occurred. It is apparent that most of the events occurred in either the winter or summer months, rather than in spring or autumn. Winter is also the season which has experienced the most disruption as a result of severe weather – nine of the twenty events reported in winter months were either 1st or 2nd order (compared to just two 1st order events in summer months) and were mostly as a result of strong winds.

Strong winds and floods were the most frequent type of severe weather experienced over the LCLIP study period (see table 2), and were also the events responsible for the highest level of disruption. Strong winds accounted for three 1st order events and 4 second order events over the study period; whereas flooding featured in three 1st order events and two 2nd order events.

Table 2: Frequency of severe weather events by type

Year	Strong winds	Flooding	Heavy rain	Lightning strike	Wintry conditions	Heat
2002	3	3	1	0	0	0
2003	1	0	0	1	1	2
2004	1	1	0	0	2	0
2005	2	2	0	0	2	0
2006	1	2	3	1	1	1
2007	1	1	0	0	0	0
2008	3	2	2	0	4	1
Total:	12	11	6	2	10	4

There is currently a high level of awareness of flood risk in Leeds partly as a result of recent high-profile flooding events and partly because of the drive both locally and nationally for climate change initiatives. As a result a lot of work is currently underway which will help the district to wherever possible avoid or else improve the response to flooding – this work is discussed further in chapter 4.

Gales are already a significant issue in the current climate, and are thought likely to increase in the future. There are currently few policies in place that enable developers or authorities to adapt to the impacts of gales and associated damage or disruption in Leeds. This is an area that could therefore be considered as an adaptation priority despite any uncertainty about future increases in storminess and strong winds.

Wintry conditions also feature quite prominently on the list of weather related events encountered in Leeds since 2002, and are even responsible for a couple of 1st or 2nd order events. However, climate change models predict warmer winters with less extreme cold temperatures and so it is envisaged that snow and ice are less likely to be a problem in Leeds in the medium to long term.

Further implications of these findings will be discussed for each relevant sector in the chapter 4 on service summaries.

3. COUNCIL RECORDS OF THE IMPACT OF SEVERE WEATHER

3.1 Leeds City Council

By looking at the events described in the previous section, it is clear that severe weather can and does have a significant impact to the people of Leeds and to services provided in the district. However, the full scale of the impact is at present impossible to quantify due to a lack of systems to adequately report damage or impacts to services specifically due to weather events. For example, a log of all calls to the council reporting problems or complaints are recorded by the council's Contact Centre, but are logged by the nature of what action needs to be taken by the authority (such as 'housing repair' or 'road resurfacing') and as such cannot be linked back to the cause of the problem. Costs of repairs and the clean-up from severe weather events are also often incorporated into general maintenance provision and are not specifically recorded as being as a result of severe weather.

Leeds City Council's Land Drainage team does keep a record of calls it receives from members of the public, although these only record the number of calls received on a particular date. Therefore it is possible to approximately gauge the severity of an event by the number of calls received reporting problems, but do not provide specific information on the number or location of flooding events, or even the type of flooding that has been reported (e.g. highway, homes, etc).

However, the aftermath of the flooding in Leeds in June 2007 incurred significant costs to the council, and as a result a claim was made under the Bellwin scheme – a scheme of emergency financial assistance from the Government to help local authorities to meet uninsurable costs incurred when dealing with the aftermath of an emergency in their area. Table 3 details the costs included in the claim and it can be seen that the Authority incurred costs of £1,588,383 responding to the flooding. Other costs across the city outside of the Authority's area of responsibility (namely flooding of residential property and vehicles) were also estimated and can be seen in Table 3. In total these were estimated at over £10 million in insurance payouts.

Table 3: Non-Council Related Costs as a result of June 2007 flooding

Affected area	Detail	Cost (£)	Notes
Flooding to residential properties	250 properties at average buildings and contents damage of £35,000 per ABI	8,750,000	Further 4,250 properties made some form of insurance claim including for damage to sheds, garages etc.
Flood damaged vehicles	250 vehicles	1,875,000	Assume average payout of £7,500

3.2 Environment Agency Floodline Records

The Environment Agency provide a national Floodline service, which offers the public simple advice on what to do when there is a risk of flooding. Although records of calls received are kept by Floodline, they are classified at a regional level and therefore local records are not available. In addition no record made of the nature of the calls (Environment Agency, personal correspondence, 2009) and so provide limited information when examining severe weather impacts.

Table 3: Details of costs reclaimed under Bellwin Scheme for June 2007 flooding

Team / department	Detail	Cost(£)	Note
Land Drainage	Additional non-main river maintenance & air brick covers	8,000	Includes the procurement of 800 additional airbrick covers.
Structures	Staff costs incurred on bridge and structure inspections.	10,500	
	Underwater inspection requirements.	7,000	
Parks and Countryside	Removal of trees and timber	64,000	
	Staff time re flood enquiries	1,735	
	Flood damage at Springhead Park	8,966	
	Flood damage at Roundhay Park	5,818	
	Checking inspection chambers and drains	816	
	Drain clearing and sandbagging	511	
Highways	All highways costs incurred across all depots.	80,000	
Environmental Services	Gully tanker crew response 24/7.	10,088	
Area Management	Skips, staff overtime, etc.	7685	
Land Drainage	Provision of flood boards for specific properties	150,000	
Structures	Damage to structures: - Fingreen wall/parapet	52,500	
	- Milner Lane culvert	157,500	
	- Fox Wood footbridge	21,000	
Parks and Countryside	West and Northwest wedge	184,013	
	South wedge	66,969	
	East and Northeast	36,069	
	Countryside and access	209,334	
	Redhall and nursery	14,500	
Former Learning & Leisure properties	Thwaite Mills and Armley Mills	7,500	
	Springhead Park Depot	3,000	
Highways	All highways costs incurred across all depots.	100,000	
Education Leeds	Damage to schools	233,429	
Council Tax	Award of Council Tax relief to affected households.	52,000	
Facilities Management	Mandela Centre - damage to retaining wall.	35,000	
	Weston Lane Community Centre - damage to floor.	13,500	
	Blackburn Hall & Strawberry Lane Community Centre - major roof damage	19,000	
	Cross Green Youth Club - floor repairs	2,750	
	17 Properties - minor roof and decoration repairs	10,200	
Total		£1,368,264	

4. SERVICE SUMMARY

4.1 Transport

	TYPE OF SEVERE WEATHER EVENT					
	Strong winds	Flooding	Heavy rainfall	Lightning strike	Wintry conditions	Heat
Strategic roads Of which are 1 st or 2 nd order:	9 1 st : 2 2 nd : 3	4 1 st : 3 2 nd : 0	1 1 st : 0 2 nd : 0		1 1 st : 1 2 nd : 0	
Local roads Of which are 1 st or 2 nd order:		5 1 st : 2 2 nd : 1			5 1 st : 2 2 nd : 0	
Rail Of which are 1 st or 2 nd order:	3 1 st : 1 2 nd : 1	4 1 st : 2 2 nd : 1	1 1 st : 0 2 nd : 0	1 1 st : 0 2 nd : 0	2 1 st : 1 2 nd : 0	2 1 st : 0 2 nd : 0
Bus services* Of which are 1 st or 2 nd order:	1 1 st : 1 2 nd : 0				2 1 st : 1 2 nd : 0	
Airport Of which are 1 st or 2 nd order:	3 1 st : 2 2 nd : 1				2 1 st : 1 2 nd : 0	

* Where specific impacts to bus services have been mentioned. It can also be assumed that where the road network has been impacted buses using those roads will also be affected.

There were 37 weather-related severe weather events that impacted on the transport system over the seven-year LCLIP period, by far the most of any other sector. Most of these were as a result of strong winds, particularly on the strategic road network, and five out of the nine reported incidents on strategic roads as a result of high winds were classified as 1st or 2nd order events (most disruptive). There is uncertainty about how the frequency and severity of gales will change with climate change, although it is thought that the small increase in average winds speeds predicted by climate models could manifest itself in a few very severe events rather than a general increase (discussed further in chapter 6). As strong winds have been found to be the type of weather event to currently have the highest impact, actions to reduce wind damage or disruption on the transport network could be considered a priority for adaptation. Possible measures that could be considered include natural shelter belts; selecting resilient tree species alongside highways; or installation of wind diffusers along highways and on rail embankments. Other measures could involve greater enforcement of Highway Agency speed warning systems targeting high-sided vehicles during episodes of severe cross winds on the strategic network.

The second most commonly encountered in this sector was flooding of roads and rail networks, and the majority of flooding incidents reported were classed as either 1st or 2nd order events. Measures to avoid flooding of highways and to facilitate the clean-up of any floods that do occur have been incorporated into the Water Asset Management Working Group's action plan, detailed in appendix A

Disruption due to wintry conditions was another commonly reported impact, and is also represented in a fairly high proportion of events categorised as either 1st or 2nd order events. Wintry weather was found to affect all types of transport, although problems were most commonly reported for the local road network. With climate change the frequency of snowy and icy conditions is expected to reduce, and so impacts associated with this type of weather may become less of a problem. In the short to medium term slight warming of winter average temperatures could lead to more frequent marginal weather conditions, where the

temperature hovers close to freezing point. When coupled with greater frequency of rain, grit and salt are flushed off the highway either requiring more frequent gritting. This phenomenon has already been observed by the winter maintenance team at Leeds City Council's Highways department in recent years, where despite modifications and improvements to winter maintenance the decision of when to grit roads has proved to be difficult, resulting in either a risk of increased costs associated with unnecessary gritting or the risk of more accidents on the road network.

Hot weather conditions were only reported to affect rail lines over the course of the study period (through signal damage and risk of rails buckling). Periods of intensive heat are expected to become more frequent in the future with climate change and problems associated with hot weather can be expected to get worse. Hot weather impacts on transport can include rails buckling, signal damage (both rail and road), tarmac melting, and the risk of heat exhaustion and thermal discomfort for passengers on public transport.

Of the 46 transport impacts recorded as a result of severe weather events throughout the LCLIP period, 26 were classified as either 1st or 2nd order events (those incurring the most amount of damage and disruption). The types of impact that occurred over the time period from these types of events were:

- Rail power lines down in strong winds
- Burst manhole covers (flooding).
- Road traffic accidents.
- Lorries blown over.
- Flooded roads.
- Flooded rail line.
- Debris and fallen trees on roads and rail lines.
- Flights cancelled or delayed because of strong winds or snowfall.
- Roads and bus routes impassable because of snow.

Other less disruptive impacts reported over the LCLIP period included:

- Rail power lines down in strong winds.
- Rail speed restrictions (threat of buckled rails in hot weather).
- Lightning strike damage to rail signals.
- Vehicles stranded because of flooding.
- Rural bus services suspended because of snow.

4.2 Residential Property

	TYPE OF SEVERE WEATHER EVENT					
	Strong winds	Flooding	Heavy rainfall	Lightning strike	Wintry conditions	Heat
Residential flooding		9				
Of which are 1 st or 2 nd order:		1 st : 4 2 nd : 2				
Fires				2		
Of which are 1 st or 2 nd order:				1 st : 0 2 nd : 0		
Wind damage	4					
Of which are 1 st or 2 nd order:	1 st : 2 2 nd : 1					

From the table above we can see that of the weather events studied flooding has had most recorded impacts on housing over the seven year LCLIP period, and of these two thirds were classified as either 1st or 2nd order events (i.e. those causing the highest level of damage and disruption). This suggests that as well as flooding being the most common weather-related impact on housing, it is often very damaging when it does occur. It is widely anticipated that flooding events will increase in both frequency and severity in the future with climate change and so it appears that preventing flood events and protecting vulnerable properties should be considered a priority for future action. This has already been realised in Leeds and a lot of work has been undertaken to ensure a high level of maintenance of drainage systems in Leeds. Support from Leeds City Council is also being given to the Environment Agency's bid for a major flood defence scheme on the River Aire - this work is discussed further in chapter 6.

Wind damage was the next most commonly incurred weather impact in the residential sector. There were four incidents of wind damage to houses recorded over the LCLIP period and three of these were incurred during 1st or 2nd order events.

The only other weather type that was found to impact on residential housing was lightning which caused fires and structural damage to houses on two occasions. As lightning strikes only generally affect one property at a time and the damage caused to an individual property can be severe, none of the strike events were classified as 1st or 2nd order events as there was limited damage caused to the district as a whole.

Specific weather-related impacts incurred in the LCLIP:

- Flooding of houses.
- Fires sparked by lightning strikes.
- Wind damage to properties (roofs, windows, gable ends blown down).
- Structural damage caused by lightning strikes.

4.3 Utilities and Infrastructure

	TYPE OF SEVERE WEATHER EVENT					
	Strong winds	Flooding	Heavy rainfall	Lightning strike	Wintry conditions	Heat
Power cuts Of which are 1 st or 2 nd order:	1 1 st : 0 2 nd : 0	1 1 st : 1 2 nd : 0				
Demand for additional electricity production Of which are 1 st or 2 nd order:						1 1 st : 1 2 nd : 0

Utilities and infrastructure were affected over the LCLIP period by two 1st order events - one from flooding, one from heat. Flooding and extreme heat are expected to get more common in the future and so impacts from these types of can be expected to occur more frequently.

In addition two events (one from flooding, one from strong winds) resulted in power cuts. These types of weather event are expected to increase in frequency and possibly severity in the future with climate change.

On one occasion extra demand for power during a heat wave was attributed to an increase in the use of air conditioning systems. This is an area that could need addressing as use of air conditioning units is likely to increase as heat wave conditions become more frequent. There are obvious health and comfort issues relating to overheating, and therefore it is important to be able to control temperature inside buildings, although widespread installation of energy-dependant cooling systems will ultimately exacerbate the problem by contributing to climate change through increased carbon emissions. Alternative cooling and ventilation systems should be considered wherever possible.

4.4 Leisure (sports, events, tourism)

	TYPE OF SEVERE WEATHER EVENT					
	Strong winds	Flooding	Heavy rainfall	Lightning strike	Wintry conditions	Heat
Regional/national sports events cancelled Of which are 1 st or 2 nd order:		1 1 st : 0 2 nd : 0				
Local sports pitches closed Of which are 1 st or 2 nd order:		1 1 st : 0 2 nd : 0			1 1 st : 0 2 nd : 0	
Local events cancelled Of which are 1 st or 2 nd order:	1 1 st : 1 2 nd : 0	1 1 st : 1 2 nd : 0				
Museums, etc. closed Of which are 1 st or 2 nd order:		2 1 st : 1 2 nd : 1				
Parks affected/closed Of which are 1 st or 2 nd order:		1 1 st : 1 2 nd : 0				
Increased tourism Of which are 1 st or 2 nd order:						2 1 st : 0 2 nd : 0

Impacts appear to be spread fairly evenly across different aspects of the leisure and sports sector, however over the past seven years we can see that flooding has been responsible for the majority of the impacts reported and many of the flooding incidents occurred during 1st or 2nd order events. Flooding is expected to get worse with climate change and so any actions that can be taken to safeguard leisure activities / facilities from flooding in the future should be prioritised where possible and if deemed necessary (e.g. it may be preferable to let sports pitches flood than other more sensitive areas).

Other impacts recorded have been from strong winds (ice rink and outdoor photography exhibition closed/cancelled); wintry conditions (council sports pitches closed); and heat (rise in foreign holidays to escape humid hot weather, increased tourism from good weather).

None of the impacts occurring as a result of wintry weather or heat waves were classified as being part of either a 1st or 2nd order event, and so were not considered to be significantly damaging or disruptive to the people of Leeds. Those impacts relating to severe winter weather events can be expected to occur less frequently in the future as climate change prediction models forecast warmer winter seasons. If heat waves are to become more common in the future there may be negative effects in terms on participation in sports, etc. although it is likely that more benefits/opportunities will arise in the sports, leisure and tourism sectors as a result of generally warmer summer weather.

4.5 Emergency Services

	TYPE OF SEVERE WEATHER EVENT					
	Strong winds	Flooding	Heavy rainfall	Lightning strike	Wintry conditions	Heat
Dangerous buildings / structures in public areas Of which are 1 st or 2 nd order:	2 1 st : 0 2 nd : 1					
Damage to property Of which are 1 st or 2 nd order:	2 1 st : 0 2 nd : 1	1 1 st : 0 2 nd : 0				
Damage to highways structures Of which are 1 st or 2 nd order:	1 1 st : 0 2 nd : 0					
Fallen trees Of which are 1 st or 2 nd order:	4 1 st : 0 2 nd : 1					
High levels of calls received*	3	4				

* These events may be double counted in the table as they are recorded as high levels of calls and by the nature of the call (e.g. high levels of calls regarding damage to property due to high winds will be listed both as high levels of calls and damage to property).

Strong winds were responsible for almost all of the incidents reported to emergency services, with fallen trees the most common cause for alerting emergency crews as well as damage to residential buildings and unsafe buildings/structures in public areas.

The only other type of weather event that was specifically reported in the local media to directly involve the emergency services was flooding, and the high number of calls was received by emergency services to report flooding incidents implies that widespread disruption was regularly experienced during flood events.

4.6 Commercial / Retail

	TYPE OF SEVERE WEATHER EVENT					
	Strong winds	Flooding	Heavy rainfall	Lightning strike	Wintry conditions	Heat
Business activity restricted / suspended	2	6				
Of which are 1 st or 2 nd order:	1 st : 0 2 nd : 2	1 st : 5 2 nd : 0				
Commercial or retail property damage	4	7				
Of which are 1 st or 2 nd order:	1 st : 3 2 nd : 1	1 st : 5 2 nd : 1				
Sales boost						1
Of which are 1 st or 2 nd order:						1 st : 0 2 nd : 0
Sales drop						1
Of which are 1 st or 2 nd order:						1 st : 0 2 nd : 0

Almost all of the weather-related impacts encountered by the commercial and retail sector were as a result of flooding and gales, resulting in physical damage to property and loss of business often as a result of having to close because of the damage. It is widely expected that flooding will become more frequent in the future because of climate change, and the possible cost to the local economy because of damage and disruption to local businesses is a big concern in Leeds. This is an area that will need to be prioritised when establishing adaptation actions in Leeds due to the high likelihood of flooding affecting the commercial and retail sector.

Although there is uncertainty in the climate models, it is also thought that there may be an increase in the strength and severity of gales in with climate change. Given that significant damage is already being seen as a result of strong winds (there were six 1st and 2nd order events over the LCLIP period affecting business activity or damaging commercial property) wind damage is also an area that should be considered when establishing adaptation actions.

4.7 Waste Collection

	TYPE OF SEVERE WEATHER EVENT					
	Strong winds	Flooding	Heavy rainfall	Lightning strike	Wintry conditions	Heat
Disrupted refuse collection					2	
Of which are 1 st or 2 nd order:					1 st : 1 2 nd : 0	

Wintry weather is the only problem reported to have impacted on waste collection over the LCLIP period, as waste refuse vehicles sometimes cannot operate on icy or snowy roads. As winters in the future are expected to become warmer, these problems are expected to become less frequent in the future. However additional problems in the future could arise with the expected warmer climate, particularly in summer as problems with odour and vermin may become more frequent.

4.8 Health

	TYPE OF SEVERE WEATHER EVENT					
	Strong winds	Flooding	Heavy rainfall	Lightning strike	Wintry conditions	Heat
Injuries from wind-blown debris	3					
Of which are 1 st or 2 nd order:	1 st : 2 2 nd : 1					
Health advice given						1
Of which are 1 st or 2 nd order:						1 st : 1 2 nd : 0
Road traffic injuries					1	
Of which are 1 st or 2 nd order:					1 st : 0 2 nd : 1	

Most health impacts reported over the LCLIP period related to injuries arising from flying debris in high winds. There were only two other health-related impacts reported: one as a result of a road traffic accident in icy conditions; and the other being the issuing of health advice during hot weather conditions.

All of the health impacts listed in the table above occurred during 1st or 2nd order events, implying that health was only endangered during the most severe weather events. Although the future likelihood of higher winds is uncertain, it is thought that increased storminess can be expected in the future. If this is the case, problems with structural safety may become more of an issue. Periods of extreme heat are widely expected to become more common in the future and so health problems associated with extreme heat (respiratory problems, dehydration, etc.) could become a significant problem.

4.9 Education

	TYPE OF SEVERE WEATHER EVENT					
	Strong winds	Flooding	Heavy rainfall	Lightning strike	Wintry conditions	Heat
School closures	2	3			3	
Of which are 1 st or 2 nd order:	1 st : 1 2 nd : 0	1 st : 3 2 nd : 0			1 st : 2 2 nd : 0	
School building damage	2	2				
Of which are 1 st or 2 nd order:	1 st : 1 2 nd : 0	1 st : 2 2 nd : 0				
School buses affected					3	
Of which are 1 st or 2 nd order:					1 st : 2 2 nd : 0	

Schools have been quite widely affected by weather over the LCLIP period, most commonly from school closures as a result of strong winds, flooding and wintry conditions. These types of weather can affect schools either through structural damage to the school building (as is the case with wind damage and flooding) or because pupils and teachers are unable to travel to the school (e.g. wintry weather).

Problems arising as a result of wintry weather can be expected to occur less frequently in the future. However damage and disruption as a result of flooding in particular, but also possibly wind damage, may get more frequent and severe.

5. FUTURE CLIMATE CHANGE

5.1 Yorkshire and Humber Climate Change Adaptation Study 2009

Modelling carried out for the adaptation study assessed current climate variability and trends in the region and 'downscaled' climate projections for the region (UKCIP 02, medium-high emissions scenario) using the Environment Agency's Rainfall and Weather Generator (EARWIG). This enabled more detailed projections to be made than have previously been available, and the key projected climate changes found are included in table 4 below.

Table 4: Projected climate changes for the Leeds City Region generated by EARWIG

- **Annual average daily temperatures rising by almost 2°C;**
- **Extreme hot temperatures will increase, with summer temperatures reaching 34°C;**
- **A reduction in annual rainfall of up to 6%, although by less in upland areas;**
- **Greater seasonality of rainfall, with increases in winter combined with significant reductions in summer;**
- **In northern and upland areas an increase in the in the number of extreme rainfall events;**
- **Dry spells (over 10 consecutive days without rain) are expected to increase in number;**
- **Significant reductions in the number of days of frost and snow;**
- **Marginal increases in winter average wind speeds, although summer and autumn speeds reduce slightly.** According to the UKCIP02 climate scenarios, mean wind speeds are little changed except for an increase (3-5%) in winter by the 2080s. This is likely to be due to an increase in the number of occasions of strong winds. However, as neither the 2002 or the 2009 climate models are able to produce accurate regional estimates of future wind patterns it is not possible to predict future wind events with any confidence. Changes in storminess (extremes of wind and rainfall) are also uncertain, and have not been adequately validated.

5.2 UK Climate Projections 2009

Since the regional adaptation study was completed, the UK Climate Projections (UKCP09) have been published and provide updated climate information for the UK up to the end of this century. The UK Climate Projections are based on a new methodology designed by the Met Office, and allows a measure of the uncertainty in future climate projections to be included in the information. The 2009 findings for the Yorkshire and Humber region predict the same key changes to the climate as the 2002 scenarios, but are able to provide a guide to the likelihood of a particular aspect of climate change to occur for various timescales and emissions scenarios. Key findings for Yorkshire and Humber in the 2080s for a medium emissions scenario are listed below:

- **Increase in winter mean temperature:** The central estimate of change is a 3°C increase; it is very unlikely to be less than 1.6°C and is very unlikely to be more than 4.6°C.
- **Summer mean temperature:** The central estimate of change is a 3.3°C rise; it is very unlikely to be less than 1.7°C and is very unlikely to be more than 5.4°C.
- **Winter mean precipitation:** The central estimate of change is an increase of 15%; it is very unlikely to be less than 2% and is very unlikely to be more than 33%.
- **Summer mean precipitation:** The central estimate of change is –23%; it is very unlikely to be less than –44% and is very unlikely to be more than 0%.

6. PAST AND POTENTIAL FUTURE WEATHER IMPACTS IN LEEDS

The future climate impacts identified in the Regional Adaptation Study is now considered further, looking at how each of these types of weather event have affected Leeds in the past; what impact they may have in the future; and what we can learn from past experience in terms of adapting to cope with extreme weather.

6.1 Higher temperatures

i. Summary of impacts of recent weather events on Leeds

The impacts of hot weather documented in Leeds since 1992 are summarised below:

- Record sales were recorded at Richmond Ice Cream factory in Cross Gates, Leeds in August 2003.
- In July 2006 rail restrictions and speed limits were put in place on rail lines around Leeds for fear of the rails buckling in high temperatures.
- Medical advice to avoid effects of the sun and to keep hydrated were published in local media.
- A rise in foreign holidays was reported in August 2006 as people tried to escape the heat in the UK.
- Centrica's gas-fired South Humber plant was switched on unexpectedly in August 2006 as power firms were asked to generate more electricity following a surge in demand as air conditioning is used.
- Fall in shoppers in hot weather reported in August 2006.

ii. Potential/future impacts

In the Yorkshire and Humber region average daily temperatures are expected to rise by almost 2°C (Yorkshire and Humber Assembly, 2009). Extreme hot temperatures are also expected to increase, with summer temperatures more regularly exceeding the day-time threshold for declaring a heat wave, which in Leeds is 29°C (Leeds Primary Care Trusts, 2005). Associated health impacts associated with heat wave conditions, such as heat stroke and heat exhaustion, are well documented.

It is anticipated that higher temperatures will lead to an increased risk of photochemical pollution episodes from road traffic emissions, which will affect the health of people suffering from respiratory illness. Increased frequency of hot, dry weather may also result in high levels of dust and other particulate matter in the air, similarly affecting respiratory health.

In addition plant and animals species could be affected by increasing temperatures, and their natural distributions and ranges could change. This could mean the loss of some species whose natural habitats are no longer viable due to higher temperatures, although new species will establish themselves in the warmer climate creating new opportunities for horticulture and agriculture (e.g. the possibility of more commercial vineyards in Leeds).

Higher temperatures could have varying impacts on travel behaviour. Warmer weather may encourage more people to walk and cycle, although extremely high temperatures could put people off and lead to thermal comfort issues for people using public transport.

The Yorkshire and Humber Climate Change Adaptation Study Local Area Report for Leeds (Yorkshire and Humber Assembly, 2009) identifies the following as key impacts for the Leeds metropolitan district:

- Higher summer temperatures are expected to increase demand for leisure and tourism, especially rural and outdoor amenity, over an extended season. It is thought that this may place strain on existing attractions and infrastructure.
- Indoor air temperatures are likely to rise in the summer in schools and public buildings particularly in urban areas, with impacts on indoor air quality and thermal comfort.

iii. Actions already taken

Heatwave Plan

In recognition of the potentially dangerous health effects from heat exhaustion and heat stroke and the fact that heatwaves are expected to become more common in the UK with climate change, a Heatwave Plan was drawn up by the Leeds Primary Care Trusts in 2005. This plan is operational between 1st June and 15th September each year, and sets out what needs to happen before and during the heatwave event and includes specific at-risk groups.

There are four levels of response based upon threshold temperatures: Level 1 (Awareness), Level 2 (Alert), Level 3 (Heatwave), and Level 4 (Emergency). At each level action required by the Primary Care Trusts and Leeds City Council Social Services Department are set out in the Heatwave Plan.

The Plan is based on threshold day and night time temperatures as defined by the Met Office. In the Yorkshire and Humber Region a heatwave (Level 3) will be declared when the daytime temperature reaches 29°C and the night-time temperature does not fall below 15°C. When Level 4 is reached a major incident may be declared locally, regionally or internationally. Effects may be judged to extend beyond the health and social care systems, and existing emergency policies and procedures will apply.

DfES Standards for School Premises

This guidance was produced to describe the minimum standards set in The Education (School Premises) Regulations 1999 for the premises of all maintained schools in England and Wales, as well as describing how these standards can be achieved. Non-maintained special schools and approved independent schools must also meet some of these standards.

Although not specifically aimed at climate change, the standards establish optimum temperatures for children in schools (see table 5) as well as ventilation. Both of these factors will become of increasing importance with climate change.

Table 5: DfES standards for school premises – optimum temperatures

Use of room / space	Optimum internal temperature
Special needs schools, low activity areas or areas with very young children	21°C
Circulation spaces (e.g. corridors) and for areas with high levels of activity e.g. sports halls	18°C
Special needs schools, low activity areas or areas with very young children	15°C

Schools need to have the capability to ventilate certain areas at a higher rate than usual on very hot days. In most rooms this additional ventilation can be achieved by opening windows, doors or air vents, but if this is not possible mechanical ventilation needs to be considered.

iv. Potential/future actions

The Yorkshire and Humber Adaptation Study's Sub-Regional Assessment for West Yorkshire identified the following adaptation responses:

- High levels of insulation in buildings will cool internal environments during hot spells and retain heat in the winter. Urban and building design should consider the following:
 - a. Use trees and other vegetation widely throughout urban areas. Trees can effectively reduce surface temperatures and provide shade. They also have valuable biodiversity, health and social benefits.
 - b. Green roofs on new buildings help to reduce water run off (and thus flooding risk), promote urban cooling and provide habitats for biodiversity. Old buildings could also be retrofitted with green roofs. They also provide additional wellbeing benefits by allowing occupants of the building to enjoy the green spaces that they provide.
 - c. Building design should make the best possible use of natural light, shading and ventilation as an alternative to energy intensive heating and cooling systems. Incorporate renewable energy generation systems into buildings.
- Education campaigns aimed at schools and colleges to help them understand the relationship between the environment and health and wellbeing. Schools should feature trees and green spaces, and consideration could be given to modifying schooling hours to reduce the impact of increasing temperatures.
- Educating residents of the likely impacts of climate change to enable people to build resilience into their own lifestyles and those of their neighbours.
- Target vulnerable households and communities to improve the standard of insulation and reduce vulnerability to heat poverty. Overcome language barriers to explain climate change to minority groups, including its likely impacts and the adaptation steps that can be taken.
- Occupational heat stress could be managed through wider introduction of flexible working hours and home working policies. It is particularly important to

address this in sub-regions such as West Yorkshire where the majority of residents work in large urban centres.

- Improving accessibility by sustainable transport could help to control urban air pollution in periods of hot weather.
- During planned replacements of the rail networks, upgrade the short-life infrastructure such as tracks to withstand increasing temperatures.
- Improved public building design, especially for hospitals and care homes, so that they are able to maintain internal temperatures at comfortable levels during extreme temperature events. Buildings should use natural ventilation as far as possible and be constructed from materials that reflect rather than retain energy. Include green roofs, and make the best use possible of trees to provide shade.
- Long term changes in the tourism industry, including visitor numbers, should be built into visitor management strategies and infrastructure plans. These should focus on ensuring that whilst the industry benefits from greater visitor numbers there are not negative effects on natural environments and community structures.

Leeds City Council has its own internal adaptation working group. The following measures for adapting council services have been discussed in the course of the group's meetings:

- Implement and practice Leeds Heatwave Plan
- Increase advice to public and businesses on safe food storage.
- Increase advice to public on health hazards associated with exposure to the sun.
- Research risk and raise awareness of pests associated with warmer climates.
- Make highway surfaces more resilient to increased temperatures.
- Operate air quality alert systems to reduce exposure of vulnerable groups.

6.2 Reduction in annual rainfall and an increase in dry spells

i. Summary of impacts of recent weather events on Leeds

No droughts were recorded over the period covered by this LCLIP. The last significant drought in the Leeds area was in 1995 and although this was a national event, West Yorkshire was one of the worst affected areas. During the drought period hosepipe bans were enforced throughout Yorkshire and Drought Orders were made restricting both supplies and abstractions of water in Yorkshire (UK Parliament, 1995). Rainfall between April and October in 1995 was less than half of the long term average, but the drought was also exacerbated by unprecedented peak demand for water and high rates of water company leakage – in 1994/5 Yorkshire Water's estimated leakage rate was 32% of water.

A report commissioned for the Department of the Environment after the 1995 drought found that supplying water cost an extra £96m that year. Prices for fresh vegetables were around 30% higher because lack of water damaged crops (BBC, 1998).

ii. Potential / future impacts

Modelling undertaken for Yorkshire and Humber Climate Change Adaptation Study (Yorkshire and Humber Assembly, 2009) suggests a reduction in annual rainfall of up to 6 % by the 2050s, although less in upland areas. Climate change will put pressure on water resources and water and sewerage infrastructure. Reduced rainfall may result in lower availability and increased demand of water, as well as affecting river water quality.

Biological Effects of Drought

Lowered water levels and reduced flow rates in water courses can harm living communities within the water through changes in temperature, increased concentration of pollutants and increased algal growth. Algae uses up oxygen in the water and so large populations of algae can starve other organisms (including fish) of oxygen. In droughts, low flows of water can also affect fish in other ways, including higher water temperatures (which can prevent spawning), increased competition for space and food, and predation (Environment Agency, 2006).

Social Impacts of Drought

Water shortages could have significant impacts on local communities. Rota cuts and stand pipes would result in considerable inconvenience to households. Schools may have to close, and the fire service would suffer from disruption to supply potentially increasing the risk to life. Similarly, health services could be seriously affected in the event of water shortages.

Economic Impacts of Drought

Many industries based in Leeds are also heavily reliant on water supplies: for instance textiles, brewing and agricultural could suffer losses in the event of a disruption to supply. Many areas in Leeds lie on clayey soils which are a product of the underlying coal measures, and therefore could be prone to shrinkage in periods of drought. Any buildings constructed on these soils may therefore suffer from subsidence in the future as longer, drier summers become more common.

iii. Actions already taken

Environment Agency Drought Plan

It is difficult to take action to prepare for a drought as each drought varies widely in its causes and effects (Environment Agency, 2006). The last significant drought in the Leeds area was in 1995, and the lessons learnt from this episode have guided the Environment Agency's Drought Plan for the North East Region - Ridings Area (Environment Agency, 2006). The Drought Plan sets out:

- the Area's drought management structure;
- the drought monitoring that will be undertaken ;
- the drought management actions that the Area Drought Team may need to take and the triggers for these actions;
- how the Area deals with drought permit and drought order applications;

- the Area's drought communications actions, including reporting during a drought.

The Environment Agency routinely monitors the flow, quantity, and quality of waters. This monitoring includes hydrometric monitoring, ecological monitoring and water quality monitoring. The results from routine monitoring are used by the Environment Agency as a surveillance tool to monitor the onset and impacts of droughts. Notable impacts will be reported to that area's drought team who will determine whether additional field monitoring can be used to investigate impacts with a view to remedying habitat and water quality deterioration.

iv. Potential / future actions

Problems of potential subsidence in new buildings could be countered by taking into account ground conditions and where appropriate designing buildings to be more resistant to subsidence – for example through the use of raft foundations.

Alternative selections of plant species in parks, etc. could be considered that are more resistant to drought and that would require less watering in hot dry weather. Changes could also be considered to the selection of tree species to favour trees that are deeper rooting and therefore more resistant to drought.

6.3 Greater seasonality of rainfall and an increase in extreme rainfall events

Greater seasonality of rainfall would mean that more rainfall will fall in winter than it does today, but summers are likely to become drier.

i. Summary of impacts of recent weather events on Leeds

Flooding is one of the most common and most disruptive weather-related events experienced in Leeds over the LCLIP period, and flooding can impact the community in a number of ways. Leeds is vulnerable to both river flooding and surface water flooding, and a wide range of impacts from flooding over recent years have been identified in this report. These impacts have been discussed more fully earlier in the LCLIP, but can be summarised as follows:

- Roads have been closed as a result of flooding on a number of occasions. As well as the local road network significant traffic disruption has been caused by the flooding of major strategic routes in and around Leeds the Inner Ring Road in August 2004 and August 2006, and the M1 at Stourton in August 2004. Widespread flooding of the road network was experienced in June 2007 and stretches of most of the city's motorway network and primary roads were submerged causing many hours of delays for motorists.
- Significant disruption to rail services has been incurred in Leeds on several occasions since 2002 as a result of flooding.
- Flooding of residential properties occurred in December 2002; August 2004, May 2005; January 2008 and most significantly in June 2007 when approximately 250 houses were flooded in Leeds. In August 2004 residents in Cross Gates had to be evacuated from the first floor of their properties, and in June 2007 rest centres had to be set up in Gipton and Leeds Town Hall to

accommodate those stranded in the city or unable to stay in their own homes as a result of flooding.

- Shops in the city centre had to close due to flooding or water leaking in through the ceiling in May 2005; June 2007 and January 2008. 50 businesses in the District were reported to have been inundated during flooding in June 2007. The River Aire also burst its banks in the city centre in January 2008 causing widespread disruption and significant damage to a number of businesses close to the river.
- Schools have been closed as a result of flooding in Leeds in August 2004; May 2005; and June 2007 when 13 schools had to close.

ii. Potential / future impacts

Modelling work undertaken as part of the Regional Adaptation Study (Yorkshire and Humber Assembly, 2009) anticipates greater rainfall in winter months and an increase in the number of extreme rainfall events in the future. This could lead to an increase in winter flooding from rivers and streams, and also to an increase in flash flooding. Smaller watercourses and drains are susceptible to flash flooding as a result of localised intense rainfall, as they can be subject to very rapid, unexpected rises in water levels (Leeds City Council, 2007).

Parts of the city centre are estimated to have a 1 in 20 year risk of flooding from the River Aire, and if this were to occur there would be a considerable economic impact for Leeds as well as for the wider region (Leeds City Council, 2007). If widespread flooding of the city centre were to occur it is estimated that:

- Nearly £400 million of direct damage would be incurred.
- Over 3700 residential and almost 700 non-residential properties could be affected.
- Leeds Rail Station could close, affecting over 120,000 passengers per day.
- Key access routes could be close, including Kirkstall Road which is used by over 45,000 vehicles a day.

iii. Actions already taken

Water Asset Management Working Group (WAMWG)

The flooding events in 2004 and 2005 in Leeds revealed a number of shortcomings in how effectively the city responded to the floods. These shortcomings were related largely to the resources available for the response; confusion over responsibilities and the level of cooperation between different agencies during flooding events. In response to these issues Leeds City Council set up a cross-departmental Water Asset Management Working Group to develop costed recommendations for actions to improve the way in which the Council responds to flooding incidents (Leeds City Council, 2008).

The Working Group consists of senior officers from the following service areas: land drainage, highways, streetscene services, enforcement, asset management, bridges, and audit and risk. Additional annual funding of £1.1 million was provided to relevant services to fund improvements. Although this work is ongoing, more recent episodes of heavy rain and flooding in Leeds show that the new

mechanisms for dealing with flooding appear to be making a difference. Some of the actions developed by the group are detailed in appendix A.

Dunhill Estate Pilot Flood Protection Project

As part of the first phase of the Government's strategy for flood risk management, Making Space for Water, Defra funded a £500,000 pilot scheme in 2008 to examine whether grants provided an effective means of increasing take-up of flood protection. The Dunhill Estate in Leeds was subject to flooding three times in four years, and was one of the areas chosen to take part in the pilot. Central government funding of £90,000 was provided to protect 68 residential properties at greatest risk in the area with flood boards for doors and air brick covers. Leeds City Council provided an additional £150,000 towards the pilot scheme, and a further £10,000 was provided by the Yorkshire Regional Development Flood Defence Committee, providing a total fund of £240,000 for a pilot flood protection scheme.

Strategic Flood Risk Assessment (SFRA)

In accordance with the national Planning Policy Statement (PPS25: Development and Flood Risk), Leeds City Council commissioned a Strategic Flood Risk Assessment (SFRA) (Leeds City Council, 2007b) to bring together information on flooding from rivers and other sources to provide a fuller picture of flood risk across the District.

The SFRA aims to deliver the following key outcomes:

- To collate all known sources of flooding that may affect existing and/or future development within the District.
- To identify and map areas with a 'low', 'medium' or 'high' probability of flooding within the District.
- To consider the risk of flooding to life and property within the District.
- Within the flood affected areas, recommend appropriate land uses that will not unduly place people or property at risk of flooding.
- Where flood risk has been identified as a potential constraint to future development, recommend possible flood mitigation solutions that may be integrated into the design to minimise the risk to property and life should a flood occur.

The Assessment was completed in 2007, and is now being used to inform decisions on individual planning applications and to guide the preparation of the new Local Development Framework which sets out spatial development plans for the whole Leeds district.

Sustainable Drainage

A number of mechanisms are in place in the planning system to encourage sustainable drainage to be incorporated into developments:

- The Leeds Unitary Development Plan (UDP) encourages development to be to “consistent with the principles of sustainable development” (Strategic Goal 4).
- The Leeds UDP Review proposed a new policy, N39A: ‘Development proposals should, wherever practicable, incorporate sustainable drainage systems’.
- Planning permission considerations are covered by general policy 5 (GP5).
- The Sustainable Development Design Guide (Supplementary Guidance No. 10) includes a section on Protecting Water Resources, and suggests various methods of sustainable drainage.
- Planning Policy Guidance Note 1 General Policy and Principles identifies sustainable development as a key objective for the planning system.
- Planning Policy Guidance Note 25 Development and Flood Risk provides guidance on the promotion of sustainable drainage systems through the planning system, and lists essential considerations early in the planning and design stages, including:
 - Integration of sustainable drainage systems into the overall site concept and layout;
 - The need for investigation and subsequent remediation of contaminated land;
 - Agreements on adoption, maintenance and operation of the systems; and
 - The need for monitoring long term performance.
- The Building Regulations require that adequate surface water drainage is provided. Approved Document H includes a priority for soakaways or other infiltration systems over drainage to watercourses or sewers.

Supplementary Planning Guidance (SPG) document ‘Sustainable Drainage in Leeds’ has been produced to provide information to developers on the use of sustainable drainage techniques in new developments, which expands current City Council and national guidance. The SPG document also sets out a procedure for dealing with drainage issues through the planning process.

iv. Potential/future actions

As a result of the work arising from the Water Asset Management Working Group Leeds has recently been able to implement a number of measures to reduce both the likelihood and the impact of flooding on the people of Leeds, and to improve the flood response and clear-up when flooding does occur. A number of these actions are ongoing and will continue to be implemented into the future.

Leeds Flood Alleviation Scheme

Despite the fact that there has been a long history of flooding on the River Aire (1775, 1866, 1947 plus near-misses in 2000, 2002, 2007 and 2008), there are no formal flood defences along its banks. The only protection of the city is currently by informal defences such as walls, which are assessed as providing protection against flooding on a 1 in 5 year basis (which means there is a 20% chance of flooding).

Given the risk of serious flooding in the city centre, a design for a River Aire Flood Alleviation Scheme was developed by the Environment Agency, but this was shelved in January 2007 as it failed to score highly enough under Environment Agency criteria. Following the flooding and the near-miss of the River Aire breaching its banks in June 2007 a decision was made for the scheme to be resurrected in July 2008.

The scheme would implement flood defences along a 19 km length of the River Aire from Newlay to Woodlesford and would integrate the Council's regeneration aspirations as well providing wildlife, recreational and access benefits where possible. Construction is currently expected to begin in 2010-2011, and the total cost of the scheme is estimated at £80-£100m. The Environment Agency's capital programme includes provision for £1.2m in 2008/09, £20K in 2009/10, and £15m in 2010/11, although a significant proportion of the funding requirements has yet to be sourced. A Project Investment Group has been set up to identify potential funding sources.

6.4 Marginal increase in winter average wind speed

Leeds is vulnerable to strong westerly winds which are often generated by deep depressions passing to the north of the UK. These strong winds are modified by local rural and urban topography, resulting in increased wind speeds and gustiness. Wind stress and related damage is often exacerbated as a result of a number of local factors including: turbulent flow generated downwind of the Pennines; funnelling of winds down the Aire and Wharfe valleys and; the wake effect of tall buildings in Leeds.

i. Summary of impacts of recent weather events on Leeds

Gales have always been a common occurrence in Yorkshire. There have been a number of incidences of damage or disruption resulting from wind damage recorded in the weather events discussed in this report. These are summarised below:

- There have been a number of incidences of rail services being cancelled or delayed as a result of high winds damaging power lines and leaving debris on the tracks.
- Regular disruption to road traffic has also been documented, including motorways and trunk roads being closed as a result of high-sided vehicles blowing over. On all road networks incidents of damage to traffic and street lighting, debris and fallen trees have been reported.
- Leeds Bradford International Airport was closed for part of the day on 19th January 2007 as a result of high winds.

- Structural damage to buildings has been recorded as a result of high winds. Over 20 schools in Leeds suffered wind damage in January 2007 including Knottingley High School's roof being torn off. The gable ends of houses in Rodley and Drighlington were also blown down in January 2007.
- Safety concerns over temporary structures and scaffolding – in January 2007 the Headrow in Leeds city centre was closed to pedestrians and vehicles due to fears of scaffolding becoming unsafe.
- Uprooted trees are commonly reported on high winds. In the storm of September 2006 alone, an estimated 300-500 trees in Leeds were damaged as a result of high winds, and one man was hospitalised due to injuries from a tree falling on him.

ii. Potential/future impacts

Recent climate change modelling work undertaken as part of the regional adaptation study (Yorkshire and Humber Assembly, 2009) predicts marginal increases in winter average wind speeds, although summer and autumn speeds are expected to reduce slightly. There is uncertainty about how the frequency and severity of gales will alter with climate change, although it is thought that the small increase in average winds speeds predicted by the climate models could manifest itself in a few very severe events rather than a general increase. This could result in further impacts similar to those described above.

iii. Actions already taken

Large buildings in Leeds can generate local wind problems as a result of their drag and wake effect. Depending on the shape and size of the buildings severe turbulence can cause very gusty winds at street level. This effect has been most notable close to Bridgewater Place, Leeds' tallest building with 32 floors on the south of the city centre. During windy conditions walking and cycling across the Neville Street junction with Water Lane can be dangerous. As a safety measure Leeds Highways have constructed a concrete barrier and pedestrian guard rails to reduce the potential risk of casualties between pedestrians and road traffic.

Leeds City Council is also developing a Tall Buildings Design Guide as a supplementary planning document. It includes advice on reducing building turbulence through consideration of the following issues:

- The shape and height of buildings;
- Adequate wind tunnel testing of building and effects of appropriate wind diffusers;
- The comfort of pedestrians walking and sitting in the vicinity of a tall building;
- The likely impact of extreme turbulence from the building on nearby pedestrians, cyclists and high-sided vehicles; and
- Appropriate mitigation measures.

iv. Potential/future actions

Some tree species are more resistant than others to strong winds. Authorities could investigate planting tree species that are resistant to wind damage. This could provide a double benefit of providing shelter from high winds and establishing trees that are more resistant to wind damage themselves, avoiding disruption and damage from falling trees.

Investigations are ongoing at Bridgewater Place in Leeds to further develop wind tunnel modelling, gain a better understanding of building turbulence effects and where appropriate develop mitigation measures. It is hoped that this information will also be useful for the design of other tall buildings constructed in Leeds in the future. Typical mitigation measures could include:

- Bespoke design of wind diffusers (an open structure or canopy) designed to reduce wind speeds without creating turbulence; and
- Use of natural wind diffusers, for example planting of resilient trees in vulnerable areas close to tall buildings.

7. SEVERE WEATHER AND MANAGEMENT OF NATIONAL INDICATORS

A set of 198 national indicators has been developed by the Government to reflect the its national priorities. Performance against each of the 198 indicators will be reported for every local authority area, and the indicator set is now the only measure by which central government will monitor the performance of local government.

The potential for each of the national indicators to be affected the weather was considered as part of this report. For 47 of the 198 national indicators (almost 24%) it was thought that local performance against the indicator could be influenced by extreme weather events or by the changes in seasonal extremes expected with climate change. These indicators are included in table 6, along with a brief explanation of how they may be affected by the weather or future climate.

This highlights just how far-reaching the effects of climate change are likely to be and how diverse adaptation responses may need to be in order to manage these impacts. The table below lists each of the national indicators that could be potentially affected by the changes in patterns of severe weather events and seasons predicted for Leeds in the future, and considers some of the ways in which these indicators could be affected and how management of them may need to accommodate our changing climate.

Table 6: Potential influence of severe weather on the national indicators set

NATIONAL INDICATOR	INFLUENCE OF SEVERE WEATHER	INFLUENCE OF SEASONAL CLIMATIC CHANGES
NI 5 Overall / general satisfaction with local area		Hotter weather may lead to increases in outbreaks of pests and potential issues related to waste collection which may, if hot periods of weather are more regular, influence people's overall satisfaction with their area.
NI 7 Environment for a thriving third sector	Experience of severe weather events can generate more interest in environmental campaigns, etc.	Experience of the seasonal effects of climate change can generate more interest in environmental campaigns, etc.
NI 8 Adult participation in sport	Severe weather may impact on participation in sport, e.g. pitch closures in floods or icy conditions.	Generally warmer summers and winters may encourage more uptake in sports.
NI 10 Visits to museums or galleries	Severe weather could impact on the number of visits to museums / galleries.	
NI 16 Serious acquisitive crime	There may be an higher rate of house burglaries, car thefts, etc. during heatwaves as people may leave windows open more regularly.	
NI 17 Perceptions of anti-social behaviour	In heatwaves perception of antisocial behaviour could increase as more people will have doors and windows open and spend more time outdoors.	During warmer, drier summers perception of antisocial behaviour could increase as more people will have doors and windows open and spend more time outdoors.
NI 20 Assault with injury crime rate	Heatwaves are known to be associated with an increase in violent crime.	
NI 33 Arson incidents	There is often a higher incidence of grass fires, etc deliberately started in hot, dry weather.	
NI 41 Perceptions of drunk and rowdy behaviour as a problem	People drinking outdoors on hot days could increase perception of drunk or rowdy behaviour.	People drinking outdoors during warmer, drier summers could increase perception of drunk or rowdy behaviour.
NI 47 People killed or seriously injured in road traffic accidents	There is a higher risk of accidents during severe weather events such as heavy rain, snow, icy conditions, or strong winds.	Warmer weather may also encourage more pedestrians and cyclists, who are more vulnerable to serious injury in road traffic accidents.
NI 48 Children killed or seriously injured in road traffic accidents	There is a higher risk of accidents during severe weather events such as heavy rain, snow, icy conditions, or strong winds.	Warmer weather may also encourage more pedestrians and cyclists, who are more vulnerable to serious injury in road traffic accidents.
NI 57 Children and young people's participation in high quality PE and sport	Heatwaves, wintry weather, intensive rainfall, strong winds and flooding can affect uptake in outdoor sports.	Generally warmer summers and winters may encourage more uptake in sports.
NI 73 Achievement at level 4 or above in both English and Maths at Key Stage 2	Extreme temperatures can affect pupils' performance in class. In some cases schools may have to close because of severe weather (e.g. heatwaves or flooding) which can	

	also result in lower educational achievement as a result of reduced teaching time.	
NI 74 Achievement at level 5 or above in both English and Maths at Key Stage 3	Extreme temperatures can affect pupils' performance in class. In some cases schools may have to close because of severe weather (e.g. heatwaves or flooding) which can also result in lower educational achievement as a result of reduced teaching time.	
NI 75 Achievement of 5 or more A*-C grades at GCSE or equivalent including English and Maths		
NI 76 Achievement at level 4 or above in both English and Maths at KS2		
NI 77 Achievement at level 5 or above in both English and Maths at KS3		
NI 78 Achievement of 5 or more A*-C grades at GCSE and equivalent including GCSEs in English and Maths		
NI 79 Achievement of a Level 2 qualification by the age of 19		
NI 80 Achievement of a Level 3 qualification by the age of 19		
NI 83 Achievement at level 5 or above in Science at Key Stage 3		
NI 84 Achievement of 2 or more A*-C grades in Science GCSEs or equivalent		
NI 93 Progression by 2 levels in English between Key Stage 1 and Key Stage 2		
NI 94 Progression by 2 levels in Maths between Key Stage 1 and Key Stage 2		
NI 95 Progression by 2 levels in English between Key Stage 2 and Key Stage 3		
NI 96 Progression by 2 levels in Maths between Key Stage 2 and Key Stage 3		
NI 97 Progression by 2 levels in English between Key Stage 3 and Key Stage 4		

NI 98 Progression by 2 levels in Maths between Key Stage 3 and Key Stage 4		
NI 119 Self-reporting measure of people's overall health	Health can be affected by severe weather events – e.g. asthma attacks tend to increase during heatwaves; there may be restricted access to health care facilities during flooding or snowy spells; and more deaths among vulnerable people in cold spells as a result of fuel poverty.	
NI 121 Mortality rate from all circulatory diseases at ages under 75		Higher winter temperatures and reduced fuel poverty. Incidence of circulatory diseases may decrease with higher winter temperatures, lowering fuel poverty.
NI 122 Mortality from all cancers at ages under 75	Increased risk of skin cancer from exposure to sun during heatwaves.	Increased risk of skin cancer from exposure to sun as hotter summers are predicted under climate change.
NI 124 People with a long-term condition supported to be independent and in control of their condition.	This indicator includes long-term conditions such as asthma that are affected by weather conditions.	
NI 167 Congestion – average journey time per mile during the morning peak.	Disruption to road and rail travel is common in severe weather.	
NI 168 Principal roads where maintenance should be considered	Severe weather events such as flooding, heatwaves, wintry conditions and strong winds (fallen trees) can all affect road maintenance.	
NI 169 Non-principal roads where maintenance should be considered	Severe weather events such as flooding, heatwaves, wintry conditions and strong winds (fallen trees) can all affect road maintenance.	
NI 175 Access to services and facilities by public transport, walking and cycling.	Public transport services and uptake of walking and cycling can be affected by severe weather.	
NI 178 Bus services running on time.	Flooding, intensive rain, strong winds and extreme heat can all affect road networks and consequently bus journey times.	
NI 184 Food establishments in the area which are broadly compliant with food hygiene law.	Heat waves often lead to an increase in food poisoning cases.	
NI 185 CO2 reduction from local authority operations.		Warmer winters should result in a reduced need for central heating, although hotter summers may lead to an increase in air conditioning.
NI 186 Per capita CO2 emissions in the local authority area.		Warmer winters should result in a reduced need for central heating, although hotter summers may lead to an increase in air conditioning.

NI 188 Adapting to climate change.	More severe weather events are predicted with climate change, and authorities will need to be in a position adapt to these and to respond effectively.	Seasonal changes are also predicted with climate change (e.g. longer, drier summers) and actions may be needed to adapt effectively.
NI 189 Flood and coastal erosion risk management.	Likely to be more extreme rainfall events and flash floods with climate change.	
NI 190 Achievement in meeting standards for the control system for animal health.	Flooding and strong winds are thought to play a role in spreading diseases such as foot and mouth. Heatwaves may also impact upon animal health.	
NI 192 Household waste recycled and composted.	Household waste may start to smell or attract vermin in heatwaves. Different bins or changes to the collection system may be required.	A general trend for hotter summers may cause household waste to smell or attract vermin. Different bins or changes to the collection system may be required.
NI 194 Level of air quality – reduction in NOx and primary PM10 emissions through local authority's estates and operations.	Heatwave conditions can lead to episodes of poor air quality.	
NI 197 Improved local biodiversity – active management of local sites.	Flooding is important for some habitats and species. Drought and heatwaves can have negative effects.	
NI 198 Children travelling to school.	Severe weather can affect people's travel choices.	Warmer weather may encourage more cycling.

8. NEXT STEPS

A number of areas of follow-up studies leading on from the LCLIP have been identified. These include the development of a flood visualisation model and development of the UKCP09 weather generator tools to consider the future impact of climate change on Leeds City Council services.

8.1 Flood Visualisation Model

Following on from the LCLIP, a study is being undertaken on behalf of Leeds City Council into the development of a three-dimensional flood visualisation model to assist emergency and strategic planning in Leeds. The pilot vulnerability model will improve communication of the spatial impacts of flooding in Leeds and enhance understanding of local vulnerability. This will in turn allow for more informed climate change adaptation policies and the ability to develop adaptive capacity throughout the district.

A 3D computer model was developed by Arup as part of the public consultation for the Leeds Flood Alleviation Scheme which simulated the effects of flooding on the city. The Flood Visualisation Model shall develop this model to create a pilot vulnerability model for flooding in Leeds and to identify those areas or facilities vulnerable to flooding in Leeds. One example of practical application of the model could be route planning for emergency services to avoid potential limitations such as low lying roads during flood events.

Further information on this study can be obtained from the Leeds City Council Environment Policy Team.

8.2 UKCP09 Weather Generator Case Studies

Another study is also underway looking at the likely future impacts of climate change on Council services. Initially the work shall concentrate on transport – the sector identified as having incurred the highest level of disruption as a result of severe weather over the LCLIP period. The LCLIP has identified the type of severe weather that is known to impact on transport. These events shall be investigated further and weather thresholds established to define the type of weather event that is likely (or known to occur from past experience) to cause problems. The weather generator and threshold detector tools developed as part of the UK Climate Projection Models 09 can then be used to investigate how the frequency of such events in the future may change with climate change. This work can then be used to identify what adaptation measures may be required at various points in the future and help inform development of the most appropriate adaptation response.

9. CONCLUSION

As we have seen throughout the LCLIP, Leeds has incurred a significant level of damage and disruption as a result of severe weather over the past seven years – there were seven separate ‘first order’ events (considered to be highly disruptive) and six ‘second order’ events (disruptive). The most common types of weather to cause problems were flooding, strong winds and wintry conditions. Incidents of flooding in particular, but also strong winds, are expected to increase in both frequency and magnitude with climate change. Despite the predicted increase in winter temperatures, there may also be problems for highway maintenance teams in the short term with an increase in marginal freezing conditions. Therefore many of the impacts that have already been experienced in Leeds can only be expected to occur again in the future, and we should consider how we can respond to these incidents and adapt accordingly.

From the study of the national indicator set in chapter 6 we can see just how far-reaching the effects severe weather and seasonal changes in climate could be. In total almost 24% of all national indicators were identified as having a possible impact from weather or climate change, from educational attainment to highway maintenance; and road traffic accidents to food hygiene. This again highlights the potential range of adaptation measures that will need to be considered to effectively manage local performance on a wide range of service areas.

Due to the significant range of adaptation measures that could be implemented, further work will need to be done to target resources most effectively. The Flood Visualisation Model pilot and the UKCP09 weather generator transport case studies described in chapter 8 will help to inform adaptation policies in Leeds, ensuring resources are focussed towards those areas that would benefit most. Further work on risk assessment taking into account past experience of weather events could also help to identify the most vulnerable areas and the most appropriate actions. Improvements to the way severe weather impacts are recorded would help to identify when the most gains will be achieved – as without a record of the true cost of an event it will be difficult to accurately target those adaptation measures that will bring the greatest benefit.

10. REFERENCES

BBC (1998) 'Special Report: Where has all the water gone?', www.bbc.co.uk.

Environment Agency (date unknown) 'Regional Drought Plan for North East region', EA North East Regional Office, Leeds.

Leeds City Council (2007) 'Report of the Director of City Development / Director of Resources: impact of flooding events in June of the Leeds District'.

Leeds City Council (2007a) 'Leeds City Council Corporate Financial Management Briefing Note: Costs incurred following the flooding on June 2007'.

Leeds City Council (2007b) Leeds City Council Core Strategy Development Plan Document: Leeds Strategic Flood Risk Assessment.

Leeds City Council (2008) 'Learning the lessons: progress on enhanced management of flood risk in Leeds: Annual report by the Water Asset Management Working Group'.

Leeds Initiative (2009) 'Leeds Climate Change Strategy: Vision for Action', www.leedsinitiative.org

Leeds Primary Care Trust (2005) 'Heatwave Plan', National Health Service.

Parliamentary Office for Science and Technology (1995), 'POST Technical Note 71: The 1995 Drought', UK Parliament.

Rooney, J. F. (1967) 'The urban snow hazard in the United States: an appraisal of disruption', Geographical Review, Vol. 7, No. 4, pp 538-559, American Geographical Society.

UK Climate Impacts Programme (date unknown) 'A Local Climate Impacts Profile (CLIP) for your community', UKCIP, Oxford.

UK Climate Impacts Programme web site (2009) www.ukcip.org.uk

UK Climate Impacts Programme / Met Office (2009) 'UK Climate Projections 2009 (UKCP09)', <http://ukclimateprojections.defra.gov.uk>

UK Parliament (1999) 'The Education (School Premises) Regulations 1999, Statutory Instrument 1999 No. 2'.

Yorkshire and Humber Assembly (2009) 'Weathering the Storm: Yorkshire and Humber Climate Change Adaptation Study', www.adaptyh.co.uk.

Yorkshire Water (date unknown) 'Report into the cause of flooding of Wykebeck Valley Road and Foundry Road, Leeds on 12th August 2004 and 3rd May 2005 (addendum to section 4 of East Leeds Flooding Report)'.

Appendix A: Example of actions arising from the Water Asset Management Working Group

Service	Action
Land Drainage	Direct maintenance of Council-owned watercourses by the Land Drainage Section, rather than functional Departments, to ensure that blockages and flood risk are minimised.
	Additional staff for beck inspection, record maintenance, vetting of planning applications for flood risk, and technical assistance.
	Improved systems for recording water assets - including watercourses, culverts, ponds and lakes.
	Support for private owners and communities in fulfilling their responsibilities – including participation in flood fairs.
	Support for the Bridges Section in assessing the capacity of existing highway culverts and the development of a risk-based rolling programme of upgrades.
	Identification and recording all lakes and dams in order to facilitate a programme of hazard assessment.
	A dam inundation study for Waterloo Lake.
	A multi-agency technical forum with the Environment Agency and Yorkshire Water.
	Helping in the development of flood alleviation measures for the Wyke Beck catchment.
	Highways Bridges
A term diving contractor is being used to remove debris from major rivers as specialist personnel and equipment are required to carry out this work.	
Bridges Section carries out debris clearance work on a reactive basis when notified of blockages.	
In conjunction with Land Drainage, Bridges Section is involved with debris clearance from blockages to culverts.	
Engaged consultants to carry out a survey of existing culverts, including access details, distance of culvert to a road, whether the culvert can be inspected from the highway, size of the culvert and distance to nearest property. This information is then passed to Land Drainage to determine the culvert's capacity.	
Asset Management	GIS work on the CAPS system to plot and compare the position of Council properties against flood risk maps to identify council properties at risk of flooding. A programme of inspections of these properties has been instigated to identify actions that could reduce vulnerability to flooding.
	Plans from the Caps system now made available to Land Drainage to allow quick identification of Council ownership of land or property should blockages or potential flooding be identified.
Highways Services	A gully survey has been undertaken to identify the location and collect detailed information on every gully in Leeds (an estimated 130,000 gullies across Leeds). The survey aims to improve efficiency of cleaning activities and allow targeted maintenance work in problem areas.

	Provision of rapid sandbag filling machines. Three rapid sandbag filling machines have been purchased and are located at depots. A hierarchy has been established to ensure that sandbags are deployed to maximum effect: delivering first to vulnerable individuals/establishments, then residential properties; then business and non-residential properties.
Environmental Services	Two additional gully cleansing machines were leased in 2005 by Streetscene Services to provide a significantly enhanced service, including more regular cleansing at known problem areas. An informal out-of-hours call out service has also developed and it is hoped this will be formalised in the near future.
Enforcement Section	The Council has adopted legal powers to recover abandoned shopping trolleys, which regularly cause water blockages, and deliver them back to the owning supermarkets. A company has been identified that will remove these trolleys at no extra cost to the Council.
Peace and Emergency Planning Unit	Ensure that a protocol on the co-ordination and response to flooding incidents with partner agencies is incorporated into Leeds City Council and multi-agency plans and tested with partners. A West Yorkshire multi-agency flood response protocol with clear roles and responsibilities was ratified by all partners in December 2005 and incorporated into agencies' flood plans. This protocol was subsequently tested in a West Yorkshire Resilience Forum Gold-level exercise (Exercise Merlin Aware) and was found to work well.
	Develop proposals to provide the capability for rapid deployment of flood mitigation and recovery resources. An Emergency Co-ordination Vehicle has been purchased to provide an essential focal and communication point for Council services at a flood incident scene. The vehicle contains a control area in the rear of the vehicle with desking, white boards, laptops, printer / fax / scanner, mobile phones and personal protective equipment such as high-visibility jackets and waterproofs. The vehicle also has a microwave and a kettle for responders to be provided with essential food and refreshments. A towable trailer has also been purchased to be linked to the above, which contains a range of flood recovery resources, such as shovels, disposable cameras and wellington boots, to hand out to residents to aid their recovery from the effects of incidents. Further resources in the shape of air brick covers which can be provided to residents who have received warnings of predicted flooding have been procured and are held in vehicles used by Land Drainage staff and gully cleansing operatives for distribution when they are deployed to a flood incident scene.
	Develop and implement a multi-agency checklist of questions and a flowchart for use in Leeds City Council and partners' call centres for use in establishing what form of flooding was involved and who this should be referred to. Flood Operator guidelines have been developed and implemented to enable calls from members of the public to be referred through to the most appropriate organisations. PEPU is also working with the Environment Agency and West Yorkshire colleagues in developing the Environment Agency's Floodline service to provide a 'one-stop' number, so members of the public can call one number to report any type of flooding.

	<p>Continue to participate in the West Yorkshire Flooding sub-group of the West Yorkshire Emergency Planning Officers Forum. PEPU chairs the West Yorkshire Flooding sub-group and provides the impetus for much of its work, including a range of innovative solutions to longstanding problems.</p>
	<p>Develop a package of measures to support private riparian owners and communities to fulfil their responsibilities, such as 'flood fairs' and public information campaigns. In October 2006 the Unit assisted the Environment Agency in developing and running a 'Flood Fair' at the Royal Armouries for communities at risk from Flooding PEPU is currently working with a community group in Methley/Mickleton to develop a local flood plan which may serve as a model for other communities and areas.</p>
<p>Parks and Countryside</p>	<p>Construct and install a primary trash screen across Wyke Beck upstream of York Road to catch large items of rubbish such as supermarket trolleys that cause blockages and exacerbate flooding around the Dunhills area of Halton. The screen is subject to regular checks and has already work proved its worth in subsequent flood events.</p>
	<p>Install cut-off drains at King George V playing fields (behind Foundry Lane) and at the Chantry in Colton to intercept surface run-off. Drainage problems at two recreation sites were identified during previous flooding incidents. At Fearnville Playing Fields at Gipton a cut-off drain was designed and installed to intercept water run-off from the sports pitches and prevent this inundating houses on Foundry Lane. A similar piece of work was carried out on a green space at the Chantry in Colton.</p>
	<p>Following a risk assessment exercise, work has been undertaken at Chippy's Pond near Scholes to construct a new dam and spillway as well as to regrade the embankments. New culverting has also been installed downstream to protect properties from flooding on the overflow culvert.</p>