Appendix 1

Hull City Council
Flood Investigation Report

Section 19 – Heavy Rain August 2014

Source Hull Daily Mail

10 August 2014
Investigation Ref No HCCFWMAS190003

Revision Schedule

Hull City Council
Flood Investigation Report

10th August 2014
Investigation Ref No HCCFWMAS190003

Rev	Date	Details
01	**10/9/14**	**Working draft**
02	**22/12/14**	**Final draft**
02	**20/1/15**	**Planning Committee review**
02	**23/3/15**	**Cabinet review**

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Executive Summary

Kingston upon Hull experienced widespread highway flooding and 2 properties are known to have flooded during intense storms on 10th August 2014.

A formal investigation under Section 19 of the Flood and Water Management Act (FWMA) was considered appropriate. This was led by Kingston upon Hull City Council as the Lead Local Flood Authority (LLFA). This report details the findings of the investigation. The cooperation of all partners was received and welcomed throughout.

Investigations have been carried out by Hull City Council (HCC) and Yorkshire Water as the main operating authorities involved in a surface water event in the city. A range of findings have been reported in the investigation and works have taken place to improve the drainage network by both partners. Further works are being developed to deliver further improvements and surface water flood risk management schemes.

Formal and targeted advance warnings for surface water flooding do not exist but Environment Agency and Met Office Flood Guidance Statements highlight the potential risks from surface water flooding. Flood Guidance Statements leading up to the event showed an increased risk but no expectation was in place for the severity of risk that occurred. Recommendations are made to establish a system of preparedness for surface water flood risk.

All relevant partners responded to the event and all key infrastructure was operated, many areas experienced such rainfall volumes that flooding occurred often before the receiving drainage infrastructure could convey flows. Residents took action where possible and many contacted flood risk operating authorities.

In all cases it is expected that the main cause of flooding during the 10th August weekend was the extreme heavy rainfall and strong winds from remnants of Hurricane Bertha. Hurricane Bertha hit the Caribbean on Monday, with 90mph winds reported which was isolated to a narrow east – west band across the centre of the city

Flooding from such rainfall is often a possibility and a recommendation is made to work with residents to ensure all understand the risks of surface water flooding and the ways in which a resident or community can help themselves.

1. Introduction

1.1 LLFA Investigation

HCC as the LLFA has a responsibility to record and report flood incidents as detailed within Section 19 of the FWMA:

Section 19
(1) On becoming aware of a flood in its area, a lead local flood authority must, to the extent that it considers it necessary or appropriate, investigate:

(a) which risk management authorities have relevant flood risk management functions, and
(b) whether each of those risk management authorities has exercised, or is proposing to exercise, those functions in response to the flood.

(2) Where an authority carries out an investigation under subsection (1) it must:
(a) publish the results of its investigation, and
(b) notify any relevant risk management authorities.

It was deemed necessary to complete an investigation into the flood incident on 10th August 2014 as properties and multiple roads were reported as flooded.

This report provides the details of the conditions leading to the flooding, the impacts of the flooding and the roles and responsibilities of all operating authorities in the area. Following further investigations of relevant authorities recommendations and conclusions are given.

Reports of flooding have been obtained from a variety of sources including – direct calls to the council, fire services, Yorkshire Water, council area teams, Hull Daily Mail, social media and other media outlets.

1.2 Site Location

A range of locations of the city were affected by an intense storm on the 10th August, the below table shows where properties were flooded – where no property numbers are recorded road flooding occurred.

Location	Post Code	No. of Properties / Commercial Properties & Roads Flooded
Kestrel Avenue	HU 4	2
Hanson Electrical Willerby Road	HU 5	1
Kestrel Avenue	HU 4	
Willerby Road	HU 4	
Wymersley road (Junction)	HU 5	
Springhead Ave (Junction)	HU 5	
Chanterlands Ave (Railway Underpass)	HU 5	
Mount Pleasant	HU 8	
Kinloss Garth	HU 7	
Cranbrook Ave	HU 6	
Cottingham Road	HU 5	
Dalton Street (roundabout)	HU 1	
Hampshire Street	HU 4	
Malham Avenue	HU 6	
Kendal Way	HU 7	
Hawkshead Green	HU 7	
Holderness Road (Railway Underpass)	HU 8	
Boothferry Road (Railway Underpass)	HU 5	
Anlaby road (roundabout area)	HU3	
Trenton Way		
Howdale Road		
Norland Ave		

Table 1 – Flooded locations 10th August 2014

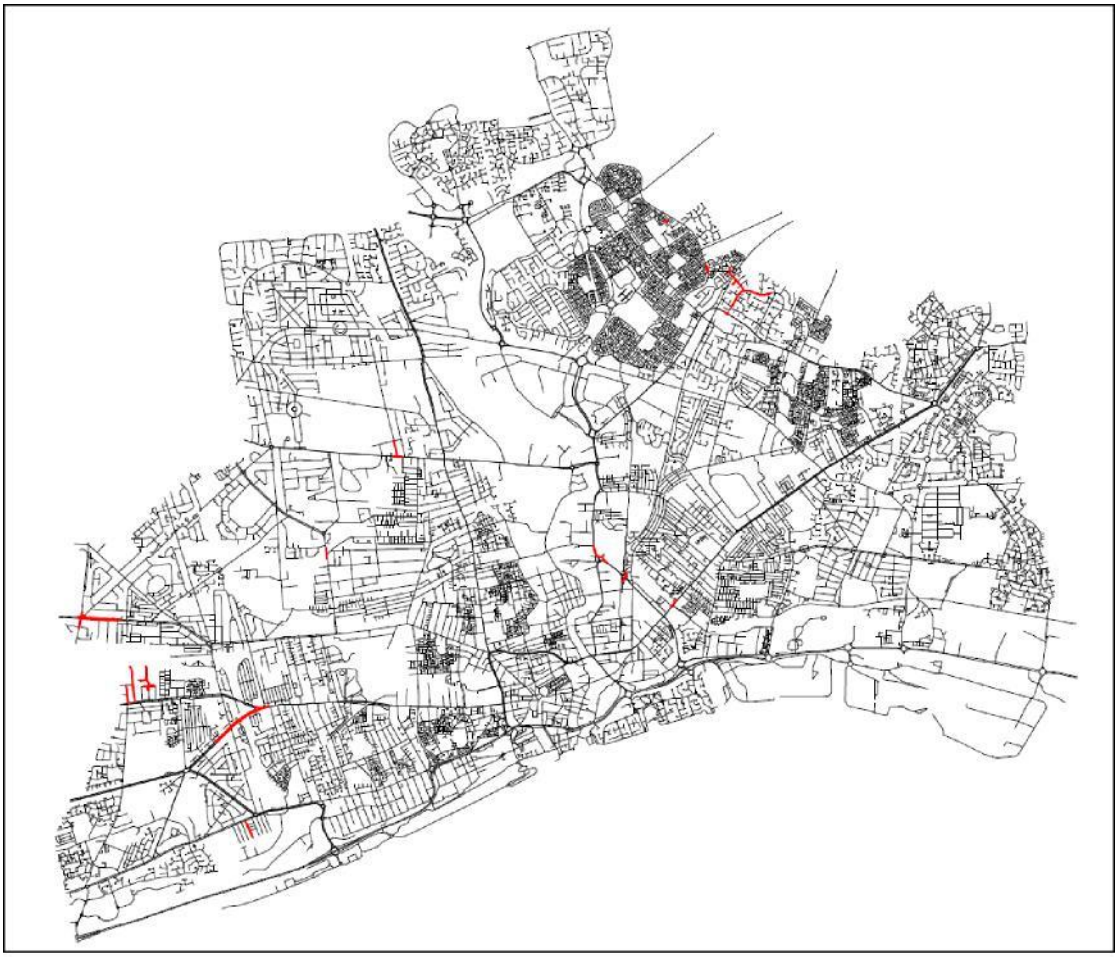


Figure 1 - Indicative map of flooded locations 10th August 2014.

1.3 Local Drainage System

The Hull drainage system is a complex interaction of rivers, streams, ditches, dykes and sewers. Many streams and ditches flow into the city from the surrounding East Riding of Yorkshire Council area and flow through the city in a mixture of Main Rivers permissively managed by the Environment Agency (EA) and open drains and streams (Ordinary Watercourses permissively managed by local authorities, or often the responsibility of riparian landowners) but much of the system is culverted below ground.

The vast majority of the system is also classed as part of the sewerage system for the city as it passes flows derived from surface water drainage onto the hard surfaces across the city. The sewerage system is pumped in times of flood through a combination of pumping stations to the treatment works in the east of the city at Salt End, the pumping stations at West and East Hull are key to this operation. The Bransholme area of the city is served by a separate surface water drainage system which discharges flows into a storage lagoon before outfalling to the River Hull. Yorkshire Water is responsible for the city's sewerage system.

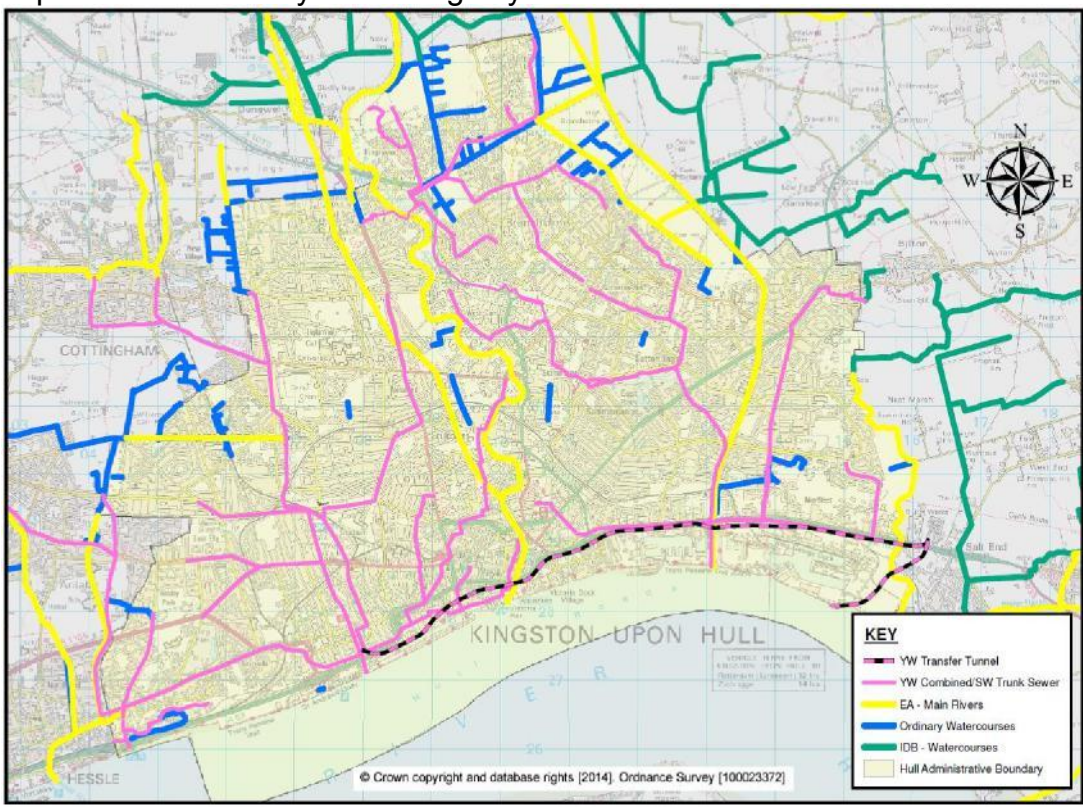


Figure 2 Hull City Drainage Systems

2. Drainage History

2.1 Previous Surface Water Flood Incidents

The floods of 2007 followed some of the highest rainfall on record across many parts of the region and many drains, ditches and watercourses were overwhelmed. Many streams and ditches flowing through the East Riding of Yorkshire Council (ERYC) villages of Anlaby, Cottingham and Willerby were overwhelmed and flood flows came out of bank and caused significant flooding through these towns, these flows then passed onto the west of the city of Hull where the flooding of Anlaby Park, Orchard Park and Derringham followed. The flooding of these areas was caused by the capacity of the drainage system being unable to pass flood flows. Similar flooding extended across large areas of the east of the city where drainage systems were unable to cope with excessive rainfall, flooding again extended outside of the city boundary with many villages east of the city suffering from flooding.

Flooding in the North East area of the city was exacerbated due to infrastructure failure at the Bransholme Pumping Station; significant areas of Bransholme and Kingswood were affected.

More than 1300 businesses and 8600 residential properties were flooded in the city; many more were affected in the ERYC villages.

2.2 25th August 2012

The flood event of 25th August 2012 was caused by an intense storm localised to the city, surrounding areas have not reported similar incidents from this event and similarly many of the other events which caused problems in surrounding areas did not impact significantly on the city. Problems were reported across the city but are broadly concentrated in a ‘central belt’. 19 residential and 2 commercial properties have been recorded as flooded and many other roads.

See figure 3 Indicative map of flooded locations 25th August 2012.

Figure 4 shows the Flood Guidance Statement and Met Office information published prior to flooding on the 25th August 2012.

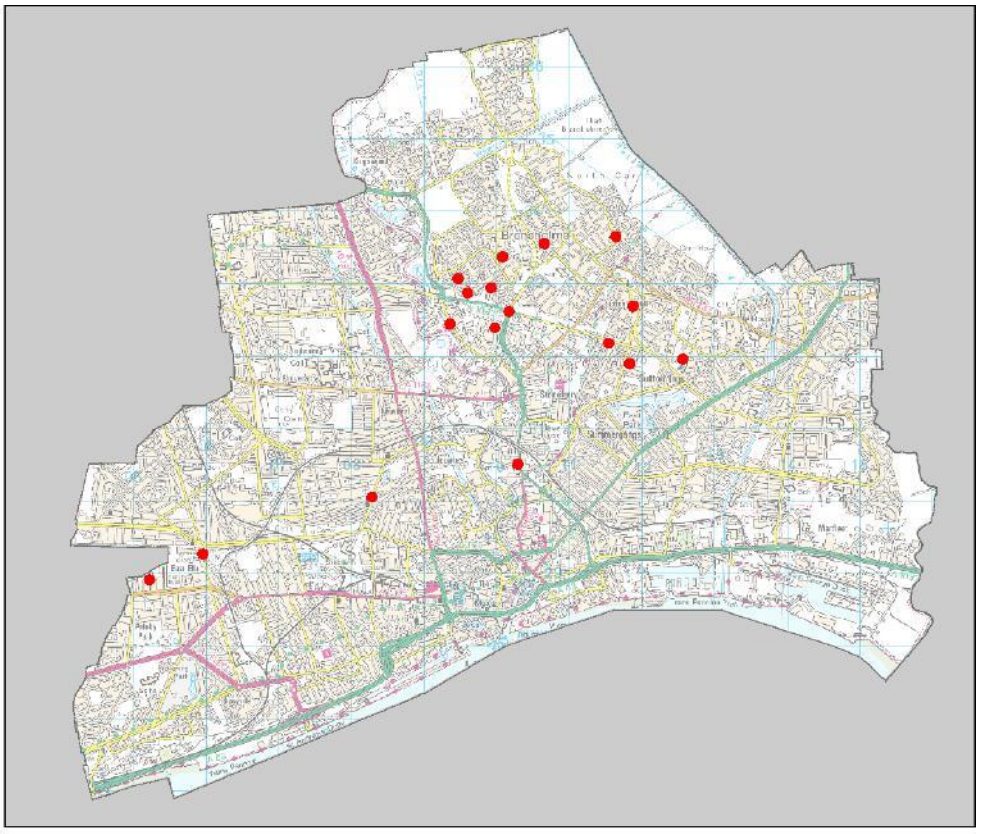
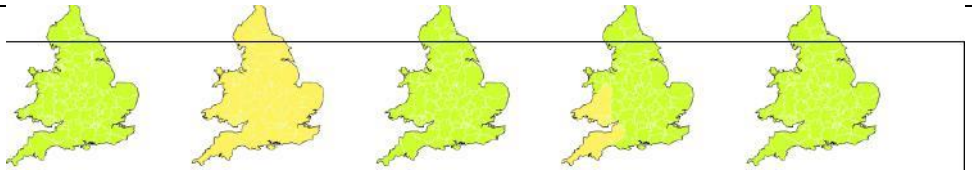


Figure 3

Flood Guidance Statement 10:30hrs 24 August 2012

Our assessment of daily flood risk for England and Wales is below.



10:30 - 23:59hrs Friday 24 August 2012	00:00 - 23:59hrs Saturday 25 August 2012	00:00 - 23:59hrs Sunday 26 August 2012	00:00 - 23:59hrs Monday 27 August 2012	00:00 - 23:59hrs Tuesday 28 August 2012

Headline

Low flood risk on Saturday with isolated instances of significant disruption possible. Further flooding disruption possible on Monday.

General Overview of Flood Risk

Heavy, slow moving showers and more prolonged periods of rain will affect much of England and Wales on Saturday. Whilst there is likely to be a number of minor river and surface water flooding impacts for several places, there is also the possibility of isolated instances of more significant disruption. As a result the overall surface water and river flood risk for Saturday is LOW.

Flood Guidance Statement 10:30hrs 25 August 2012

Our assessment of daily flood risk for England and Wales is below.

10:30 - 23:59hrs Saturday 25 August 2012	00:00 - 23:59hrs Sunday 26 August 2012	00:00 - 23:59hrs Monday 27 August 2012	00:00 - 23:59hrs Tuesday 28 August 2012	00:00 - 23:59hrs Weinesday 29 August 2012

Saturday 25th August

In AreaA, there is a LOW overall flood risk. This results from a medium likelihood of minor flooding disruption from river and surface water flooding. Typical flooding impacts in this area are likely to include instances of flooding affecting land, roads and individual properties. Localised disruption to travel is also possible.

In Area B, there is a LO/ overall flood risk. However, in this area there is a law likelihood of isolated but significant river and surface water flooding.
This could include flooding affecting properties and parts of communities, disruption to key sites identified in flood plans and isolated but significant disruption to travel.

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Peterborough
Clit
swich r• Oxford Lutn
London
Thanet

Figure 4 Selected outputs from the EA and Met Office Flood Guidance Statement

2.4 10th August 2014

From Sunday 10th to Monday 11th August 2014, the UK experienced some unseasonably windy and very wet weather from the remnants of ex-hurricane Bertha. Bringing strong winds and heavy rain, with parts of eastern England and north-east Scotland worst affected. The centre of the low pressure system then remained close to Shetland through until 13 August.

Due to the speed in which the storm arrived and short nature of the incident, attendance at sites for all partners was limited. Area Team staff requested sandbags at a number of places and council sandbag supplies were dispatched, Fire Service early responder crews and full fire brigade appliances visited a range of sites listed in Table 1 and pumping was commenced in a range of locations.

No targeted warnings were in force as this was a surface water event, in times of forecasted intense rainfall the EA and Met Office issue Weather Warnings and Flood Guidance Statements, both reports were received by the council at various frequencies leading up to the event and did not indicate a heightened risk or requirement to mobilise resource, a selection of outputs from the report is highlighted in figure 5 below.

Environment Agency data showed that water levels in the River Hull and smaller watercourses within the city were normal and able to receive flows. The tidal levels were also at a lower extent so there were no recorded issues with water discharging to the Humber. This shows that the incident was purely based around a pluvial event, flooding from surface water and sewers.

Figure 5 Selected outputs from the EA and Met Office Flood Guidance Statement

FLOODFORECASTINLCENTRE

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Flood Guidance Statement 10:30hrs Sunday 10 August 2014

Ott assessment of daily flood risk for England and Wales, ...corking with flood forecastng teams in the Ensucrunem Agency and Natural Resources *Wale,* m below

10.30 - 23.591ve Sunday 10 August 2014 | Monday 11 August 2014 | Tuesday 12 August 2014 | Wednesday August 2014 | Thursday 14 August 2014

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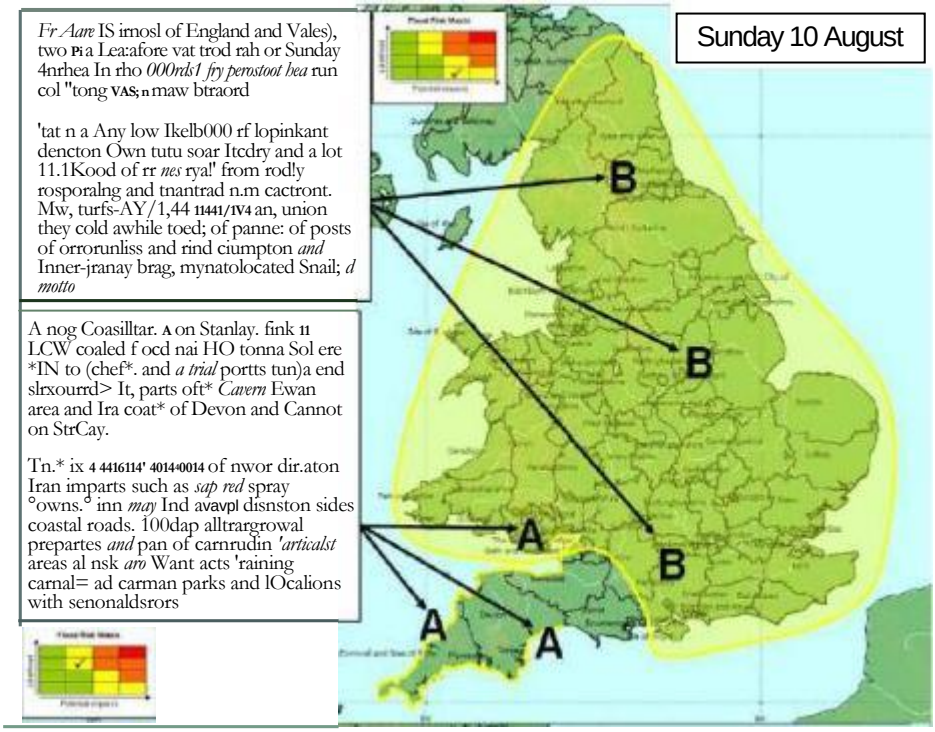
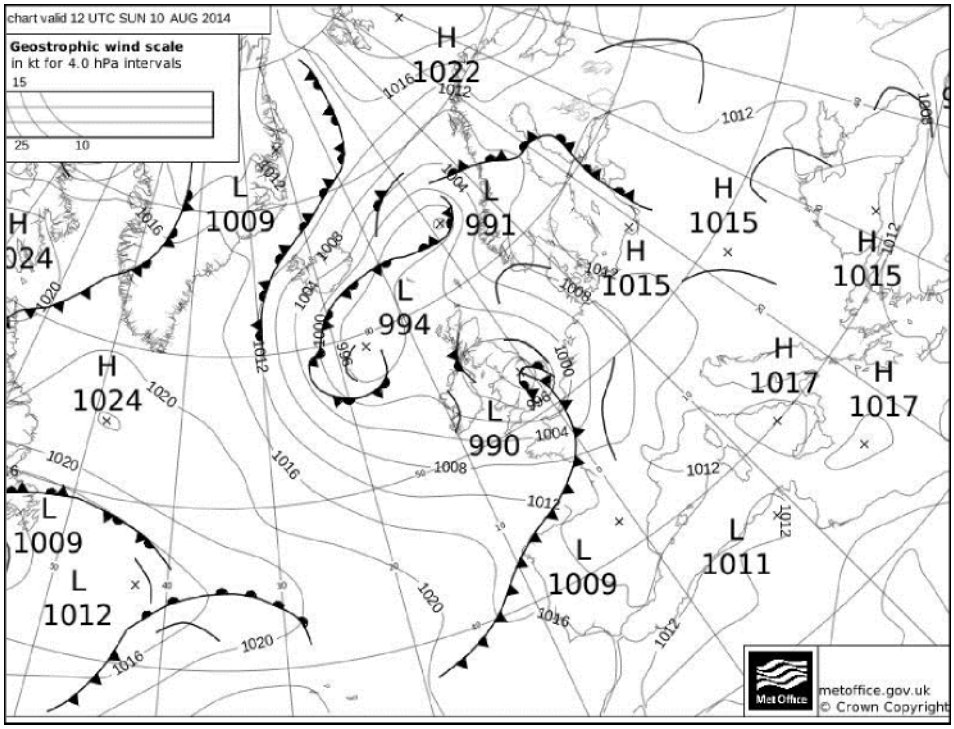
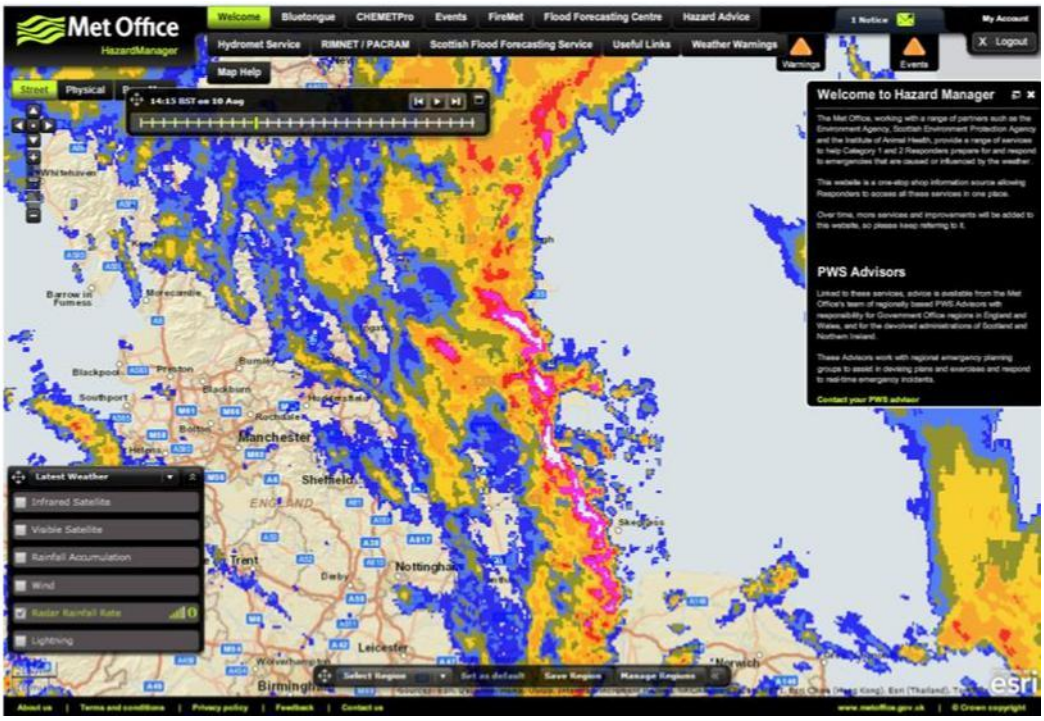


2.5 Analysis data from Met office

The analysis chart below shows the storm tracking across UK, before drifting northward into the North Sea



Analysis chart 1200 GMT Sun 10th August 2014 Figure 6



Met office Hazard Manager data on the 10th August 2014 Figure 7

The Met office Hazard Manager data is available to anyone who works for a Category 1 or Category 2 organisation (as defined in the Civil Contingencies Act 2004) can access Hazard Manager. The Met Office provides a range of services that help authorities prepare for and respond to emergency incidents and long-term risks that are caused or influenced by weather and climate. Hazard Manager is a one-stop information source for the emergency response community. It is an interactive web portal using maps which can be overlaid with weather and incident related information.

The interactive map colours indicate the amount of rain fall excepted

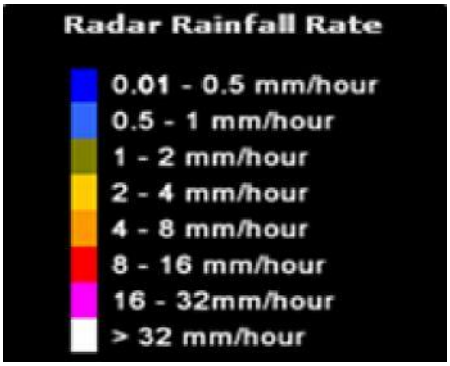


Figure 8 colour bar

2.6 10th August 2014 Rainfall Analysis

HCC & ERYC RAIN GAUGE READINGS
10TH AUGUST 2014

HCC — North Bridge :-

24hr rainfall = 37 4mm

Heavy rain between 9.40 & 13.25 GMT

Max rainfall in 15 minutes (between 13:00 — 13.15 GMT) = 7.4mm

Time (GMT)	Rainfall
00:00 — 01:00	0.4mm
01:00 — 02:00	1.2mm
02:00 — 03:00	0.2mm
03:00 — 04:00	1.6mm
04:00 — 05:00	0
05:00 — 06:00	0
06:00 — 07:00	0
07:00 — 08:00	0
08:00 — 09:00	0
09:00 — 10:00	5.6mm
10:00 — 11:00	3.6mm
11:00 — 12:00	5.8mm
12:00 — 13:00	1.6mm
13:00 — 14:00	10.6mm
14:00 — 15:00	0.2mm
15:00 — 16:00	0
16:00 — 17:00	1.8mm
17:00 — 18:00	0.2mm
18:00 — 19:00	0
19:00 — 20:00	0
20:00 — 21:00	0
21:00 — 22:00	0
22:00 — 23:00	1.2mm
23:00 — 24:00	3.4mm
24:00 — 01:00	0.6mm

ERYC — Cottinctham :-

24hr rainfall = 43mm

Heavy rain between 9.25 & 13.25 GMT

Max rainfall in 15 minutes (between 12:50 — 13.05 GMT) = 10.4mm

Time (GMT)	Rainfall
00:00 — 01:00	0.6mm
01:00 — 02:00	0.8mm
02:00 — 03:00	0
03:00 — 04:00	1.4mm
04:00 — 05:00	0
05:00 — 06:00	0
06:00 — 07:00	0
07:00 — 08:00	0
08:00 — 09:00	0
09:00 — 10:00	6.4mm
10:00 —11:00	2.8mm
11:00 — 12:00	5.6mm
12:00 — 13:00	13.8mm
13:00 — 14:00	4.2mm
14:00 —15:00	0
15:00 —16:00	0
16:00 —17:00	1.6mm
17:00 — 18:00	0.2mm
18:00 —19:00	0
19:00 — 20:00	0
20:00 — 21:00	0
21:00 — 22:00	0
22:00 — 23:00	2.0mm
23:00 — 24:00	3.6mm
24:00 — 01:00	0

ERYC — Hessle :-

24hr rainfall = 40.6mm

Heavy rain between 9:40 & 13:00 GMT

Max rainfall in 15 minutes (between 12:45 — 13.30 GMT) = 10.2mm

Time (GMT)	Rainfall
00:00 — 01:00	0
01:00 — 02:00	0.8mm
02:00 — 03:00	0
03:00 — 04:00	0.8mm
04:00 — 05:00	0
05:00 — 06:00	0
06:00 — 07:00	0
07:00 — 08:00	0
08:00 — 09:00	0
09:00 — 10:00	6.0mm
10:00 — 11:00	2.2mm
11:00 — 12:00	6.0mm
12:00 — 13:00	15.6mm
13:00 — 14:00	1.4mm
14:00 — 15:00	0
15:00 — 16:00	0
16:00 — 17:00	3.4mm
17:00 — 18:00	0
18:00 — 19:00	0
19:00 — 20:00	0
20:00 — 21:00	0
21:00 — 22:00	0
22:00 — 23:00	1.6mm
23:00 — 24:00	2.8mm
24:00 — 01:00	0

ERYC — Hedon :-

24hr rainfall = 36.2mm

Heavy rain between 9.05 & 13.20 GMT

Max rainfall in 15 minutes (between 10:50 — 11.05 GMT) = 8mm

Time (GMT)	Rainfall
00:00 — 01:00	1.2mm
01:00 — 02:00	1.0mm
02:00 — 03:00	0.6mm
03:00 — 04:00	0.4mm
04:00 — 05:00	0.2mm
05:00 — 06:00	0
06:00 — 07:00	0
07:00 — 08:00	0
08:00 — 09:00	0.2mm
09:00 — 10:00	6.0mm
10:00 — 11:00	7.8mm
11:00 — 12:00	7.0mm
12:00 — 13:00	0
13:00 — 14:00	6.4mm
14:00 — 15:00	0.2mm
15:00 — 16:00	0
16:00 — 17:00	1.6mm
17:00 — 18:00	0
18:00 — 19:00	0
19:00 — 20:00	0
20:00 — 21:00	0
21:00 — 22:00	0
22:00 — 23:00	1.0mm
23:00 — 24:00	2.6mm
24:00 — 01:00	0.4mm

ERYC – Bilton :-

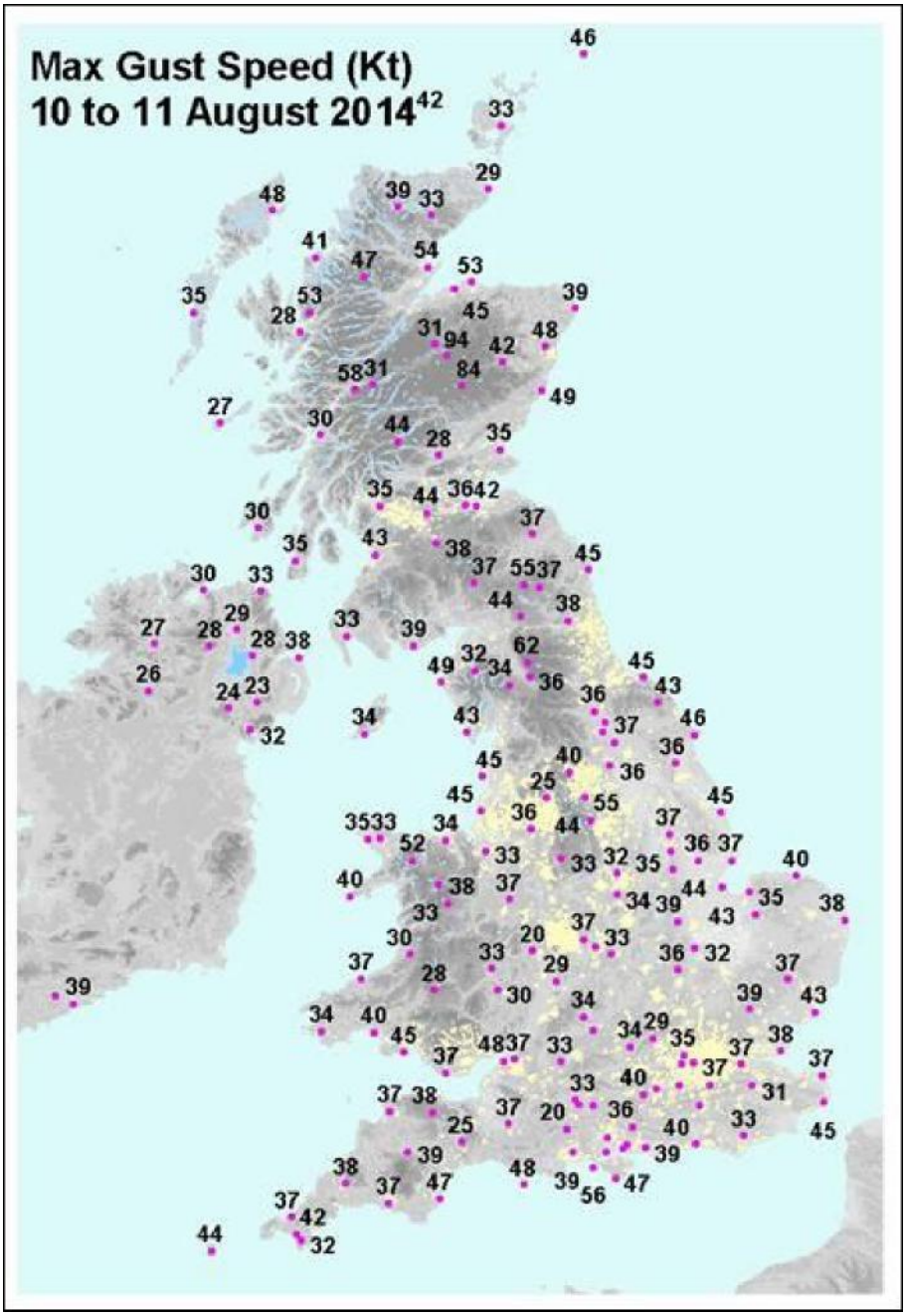
24hr rainfall = 31.8mm

Heavy rain between 9.35 & 13.30 GMT

Max rainfall in 15 minutes (between 13:00 – 13.15 GMT) = 4.4mm
(between 13:15 – 13.30 GMT) = 4.2mm

Time (GMT)	Rainfall
00:00 – 01:00	0.4mm
01:00 – 02:00	1.2mm
02:00 – 03:00	0
03:00 – 04:00	1.4mm
04:00 – 05:00	0
05:00 – 06:00	0
06:00 – 07:00	0
07:00 – 08:00	0
08:00 – 09:00	0
09:00 – 10:00	5.4mm
10:00 – 11:00	4.0mm
11:00 – 12:00	4.2mm
12:00 – 13:00	0.2mm
13:00 – 14:00	9.6mm
14:00 – 15:00	0.4mm
15:00 – 16:00	0
16:00 – 17:00	1.6mm
17:00 – 18:00	0.2mm
18:00 – 19:00	0
19:00 – 20:00	0
20:00 – 21:00	0
21:00 – 22:00	0.2mm
22:00 – 23:00	0.8mm
23:00 – 24:00	2.2mm
24:00 – 01:00	0.6mm

The above records show that the showers where localised and torrential in some areas. Hull City Councils gauge at North Bridge did not record any extreme rainfall and the ERYC gauges at Albion Mills, Willerby and Atwick Village Drain both recorded negligible rainfall, the private weather stations confirmed these records. The highest recorded intensity of rainfall was east of the city; this was confirmed by the analysis of the Met Office radar records.



The heavy rain was accompanied by some strong winds Figure 9

The wind contributed to the amount of debris such as leaves and twigs which could block the gullies and sewers.

2.7 Drainage Assets

This was a pluvial flood event in all locations, that is to say it was fully attributable to intense rainfall and the ability of the drainage network to receive and convey this rainfall effectively.

In this effect the network of roadside gullies and the receiving network of drains and sewers are the key assets under scrutiny to understand the causes of flooding on the 10th of August 2014. Further details of individual locations are discussed in section 3.

3. Possible Causes

Section 2.4 highlights the localised nature of the intense rainfall, given the short duration and severity of the event it is difficult to definitively separate any problems between receiving infrastructure – road gullies etc – and conveyance infrastructure – highways drains / sewers. The existing road gulley system is not designed to receive such rainfall volumes. This is because much of the system is confined by existing development and there is little room to expand the drainage system without huge expense.

Once the rainfall is received by the conveying sewers the flows pass by gravity through the system, Yorkshire Water observe levels at their key pumping stations and 6 level monitors around the city and when necessary pump the flows. Telemetry data from Yorkshire Water shows how the pumps in West, East and Bransholme pumping stations were operated. A time delay is experienced between the onset of the rainfall and pumping operations, this is to be expected as the pumps cannot operate until the water in the sewers reaches them.

It is suggested that due to the intensity of the rainfall many locations where roads, and in some cases properties, were flooded, the receiving sewers were still ‘filling’ and even if flow monitors triggered pumping operations the localised nature of the rainfall may in some cases have meant that the ‘downstream’ sections of sewer were not running full and pumping would therefore be limited in its effectiveness. It is not until the flows from the area of intense rainfall pass into the downstream section of sewers that effective pumping can take place, this is often seen as a ‘drawdown’ of water level in a location as the pumping operation begins to take effect, some residents around Noddle Hill Way, Hawkshead Green and Willerby Road observed a similar occurrence on the 9th of June 2014 and the 8th of July 2014.

Investigations by Hull City Council have identified locations where we can modify road infrastructure and public realm to manage future surface water issues – In the East of the city and the West.

Location	Investigation Findings
1. Kestrel Avenue	Overloading of the YW Sutton Branch Sewer leading to overwhelming of smaller YW and Highway drainage systems.
0. Hanson Electrical Willerby Road	Overloading of the YW Northern Trunk Sewer leading to overwhelming of smaller YW and Highway drainage systems.
1. Wymersley road (Junction)	Overloading of the YW Northern Trunk Sewer leading to overwhelming of smaller YW and Highway drainage systems.
2. Springhead Ave (Junction)	Overloading of the YW Northern Trunk Sewer leading to overwhelming of smaller YW and Highway drainage systems.
3. Chanterlands Ave (Railway Underpass)	Overloading of the YW Newland Branch Sewer leading to overwhelming of smaller YW and Highway drainage systems.
2. Mount Pleasant	Overloading of the YW Drypool Trunk Sewer leading to overwhelming of smaller YW and Highway drainage systems.
3. Kinloss Garth	Overloading of the YW Bransholme Trunk Sewer leading to overwhelming of smaller YW and Highway drainage systems.
4. Cranbrook Ave	Overloading of the YW Newland Branch Sewer leading to overwhelming of smaller YW and Highway drainage systems.
5. Cottingham Road	Overloading of the YW Newland Branch Sewer leading to overwhelming of smaller YW and Highway drainage systems.
0. Dalton Street	Overloading of the YW Drypool Trunk Sewer leading to overwhelming of smaller YW and Highway drainage systems.
1. Hampshire Street	Overloading of the YW Western Trunk Sewer leading to overwhelming of smaller YW and Highway drainage systems.
12.13,14,15 Malham Avenue, Kendal Way, Hawkshead Green, Norland Ave	Overloading of the YW Newington Trunk Sewer leading to overwhelming of smaller YW and Highway drainage systems.
16. Boothferry Road (Railway Underpass)	Overloading of the YW Newington Trunk Sewer leading to overwhelming of smaller YW and Highway drainage systems.
18. Anlaby road (roundabout area)	Overloading of the YW Newington Trunk Sewer leading to overwhelming of smaller YW and Highway drainage systems.
19. Trenton Ave	Overloading of the YW Newington Trunk Sewer leading to overwhelming of smaller YW and Highway drainage systems.

20.Holderness Road (Railway Underpass)	Overloading of the YW Drypool Trunk Sewer leading to overwhelming of smaller YW and Highway drainage systems.
21 Howdale Road	Overloading of the YW Sutton Branch Sewer leading to overwhelming of smaller YW and Highway drainage systems.

Table 2 – Survey and investigations from all partner organisations

4. Roles and Responsibilities

4.1 Lead Local Flood Authority

Hull City Council is defined as a Lead Local Flood Authority in the FWMA, main responsibilities: flooding from surface runoff, groundwater and ordinary watercourses, permissive powers to maintain none Main Rivers, development of a Local Flood Risk Strategy, Asset Plans and Investigations.

The council received advance weather warnings for the 10th August 2014 event as detailed in section 2.4, the warnings showed a limited risk. Identified problem gullies and known hotspots were targeted for utilising the street cleansing crews to ensure that litter was kept to a minimum to prevent blockage of gullies.

All council owned trash screens on the ordinary watercourses were checked and cleaned prior to the event.

4.2 Environment Agency

Key responsibilities are: flooding from main rivers, the sea and reservoirs including coastal erosion risk management, permissive powers to maintain Main Rivers, Strategic Overview over all forms of flooding and development of a National Flood Risk Strategy.

Due to the event being a surface water / pluvial event the Environment Agency have no formal operational role in the management of the events of 10th August 2014. The Environment Agency's role with regard to forecasting is via Flood Guidance Statements and discussions with partners emergency planning officers, due to the difficulty in predicting the exact locations of intense events and the likelihood of surface water flooding the Agency can only advise and these issues are often discussed with partner organisations.

Work to develop warnings for surface water and pluvial flooding is being assessed by the Agency. This will be a difficult process to deliver with any degree of certainty but is part of a package of resilience and awareness raising measures which needs producing. This is included as a recommended action in Section 5.

4.3 Water and Sewage Company

Yorkshire Water Services are the water and sewage company covering Hull City Council and the surrounding catchment area, their key responsibilities are: the provision of a water supply, the discharge of foul and grey water from properties. This includes managing the risks of flooding from water supply, surface and foul or combined sewer systems and commenting on planning applications in regards to the capacity of the sewers to accept discharge from new developments.

Yorkshire Water responded in a range of areas across the city during and after the event, their infrastructure and pumped drainage network was operated and as highlighted in Section 3 it worked as designed although it may have had limited effectiveness due to the isolated and intense nature of much of the rainfall before the system became fully 'surcharged'.
Yorkshire Water continues to be involved in the Hawkshead Green area and Merlin Close/ Kestral Way area. Several jetting and cleansing operations have taken place in the area and the effectiveness of the local system will now be optimised but observations suggest wider problems in the branch sewer network. Hull City Council are in regular contact with residents and are supportive of Yorkshire Water carrying out further work as required, this will be a recommendation in Section 5.

4.4 Highways Authority

The localised nature of the flooding on the 10th August meant that the highways affected were none arterial roads and are the network managed by the council, key responsibilities are: providing and managing highway drainage and roadside ditches under the Highways Act 1980.

The intensity and severity of the storm overwhelmed many roadside drains and gullies; a risk based clearance regime is in place to ensure that roadside gulley pots are fully operational. Several site investigations have shown that the vast majority of gullies were clear and Yorkshire Water investigations have similarly confirmed this. The storm intensity was greater than the design standards of much of the highway drainage infrastructure.

In some locations improvements have been developed since the 25th August flooding 2012. These have been done by the council's flood risk management and highways staff which include adaptation of and improvements to the highway drainage infrastructure at Noddle Hill Way. The solution involves increasing the highway drainage provision at a low spot in the road. This means that water flowing down the roads can be stored within the highway without flowing into properties and gardens. The council as a Lead Local Flood Authority has developed this scheme using small changes to the existing infrastructure to ensure it is cost beneficial. This type of measure will reduce the frequency of flooding in the area but it would not prevent a flood of their magnitude of 2007 from happening again.

4.5 Residents

Residents are encouraged to understand the flood risk in their local area and have a flood plan to help target what actions they could do themselves to help in a flood situation. Communities are also encouraged to have plans to enable help for the more vulnerable people in the area. . Actions such as placement of sandbags, moving valuable items to a safe place and semi / permanent measures such as installation of floodgates, airbrick covers etc are encouraged to reduce the consequences of flooding at a property level.

It is recommended that residents sign up to appropriate warnings for their area and keep contact details up to-date and act upon all warnings appropriately. When flooding does occur residents are encouraged to document as much information as possible to aid the investigations of all operating authorities and to provide information to their loss adjusters and insurers.

The event was surface water / pluvial in nature and due to this no formal warnings exist. The event took many by surprise due to its ‘un-seasonal’ nature. Whilst there has been experience of periods of heavy rainfall at all times of the year, this combined with the intense showers and extremely high winds made this incident unpredictable. Many residents are prepared to take action and evidence has been seen of self-help, others looked to the council to respond.

5. Recommendations

The investigation has concluded that the main cause of the flooding on the 10th August 2014 was the intensity and localised nature of the rainfall, many areas experienced significant rainfall volumes and high winds which served to show the 'un-seasonal' nature of the event.

The main operating authorise involved are Hull City Council in its Lead Local Flood Authority role and Yorkshire Water Services, investigations by both have led to a range of remediation measures and planned interventions.

Operating Authority / Stakeholder	Recommended Actions
Hull City Council & Yorkshire Water	Deliver a series of small flood alleviation schemes/aqua greens city wide where possible
Hull City Council	Encourage and inform residents how to report incidents of sewer flooding to Yorkshire Water
Yorkshire Water	Resolution of problems at Hawkshead Green area in full cooperation with Hull City Council
Yorkshire Water	Review and survey existing mapping data to correspond with actual in the ground built systems
Yorkshire Water	Yorkshire Water work with Hull City Council to identify known priority locations in the city to look at joint solutions for managing flood risk. The evidence used for this will be section 19 reports, DG5 register and utilising the information contained in previous studies and integrated modelling work.
Yorkshire Water	Work with Hull City Council and the communities to increase the knowledge on the complex nature of Hull's drainage systems and pumping stations by engaging with Councillors and communities in the city
Yorkshire Water	Produce clear guidance for customers on reporting flooding to Yorkshire Water. This should include what can be reported, how and when.
Environment Agency	The surface water / pluvial nature of the event highlights the lack of warning from this flood source, all sources warnings are being developed by the Environment Agency, Hull City Council recommends that this is delivered as soon as practicable and welcomes any involvement in the delivery of the approach
Hull City Council	Communication with residents to enable a greater understanding of the risk of surface water flooding and the ways in which residents and communities can be better prepare and more resilient to flood risks.
Hull City Council	Replace road gullies in key risk areas with larger waterway gullies grate.

Hull City Council	Develop GIS layers of historical key flooding hot spots to support operational teams and provided target areas for future alleviation schemes

Table 3 – Recommendations

6. Conclusion

The intense rainfall of the 10th August 2014 was another reminder that the infrastructure needs to be more adaptable to be able to cope with flash flooding type events. The data regarding the amount of rain that fell shows that it was not particularly significant across the whole of the city but extremely localised and heavy in some areas. This put pressure on the existing systems such as the sewers and gullies. The receiving watercourses were not affected by the event and the levels did not show a reaction to the rain.
The storm resulted in extensive road and isolated property flooding despite, all operating authorities responding and the infrastructure working as designed. Issues were caused by the storm intensity and speed which meant that many areas were affected shortly after the onset of rainfall and before the receiving infrastructure accepted flows.

The pure intensity of rainfall and high winds is identified as the main problem on the 10th August 2014 with the existing traditional systems unable to cope due to the speed of flow rates and volumes of run off.

A range of remediation measures have and are still needed to be carried out by all partners and others are being developed, recommendations for their delivery and continued improvements.

Abbreviations / Acronyms

EA Environment Agency

HCC Hull City Council

FIR Flood Investigation Report

FWMA Flood and Water Management Act 2010

LDA Land Drainage Act 1991

LLFA Lead Local Flood Authority

WRA Water Resources Act 1991

Useful Links and Contacts

Useful Contacts and Links

Environment Agency
General Enquiries 08708 506 506 (Mon-Fri, 8am - 6pm)
Incident Hotline 0800 80 70 60 (24hrs)

Lead Local Flood Authority
Hull City Council
General Enquiries (emergency calls handled via this number) 01482 300 300

Water and Sewage Operator
Yorkshire Water 0845 1 24 24 24

Flood and Water Management Act 2010:
http://www.legislation.gov.uk/ukpga/2010/29/contents

Highways Act 1980:
http://www.legislation.gov.uk/ukpga/1980/66/contents

Water Resources Act 1991:
http://www.legislation.gov.uk/ukpga/1991/57/contents

Land Drainage Act 1991:
http://www.legislation.gov.uk/ukpga/1991/59/contents

EA - 'Living on the Edge' a guide to the rights and responsibilities of river side occupation:
http://www.environment-agency.gov.uk/homeandleisure/floods/31626.aspx

EA - River and Coastal Maintenance Programmes:
http://www.environment-agency.gov.uk/homeandleisure/floods/109548.aspx

EA - Prepare your Property for Flooding:
How to reduce flood damage
Flood protection products and services
http://www.environment-agency.gov.uk/homeandleisure/floods/31644.aspx