

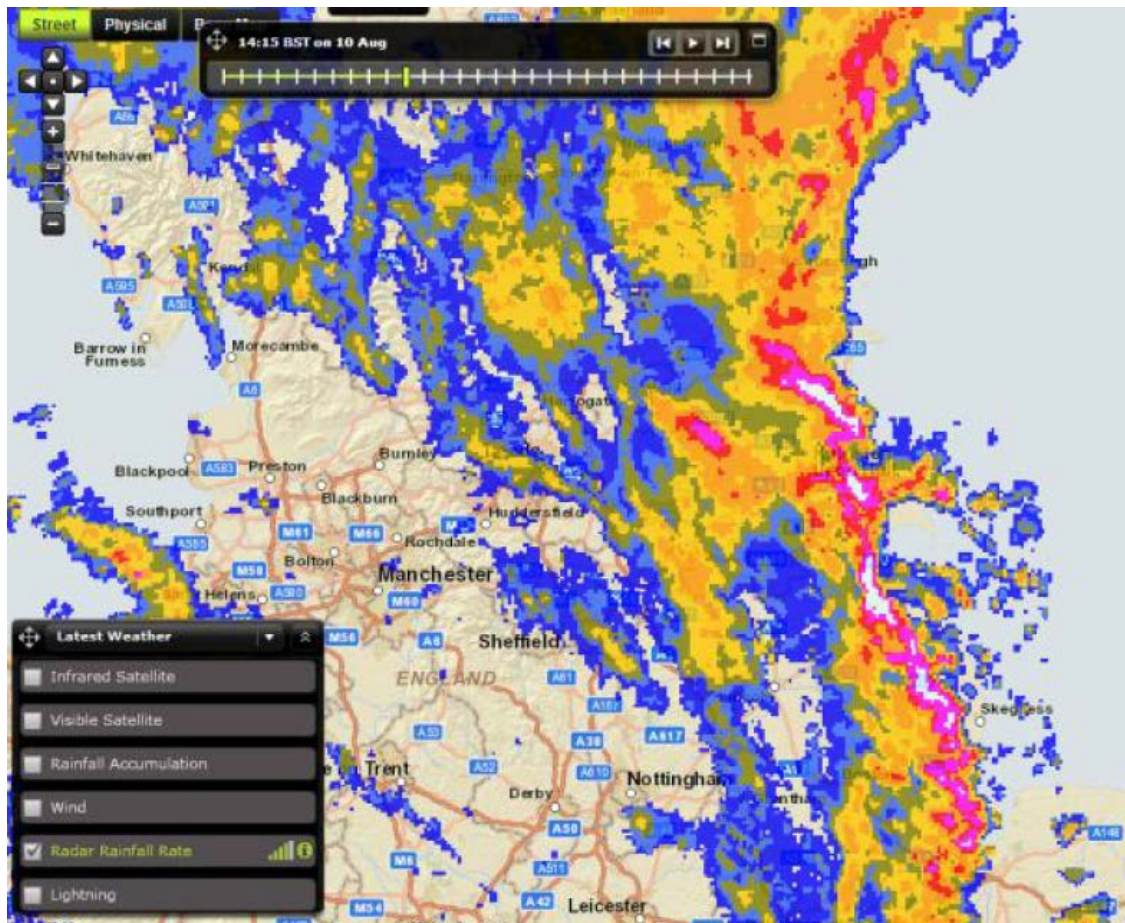
Flood Investigation Report

Ex Hurricane Bertha 10 August 2014:

East Riding Flooding Events

CES\D190

January 2015



EAST RIDING
OF YORKSHIRE COUNCIL

The Cover illustration is a screen-shot image from the Met Office Hazard Manager Rainfall Radar, indicating very heavy rainfall in East Yorkshire.(See also page 18)

Revision Schedule

East Riding of Yorkshire Council

Flood Investigation Report: Ex Hurricane Bertha East Riding Flooding Events 10 August 2014.

Rev	Date	Details	Author	Checked and Approved By
Rev 1	07/11/14	Initial Draft	AM	
Rev 2	21/11/14	Draft for Technical Consultation	AM	
Rev 3	08/12/14	Draft for Corporate Consultation	AM	DW
Rev 4	15/12/14	Draft following consultation with YW	AM/DW	

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Records of the public sewer system included are a facsimile of the statutory record provided by Yorkshire Water Services. For the purposes of this report minor sewers and other non- relevant data have been omitted from the plans for clarity. The statutory public sewer record is held by Yorkshire Water Services Ltd.

Acknowledgements

East Riding of Yorkshire Council would like to thank the following for their co-operation and assistance throughout this investigation.

Yorkshire Water Services Ltd

Hull City Council

Residents of Anlaby

Ward Councillors

Residents of Swinemoor Estate, Beverley

South Cave Parish Council

Market Weighton Town Council

Humberside Fire and Rescue Service

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Lead Local Flood Authority and Responsibilities

East Riding of Yorkshire Council, as the Lead Local Flood Authority (LLFA), has a responsibility under Section 19 of the Flood and Water Management Act 2010 to investigate significant flood incidents in its area. Section 19 states:

- (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.*
- (3) The LLFA has lead responsibility for managing the risk of flooding from surface water, groundwater and ordinary water courses.*

This report has been prepared by East Riding of Yorkshire Council in its role as LLFA in response to extensive flooding which affected properties internally in Anlaby, Beverley, Burton Pidsea, Keyingham, Kirk Ella, Little Weighton, Ottringham, New Ellerby and Welton, as well as other areas across the East Riding.

This report provides an overview of flooding that has occurred, describes the conditions which led to the flooding, considers the response to the flooding thus far and makes technical recommendations for the flood risk authorities concerned.

Relevant Flood Risk Management Authorities

The risk management authorities that have relevant flood risk management functions are:

East Riding of Yorkshire Council

East Riding of Yorkshire Council is the Lead Local Flood Authority responsible for managing flood risk from surface runoff, groundwater and ordinary watercourses, development of a Local Flood Risk Strategy, Asset Plans and Investigations under the Flood and Water Management Act 2010. East Riding of Yorkshire Council also has responsibility for some Coastal erosion risk management, and is the Highway Authority with responsibility for highway drainage under the Highways Act 1980.

Environment Agency

Responsible for managing the flood risk 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.

Internal Drainage Boards

Internal Drainage Boards are independent public bodies established in areas of special drainage need in England and Wales. They have permissive powers to manage water levels and to undertake works to reduce flood risk to property within their drainage districts.

Yorkshire Water

Yorkshire Water Services is the statutory sewerage undertaker for the Yorkshire region with a duty to effectually drain sewers pursuant to the Water Industries Act 1991.

Other LLFA's

Hull City Council is the Lead Local Flood Authority within the Hull City boundary.

In addition:

Riparian Landowners

Riparian landowners are those who own land adjoining a watercourse and have certain responsibilities, including the following:

- They must maintain the bed and banks of an open watercourse, and also the trees and shrubs growing on the banks.
- They must clear any debris, even if it did not originate from their land, this debris may be natural or man-made.
- They must keep any structures that they own clear of debris. These structures include culverts, trash screens, weirs and mill gates.

If they do not carry out their responsibilities, they could face legal action under the Land Drainage Act 1991. Details of a riparian landowners responsibilities can be found in 'Living on the Edge' published by the Environment Agency.

1 Executive Summary

On 10 August an intense low pressure weather system, identified as ex-hurricane Bertha travelled northeast across the UK, resulting in high winds and intense periods of rainfall which led to widespread problems in many areas of the country including the East Riding.

The storm had travelled east across the Atlantic Ocean before turning towards the northeast passing over the UK. The rainfall data obtained indicates that the rainfall was significant: the peak recorded rainfall intensity for the storm was 53 mm/hr in a 5 minute period, with 40mm falling in 5 hours in Beverley. In Anlaby it is estimated some 23 mm fell in a similar period, at Albion Mills 45mm fell.

Internal property flooding occurred in Anlaby, Beverley, Burton Pidsea, Keyingham, Kirk Ella, Little Weighton, Ottringham, New Ellerby and Welton affecting a total of 20 properties. In total some 26 settlements across the East Riding reported flooding, including Market Weighton in the west and as far east as Bridlington and Withernsea. The worst affected area was Anlaby where some 38 properties were affected by area flooding and 8 properties flooded internally.

In all the affected areas it was evident from the data obtained and from reports received that the drainage systems were simply overwhelmed by the amount and intensity of the rainfall.

In the worst affected area, Anlaby, it is concluded that the capacity of the local drainage infrastructure was unable to cope with the intensity of the rainfall. Levels receded quickly once the intensity of the rainfall eased and the pumping operations at West Hull started.

Current and historic design standards for drainage infrastructure including public sewers are only intended to contain “normal” heavy rainfall and would not be expected to cope with the high volumes of intense rainfall from Ex Hurricane Bertha.

Overall this report concludes that on 10 August 2014 the rainfall was of exceptional intensity and exceeded the current or historic design standards for the drainage infrastructure, and that the relevant flood risk management authorities exercised their functions in response to the flooding incidents.

2 Location of Flooding

Areas affected in the East Riding:

Anlaby	Driffield	Nafferton	Willerby
Beverley	Hedon	New Ellerby	Wyton
Bridlington	Hessle	North Ferriby	
Brough	Keyingham	Ottringham	
Burstwick	Kirk Ella	South Cave	
Burton Pidsea	Little Weighton	Skidby	
Cherry Burton	Market Weighton	Welton	
Cottingham	Molescroft	Withernsea	

See Appendix 1 - Plan and List of affected areas.

Also Appendix 2 – List of Properties Affected.

2.1 Affected Areas

Some twenty six settlements within the East Riding were reportedly affected by flooding issues on 10 August as a result of severe weather (ex hurricane Bertha) with strong winds and heavy rain.

All these areas (see Appendix 1) reported highway and garden flooding. In parts of Anlaby, Beverley, Burton Pidsea, Keyingham, Little Weighton, Kirk Ella, Ottringham, New Ellerby and Welton internal property flooding was also reported. Many roads were affected with some temporarily closed while the flood water drained away.

It can be seen from Appendix 1 (plan showing the affected areas), and from the rainfall data collected (see Appendix 3) that as the storm travelled north it produced heavy rainfall as it moved towards the higher ground of the Wolds. This led to flooding to the south of the Wolds from South Cave across to Withernsea, including Anlaby, with more isolated heavy showers affecting settlements further north, such as Beverley, Bridlington and Driffield.

2.2 Flooding to Highways

Many of the affected areas suffered highway flooding and it is believed that other areas will also have experienced highway flooding but no definite reports were received.

In some cases highway gullies were reported to be not working, however it is apparent that they were unable to discharge into the receiving drain or sewer as these will have been overwhelmed by the volume of rainfall. This was confirmed when witnesses reported flood water which had been standing starting to flow away down the gullies once the rain had eased and the drains began to empty, indicating that the receiving drain or sewer had been full and gullies and branch sewers had restricted discharge.

3 Drainage Systems

3.1 Drainage Systems in the Affected Areas

3.1.1 Anlaby and Hull Trunk Sewer Network

The sewer network from parts of the East Riding and the west of Hull City discharge into the YWS Trunk Sewers and into the Hull Tunnel adjacent to the West Hull Pumping Station(WHPS). (See Figure 1 below, also see Appendix 5).

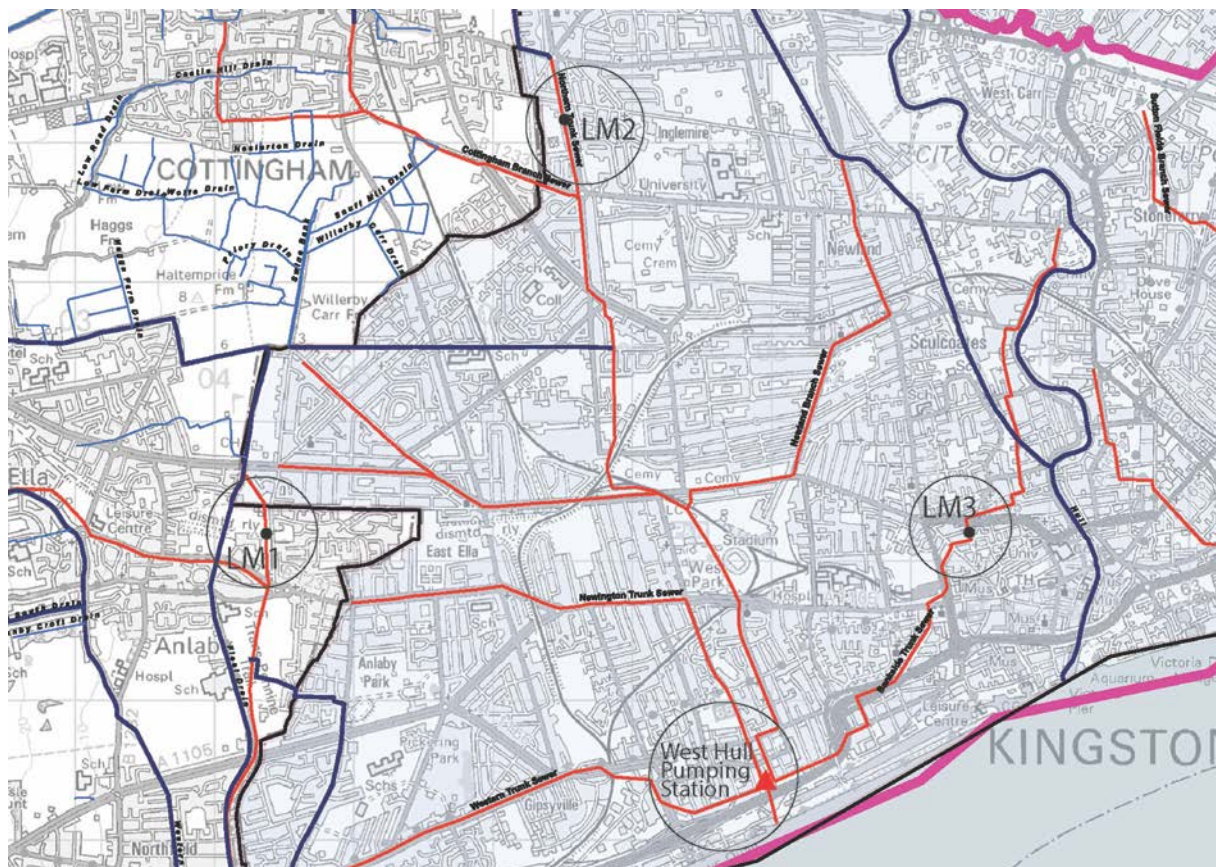


Figure 1: YWS Hull City Trunk Sewer Network, with Level Monitor Locations

In Figure 1 (above) the trunk sewers are labelled and the locations of the sewer level monitors, LM1, LM2 and LM3 in the sewer network are also indicated. (See Figure 2 in Appendix 6) for levels during the event). The local sewer networks serving the properties in the area discharge into the trunk sewers.

Anlaby and Cottingham and much of the Haltemprice area in East Riding drain into the YWS sewer network in Hull City, largely into the trunk sewer network. There are two trunk sewers which serve the area of Anlaby: one in Anlaby Road, the Newington Trunk, the other runs down Springhead Lane into the Western Trunk. (See Figure 1 above).

The trunk sewers discharge into the Tunnel sewer, constructed as part of the Humbercare Scheme, which carries flows to the Saltend Treatment Works, the Tunnel also takes flows from the east of the city, adjacent to East Hull Pumping Station on Hedon Road. The Tunnel is designed to act as storage during high flows. When the tunnel capacity is exceeded the West Hull Pumping Station can act as

an overflow and is used to discharge excess flows directly into the estuary. (See Appendix 6 for notes on the operating procedure for WHPS).

YWS have provided level data for the trunk sewers and for the Tunnel adjacent to WHPS for the 10 August, (see, Appendix 6).

3.1.2 Beverley Swinemoor Estate

The estate is served by a separate drainage system, which means that rainwater feeds into dedicated surface water sewers in the area. These sewers, together with the foul sewers, are maintained by YWS. The surface water sewers on the Swinemoor Estate discharge into culverted ditches which run along both sides of Swinemoor Lane. The Council is the riparian owner of these culverts, and are therefore responsible for maintaining them. The culverts discharge into Beverley and North Holderness Internal Drainage Board maintained open watercourses which cross Swinemoor, to discharge into the Barmston Drain.



Figure 2: Drainage System on the Swinemoor Estate, Beverley

All of the road side gullies within the public highway, and connections into the surface water sewers are the responsibility of the Council as highway authority to maintain.

3.1.3 Burton Pidsea

The village is served by a separate drainage system, with foul sewers and surface water sewers maintained by YWS; there are also some culverts maintained by riparian owners. The surface water sewers and the culverts discharge to riparian open watercourses, which in turn discharge into an IDB watercourse. The Council has recently funded work to construct a section of ditch to the north of the village, designed to divert water flowing from the east of the village around the village rather than passing through the village.

3.1.4 Keyingham

The village is served by a separate drainage system, with foul sewers and surface water sewers maintained by YWS, with some riparian culverts. The surface water sewers and the culverts discharge into an IDB watercourse.

3.1.5 Kirk Ella

The area is served by a combined sewer system and riparian surface water ditches and culverts.

3.1.6 Little Weighton

The village is served by a foul sewer system with riparian surface water drains which discharge into the village pond.

3.1.7 Ottringham

The village is served by a combined sewer network with some riparian surface water drains which discharge to an IDB watercourse.

3.1.8 New Ellerby

The village is served by a combined sewer network with some riparian surface water drains which discharge to an EA maintained watercourse.

3.1.9 Welton

The village is served by a combined sewer system and riparian surface water ditches and culverts.

3.2 Flooding History

In areas where property flooding was reported.

In Anlaby the flooded areas include roads and properties within Hull City, as the administrative boundary runs through the worst affected areas. Norland Avenue, Kendal Way, Hawkshead Green and Westborough Way areas have previously experienced area flooding as a result of heavy rainfall, with some property flooding in more severe events such as in 2007. On July 8 highway and some garden flooding was reported when Cottingham was flooded. There is a history of highway flooding as a consequence of heavy rain in Pryme Street/Wilson Street and Kingston Road/Willerby Road areas, and along Tranby Lane.

In Beverley the Fotherby Walk/Burdern Road/Pennyman Road areas and also Windsor Close have a history of highway flooding during intense rainfall events, with property flooding during more severe events such as in 2007.

In Burton Pidsea there is a history of highway and garden flooding in parts of the village during heavy rain, with property flooding during more severe events. A Council funded scheme was completed in 2013 to divert flows from an open watercourse flowing from the east of the village around to the north. There were no reports of problems from the properties in this part of the village.

In Keyingham there is some history of highway and garden flooding during heavy rain, with property flooding during more severe events.

In Kirk Ella, Little Weighton, Ottringham, New Ellerby and Welton, there is no specific history of flooding except in very severe rainfall events such as in 2007.

In other areas where highway and garden flooding was reported

In Cottingham, Market Weighton and South Cave, there had been extensive flooding during summer storms in July (all subjects of separate S19 reports). Many other settlements reporting problems had previously been affected in more severe events such as 2007.

4 The Flooding Event

4.1 Weather Data

On 10 August a very deep low pressure system, the remnants of ex-hurricane Bertha, passed up the north sea and over parts of the UK. This resulted in damaging winds and heavy rain in many places. See Appendix 3 for the Weather Warning issued by the National Severe Weather Warning Service, which was for the possibility of “localised intense rainfall anywhere in the east of England”.

A hurricane is a very intense low pressure system which forms over warm ocean waters. When they form in the Atlantic Ocean they normally track west and north making landfall in America, once over land the storm usually dissipates. However there is a history of similar weather events in the UK when this type of weather system has not made landfall in America but has swung north then east towards the UK and Europe. In 1974, 1979, 1983, 1986 and 1992 major storms affected the UK, with damaging winds and intense rainfall causing many problems.

4.2 Analysis of the Available Weather Data (See Appendix 3)

Due to the volatility and size of the weather system which was named as ex-hurricane Bertha the forecast was constantly updated, although in general the most severe weather was not expected to hit the East Riding. (Appendix 4: Met Office Storm analysis).

The forecast had been for the possibility of more than 50mm/hr in places in the east of England. The radar image indicates rainfall of greater than 32mm/hr, over parts of the East Riding.

Council Rain Gauges across the East Riding:

Location of Gauge	Peak Rainfall rate (mm/hr)	Heaviest rainfall (9:00am to 2:30pm)	Total Rainfall in 24 hrs
Albion Mills	18.4	36.2mm in 4.5hrs	45mm
Cottingham	13.8	35.6mm in 5hrs	43mm
Brough	17.8	28.5mm in 3hrs	30mm
Hessle	15.6	31.0mm in 4 hrs	37mm
Bilton	9.6	23.8mm in 5hrs	30mm
Hedon	7.8	27.6mm in 5hrs	36mm
Beverley	7.5	16.1mm in 5hrs	40mm
Market Weighton	7.4	27.4mm in 5hrs	36mm
Bridlington	6.8	24.0mm in 5hrs	29mm
Pocklington	6.2	20.4mm in 4hrs	29mm
Atwick	7.0	16.8mm in 5hrs	25mm

The data obtained indicates that the rainfall was very intense in places for short periods, and this intensity varied across the area. The overall amount of rain which fell also varied across the area. A peak intensity estimated in Beverley at 53mm/hr, and an estimated total rainfall of 40mm in 24 hours which equated to 73% of the average monthly rainfall. At Albion Mills to the west of Willerby and Anlaby a peak rate of 18.4mm/hr was recorded with 36.2mm falling in 4.5 hours, with a total of 45mm in 24 hours, 74% of the monthly average. In Anlaby a peak intensity of 30mm/hr and a total of 23mm in 24 hours was estimated from the Met office Radar data, 38% of the average monthly rainfall (See Figure 3 below).

The rainfall experienced was typical of a large weather system with a band of rain crossing the area with intermittent dry spells, rather than continuous rain. The heaviest rain fell largely between 9:00am and 2:30pm across the area, with Brough and Hessle recording rates of 17.8 and 15.6 mm/hr respectively.

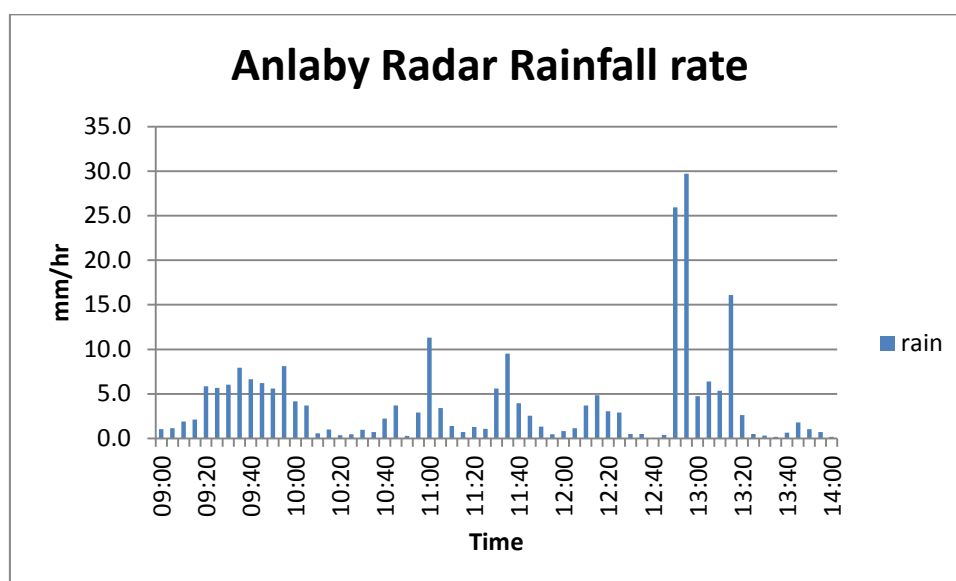
The council rain gauges across the area showed a variation in rainfall intensity from 6.2 mm/hr to 18.4 mm/hr in a 5 minute period, with the total rainfall varying from 25 mm up to 45 mm.

The EA also provided data from their Cottingham rain gauge for 10 August. Peak rainfall was 7.2mm in 15 minutes, with some 40mm in 24 hours. Minor flooding to some areas in Cottingham was reported but nothing similar to that experienced in Anlaby on this occasion.

Met Office Rainfall Radar Interpretation:

Location	Met Office Estimated peak rainfall rate (mm in 1 hour)	Estimated rainfall rate (mm/hr in 5 mins)	Total rainfall in 24 hours
Anlaby	8.0 mm	30 mm/hr	23 mm
Beverley	8.3 mm	53 mm/hr	25 mm
Burton Pidsea	10.3 mm	25 mm/hr	26 mm

Figure 3: Met Office Rainfall Radar Data



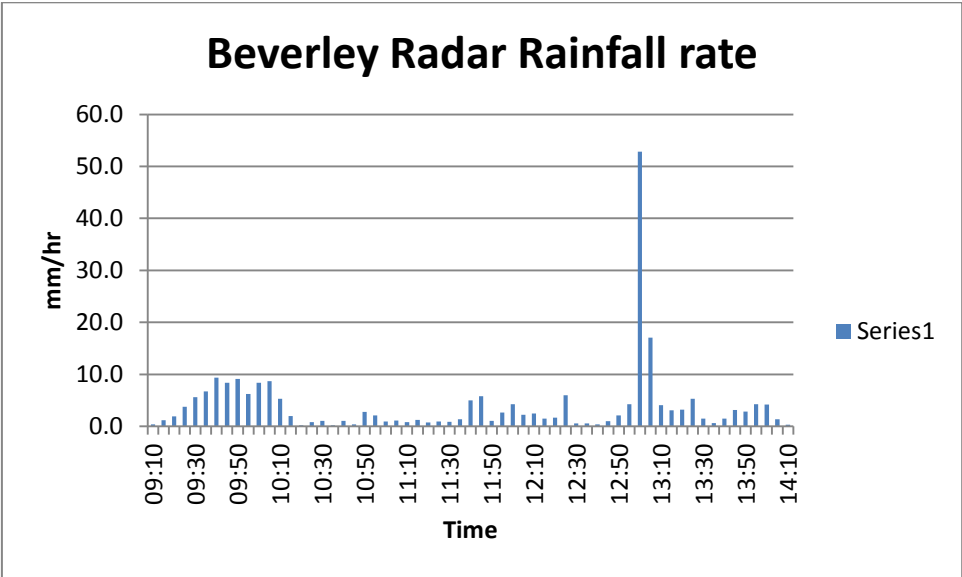
Rained all morning from 9:00am, heaviest rainfall at 1:00pm.

By 11:00am 7.5mm of rain had fallen on Anlaby in 2.0 hrs.

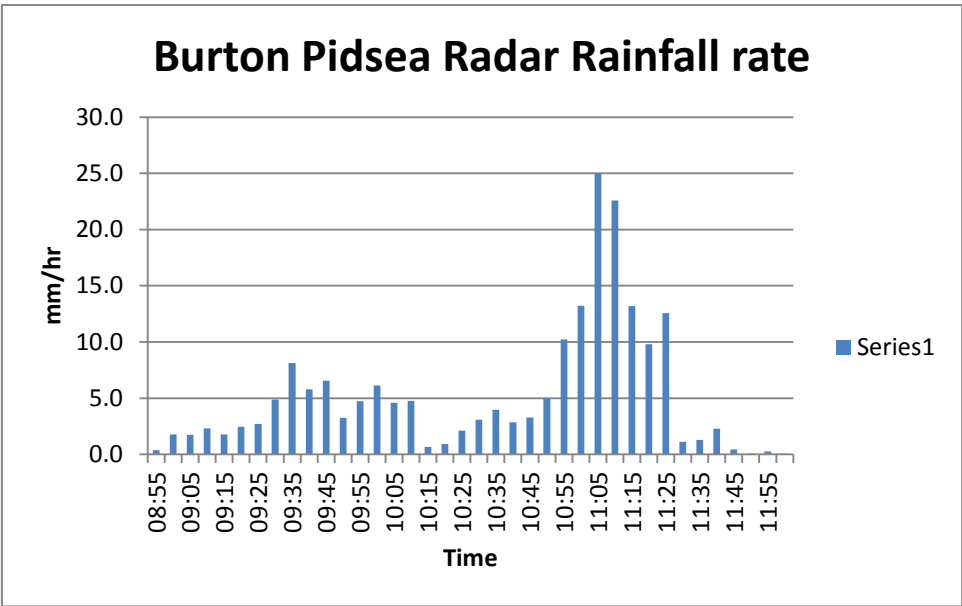
By 12:30 11.6mm of rain had fallen on Anlaby in 3.5 hrs

By 14:00 19.6mm had fallen in 5 hours.

Indicating that the rainfall was of exceptional intensity from 12:30 onwards.



Rained all morning from 9:00am, heaviest rainfall at 1:00pm.
By 12:00 noon 9.3mm of rain had fallen on Beverley In 3.0 hrs.
By 14:00 19.6mm had fallen in 5 hours.
Indicating that the rainfall was of exceptional intensity from 13:00 onwards.



Rained all morning from 9:00, heaviest rainfall at 11:00am.
By just before 11:00am 7.8mm of rain had fallen on Burton Pidsea in 2.0 hrs.
By 12:00 16.3mm of rain had fallen on Burton Pidsea in 3.0 hrs

Below is an image taken from the Met Office Hazard Manager web site showing rainfall radar, the lighter the colour the more intense the rainfall. (White patches across East Riding indicating rainfall of more than 32mm/hr in places).

This also illustrates the variation in the intensity of the rainfall across the areas affected.



Key to figure 4 below: lighter colours indicate more intense rainfall.

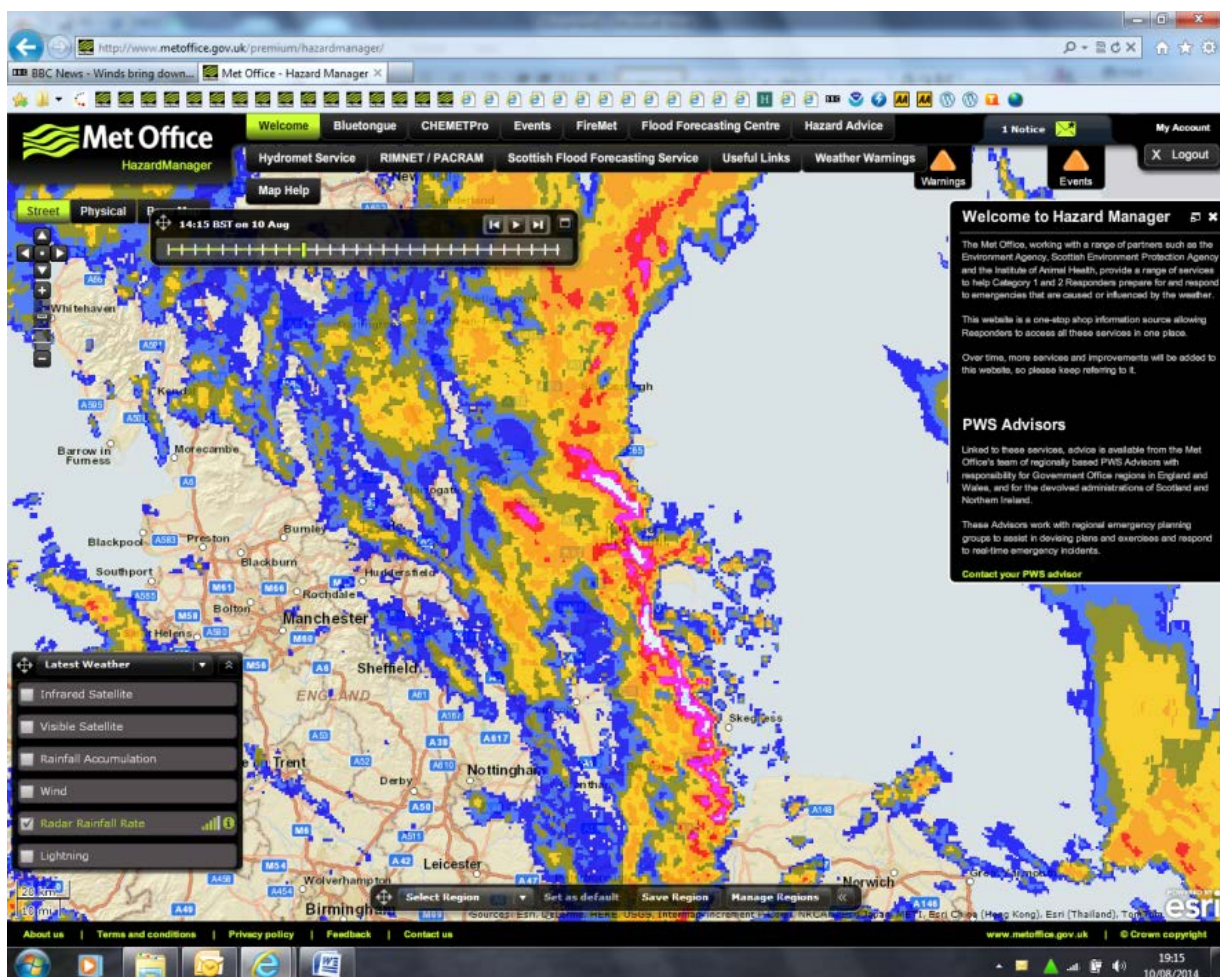


Figure 4: Met Office Hazard Manager Screen Shot of Rainfall Radar at 14:15 on 10 August 2014

Most of Yorkshire is shown to be under rainclouds, with lighter colours (heavier rain) shown across East Yorkshire at the time of the image (14:15 BST).

This Met office radar images indicate that rainfall across the region was extremely variable and very heavy in places: over 32 mm/hr being indicated in localised areas.

4.3 Flood Warning System

The National Severe Weather Warning Service issues various warnings when forecast weather conditions are expected to cause disruption.

4.3.1 Severe Weather Warnings

For heavy rainfall, high winds, fog, ice and snow etc.

- Yellow warning - be aware
- Amber warning - be prepared
- Red warning - take action

The joint Met Office and Environment Agency Flood Forecasting Centre provide a flood warning service based on weather forecasts and forecast river and tide levels.

The EA routinely issue alerts and warnings for forecast flooding, with warnings graded dependent on the expected severity.

For the 10 August events **Flood Alerts** were issued for the north-sea coast and for along the Humber estuary.

4.4 Reports

When preparing a Flood Investigation report the Council is dependent on residents reporting incidents in order to build up a complete picture of the extent of problems caused by flooding events. Some properties reported flooding to YWS, these have been included in the report as YWS supplied information to the Council during the preparation of this report. It is possible some other areas and properties may have been affected during this event but that the details have not been reported to either YWS or the Council.

Anlaby (see photos 1 to 8)

In Anlaby village the Pryme Street, Wilson Street, Wolfreton Drive Springfield Way area was affected by highway flooding. In the Kendal Way, Norland Avenue, Westborough Way area, which has a history of flooding during exceptionally heavy rainfall, there was area flooding at some 46 locations, including 8 flooded properties.

The affected area around Anlaby Common also extended across the county boundary into adjacent parts of Hull City. The drainage from the Anlaby area discharges into the public sewer system in Hull.

These areas all drain into the trunk sewers either into the Anlaby Road sewer (Newington Trunk) or the Springhead Lane sewer (Western Trunk) which both ultimately discharge into the Hull Tunnel sewer adjacent to the West Hull Pumping Station (WHPS). The levels in these sewers are monitored at LM1 (Level Monitor 1) on Springhead Lane and in the Tunnel adjacent to WHPS. (See Appendix 6).

The rainfall intensity and subsequent flooding varied across the area. It is therefore considered probable that with intense rainfall in the upstream catchment overwhelmed the trunk sewer network to the west of the Anlaby Common area before the intense rain reached all parts of Anlaby.

Therefore it is considered likely the flooding experienced in Anlaby was as a result of the inability of the local drainage systems to discharge quickly enough into the trunk sewers due to the intensity of the rainfall, which in turn discharge into the tunnel at WHPS. (See Figure 6 and Figure 8 above and Appendix 6).

Flood levels receded quickly once the intensity of the rainfall eased and the pumping operations at West Hull started. The EA must also give temporary consent for the operation of the pumps. (See Appendix 6).

Beverley (see photos 9 & 10)

In Beverley, areas of the Swinemoor Estate experienced flooding to roads and gardens with at least 1 property reportedly affected internally. The Fotherby Walk/Burden Road/Pennyman Road areas have a history of highway and garden flooding during intense rainfall events. The estate is served by a YWS maintained separate drainage system. The surface water systems discharge into a culverted watercourse on Swinemoor Lane, which is the responsibility of the council as riparian owners. This then discharges into an open watercourse on Swine Moor, which is the responsibility of the Beverley and North Holderness IDB.

Some residents in Sigston Road took the decision to employ a local contractor with a tanker to remove some of the flood water from the area.

Keyingham (see photos 14 to 17)

In Keyingham there was extensive highway flooding in School Lane, Willowfield Drive, Crompton Drive and Westerdale Close with 4 properties flooding internally. Riparian culverts and the sewer system were overwhelmed, leading to overland flows. Subsequently sewer and culvert cleaning and CCTV inspections have been undertaken and some repairs and modifications to culverts completed.

Ottringham

In Ottringham there was extensive highway flooding in St Wilfreds Close, Chapel Lane and Patrington Road, with 1 property flooded internally.

South Cave, Market Weighton and Cottingham

Highway and garden flooding were reported in South Cave, Market Weighton and Cottingham, although no property flooding was reported. These settlements were affected by flooding during July.

Other Locations

Many other locations in the East Riding (see Appendix 1 and 2) were affected by area flooding with isolated properties also suffering internal flooding.

In many cases water was unable to drain away during the heaviest rainfall and for a period following, but it did drain away normally once the rain had stopped and the drainage system began to drain down normally.

Burton Pidsea

Southfield and Bellsgarth Road residents reported problems were due to land drainage problems along Burton West Drain, which is an IDB watercourse. Passed to Keyingham Levels IDB who are investigating further.

Little Weighton

Property in Old Village Road, reported cellar affected by backing up from gully. Passed to YWS to investigate further.

Problems in New Ellerby, Kirk Ella, Ottringham and Welton, were reported directly to YWS.

YWS Investigations: CCTV surveys of the sewers serving the affected properties

New Ellerby – tree roots found in the combined sewer now removed.

Kirk Ella – silt found in the sewer, now removed.

Ottringham – CCTV found a collapsed sewer and blockage, now repaired.

Welton – all assets inspected no issue identified.

5 The Effects

See Appendix 1 and 2.

Flooding was experienced in 26 settlements across the East Riding. In Anlaby many roads were flooded and properties affected, principally in the Norland Avenue/Kendal Way area. In the Wilson Street/Pryme Street area and along Tranby Lane highway and garden flooding occurred.

In Anlaby 8 properties were flooded internally and 38 were affected by highway and garden flooding. A meeting was arranged by residents with YWS and the Council FCERM and a ward member to discuss the event and what could be done. (See photos 1 to 8).

In Beverley 1 property was reportedly flooded internally and areas of the estate suffered highway flooding with gardens affected, a petition has been submitted by a Flood Action Group formed by residents. (See photos 9 & 10).

In Burton Pidsea 1 property adjacent to a watercourse was affected by water unable to get into the watercourse while it was at high level due to the rainfall. Some highway flooding occurred when the drains were overwhelmed and water was unable to drain away, these drains also discharge into the watercourse. Properties were affected by garden flooding and possibly under the floor in some properties.

In Keyingham 4 properties were flooded internally and extensive highway flooding was experienced (see photos 14 to 17).

In Kirk Ella, Little Weighton, New Ellerby, Ottringham and Welton 1 property was reportedly flooded internally in each settlement.

In other settlements such as Bridlington, Brough, Burstwick, Cherry Burton, Cottingham, Driffield, Hedon, Hessle, Market Weighton, Nafferton, Molescroft, North Ferriby, Skidby, Suth Cave, Willerby, Withernsea and Wyton highway and/or garden flooding was reported.

6 The Response

The Humberside Fire and Rescue Service received 45 calls between 12:00pm and 3:00pm from across the region, including Anlaby, Anlaby Common, Beverley, Burton Pidsea, Flamborough, Keyingham, Ottringham, Preston, South Cave and Willerby.

Of the calls received most were due to flooding issues. Inspections were carried out and pumps deployed in some cases but mostly the water was draining away naturally so no further action was required. The remaining calls were regarding fallen trees and loose tiles due to high winds.

Yorkshire Water Services reported that some drainage systems were overwhelmed by the floodwater, with some 37 properties reporting problems. In Anlaby the YWS flood risk strategy team were on site to liaise with Councillors and Council Engineers. Customer Case Managers provided support to their customers. Operational staff attended YWS assets in the area to ensure all pumping stations operated at full capacity. The West Hull pumping station was operated as this flooding was classed as an emergency

In Beverley sewer cleaning and CCTV surveys have been undertaken and identified root ingress which has since been removed. Further work in the Windsor Close area is planned.

Following the event YWS service partners were sent to sites to undertake clean-up operations. Investigation work followed involving inspection, cleaning and surveying of the sewer network in the affected areas. (See Appendix 5 for more details of the work undertaken).

The Environment Agency

After liaising with Market Weighton Town Council on 10 August, the EA partially closed the penstock at Market Weighton Reservoir in advance of the forecast heavy rain.

The EA received a report of flooding on Townend Lane, North Cave. Their operation team visited the site and established it was not flooding from river; but surface water flooding.

At 14:53 further reports were received from Beverley Road, Anlaby regarding high levels in Western Drain and flooding in Tranby Lane.

An operation team were sent to Western Drain FSR to clear the trash screens of debris at 15:50.

Further reports from residents regarding the flooding in Tranby Lane were received.

Pumping capacity was mobilised to Hessle Clough to overpump Fleet Drain over the high tide period from 17:39 onwards and levels were monitored in the Drain.

Internal Drainage Boards

After the events watercourses were inspected and planned routine maintenance works carried out.

East Riding of Yorkshire Council: FCERM, Streetscene Services

During the event FCERM Flood Risk Operations Engineers were out supporting the Streetscene operations and monitoring situations and liaising with other services, and advising residents. The council's mobile pumps were deployed at Hessle Clough to support the EA.

Contacting the Council Out of Office Hours:

Reportedly some residents experienced difficulties contacting the council during this flooding event, as it occurred out of office hours when a limited service is provided. During normal office hours and up until 11:00pm Customer Service Centre (CSC) staff are available to deal with phone calls. During the day on Saturday they are also available. Once the CSCs close the calls are dealt with in the Lifeline office with a back-up message service during very busy periods. If high call volumes are anticipated extra staff are deployed as deemed appropriate.

After the event inspections and investigations were carried out using jetters and CCTV to clean and inspect culverts and drains in various locations.

Further follow-on works have been undertaken at:

Beverley Swinemoor Estate. Following the event the Councils Flood Risk Management Operations team, Streetscene Services and YWS met on site to agree a plan of investigations/further works. The Council culverts on Swinemoor Lane have been surveyed by CCTV after being jetted clean. No significant issues with the culverts were identified.

Streetscene Services checked all of the gullies in the affected areas, and they were found to be clear and working well.

YWS surveyed the surface water sewers around Burden Road and Storkhill Road, during which mass tree root ingress was found, which has now been removed. Further CCTV surveys are due to be carried out on the surface water system on Sigston Road, and Windsor Close by YWS.

Although no defects or capacity issues have been identified with the Council owned culverts on Swinemoor Lane, as part of the ongoing major highway improvement scheme future proofing works have been carried out on these culverts. The twin 525mmØ culverts have been upgraded to twin 600mmØ pipes as part of the highway scheme. This will allow future additional flows from the estate to be accommodated without the need for further disruption and cost to the Council.

In Keyingham the Council, on a without-prejudice basis have cleaned and surveyed a riparian culvert through the village, (formerly an open ditch). It has also replaced an existing manhole cover on the culvert in School Lane with a grating to allow water into the culvert more readily. In addition it has carried out repairs to a manhole at the rear of Compton Drive, proved the piped system in the ditch to the rear of School Lane; further works are ongoing.

Ottringham all highway gullies and gully leads have been CCTVd and found to be satisfactory. In addition the Council has checked the outlets from the gullies outside Southside, Lyndhurst and No.5 South Side Villas. All the outlets have been jetted and camera surveyed and all were found to be in good working order.

Bridlington St Wilfred's Road, investigations have been carried out and YWS sewers jetted, a blockage was removed, the sewer has been damaged by another utility and further repairs are being arranged with the utility company.

Beck Bank Cottingham, a highway gully was found to be not working and on investigation was jetted clear.

6.1 The Recovery

As is the nature of flash floods in most areas the water drained away relatively quickly once the rain stopped and the systems started to drain down. This left many areas, together with a number of properties in need of a clean-up. The Council arranged to collect large items of flood-damaged household goods from domestic properties free of charge but from commercial premises at-cost, as commercial operators are assumed to be covered by insurance. This service is offered to residents in an attempt to help them return to normal life as quickly as possible following flooding.

Council staff also contacted vulnerable residents to ensure that they had access to all available services to meet their needs.

Meetings have been held with YWS, Hull City Council, MP's, Ward Councillors and residents to discuss the problems experienced and to arrange investigations and other works.

Investigations involving cleaning of sewers and culverts with CCTV surveys to check the condition in order to determine if further remedial work were required were carried out.

During this and previous investigations it has been observed that a significant number property owners were unaware of their riparian responsibilities for culverts or watercourses. In some instances where the condition of a riparian watercourse may have contributed to the flooding, the Council has taken the decision in the public interest to carry out necessary works on a without prejudice basis. In most cases however maintenance works have followed enforcement action against riparian owners. It is a particular problem for the Council where multiple owners are involved in cleaning a length of culvert or watercourse and has lead to delays with some owner disputing responsibility.

It is considered that if property owners were made fully aware of their riparian responsibilities when purchasing the property this situation could be avoided. The solicitors acting for prospective purchasers should be reminded to bring this matter to their client's attention; this would be a matter for the Law Society.

7 Causes and Investigation Findings

As can be seen from Appendix 1 the list of affected areas, some twenty six settlements within the East Riding reported flooding issues on 10 August.

The weather data obtained indicates that the intensity and overall amount of the rainfall varied considerably across the area. It is believed that the rainfall was exceptionally intense in many areas, but that the locations where data has been obtained were possibly not where the most intense rain fell.

In most places the flood water was seen to drain away normally without any intervention, indicating that the drainage systems were overwhelmed by the intensity of the rainfall at that location. Although in some places subsequent investigations have identified defects in the systems (e.g. root ingress, blocked gullies) which may have exacerbated to the flooding and which have since been rectified.

The worst affected area was in Anlaby with 46 sites affected. Flooding was witnessed in Wilson Street and Wolfreton Lane in Anlaby village which is upstream of Anlaby Common, draining into the same sewer system. Very heavy rainfall was recorded at Albion Mills which is to the west of Anlaby village.

In Anlaby Common it is considered probable that with the intense rainfall on the catchment upstream filled or even overwhelmed the trunk sewer network which flows from west to east through the affected area. Therefore it is likely the flooding experienced was as a result of the exceptionally heavy rain and flooding further up the catchment and the resultant inability of the local drainage to discharge quickly enough into the trunk sewers.

The trunk sewers in turn discharge into the Hull Tunnel at West Hull Pumping Station. The level data available indicates that levels in the Tunnel rose rapidly between 11:00am and 11:30am. The level rose rapidly from 12:30am and the West Hull Pumps were operated at 2:15pm. The levels in the Western and Northern Trunk Sewers rose rapidly at 1:30pm, when the most intense rainfall hit Anlaby. Levels continued to rise and water accumulated on the surface and the West Hull pumps were operated.

The sewer system started to drain down once the intensity of the rainfall eased and pumping operations were able to catch up with flows in the system. The combined pumping volumes from West Hull and Saltend were in excess of that pumped as a result of the tidal surge flooding event of 5 December 2013.

In Keyingham, Beverley, New Ellerby, Welton. Kirk Ella Ottringham where property flooding was experienced, and in other areas which experienced highway and garden flooding, the drainage systems were overwhelmed by the intense rainfall.

8 Conclusions

This Section 19 investigation concludes that the rainfall associated with ex-hurricane Bertha falling in the affected locations across the East Riding was of exceptional intensity and exceeded current or historic design standards for drainage infrastructure. With overland flows and an overwhelmed drainage and/or public sewer system, reportedly some 102 residential and commercial properties were affected, with a total of 20 properties suffering internal flooding.

The Council is required to conclude whether each of the flood risk management authorities identified has exercised, or is proposing to exercise, their functions in response to the flood incident. Following the investigation it can be concluded that the flood risk management authorities have or are proposing to exercise their relevant functions appropriately.

9 Recommendations

The investigation has identified a number of measures that potentially should improve flood resilience as set out in the following recommendations:

9.1 Recommendation 1

That in those areas where root ingress was identified (e.g. Swinmoor Estate), the responsible flood risk agencies adopt a pro-active maintenance regime including appropriate monitoring (such as cyclical CCTV surveys) to improve flood resilience.

9.2 Recommendation 2

That following this event YWS should consider undertaking a detailed survey of the Newington Trunk Sewer along its full length to the West Hull Pumping Station to establish if any serviceability issues, such as the presence of redundant ancillary structures could cause a restriction to full flow.

9.3 Recommendation 3

That as part of the ongoing modelling work on the Hull and Haltemprice Flood Risk Management Plan, the operation of the various pumping stations is specifically considered in relation to these types of rainfall event.

9.4 Recommendation 4

That the Council as LLFA write to the Law Society to remind its members of the need to apply due diligence to the identification of any watercourse which will be the riparian responsibility of a property owner whenever a property is sold and a conveyance prepared for the purchaser.

Abbreviations and Acronyms

Abbreviations	Description
AOD	Above Ordnance Datum
Dia	Diameter
EA	Environment Agency
ERYC	East Riding of Yorkshire Council
FCRM	Flood and Coastal Risk Management
GWL	Ground Water Level
HFRS	Humberside Fire and Rescue Service
HVP	High Volume Pump
LLFA	Lead Local Flood Authority
IDB	Internal Drainage Board
ABP	Associated British Ports
Km	Kilometre
Km ²	Square Kilometres
Km/h	Kilometres per hour
Ha	Hectare
FWA	Flood Warning Area
m/s	Metres per second
mm/hr	Millimetres per Hour (Rainfall)
YWS	Yorkshire water Services
WHPS	West Hull Pumping Station

Glossary

Foul Sewer

This is a pipe laid to convey waste water (foul) only away from properties and to a waste water treatment plant, and maintained by Yorkshire Water Services.

Surface Water Sewer

This is a pipe laid to convey surface water only away from properties to a proper outfall, and maintained by Yorkshire Water Services.

Combined Sewer

This is a pipe laid to convey both waste water and surface water away from properties to a waste water treatment plant, and maintained by Yorkshire Water Services.

Private Drains

These are pipes laid to convey both waste water and surface water away from properties which are the responsibility of the property owners, and are not maintained by Yorkshire Water Services.

Watercourse

This can be an open channel or piped/culverted to convey surface water away from an area, this will include land drainage as well as surface water from properties and highways. Watercourses, known as ordinary watercourses or main river, are generally maintained by riparian land owners with the Environment Agency using permissive powers to maintain main river.

Flood Protection Measures

Measures taken to prevent a property from flooding, also known as flood resistance measures i.e. Demountable door guards, air-brick covers, flood doors, barriers etc.

Flood Resilience Measures

Measures taken to reduce the impact of flooding on a property and to speed up the recovery after a flood i.e. raise floor above most likely flood level, Replace chipboard flooring with solid floor (dense screed), replace gypsum plaster with Lime plaster, move electrical outlets above flood level etc.

Design Standards, Return Periods and New Developments

Return Period

Any drainage system or flood defence should be designed to a nationally accepted standard; this standard is often expressed as a return period (in years). It is an internationally accepted methodology.

A **return period**, is the chance of an event occurring in any year.

For example, a 1 in 100 year event has a 0.01 probability or 1% chance of occurring in any one year. It does not mean that a 100 year event will happen regularly every 100 years, or only once in 100 years.

Design Standard

The standards for sewer systems used in England and Wales are designed to provide protection from flooding from a 1 in 30 year event, (with a 0.033 or 3.3% chance of occurring each year). This generally means that no sewage should escape from a sewer in a 1 in 30 year event at the time when the sewer was constructed.

The current design standard for highway drainage is the Department for Transport; Design Manual for Roads and Bridges. The design standard for new highways is that flooding should not encroach into the main carriageway as a result of 1 in 5 year event (20% chance of occurring each year).

In contrast River and Coastal Flood defences are currently designed for a 1 in 100 year event and a 1 in 200 year event respectively with an allowance for climate change, as determined by Defra.

Funding for Flood Risk Management Schemes

One of the main criteria for successful applications for funding for drainage works is that the proposed scheme must be designed to provide a standard level of protection, normally defined by a set return period.

Funding is generally allocated on the basis of the severity and frequency of the flooding, and by the costs of protection; “does the scheme give good value for money?”.

Future Developments and Sustainable Drainage

Any new residential or commercial development planned within any settlement would be required, under planning conditions, to manage surface water within the development in order to restrict the discharge of surface water into the existing drainage system to no more than the existing rate, and if possible to reduce the discharge. This must be achieved within the development itself usually by attenuating flows during storm conditions or times of high flows and discharging at a controlled rate to prevent any increased flood risk to any other area.

Appendices

Appendix 1: Plan of Reported Affected Areas of the East Riding



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Appendix 2: Reported Affected Areas and Properties

Anlaby:- Wilson Street, Pryme Street, Wolfreton Drive, Norland Avenue, Kendal Way, Normanton Rise, Hawkshead Green, Westborough Way, Tranby Lane, Chapel Lane, Dawnay Drive, Chestnut Avenue, Kingston Road, Springfield Way, Springhead Lane

Beverley:- Sigston Road, Storkhill Road, Burden Road, Fotherby Walk, Pennyman Road, Windsor Close, Molescroft Road, Godbold Close.

Bridlington:- St Wilfred's Road

Brough:- Saltgrounds Road

Burstwick:- Station Road

Burton Pidsea:- Glebelands, Bells garth, Back Lane, Southfield Lane/Fieldend Road

Cherry Burton:- Canada Drive

Cottingham:- George Place George Street, Hallgate/Beckbank, Elmfield Drive, Dene Road, Harland Way, St Margarets Avenue, Sancton Close, Oakdene, Endyke Lane, Jesmond Road

Driffild:- West Promenade, Manorfield Road

Hedon:- Cleve Road

Hessle:- The Hourne, Boothferry Road

Keyingham:- School Lane, Willowfields, Compton Drive, Westerdale Close

Kirk Ella:- Wolfreton Garth

Little Weighton:- Old Village Road

Market Weighton:- Westfield Road

Molescroft:- Molescroft Road

Nafferton:- Lowethorpe Lane

New Ellerby:- Lambwath Lane

North Ferriby:- The Green, Marine Avenue, Ings Lane, Brickyard Cottages ..

Ottringham:- St Wilfrids Close, Chapel Lane, Patrington Road

Skidby:- Little Weighton Road

South Cave:- Highfield, Market Place, Church Street, West Hall Garth, Barnards Drive, Pinfold.

Welton:- Cowgate

Withernsea:- Main Road

Willerby:- Chestnut Avenue

Wyton:- Main Road

Reported Affected Properties in the East Riding:

Location	Internal	External	Total
Anlaby	8	38	46
Beverley	1	2	3
Burton Pidsea	1	9	10
Bridlington		1	1
Brough		1	1
Burstwick		1	1
Cherry Burton		1	1
Cottingham		9	9
Driffield		2	2
Hedon		1	1
Hessle		2	2
Keyingham	4	1	5
Kirk Ella	1		1
Little Weighton	1		1
Market Weighton		1	1
Nafferton		1	1
Molescroft		1	1
New Ellerby	1		1
North Ferriby		8	8
Ottringham	2		2
Skidby		1	1
South Cave		1	1
Welton	1		1
Willerby		1	1
Withernsea		1	1
Wyton		1	1
Total Internal 20		Total External 84	Total 104

East Riding Total:104

Appendix 3: Available Rainfall Data

Rain gauges measure the rainfall at the location of the gauge, the Radar image is interpreted by the Met Office, at a specific location as requested.

EA rain gauges:

Rain Gauge Location	Peak Rainfall Rate (mm/hr in 15 mins)	Total Rainfall
Cottingham	7.2	39.8 in 24 hrs
Weighton	4.8	30.8 in 4 hrs
Great Culvert	8.0	26.6 in 5 hrs

At Cottingham some 63% of the Long Term Average rainfall for August was recorded in 24 hours.

Council Rain Gauges across the East Riding:

Location of Gauge	Peak Rainfall rate (mm/hr)	Heaviest rainfall (9:00am to 2:30pm)	Total Rainfall in 24 hrs
Albion Mills	18.4	36.2mm in 4.5hrs	45mm
Cottingham	13.8	35.6mm in 5hrs	43mm
Brough	17.8	28.5mm in 3hrs	30mm
Hessle	15.6	31.0mm in 4 hrs	37mm
Bilton	9.6	23.8mm in 5hrs	30mm
Hedon	7.8	27.6mm in 5hrs	36mm
Beverley	7.5	16.1mm in 5hrs	40mm
Market Weighton	7.4	27.4mm in 5hrs	36mm
Bridlington	6.8	24.0mm in 5hrs	29mm
Pocklington	6.2	20.4mm in 4hrs	29mm
Atwick	7.0	16.8mm in 5hrs	25mm

This data indicates that the recorded rainfall was most intense in the south west of the East Riding, also that the intensity and overall amount of rain varied considerably across the area. The highest recorded overall rainfall was at Albion Mills which is just to the west of Willerby. The rainfall across the East Riding on 10 August was Significant.

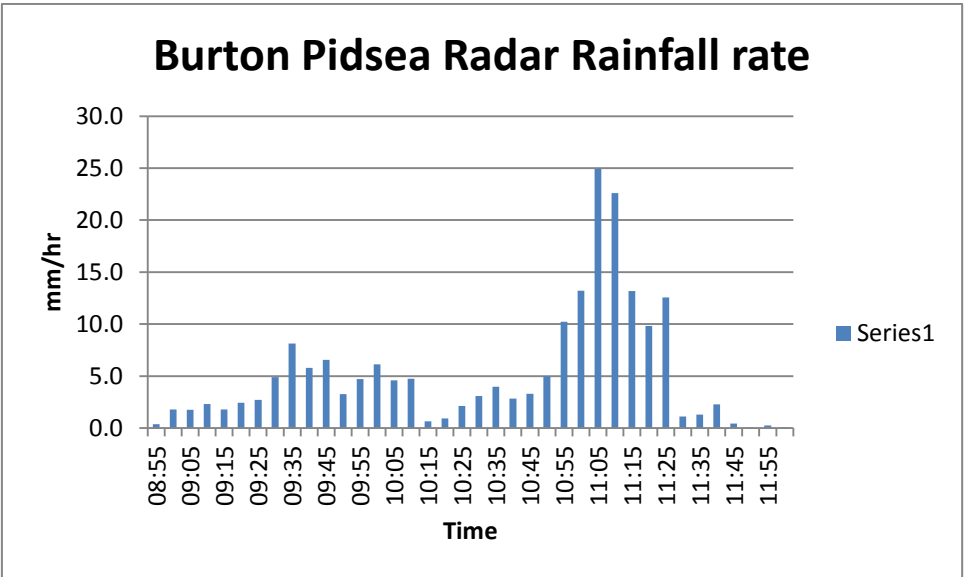
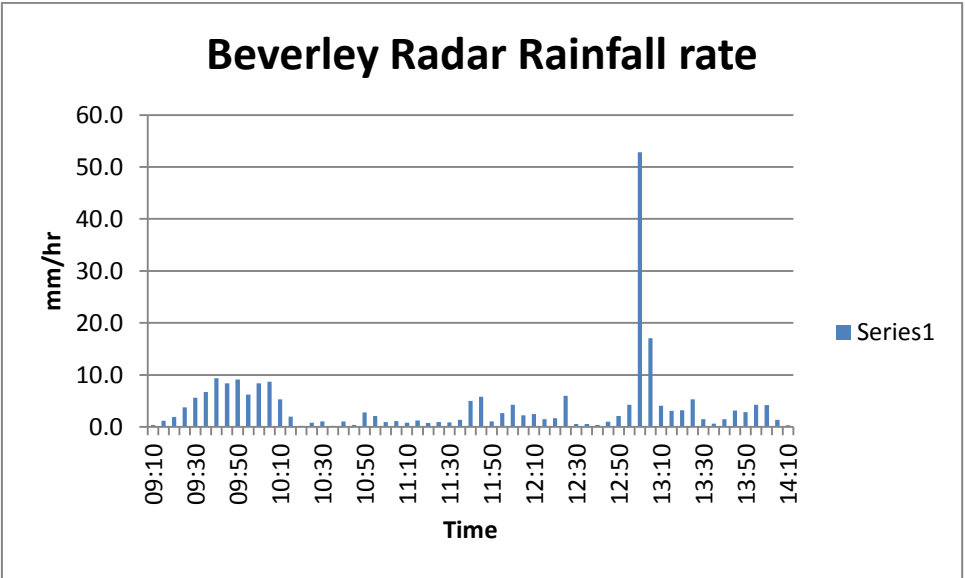
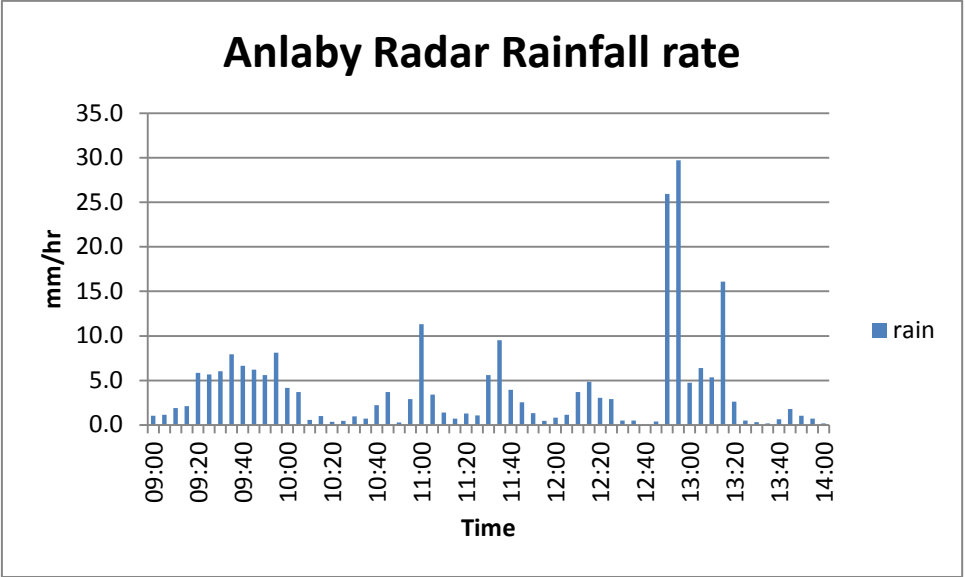
These gauges send alarms via telemetry when heavy rain is recorded;

Cloudburst (risk of flash flooding) 3mm in 15 minutes, Heavy Rain 5mm in 1 hour, Heavy persistent Rain 10mm in 6 hours, Significant Rainfall 20mm in 24 hours.

Met Office Rainfall Radar Interpretation:

Location	Met Office Estimated peak rainfall rate (mm in 1 hour)	Estimated rainfall rate (mm/hr in 5 mins)	Total rainfall in 24 hours
Anlaby	8.0 mm	30 mm/hr	23 mm
Beverley	8.3 mm	53 mm/hr	25 mm
Burton Pidsea	10.3 mm	25 mm/hr	26 mm

See also on the following page, graphs showing the rainfall intensity estimated from Met Office Radar images over 5 minute periods throughout the event.

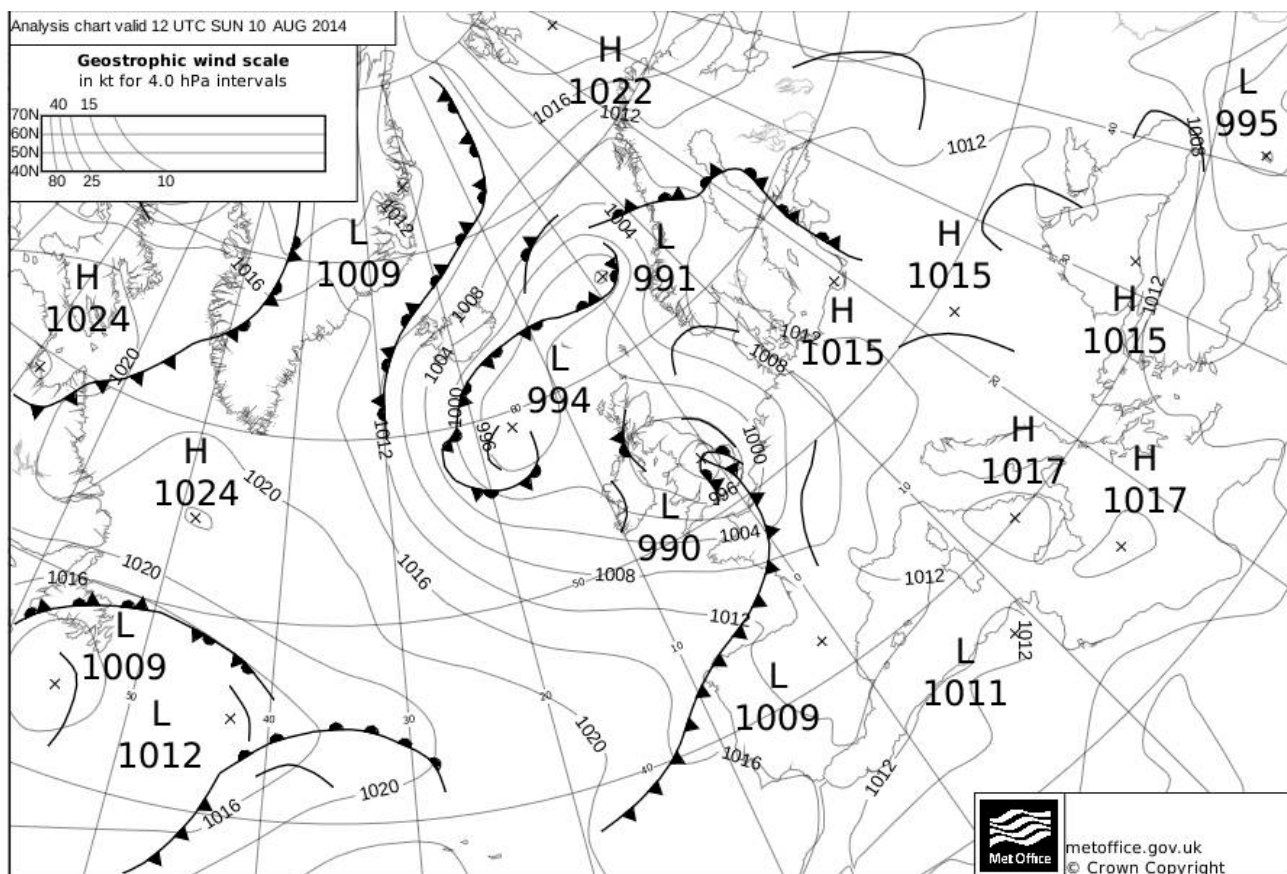


Appendix 4: Met Office Storm Analysis -The Effects of Ex Hurricane Bertha on the UK

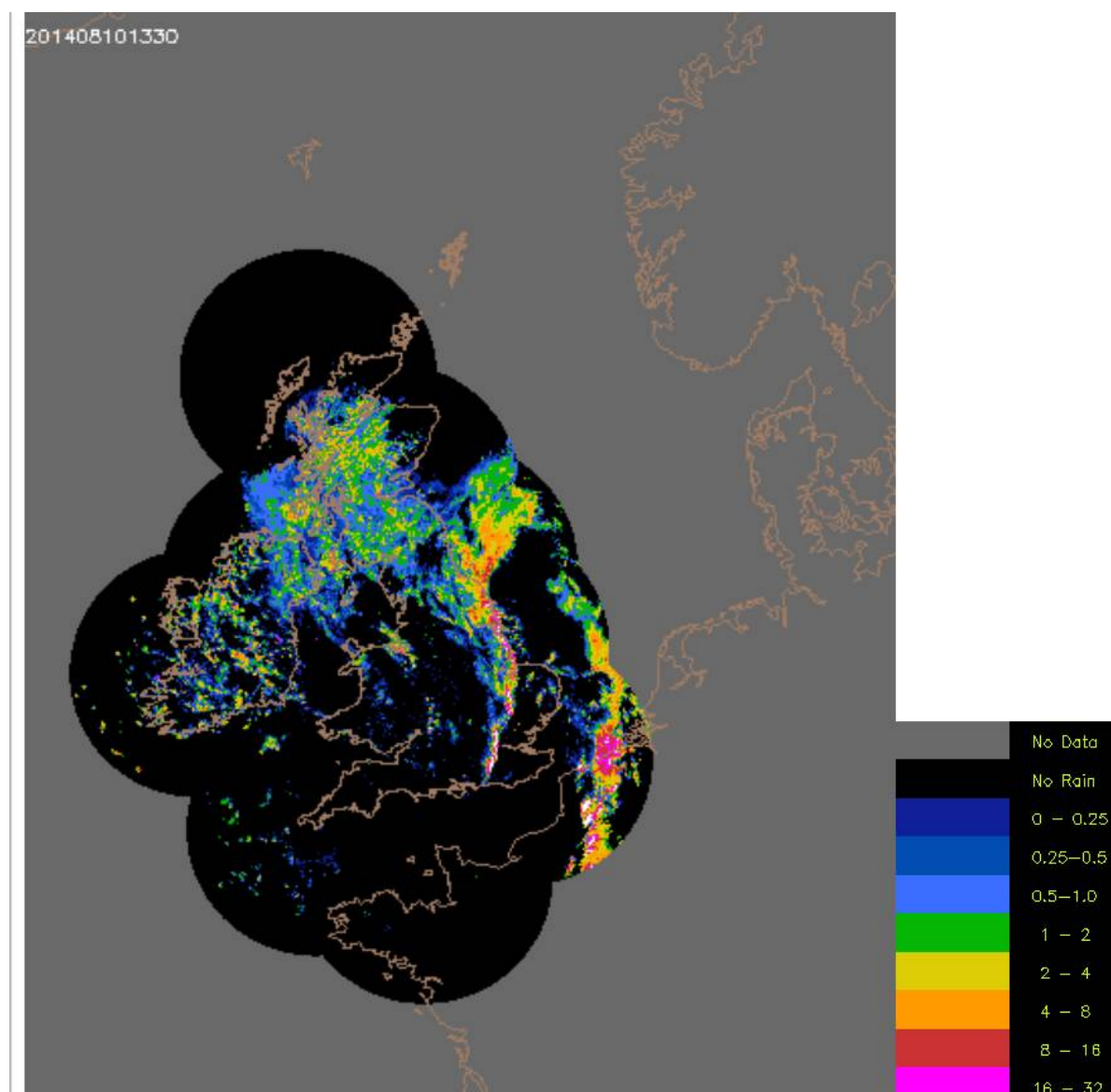
Attached is a screen grab which shows a view from Hazard Manager as the torrential rain and very gusty winds moved through (Bridlington picked up a gust of 47 KT, with just light to moderate breezes being reported across the area generally).

From Sunday 10 to Monday 11 August 2014, the UK experienced some unseasonably windy and very wet weather from the remnants of ex-hurricane Bertha. The analysis chart below shows the storm tracking across UK, before drifting northward into the North Sea, 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.

Analysis Chart 1200 GMT Sunday 10 August 2014

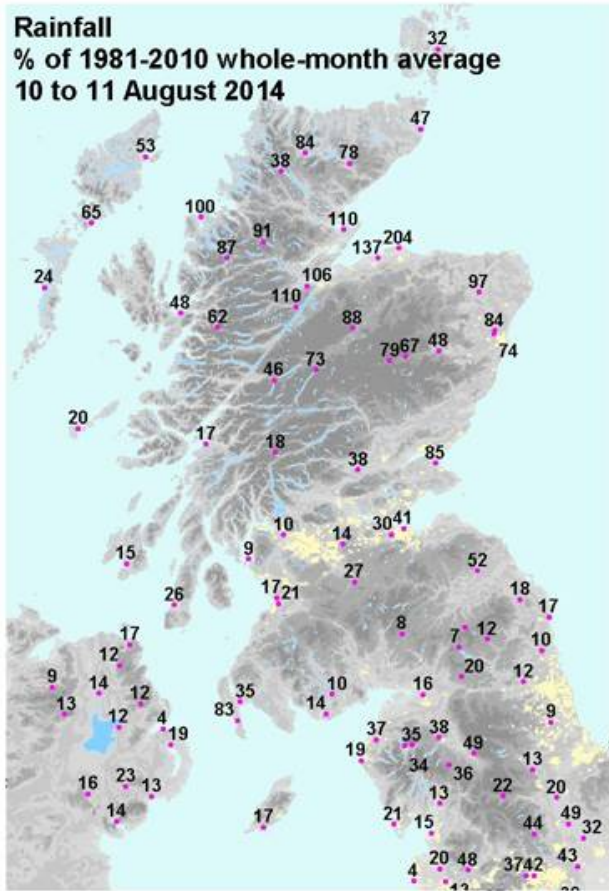
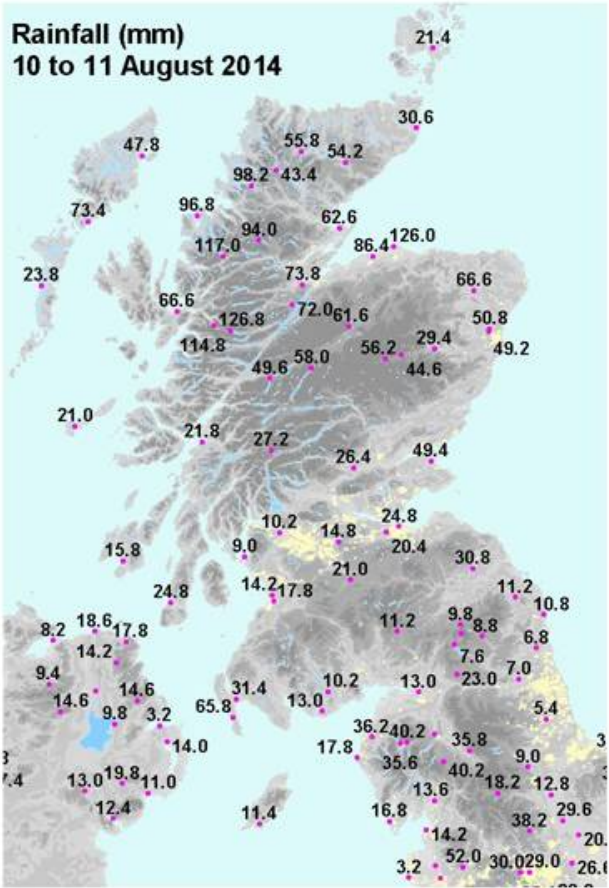


The rain-radar imagery below shows 15-minute accumulations at 1330 on 10 August 2014.

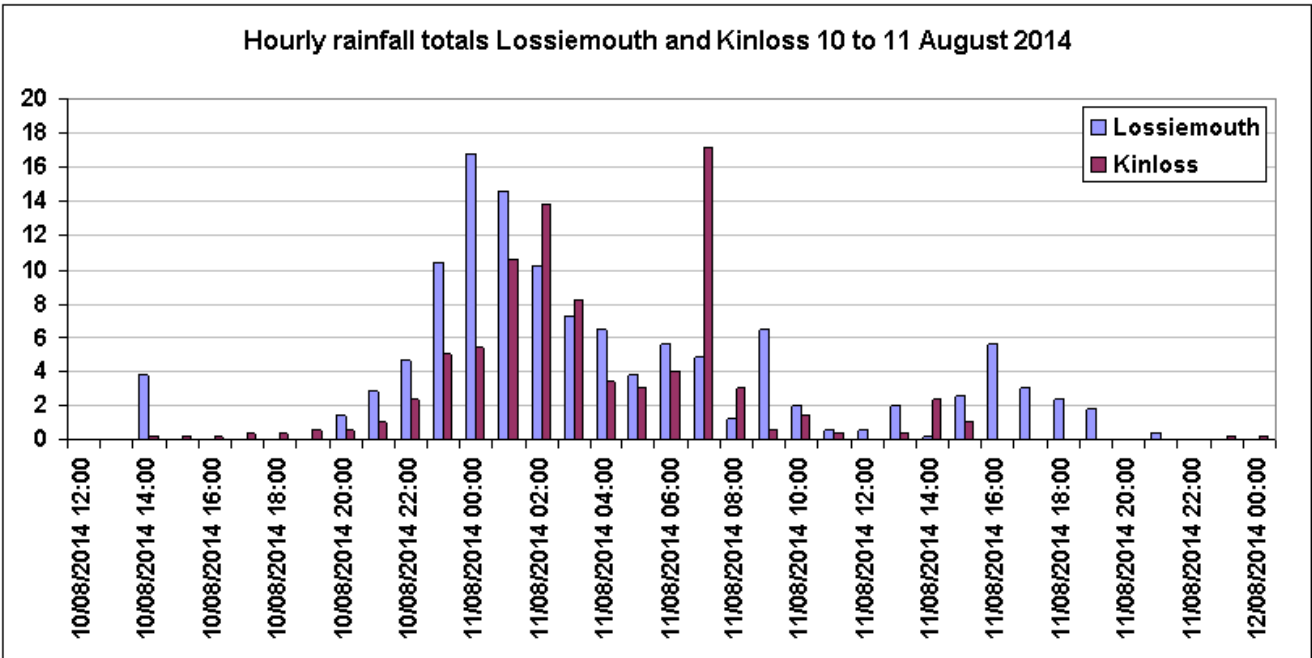


The maps below show rainfall totals for the 2-day period 10 to 11 August 2014 (i.e. 48-hours 0900 GMT 10th to 0900 GMT 12th). The wettest areas were across northern Scotland with a swathe from Ullapool toward Aberdeen receiving around the whole-month average rainfall in this period; the area around Inverness and Lossiemouth received well over the whole-month average. Lossiemouth recorded 100.0mm in the 24-hour rain-day to 0900 GMT on 11th (most of this falling overnight) and 126.0mm, around twice the monthly average rainfall in the two rain-days 10th and 11th August. The rain-radar sequence demonstrates the very significant orographic component to much of the rainfall - for the rain in the Inverness area, the north-easterly flow resulted in an effective reversal of the normal rain-shadow effect. This then shifted later to a north-westerly flow with the heavy rain affecting the West Highlands.

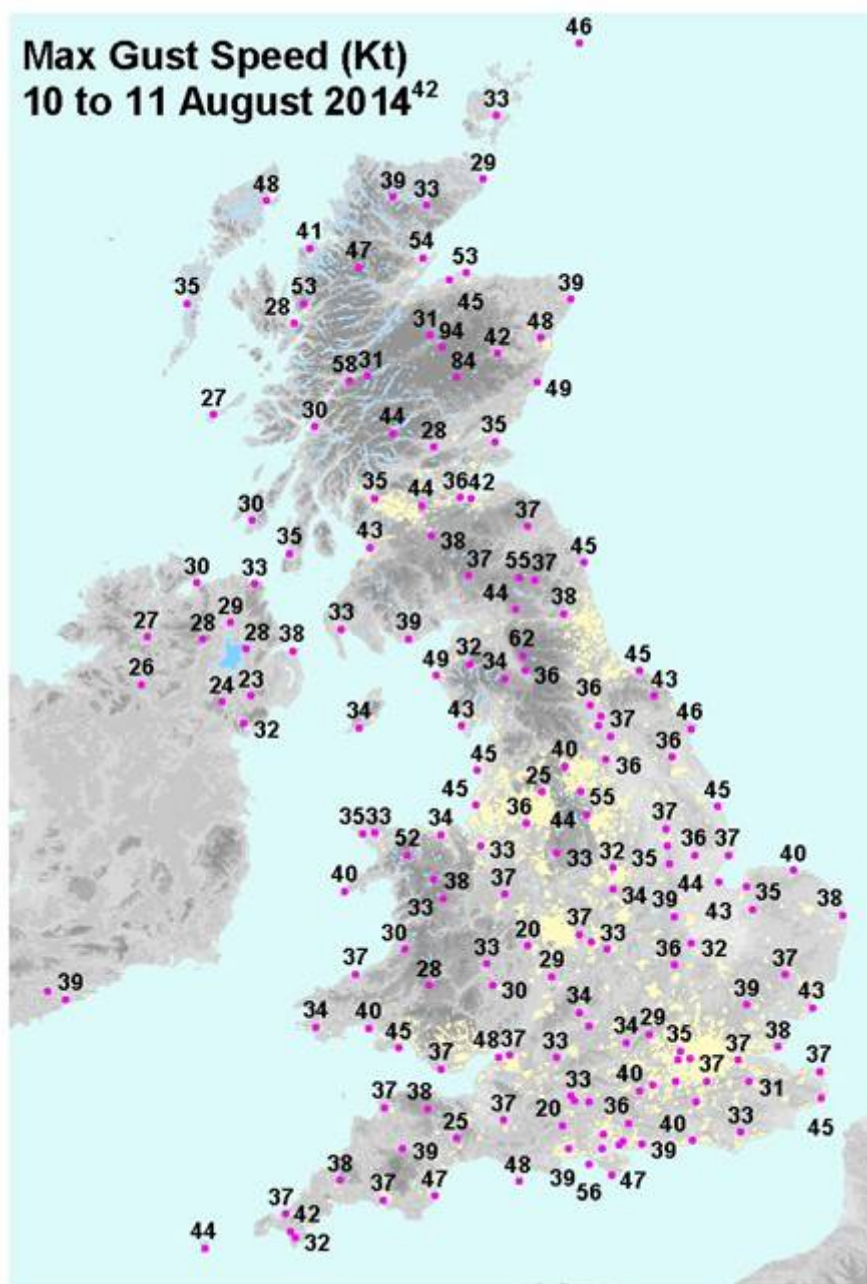
(Note that on 9 August Fair Isle recorded 132.6 mm and Lerwick 86.6 mm in 24 hours to 0900 GMT 10th as a result of heavy rain from the previous system before ex-Bertha)



The chart below shows hourly rainfall accumulations at Lossiemouth and Kinloss for this event. Lossiemouth recorded 117.0 mm in 24 hours to 1900 GMT on 11th August, of which 84.4 mm fell within 10 hours to 0700 GMT. The 1981-2010 August average for this station is 61.9 mm - this being a climatologically dry part of Scotland.



The heavy rain was accompanied by some strong winds, particularly in the north-east, with gusts including 54 Kt at Tain Range (Ross & Cromarty) and 53 Kt at Lossiemouth (Moray). Many coastal locations in the UK recorded gusts of 40 to 50 Kt - unseasonably strong for the time of year. In the Scottish mountains, Cairngorm summit recorded a gust of 94 Kt (108 mph) and the Cairnwell 84 Kt (97 mph). The map below shows maximum gust speeds from 10 to 11 August 2014.



This low pressure system resulted in some significant flood impacts, particularly across north-east Scotland, with the Ullapool area, the Moray area and the Kingussie to Aviemore area all affected. More details of impacts are given via the links below.

[BBC News - parts of Scotland affected by ex-hurricane Bertha](#)

[BBC News - UK weather still affected by ex-hurricane Bertha](#)

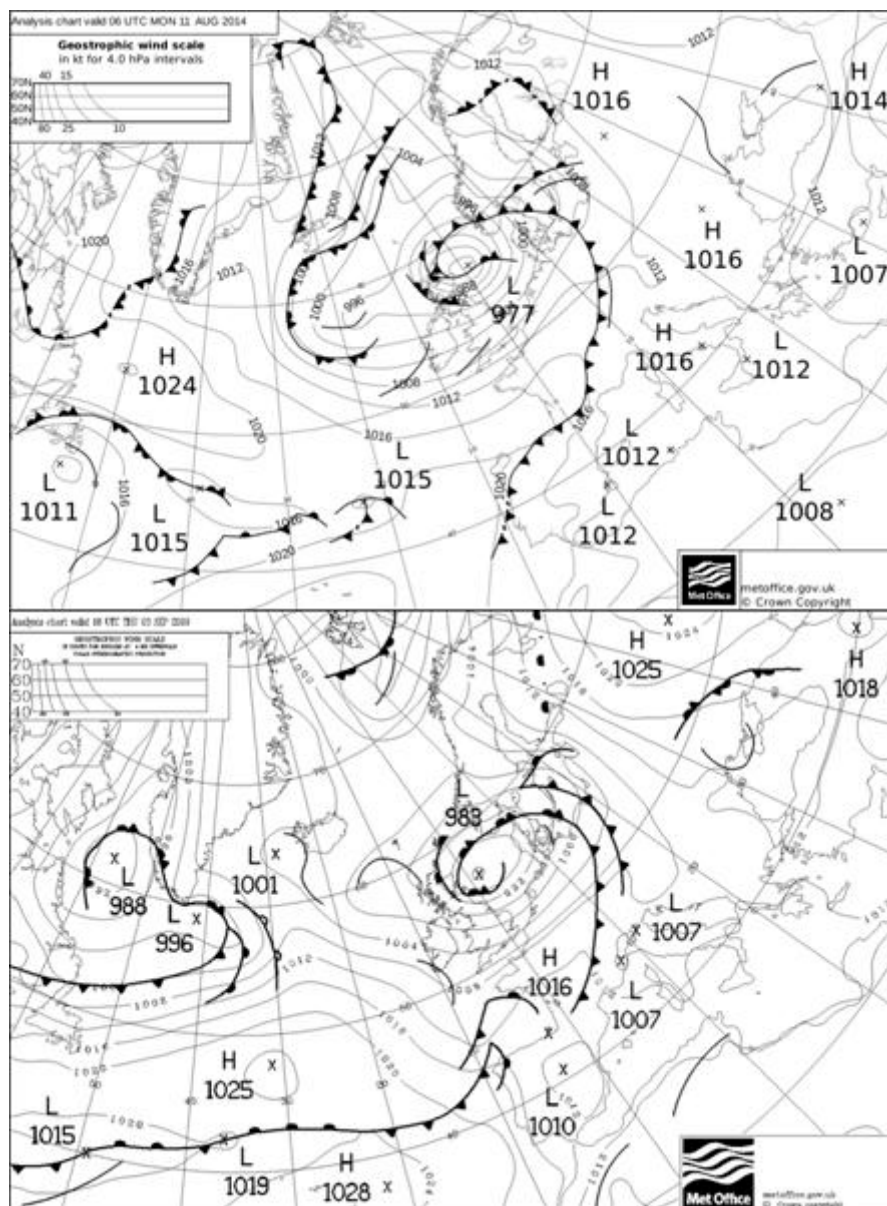
[BBC News - emergency funding for Scottish flood damage](#)

How unusual are storms of this type at this time of year? Examples of previous events are given below. Rain and wind observations for these events may be plotted by using this [Google Map interface](#)

It's worth noting that the Moray area of Scotland was significantly affected by flooding on 3rd to 4th September 2009. More details of this event are given [HERE](#), and the pressure pattern is remarkably

similar (see below). Lossiemouth recorded 86.8mm of rainfall in 24-hours to 0900 GMT on 4th September 2009. The rain-radar sequence for this event is also very similar.

Analysis charts for 0600 GMT 11th August 2014, and 1800 GMT 3rd September 2009 - compared



Most recently, **ex-Hurricane Nadine** brought heavy rain and strong winds to the UK from 24 to 26 September 2012. There was flooding in NE England, some fallen trees in the Borders area and a fatality from a fallen tree at Kew Gardens. More details are available [HERE](#)

Before this, **ex-Hurricane Katia** on 12 September 2011 resulted in widespread transport disruption and one fatality from a fallen tree in northern England. More details are available [HERE](#)

One of the most significant events of this type in recent decades was from the remnants of **Hurricane Charley** on 25 to 26 August 1986 - again bringing strong winds and widespread heavy rain. This storm also failed to make landfall over the US and instead continued back across the Atlantic toward the UK. This [Monthly Weather Summary](#) provides more details - some damage from flooding and boats driven onto rocks at Abersoch.

There was a significant August storm on 30 August 1992. This storm occurred a few days after Hurricane Andrew in the US - although Hurricane Andrew made landfall and merged with frontal systems over the Appalachians.

This [Monthly Weather Summary](#) provides more details. Trees were brought down in central London and there were 6 fatalities.

The **Fastnet Storm** occurred on 14 August 1979. 15 sailors died in the Fastnet yacht race and there were several other fatalities at sea and on land. This [Monthly Weather Summary](#) provides more details.

There were very strong winds and heavy rain from 15 to 17 August 1970, with flooding in Northern Ireland, the West Midlands and eastern Scotland. This [Monthly Weather Summary](#) provides more details. It's worth noting that this same area of Scotland - i.e. Moray - Nairn - was affected by this event.

Two other examples of significant storms at around this time of year:

2 and 5 September 1983 - four fatalities and issues with fallen trees and loss of crops. This [Monthly Weather Summary](#) provides more details.

7 September 1974 - three fatalities and issues with fallen trees in East Anglia and SE England. This [Monthly Weather Summary](#) provides more details.

Essentially, there are a significant number of major storms affecting the UK in August in the historic records - with winds in exposed coastal locations exceeding 50Kt and 40Kt inland. Some of these storms have max gust speeds quoted in the Monthly Weather Summaries considerably higher than this. Very approximately, there might be one event in August every 2 to 3 years where max gusts exceed 40Kt quite widely; whereas it might be around one event per decade where max gusts exceed 50Kt quite widely. At this time of year, trees are (of course) in full leaf, so often impacts from wind are associated with fallen trees - e.g. causing fatalities, disruption to transport networks and power supplies, lost crops from orchards etc. Often impacts are also associated with coastal recreation activities - particularly sailing.

Appendix 5: Flood and Weather Warnings issued

Update issued by the Met Office Civil Contingencies section:

Before she gatecrashes proceedings, we're looking at some pretty decent weather today, with some good sunny spells developing, and temperatures close to normal at around 20-22 Celsius (70 degrees Fahrenheit...ish).

It'll stay fine and dry right through the evening and much of the night. It looks as though the system will track across southwest England, central southern England, and exit into the North Sea just north of The Wash. The mass of cloud and rain associated with it, will extend across the whole country, so that we'll all be seeing outbreaks of rain developing through the morning, and lasting for most, if not all of the afternoon and evening. The rain is likely to be heavy at times, with 20 mm or more falling quite widely, and perhaps 40 mm or more in some spots (most likely from North and West Yorkshire northwards). You can get more detail, including a video, with further explanation, here... <http://www.metoffice.gov.uk/news/releases/archive/2014/BerthaStorm>

The **Yellow Warning** itself has just been updated, and is valid **throughout Sunday** (very **low likelihood, medium impacts**). Surface water issues are likely in prone locations, and as winds increase later in the day/evening, we may see some branches coming down. All in all, not a very nice day really. You can track the progress of the rainfall on our rainfall radar, and forecast rainfall frames on our website or Hazard Manager.

She may be an 'ex' hurricane, but she's clearly not happy, and going to take her time moving out through the North Sea, which means a blustery day on Monday, with a few showers to watch out for, and cooler than normal. The rest of the week looks like staying breezy at times, with a mixture of sunny spells and scattered showers. Temperatures still a little below normal.

Further details and explanation from the Met Office.

9 August 2014 - The remnants of hurricane Bertha looks set to track across the UK over the next few days. .

The weather will turn wet and windy in many parts from Sunday morning, with gales perhaps severe, likely along some southern coastal and inland areas.

The Met Office has been assessing the effects of ex hurricane Bertha on the UK by using its own forecast models alongside models from other world-leading forecast centres.

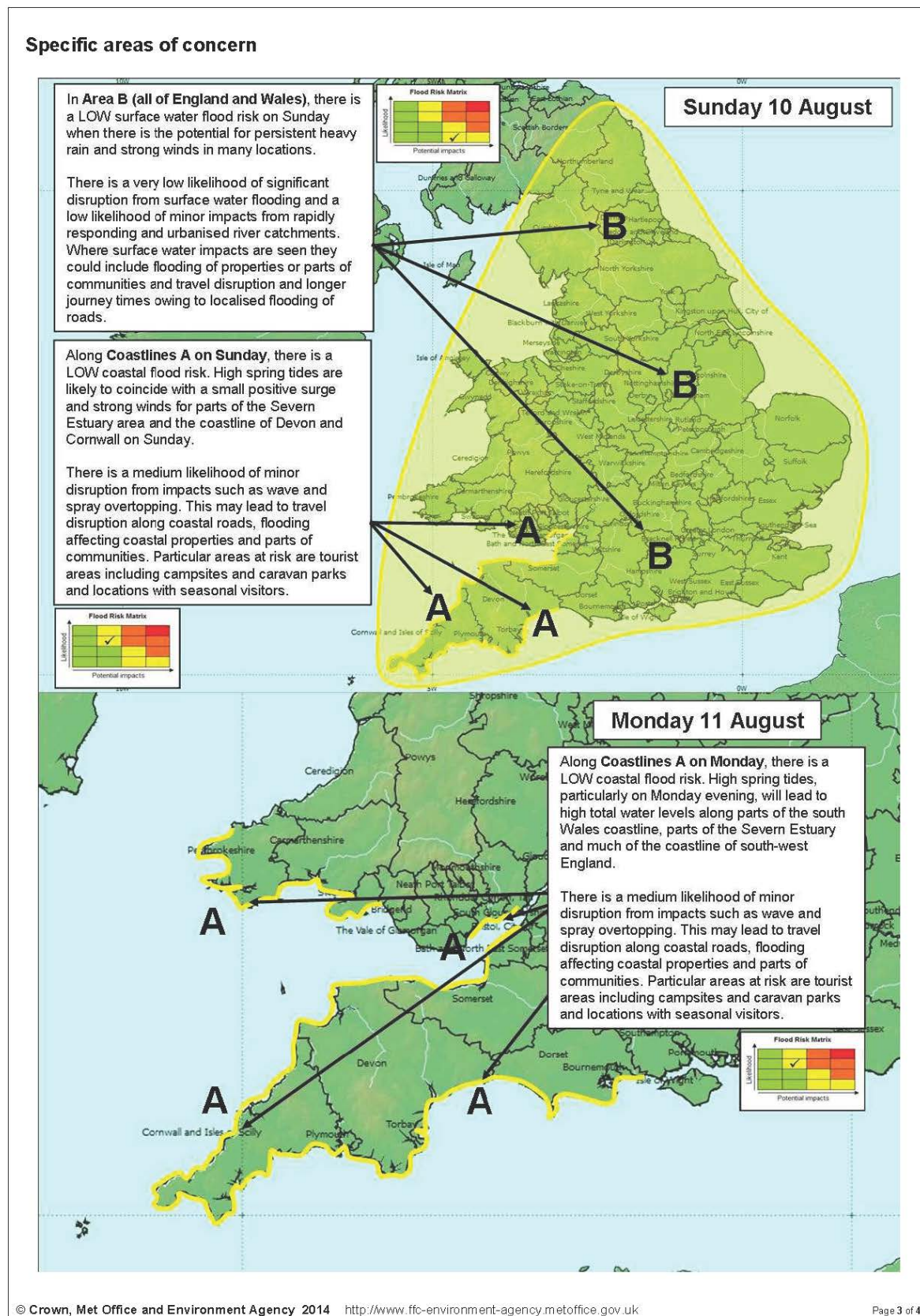
At the moment it looks as though the storm will track across the southern half of the UK on Sunday before heading out into the North Sea and travelling up the eastern coast, bringing some disruption to Scotland on Monday. Much of the UK will see large rainfall totals, however there remains some uncertainty relating to the strength of the winds, which could be locally very disruptive.

We are expecting unseasonable storm force winds in the northern North Sea with the risk of 80 mile per hour plus gusts which could be dangerous for shipping / offshore operations.

We are watching very carefully and that the forecast is constantly under review and subject to change.

Chief Meteorologist, Steve Willington, said: "Rain and strong winds may bring disruption on Sunday, especially across southern parts of the UK, with the potential for more than 50 mm of rain and coastal gusts of over 60 mph. People should stay up to date with the latest [Met Office warnings](#)."

Example of the Flood Guidance Statement issued on 9 August



Appendix 6: YW response

S14 East Riding Bertha Information Request

Details of any reported affected areas and properties across the East Riding

Street	Town	Int/Ext/RTU
West Promenade	Driffield	EXT
Manorfield Road	Driffield	EXT
Lowthorpe Lane	Nafferton	EXT
St Wilfred Road	Bridlington	EXT
Hawkshead Green	Anlaby	EXT
Main Road	Withernsea	EXT
Canada Drive	Cherry Burton	EXT
Molescroft Road	Molescroft	EXT
Godbold Close	Beverley	EXT
Little Weighton Road	Skidby	EXT
Harland Way	Cottingham	EXT
St Margarets Avenue	Cottingham	EXT
St Margarets Avenue	Cottingham	EXT
Sancton Close	Cottingham	EXT
Sancton Close	Cottingham	EXT
Sancton Close	Cottingham	EXT
Oakdene	Cottingham	EXT
Endyke Lane	Cottingham	EXT
Jesmond Road	Cottingham	EXT
Market Place	Brough	EXT
Cowgate	Brough	INT
Saltgrounds Road	Brough	EXT
The Green	North Ferriby	EXT
Marine Avenue	North Ferriby	EXT
The Hourne	Hessle	EXT
Boothferry Road	Hessle	EXT
Westerdale Close	Keyingham	EXT
Station Road	Keyingham	EXT
Cleve Road	Hedon	EXT
Patrington Road	Ottringham	INT
Lambwath Lane	New Ellerby	INT
Main Road	Wyton	EXT
Wolfeaton Garth	Kirk Ella	INT
Highway O/S	Anlaby	EXT
Dawnay Drive	Anlaby	EXT
Kingston Road	Anlaby	EXT
Chestnut Avenue	Willerby	EXT

Details of affected areas and properties in Anlaby

Please see attached customer contact information

Any estimates of Rainfall figures, and return periods for the event on 10 August

Current information:

Great culvert logger- 1 in 2 year return period

Rainfall radar- 1 in 2.4 return period

Additional data requested from the met office is currently underway and will be available in the next two week before final determination is made.

Details of works done post event, ie CCTV surveys and sewer cleaning

CCTV of combined sewers:

Westborough Way down stream to truck sewer connection (Clear)
Norland Avenue Overflow (overflow checked with CCTV to find clear)
Welebourn Walk (Connection drops into Norland Avenue 225mm)
Hawkshead Green (No issues found)
Connection query (Norland Avenue, Outstanding)

Any faults or significant defects found? ie blockages, pump failures etc?

15% silt found on Westborough Way- Now removed

10% silt found on Welebourn Walk- Work raised for removal

Latest progress on the Hydraulic model for the whole of Hull City, including Anlaby

The hydraulic model is complete and verified. Incorporated in the Hull and Haltemprice Integrated Catchment Model, used for the River Hill Integrated Catchment Strategy etc.

Any level or flow data available for the network serving Anlaby on 10 August

Please see attached West Hull SPS & Trunk Sewer levels

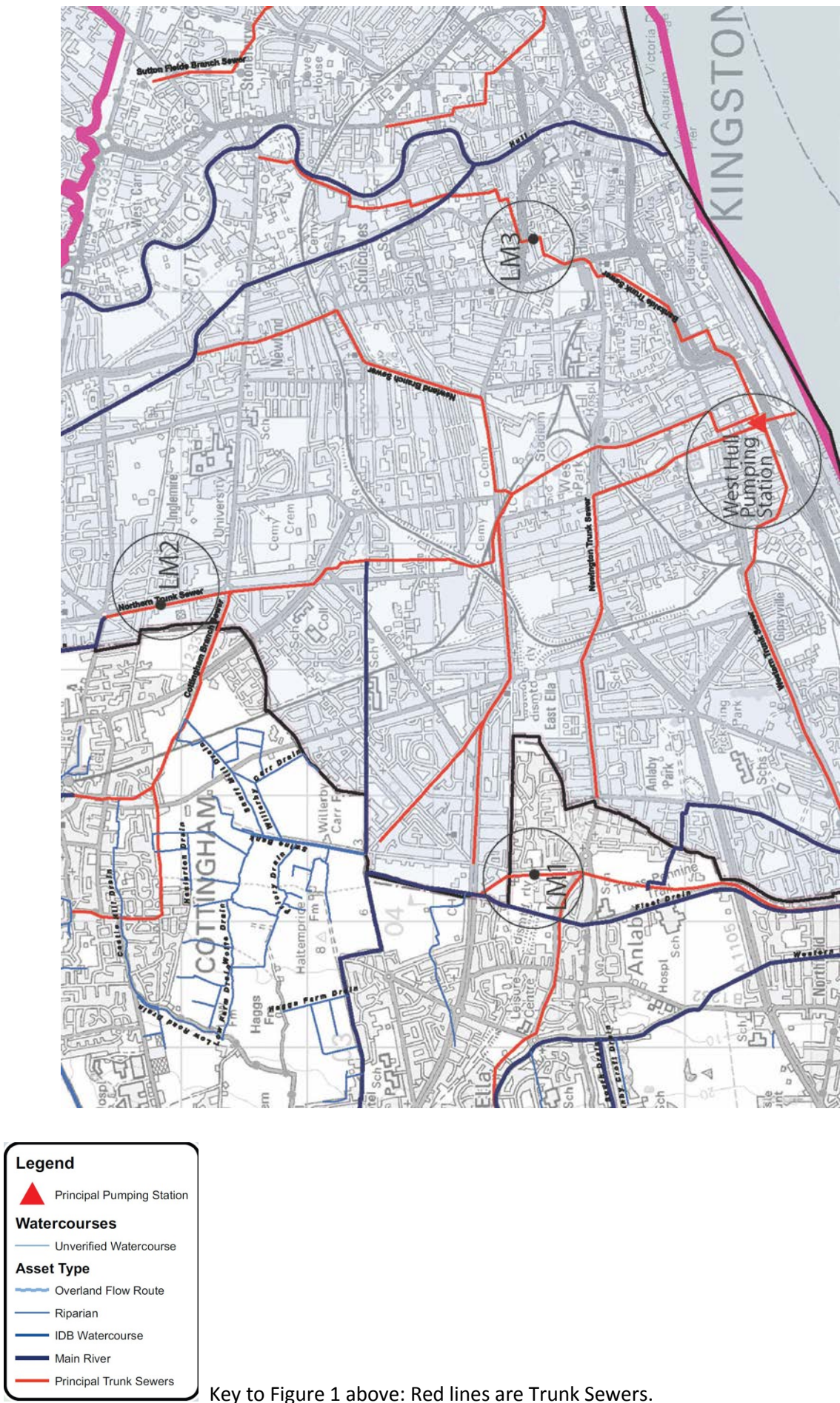
West Hull SPS Operational Breakdown 10th August 2014 –

Pumps started 14:12
Pumps stopped - 22:16
Total Pumped - 393,000 m3
Peak flows 7 pumps running @ 14:49 pumping 25,000 l/s

Any proposed work on the network serving Anlaby

Anlaby will continue to undergo normal operational maintenance on the sewer system and investigations will take place should any problems arise.

Figure 1: Hull Trunk Sewers showing level monitor locations



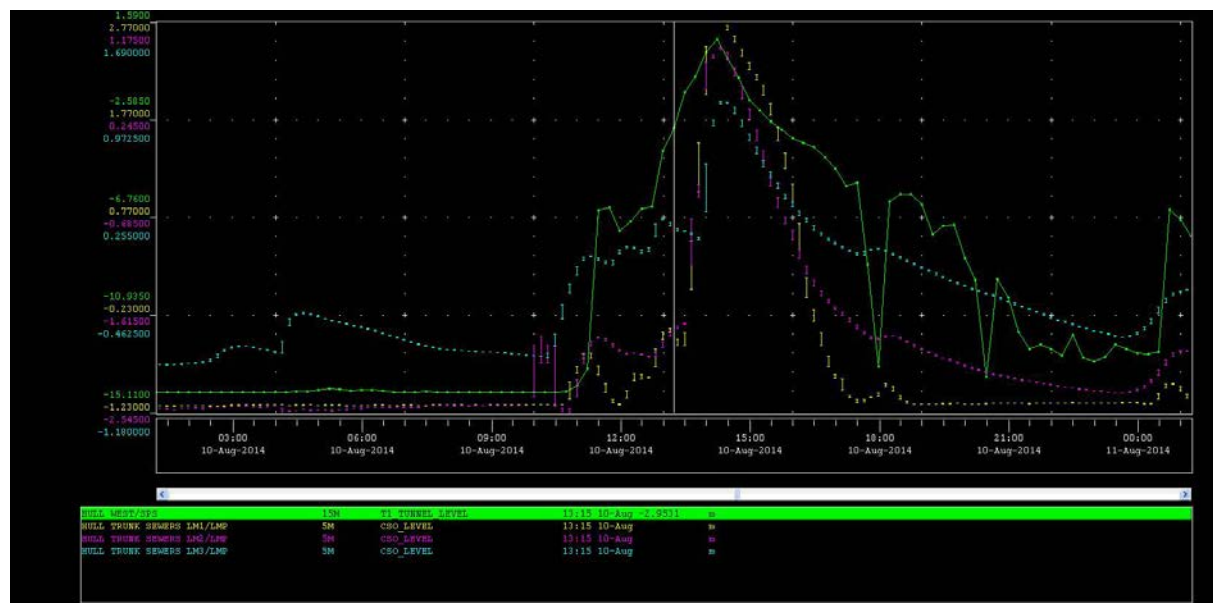


Figure 2: YWS Tunnel at West Hull Pumping Station and Trunk sewer levels

This image shows the levels in the Tunnel and in the Trunk Sewers during the event.

Green Tunnel at West Hull SPS: - levels rising steeply from 11:00am, rose 8.85m by 11:30am. By 2:15pm the level had risen by 16.4m (another 7.52m) and the pumps were switched on.

Yellow: LM1 (level monitor in the Western trunk sewer on Springhead Lane) level rose sharply from 1:30pm. Level rose 4.0m (level recorded in sewer 1.59m, ground level is on average 2.00m).

Purple: LM2 (level monitor in the Northern trunk sewer on Hall Road, also serving Cottingham) the level rose at 11:00am then rose sharply from 1:30pm, started dropping once West Hull switched on.

Blue: LM3 (level monitor in the Bankside trunk sewer on Charles Street off Freetown Way, City Centre) level rose at 2:30am then slowly dropped before rising steeply at 11:30am, started to drop once West Hull pumps were switched on at 2:15pm.

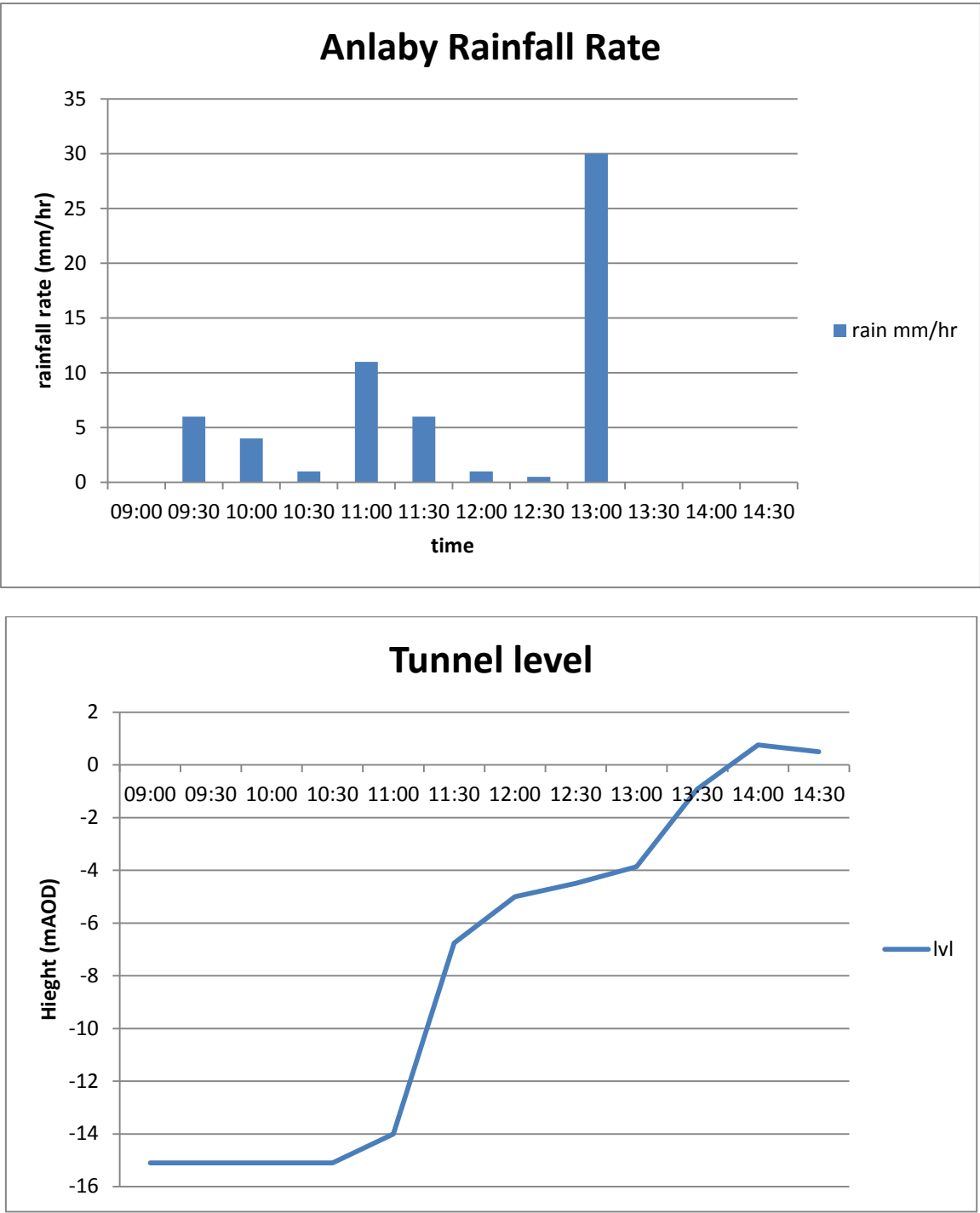


Figure 3: Comparing YWS Tunnel level at WHPS with Rainfall data

The ground level in Hull is around 1.0m (just above sea level) so flooding will occur once levels approach 1.0m. The Tunnel is of course below ground level.

These indicate that the water level in the tunnel rose quickly from 11:00am, this corresponds to heavy rain in Anlaby between 11:00am and 11:30am. The most intense rainfall recorded was at 1:00pm.

YWS Emergency Plan for Operation of the West Hull Pumping Station, Hull City

The West Hull Pumping Station (WHPS) is no longer used on a daily basis following the completion of the Humbercare Scheme, (EU Urban Waste Water Directive Treatment Scheme), and the construction of a transfer tunnel terminating at Hull Waste Water Treatment Works (WWTW). The WHPS is now used to discharge excess flows directly to the Humber when necessary and with EA consent.

During normal operation of the sewerage system, flows into the WWTW and the levels in the sewer system are routinely monitored.

On 10 August 2014 YW took the decision to operate WHPS following discussions with appropriate parties, including the EA.

The timeline for the operation of the West Hull Pumping Station on the 10 August 2014.

13:16- Operators on site

14:04 - Instruction to run station (EA consent given)

14:11- Sumps full and pumps available

14:12- Pump's started

22:16- Pump's stopped

Total flows pumped - 393,000 m³

Peak flows: 7 pumps running @ 14:49 pumping 25,000 l/s

Appendix 7: Photographs



Photo 1: Wilson Street, Anlaby



Photo 2: Wolfreton Drive, Anlaby



Photo 3: Wolfreton Drive, Springfield Way Junction, Anaby



Photo 4: Pryme Street, Anlaby



Photo 5: Pryme Street, Anlaby



Photo 6: Norland Avenue/Normanton Rise/Westborough Way, Anlaby



Photo 7: Norland Avenue, Anlaby



Photo 8: Kendal Way, Anlaby



Photo 9: Sigston Road, Beverley



Photo 10: Sigston Road/Storkhill Road, Beverley



Photo 11: Barnards Drive, South Cave



Photo 12: Pinfold, South Cave



Photo 13: West Hall Garth, South Cave



Photo 14: School Lane, Keyingham



Photo 15: School Lane, Keyingham



Photo 16: School Lane, Keyingham



Photo 17: School Lane, Keyingham

Appendix 8: Flood Resilience Information for Property Owners

People who have been flooded before have found the following guides helpful:

The Environment Agency's flood advice can be accessed here:

<http://www.environment-agency.gov.uk/homeandleisure/floods/default.aspx>

Two Environment Agency documents that might be particularly useful are: Protecting your home:

<http://cdn.environment-agency.gov.uk/geho1009brdl-e-e.pdf>

and Temporary and Demountable Defences:

<http://evidence.environment-agency.gov.uk/FCERM/en/FluvialDesignGuide/Chapter9.aspx?pagenum=10>

Homeowners guide to flood resilience:

<http://www.knowyourfloodrisk.co.uk/pdf/protection-guide.pdf>

The National Flood Forum. Ready for flooding:

<http://nationalfloodforum.org.uk/wp-content/uploads/Ready-for-flooding.pdf>

The British Insurance Brokers Association (www.biba.org.uk). Guide on getting insurance for high risk flood areas:

<http://www.biba.org.uk/UploadedFiles/600floodguide.pdf>

The Royal Institute of Chartered Surveyors. A clear guide to flooding for property owners:

http://www.rics.org/Global/Downloads/A_clear_guide_to_Flooding_for_property_owners.pdf

The Association of British Insurers. A guide to resistant and resilient repair after a flood:

http://www.abi.org.uk/Publications/ABI_Publications_A_guide_to_resistant_and_resilient_repair_after_a_flood_670.aspx

More information is available on the ERYC Website, on the A to Z, F - 8 Flooding, Flooding and Flood Preparation.

Appendix 9: Useful Links and Contact Details:

Lead Local Flood Authority

East Riding of Yorkshire
Council County Hall Beverley
East Riding of Yorkshire
HU17 9BA

(01482) 887700

www.eastriding.gov.uk

fcerm@eastriding.gov.uk

Statutory Sewerage Undertaker

Yorkshire Water Services Ltd
Western House Halifax Road
Bradford
BD6 2SZ

(08451) 242424

www.yorkshirewater.co.uk

Environment Agency

Area Office – Yorkshire (North and East)
Coverdale House
Amy Johnson Way
Clifton Moor
York
YO30 4UZ

General Enquiries:
0870 850 6506
(Mon-Fri, 8am -6pm)

www.environment-agency.gov.uk

Incident Hotline:
0800 807060
(24hrs)

Hull City Council

Guildhall
Hull
HU1 2AA

General Enquiries:
(01482) 300 300

www.hullcc.gov.uk

South Holderness Internal Drainage Board

18 Market Place
Patrington
HU12 0RB

General Enquiries:
01964 630531

www.southholdernessIDB.co.uk

Beverley & North Holderness Internal Drainage Board

York Consortium of Drainage Boards
Derwent House
Crockey Hill
York
YO19 4SR

General Enquiries:
01964 720785

www.yorkconsort.gov.uk

