

Flood Investigation Report

Goole Floods 5th and 6th July 2012

December 2013



EAST RIDING
OF YORKSHIRE COUNCIL

Revision Schedule

East Riding of Yorkshire Council Flood Investigation Report

Rev	Date	Details	Author	Checked and Approved By
/	13/05/13	Draft	PR	
A	18/05/13	To CMT	MM	
B	19/05/13	Minor Amendments	MM	
C	20/05/13	Amendments to figures/formatting and recommendations	LB	
D	23/05/13	Formatting	MM	
E	04/06/13	General minor amendments	DJW	
F	18/09/13	Rewrite of main YWS issues , model and street assessment	LB/PR/MM	
G	1/10/13	General minor amendments	DJW	
H	23/10/13	Restructured for comments	DJW	
I	24/10/13	Editing/Amending	DJW	NL
J	30/10/13	Minor Editing/Insert Drawings	MM	
K	25/11/13	Comments incorporated	DJW	CMT

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

Acknowledgment

The council would like to thank members of the Goole community, Yorkshire Water Services Ltd, The Environment Agency and the Goole & Airmyn Internal Drainage Board for their assistance in this investigation.

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Lead Local Flood Authority and Responsibilities

East Riding of Yorkshire Council is the Lead Local Flood Authority as defined within the Flood and Water Management Act 2010 and has carried out an investigation into the flooding which occurred on 5th and 6th July 2012 in Goole.

Initial findings were published in an interim report in December 2012. This report concludes the investigation.

The Pitt Review and Flood & Water Management Act (2010)

Following the widespread flooding of June and July 2007 the government appointed Sir Michael Pitt to conduct an investigation into the response and recovery from this flooding event. The final report was published in June 2008. Following on from the Pitt review the Flood and Water Management Act 2010 (F&WM Act 2010) passed into law. This Act redefines, and clarifies the roles of the various bodies that have a part to play in the identification and managing of flood risk. The Act also designates the unitary or upper tier authority for an area as the Lead Local Flood Authority (LLFA). East Riding of Yorkshire Council (ERYC) is the LLFA within the council's administrative boundary.

Purpose of this report

ERYC as the LLFA has a responsibility to record and report flood incidents within its administrative area under the F&WM Act 2010.

Whilst the management responsibility for a flood may be clear in many cases, there are occasions where this is not so. The purpose of a Section 19 investigation is for the LLFA to ascertain where responsibility for managing the flood risk lies and what is being done about it. The relevant section of the Act is F&WMA 2010 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 considered necessary to conduct an investigation into the flood incidents on 5th and 6th July 2012 as there was significant internal and external flooding of residential properties at multiple locations across Goole.

In order to assist in the preparation of a report, Section 14 of the F&WM Act 2010 grants the LLFA power to request information in connection with its functions. These powers have been exercised in the preparation of this report.

Relevant Flood Risk Management Authorities

East Riding of Yorkshire Council

ERYC as LLFA is responsible for managing flood risk from surface runoff, groundwater and ordinary watercourses. Other responsibilities included the development of a Local Flood Risk Strategy, Asset Plans and Section 19 Investigations.

ERYC as the relevant highways authority is responsible for providing, maintaining and managing highway drainage under the provisions of the Highways Act 1980.

Environment Agency

The Environment Agency (EA) is responsible for managing flood risk from main rivers, the sea and reservoirs. They also manage coastal erosion risk and have permissive powers to maintain main rivers. The EA is responsible for the development of a National Flood Risk Strategy and has a Strategic Overview over all forms of flood risk management.

Yorkshire Water Services

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

Internal Drainage Board

Internal Drainage Boards (IDB) are independent public bodies that manage water levels and reduce flooding risk within their internal drainage board districts.

Riparian Landowners

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

- i. They must maintain the bed and banks of the watercourse, and also the trees and shrubs growing on the banks.
- ii. They must clear any debris, even if it did not originate from their land, this debris may be natural or man-made.

- iii. 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. Further details of a riparian landowners responsibilities can be found in the document “Living on the Edge” published by the EA.

Residents

In addition to any responsibilities they have as riparian landowners, residents are encouraged to understand the flood risk in their local area and have a flood plan to steer their response in times of flooding. Actions such as the placement of sandbags, moving valuable items to a safe place and protective measures such as installation of floodgates, airbrick covers etc. can help to reduce the consequences of flooding at a property level.

It is widely recommended that residents sign up to appropriate warnings for their area 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.

Magnitude of Events

The likelihood or probability of an event with a specified intensity and duration, is called the return period or frequency. The intensity of a storm can be predicted for any return period and storm duration, from charts based on historic data for the location.

The term “*1 in 10 year storm*” describes a rainfall event which is rare and is only likely to occur once every 10 years, so it has a 10 per cent likelihood any given year. The rainfall will be greater and the flooding will be worse than the worst storm expected in any single year.

The term “*1 in 100 year storm*” describes a rainfall event which is extremely rare and which will occur with a likelihood of only once in a century, so has a 1 per cent likelihood in any given year. The rainfall will be extreme and flooding to be worse than a 1 in 10 year event.

As with all probability events, it is possible, though improbable, to have multiple “*1 in 100 Year Storms*” in a single year.

Rainfall can also be classified by its intensity, with

- **light rain** classified as less than 2.5mm/hr,
- **moderate rain** classified as between 2.5mm/hr and 10mm/hr,
- **heavy rain** classified as 10mm/hr to 50mm/hr and
- **violent rain** classified as anything above 50mm/hr.

The return period of the event that flooded Goole on 3rd August 2011 was calculated to be in excess of a 1 in 45 year event. The significant floods of 2007 were caused by events with return periods of much greater than 1 in 100 years.

Abbreviations and Acronyms

Abbreviation	Description
AOD	Above Ordnance Datum
CLT	Carr Lane PS Telemetry
CSO	Combined Sewer Overflow
DWF	Dry Weather Flow
EA	Environment Agency
ERYC	East Riding of Yorkshire Council
ETM	Earthtech Morrisons JV
FFT	Flow to Full Treatment
F&WM Act 2010	Flood and Water Management Act 2010
GMT	Greenwich Mean Time
GTC	Goole Town Council
HF&RS	Humberside Fire & Rescue Service
IDB	Internal Drainage Board
l/s	Litres per Second
LDA	Land Drainage Act 1991
LLFA	Lead Local Flood Authority
m³	Cubic Metres
MHWS	Mean High Water Springs
mm	Millimetres
MO	Met Office
PS	Pumping Station
Q_{max}	Maximum Flow
Q_{min}	Minimum Flow
SBU	SB Utilities Ltd. (ETM's sub-contractor)
SCADA	Supervisory Control And Data Acquisition
SP	Storm Pump(s)
SMD	Soil Moisture Deficit
WRA	Water Resources Act 1991
WSR	Water Situation Report
WwTW	Wastewater Treatment Works
YWS	Yorkshire Water Services

1 Executive Summary

Goole is a port town, located in the south western part of the East Riding of Yorkshire, towards the edge of the Humberhead Levels flood plain which is at the confluence of the Rivers Ouse and Don (Dutch River).

The wider Goole area, including Hook, Airmyn, Rawcliffe and Rawcliffe Bridge, is bounded by the River Ouse to the east, the River Aire to the north, the rivers Went and Don to the south and to the west by higher ground near Snaith, Cowick and Pollington.

The River Ouse is tidal from Naburn Lock (south of York), to its point of confluence with the Trent where it becomes the River Humber.

This area contains some 9,096 residential properties, 770 non-residential properties including a number of industrial sites, and almost 4,000 hectares of agricultural land. The town of Goole has a population of approximately 18,000.

Ground levels typically range between 2m and 4m AOD (Above Ordnance Datum). The current drainage system in Goole relies on a series of pumping stations to ensure that the dry weather flows (flow in sewers caused by events other than rainfall) are collected at the Carr Lane pumping station and then pumped to the local waste water treatment works (WwTW) for treatment prior to discharge into the River Ouse. The increased inflow due to rainfall/storm water activates a series of storm pumps that discharge the increased flow directly to the River Ouse at Lock Hill and Carr Lane.

At approximately 13:00 on 5th July 2012 an intense period of rainfall took place with heavy rain occurring for approximately 30 minutes after which time it eased to light to moderate rainfall that lasted until approximately 16:30. Calculations of the return period of this rainfall indicate that it did not exceed a 1 in 10 year event, i.e. it was within the standard design capacity for pumping stations.

Localised flooding of roads and of some properties was noted early in the event. At approximately 14:15 on 5th July a manhole cover within Carr Lane pumping station (Carr Lane PS) that provides access to the pumping station's wet well was dislodged from the roof of the wet well and flood water started to flow into the dry well. A short time after the manhole was dislodged the storm pumps started to fail due to the dry well being flooded.

At 06:00 on 6th July a second period of rainfall took place. This was less intense rainfall than that which took place at 13:00 on 5th July, and it lasted only 15 minutes. The rain then eased to light to moderate rainfall that continued for much of the morning until mid-

afternoon. In isolation this rainfall was not particularly excessive, however it resulted in further reported incidents to both the Council and to the HF&RS across the Goole area.

Flooding was recorded throughout the events of the 5th and 6th July. Different factors including sewer network or drainage system capacity issues and a very small number of blocked road gullies were identified. In addition, the reduction in pumping capacity at Carr Lane PS from the afternoon of the 5th July and throughout the 6th July resulted in a reduction of the ability of the pumping station to remove water from the Goole sewer system.

On the afternoon of 7th July YWS installed three 12" emergency pumps at Carr Lane PS to replace the failed storm pumps and from this time there was a general reduction in water levels and reports of flooding ceased.

The report has identified various actions and remedial measures that should be considered. These have been listed in this report's recommendations.

The indicative extent of the flooding within the Goole catchment is shown in Figure 19 : Plan of flooded areas in Appendix A.

2 Location of Goole

2.1 Topography

The town of Goole and the surrounding areas typically have a ground level of between 2m and 4m AOD. This is significantly lower than the Mean High Water Springs (MHWS) level for the River Ouse of 4.3m AOD. The estimated 100-year water level for the River Ouse is 5.8m AOD. The flood defences on the adjacent main rivers are therefore critical in preventing regular fluvial as well as tidal flooding from the River Ouse and River Don.

Within Goole itself, the lowest lying areas are typically located to the north and north east of the town, particularly in areas to the north of Coniston Way and the railway line and east of Thorntree Lane where levels are less than 2.0m AOD. There are also isolated areas in the vicinity of Millennium Way where levels are less than 2.0m AOD. The ground levels around Attlee Drive in central Goole and in Parklands to the west of the town centre are also less than 2.0m AOD.

2.2 Environment Agency Defences

With the exception of small areas in the vicinity of Goole Docks, all of Goole to the north of Dutch River falls within Flood Zone 3, as defined by the EA's Flood Zone Maps. This means that, without defences, the area is subject to river flooding with an annual probability of 1 in 100 (1%) from rivers and 1 in 200 (0.5%) from the sea.

The EA operates and maintains artificial defences such as earth banks and other hard structures adjacent to the Ouse, Aire and Don to significantly reduce flood risk from these rivers. These structures are designed to protect Goole from tidal flooding to a 1 in 200 year (0.5% chance per year) flood event and the condition of these defences is regularly monitored and assessed by the EA.

The nature of the flooding in July 2012 was pluvial (overland from surface water caused by rainfall) rather than fluvial (from watercourses) therefore the EA defences had no impact on the extent or cause of the flooding.

2.3 The Urban Drainage System

Goole is drained via a combination of highway gullies, private building drainage, public sewers, Goole & Airmyn Internal Drainage Board (IDB) and riparian watercourses, and pumping stations that are owned and operated by either YWS or the Goole & Airmyn IDB.

Historically the original, piped drainage system within Goole was made up of a gravity combined sewer system that carried both foul and surface water. The system originally discharged into the River Ouse at Lock Hill when the tide level in the river was sufficiently low. When the level of the River Ouse rose due to tidal action, foul sewage and rainfall would be retained within the sewers under the town until the water level dropped at the next low tide and the sewers would empty under gravity.

As a consequence, the original drainage system was constructed of larger pipes and brick culverts to provide the required storage between tides. These oversized sewers form part of the modern day urban drainage system.

More recently, parts of the sewerage system have been designed and constructed to drain rainfall (surface water) and sewage (foul water) into separate systems. These separate systems are the norm for modern estates, but in most cases in Goole they eventually discharge into the historic combined drainage system.

In order to allow foul and surface water to discharge into the River Ouse, irrespective of tide level, a series of pumping stations was constructed in the mid to late 20th century. When originally constructed the Carr Lane PS discharged foul and storm flows directly into river.

Following the introduction of the European Directive relating to the treatment of waste water, a wastewater treatment works (WwTW) was constructed to treat Goole's sewerage prior to discharge into the river. Under normal conditions the background flow in the sewers that is not caused by rainfall (known as dry weather flow), is pumped from Carr Lane PS to the Goole WwTW. Flows that reach Goole WwTW undergo treatment before being pumped back to the original outfall at Carr Lane for discharge into the River Ouse. During times of storm, additional pumps operate to discharge the storm water directly into the river. Figure 20 in Appendix A shows the major sewers and pumping stations within Goole.

Newer developments in Goole are constructed with separate sewerage systems for foul and surface water. However these will often discharge into the historic combined drainage system. More recently it has been a requirement to restrict the rate of surface water discharge into the system.

Current design standards (Sewers for Adoption 7th Edition) stipulate that sewers should have sufficient capacity to carry such volume of water/sewage so that there is no surface flooding on a storm with a 3.33% chance of occurring in any given year (1:30 Return period).

2.4 The Public Sewerage System

As the statutory sewerage undertaker for Goole, YWS is responsible for the operation and maintenance of the public sewerage system. This includes public sewers, pumping stations, rising mains, attenuation systems, sewage treatment plants and other ancillary apparatus such as treatment works.

2.4.1 Yorkshire Water Services Pumping Stations

In total there are twelve YWS pumping stations in Goole, with Carr Lane and Lock Hill being the largest (see also Figure 20 in Appendix A).

A typical pumping station will consist of multiple pumpsets that, when operated in parallel, will provide the design pumping capacity. The pumpsets will start in a sequence as the water level in the pumping station rises. The first pump to start is known as the duty pump; any subsequent

pumps are commonly labelled assist pumps. It is common practice to have an additional pump on standby that can be called into operation in the event of a failure in one of the duty or assist pumps.

The configuration of these pumping stations is commonly referred to as duty/standby for twin pump pumping stations, or duty/assist/standby for pump chambers with three pumps. In stations with four or more pumps the additional pumps are normally classified as assist pumps. In order to ensure that all the pumps in a station operate regularly, the pump acting as the duty pump will change on a rota basis each time the pump is required to start. Once a pump is operating in a duty role it will continue to operate until the water level in the station has dropped sufficiently to turn off all the operating pumps.

When a pump runs for an extended time it is usual for a warning alarm to be automatically sent to a control centre. For Carr Lane PS and Lock Hill PS these alarms would be sent to YWS's regional control centre.

Many YWS pumping stations use telemetry systems to record and monitor all the operations occurring within them and send this data back to YWS's regional control centre. YWS has provided detailed information extracted from their telemetry systems for Carr Lane PS and this data is contained within Appendix C.

2.4.2 Carr Lane Pumping Station

Carr Lane PS is Goole's main terminal pumping station. The station receives flows directly from the town drainage system and indirectly from other YWS pumping stations within the Goole catchment.

The pumping station had undergone a significant amount of mechanical and electrical upgrading works which were in the final stages of commissioning prior to the flooding event in July. Refer to Appendix D for a plan of Carr Lane PS.

The operating system at Carr Lane PS generally works as follows:-

During storm events the flow from the town drainage system increases as rainfall makes its way into the system. There is a lag time between the rainfall landing on the ground and this surface water mixed with wastewater reaching the wet wells. This lag time is known as the time of concentration and can be significant in a large urban system.

Flows from the town drainage system initially pass through the pumping station's inlet screens. These are designed to protect the pumpsets from damage by removing solid material from the wastewater flows.

The inlet screens at Carr Lane PS consist of two screens arranged in a duty/assist configuration. Automated screen cleaning equipment removes screenings and solid debris from the screens, compacts it and then discharges it to a skip. The automated screen cleaning works on a differential level between the upstream and downstream flows. As the level upstream of the screen increases

due to the solids building up on it the difference in level triggers the operation of the cleaners. The assist screen will become operational if the level differences continue. There is no bypass around the screens at Carr Lane PS and it is possible for the screens to blind up with debris¹ if the capacity of the cleaners is exceeded.

Once through the screens, flow enters the FFT pumpset wet wells via an inlet channel. There are four FFT pumpsets at Carr Lane. The operation of these pumpsets is controlled by instrumentation and ultrasonic level detectors that monitor the wastewater level in the wet wells. The FFT pumpsets pump wastewater at the required rate to the Goole WwTW.

When flow into the wet well is higher than the capacity provided by the pumps then the water levels within the FFT pumpsets wet wells (and within the town sewer system upstream of this) will rise.

When this water level reaches a specific level (approx. -7.35m below slab level) it will overflow into the storm pump wet wells. Each of the storm wet wells houses two of the storm pumpsets.

Within the storm wet wells, ultrasonic level detectors monitor and record the storm water levels and operate the relevant storm pumps. The storm pumpsets discharge into the River Ouse via a 1300mm rising main.

If the capacity of both the FFT pumpsets and the storm pumps is exceeded then wastewater levels will rise in the respective wet wells until they reach the soffit level of the structure. At which point inflow to the wet wells will be inhibited and flows will back up in the sewer system. Eventually once the capacity of the sewer network is reached, wastewater will flood out onto low lying ground areas of the town.

Due to the relatively flat nature of the Goole catchment, this also causes wastewater to enter road gullies that drain into surface water drains that are not part of the YWS system, for example the culverted sections of Hook Drain.

Wastewater Pumpsets (FFT)

There are four FFT pumps set in a nominal duty/assist/standby/standby configuration.

In normal operational circumstances the peak rate of FFT discharge (the EA consented flow) from Carr Lane PS via a 600mm diameter rising main to Goole WwTW is limited to 327l/s.

All of the FFT pumpsets are of the submersible type and were capable of running without interruption through the July flooding event. However the electric junction boxes and other equipment in the dry well was not designed to be submersible.

¹ The worst case for screen blinding is a first-flush event after a prolonged period of dry weather. This flooding event followed an extremely wet June

Storm Water Pumpsets

The storm pumping station in principal is fitted with four pumpsets arranged in a duty/assist/assist/standby configuration. The total outlet design capacity of the storm pumping station is 3270 l/s.

During the July flooding event, one of the original storm pumpsets had been replaced with two submersible pumpsets manifolded together.

2.4.3 Goole Wastewater Treatment Works (WwTW)

The WwTW that serves Goole is sited at the north west of the town, between the M62 and A614. It receives screened sewerage pumped from Carr Lane PS. After treatment the effluent is pumped back via a 600mm diameter discharge pipe into the River Ouse near Carr Lane PS.

Prior to treatment, the flow from Carr Lane is screened again at the treatment plant. If the WwTW inlet screens do blind due to solids building up on them, there is a bypass that will ensure the flows pass around the screens and on to treatment.

Goole WwTW has the ability to restrict flows from the FFT pumpsets at Carr Lane PS. This restriction can however be over-ridden by turning the FFT pumpsets at Carr Lane to “manual”, in which case the FFT pumpset can deliver more than the consented flows to Goole WwTW.

If the flows to Goole WwTW are an increase over the EA’s consented flow rate, then the treatment process can eventually overflow with the overtopping water finding its way back into the town’s land drainage system.

2.4.4 Lock Hill Pumping Station

Lock Hill PS is situated on East Parade next to the River Ouse. It receives sewerage from the southern parts of Goole including from Vermuyden Terrace, Old Goole 1 & 2 and Swinefleet Road Sewage Pumping Stations (SPS).

The pumping station has two dry weather flow (DWF) pumpsets that operate in a duty/standby configuration with a design peak capacity of 89l/s. These pumpsets discharge via a 450mm diameter rising main into a gravity combined sewer system adjacent to the railway line in the vicinity of Coniston Road, which in turn discharges into the Carr Lane PS.

All incoming flows to Lock Hill enter through a combined sewer overflow (CSO). In storm conditions the excess inflow will surcharge and weir into the storm pumps wet wells. There are two storm pumpset wet wells each containing two storm pumps. These storm pumpsets then discharge directly into the River Ouse and operate in a duty/assist/assist/standby configuration.

2.4.5 Sandhall Detention Tank

A surface water storage tank was built by YWS in the vicinity of Millennium Way and Maple Drive in 2009, following the flooding of 2007. The system is designed to store up to 900m³ of excess combined wastewater prior to pumping it back into the main sewer system at a controlled rate, theoretically reducing the instances of flooding as an additional volume of storage is available underground.

The Sandhall Detention Tank was built to the appropriate, 1 in 30 years design standards and has reduced the incidences of flooding in the area. Nevertheless flooding still took place in the area on 5th and 6th July 2012 from a rainfall event with a return period less than 1 in 30 years.

2.5 Goole & Airmyn Land Drainage System

The Goole & Airmyn Internal Drainage Board (IDB) was formed in 1962 and covers an area of approximately 1842ha of which 800ha is classed as agricultural. Within its boundary it is responsible for the maintenance of 24km of watercourses and the operation of five surface water pumping stations.

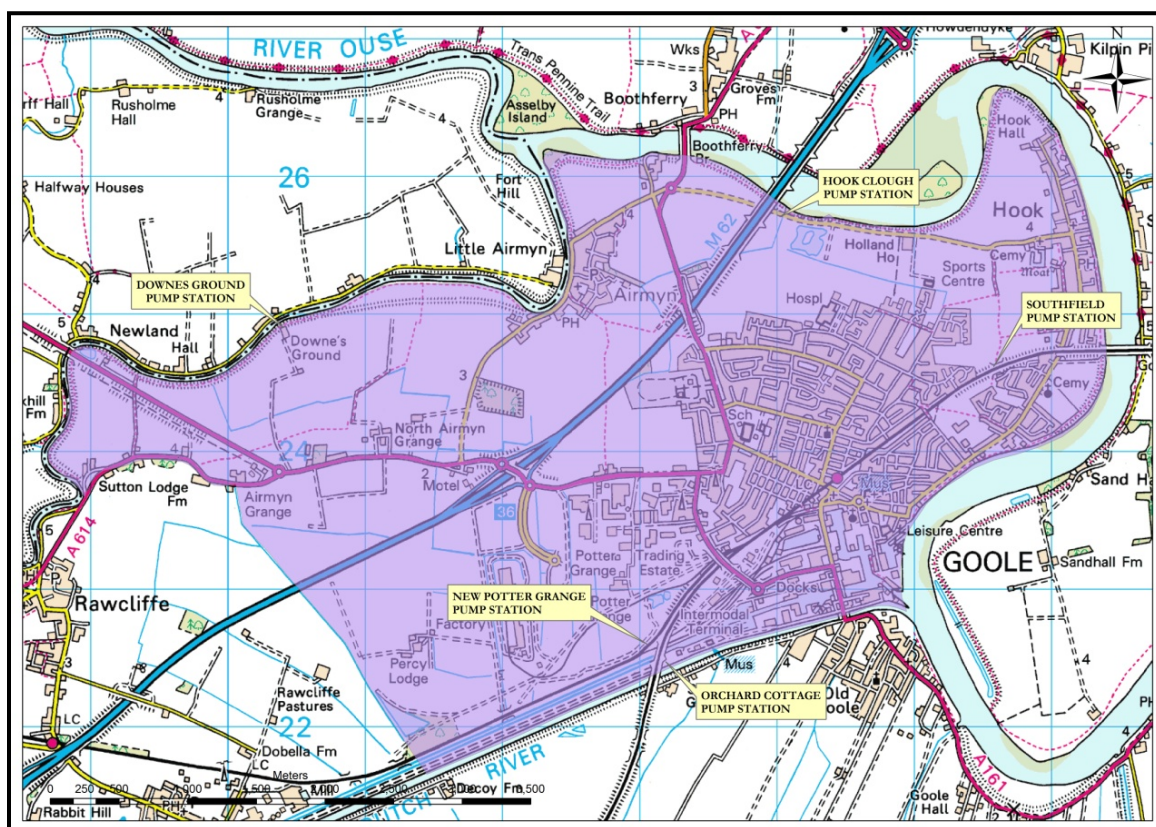


Figure 1 : Extent of the Goole & Airmyn IDB network

The pumping stations operated by Goole & Airmyn IDB undergo periodic maintenance procedures, and they are all visited daily by the Board's pump attendant.

The maintained watercourses are normally flailed in September and de-silting works are carried out where required, generally during the months of October and November. Annual flailing and de-silting works were carried out in 2011 after flooding that took place in August 2011. Areas where the banks have slipped into the Board's watercourses are maintained and remedial measures carried out when the Board becomes aware that such measures are required.

All of the Goole & Airmyn IDB pumping stations operate in a duty/assist or duty/assist/assist mode, with the duty pump rotating between pumps in order to equalise wear. There are water level detectors within the pumping stations that switch the pump(s) on at predetermined water levels. If the rate of inflow is greater than the capacity of the pump, the water level within the suction side of the pumping station will continue to rise. Once a predetermined level is reached additional pumps will then operate until the maximum capacity of the station is reached.

2.5.1 Hook Clough Pumping Station

Hook Clough is situated to the north of Goole, in the vicinity of the M62 bridge over the River Ouse. Hook Clough is the principle means of discharging land drainage into the River Ouse for the area in which Goole lies and is therefore a critical drainage asset. Discharge into the River Ouse is via a gravity system when the water level allows or a pumped outfall when the gravity outfalls are drowned.

The station was constructed between 1972 and 1974 and comprises two vertical turbine pumpsets, with a total capacity of approximately 900 l/s. The first of these pumpsets starts pumping when sump levels at Hook Clough PS reach around 1.0m and the second then starts pumping when water level reaches 1.2m (0.30m AOD and 0.5m AOD respectively). The pumpsets switch off when water levels are pumped down to -0.05m AOD and 0.15m AOD.

2.5.2 Southfield Pumping Station

Southfield pumping station is located in the east of Goole, adjacent to the Railway Line. It was constructed in 1997 and comprises two submersible pumps, each rated at 26 l/s that receive water from riparian watercourses to the south of the railway and discharge it into a watercourse that eventually discharges into Hook Clough.

2.5.3 Downes Ground Pumping Station

Downes Ground PS is located on the River Aire, between Little Airmyn and Newland, and was constructed around 1955. At this time there were two vertical lift pumps that operated at 450 l/s against a head of 3.7m. The station was extended in 1972 by the addition of a third pump capable of discharging 450 l/s against a 5.1m head. When the water level in the receiving watercourse allows, the system drains by gravity, with the pumps only operating when the outfall is restricted.

The operation of Downes Ground PS has not come into this investigation.

2.5.4 New Potter Grange Pumping Station

New Potter Grange PS is located on the south west of Goole, adjacent to the Dutch River. It receives water from riparian watercourses and lifts it into a watercourse that feeds into the adjacent Orchard Cottage pumping station. New Potter Grange PS was constructed between 1972 and 1974 and comprises two Archimedes screws with a capacity to lift 425 l/s through approximately 2.0m.

The operation of New Potter Grange PS has not come into this investigation.

2.5.5 Orchard Cottage Pumping Station

This pumping station receives flows from Goole & Airmyn IDB maintained watercourses, including an element that is pumped from the adjacent New Potter Grange PS. The original construction took place in about 1972 with an additional pump installed in 2005. There are two vertical lift pumps each capable of delivering 285 l/s of water. The pump installed in 2005 has a capacity of 290 l/s giving a total peak capacity for the pumping station of 860 l/s.

The operation of New Potter Grange PS has not come into this investigation.

2.6 Riparian Watercourses

Watercourses that are not maintained by the EA or IDB are categorised as riparian watercourses. The responsibility for maintenance of these falls to the landowner adjacent to the watercourse. These drains are shown on in Figure 21: Plan of main land drainage drains in Appendix A

2.6.1 Hook Drain

The principle riparian watercourse serving Goole is Hook Drain. This watercourse consists of both an open channel section that discharges to the north to Hook Clough PS as well as a culverted section along Long Lane and Thorntree Lane. This drains to the open channel sections to the north via a flapped outfall. It also discharges southwards into the North Street trunk sewer and from there to Lock Hill PS.

Several public sewers, lateral drains and minor watercourses discharge into Hook Drain within the culverted section. Flow from the open channel section back into the culverted section is prevented by the flap valve to the north of the drain, installed in 2010. There have also been works to remove old features, such as trash screens, that existed when the watercourse was an open channel.

Although Hook Drain is a riparian watercourse and is the responsibility of landowners that border it, in 2009 ERYC cleaned (on a without prejudice basis) and CCTV surveyed its entire length. Whilst a third-party owned and maintained asset, Council engineers have also carried out visual inspections at various points since 2009, also on a without prejudice basis. These inspections have not raised any significant cause for concern as to the condition of the watercourse.

ERYC operates a water level telemetry monitoring system in Hook Drain in the vicinity of Marlborough Avenue. This is located near to the southern extent of the culverted watercourse, within the centre of Goole, and in an area where it predominantly receives overland flow. As Hook Drain is connected to the south to YWS Lock Hill PS water levels in the drain are indicative of water levels experienced within this sub-catchment of the sewer catchment.

2.6.2 Westfield Drain

Westfield Drain is an open channel of drain that runs approximately north-south, extending from the Goole urban boundary (near Woodfield Road) to Hook Drain in the north. Westfield Drain is the responsibility of the Goole & Airmyn IDB.

The southern part of this historic watercourse between Centenary Road and open channel section of Westfield Drain is a surface water sewer. A some time in the past this was sewered and is the responsibility of YWS.

2.6.3 Hospital Drain

Hospital Drain runs approximately west to east from Westfield Drain, along the northern boundary of the Goole Hospital site. It does not connect to any other drains and is not believed to receive runoff from Goole. There are no recorded issues with the watercourse.

2.6.4 Towns Drain

Towns Drain includes a series of interlinked drains that extend westwards from Hook Clough PS and which receive runoff from areas to the west of Goole, including areas around West Park and to the north of Rawcliffe Road.

2.7 Highway Drainage

The urban area of Goole contains some 4,351 highway gullies that are the responsibility of ERYC in its role as the highway authority. These gullies discharge into a variety of receiving systems such as private sewers, water courses, designated highway drains, although the vast majority discharge directly into the public sewer system.

In addition to the highway gullies there are numerous, unrecorded gullies that are the responsibility of individuals, private companies and landowners. The points of outfall from these are generally not known, or recorded. Maintenance of these systems is carried out on an ad hoc basis by the responsible party.

Unlike the public sewer system there is no consistent design standard for gullies. Highway gullies are generally designed to drain rainfall up to an intensity equal to a 1 in 2 year return period, although standards as high as 1 in 10 years have been used.

Highway gullies are cleaned on an annual basis by ERYC. Before the flood event the most recent cleaning programme was completed in May 2012. Of the 4351 gullies scheduled for cleaning, 85 were inaccessible due to parked vehicles or other obstructions, and another 109 had defects. These are summarised below

	Number of Gullies	Percentage of Total
Gullies Cleaned	4157	95.5%
Obscured by vehicles	85	2.0%
Stuck lid	13	0.3%
Broken lid	14	0.3%
Blocked outfall	45	1.0%
Dig out Required	37	0.9%

Table 1 : Highway Gully Cleaning Summary – 2012

The annual cleaning programme before the August 2011 flooding event recorded 184 gullies inaccessible due to parked vehicles or other obstructions, and another 25 with defects. Although the number of highway gullies not cleaned out prior to the rainfall event was less than in 2011, the figures show a deterioration in the condition of the highway drainage infrastructure.

With the exception of gullies that discharge into highway drains the limit of responsibility of the highway authority is the downstream end of the pipe that connects the gully pot to the receiving watercourse or sewer. When the gully connects to a designated highway drain the limit of responsibility is the point of connection of the highway drain to its receiving watercourse.

3 The Storm Event, July 2012

3.1 Rainfall

The flooding incident that occurred in Goole on 5th and 6th July 2012 followed a rain storm. This section of the report considers the rainfall data available for the period.

Prior to the actual flooding event Met Office weather warnings were in place for Goole as follows:-

“Scattered heavy showers or thunderstorms are likely at times on Thursday, particularly during the afternoon and evening, with the potential for some torrential downpours in places. Southeastern areas of England are at less risk than areas further north, with any showers there tending to clear later. The public should be aware that these showers, where they occur, may lead to surface water flooding.”

3.2 East Riding of Yorkshire Council Rainfall Data

ERYC operates a number of rain gauges across the authority. Within the catchment relating to Goole, ERYC operates a single rain gauge located in the Lock Hill area of the town. The Goole rain gauge has been recording data since 10th October 2011.

Although data was recorded by the Goole rain gauge up until its replacement on 24th July it is not considered reliable from 12:41 on the 5th July as there is every indication that the gauge was struck by lightning. The data that was recorded following the strike shows only 0.8mm of rainfall on the 5th July and nothing further until 10th July. This is inconsistent with other data sources and eye witness accounts.

3.3 Environment Agency Rainfall Data

The EA operates a number of storage and tipping bucket rain gauges across the country. These gauges provide daily total rainfall amounts and 15-minute period rainfall records respectively.

None of the EA's gauges is particularly close to Goole but relevant data is available from storage gauges located at:

- 1) Harswell (SE 82637 40815), approximately 17.9km to the north north east:
- 2) North Cave (SE 89819 32757), approximately 17.0km to the north east:
- 3) Kirk Bramwith (SE 61839 11461), approximately 18.5km to the south west: and
- 4) Gale Common (SE 53358 21680), approximately 21.5km to the west.

Tipping bucket rain gauges provide a greater resolution of recorded rainfall events than storage gauges do. Rainfall is typically recorded after each 0.2mm of rain and this is converted into a record that shows the depth of rainfall within a 15-minutes period.

Relevant data is available from the EA's tipping bucket rain gauges located at:

- 1) Broomfleet (SE 92160 32703), approximately 19.1km to the north east:
- 2) South Elmsall (SE 48382 10712), approximately 29.8km to the south west: and
- 3) Newbald Becksies (also at SE 92160 32703), approximately 19.1km to the north east:

The EA's records show that the Goole area had experienced above average rainfall in the 12 months prior to the event, 75% of which was received between April and June. As a result Soil Moisture Deficit (SMD), which is a measure of how much rainfall is required to cause a soil to reach its capacity to absorb rainfall, was lower than average. Figure 2 shows the SMD for the Yorkshire and North East Region in the months prior to July.

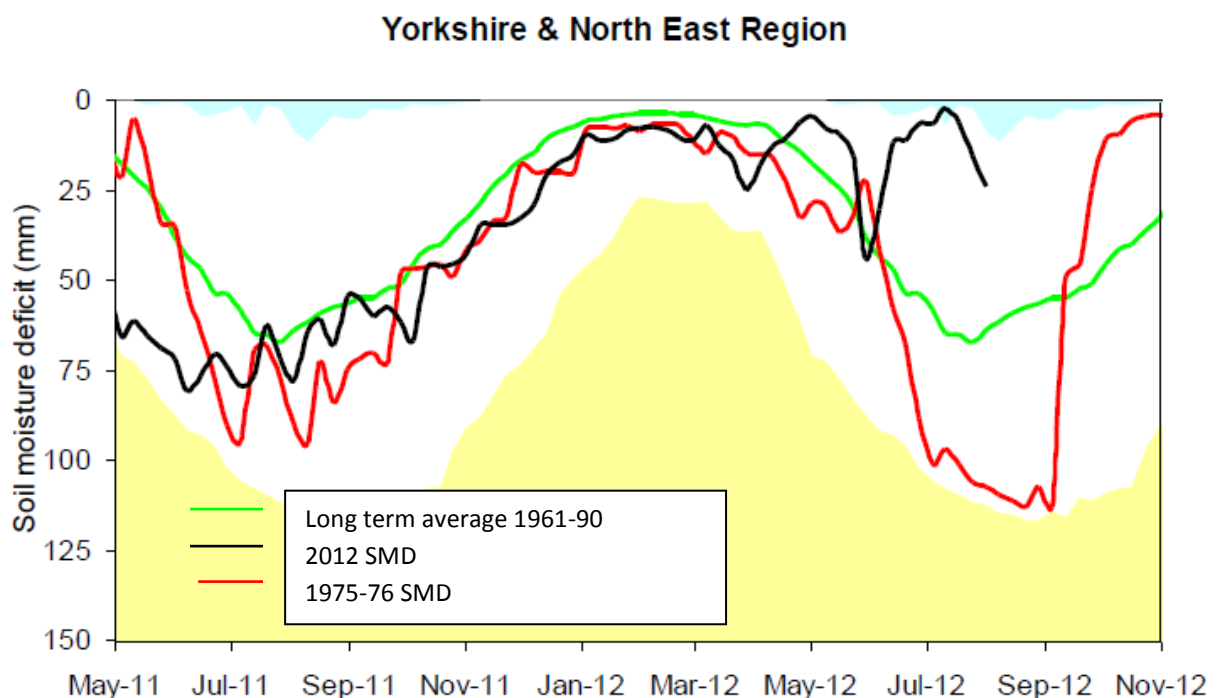


Figure 2: Soil Moisture Deficit prior to July 2012

The WSR shows that the SMD in Goole before the event was less than 10mm, indicating a wet catchment with little capacity to accept more rainfall. As such land drained by the Goole & Airmyn IDB drains would have been wet and responsive to rainfall. Despite this the IDB drains were operating normally prior to the event and maintaining normal water levels.

Permeable areas within the urban area of Goole were also wet and more responsive to rainfall.

3.4 Met Office Rainfall Data

Rainfall radar data was obtained from the Met Office for the flooding event. This data provides information on rainfall intensity over a 30km by 28km area centred on Goole.

This data provides information at points on a 2km resolution grid within this area, indicating the instantaneous rainfall intensity in mm per hour recorded at 15-minute intervals. The Met Office radar data analysed covers the period from midnight on 4th July until 00:15 on 8th July.

Four radar grid cells cover Goole town. Cells 85, 86 cover Airmyn and Hook respectively and Cells 101 and 102 cover the south west and south east of Goole as shown in Figure 3: Met Office radar 2km grid coverage at Goole.

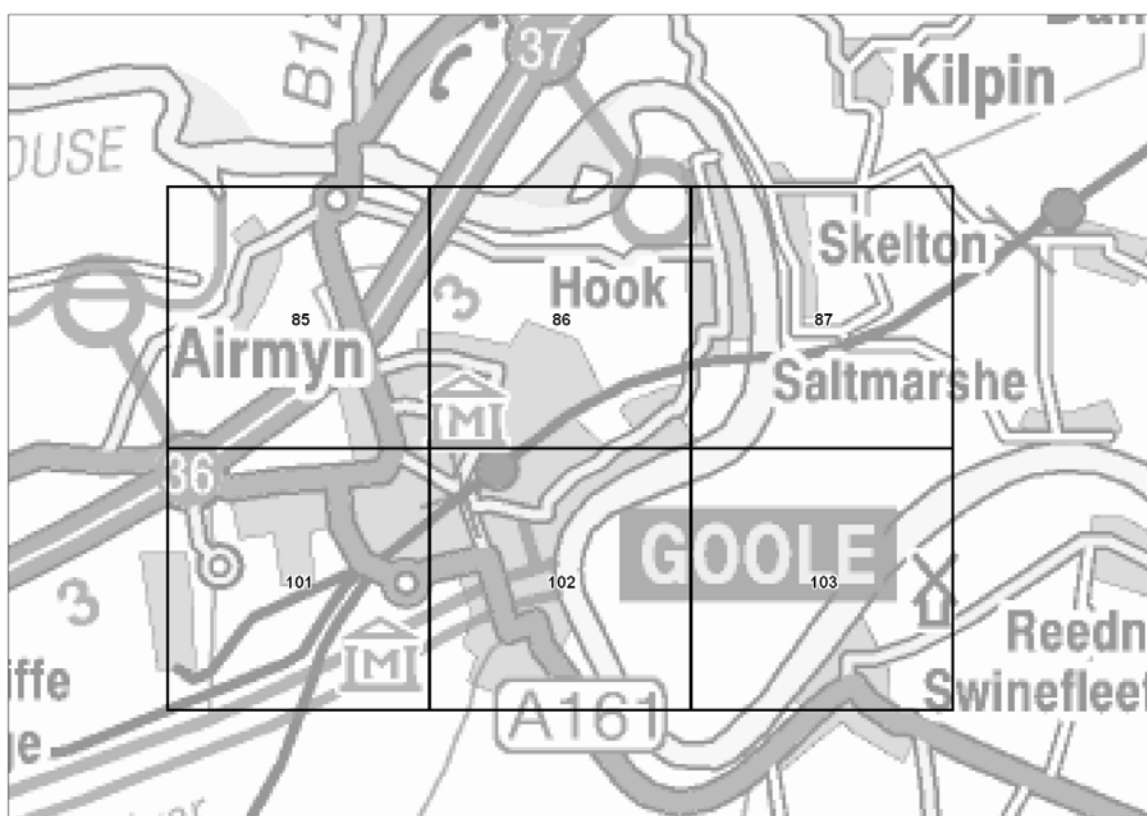


Figure 3: Met Office radar 2km grid coverage at Goole

The nearest Met Office radar to Goole is at Ingham, to the south. The type of radar data available is Nimrod Corrected Single Site data, which has had appropriate corrections applied to it to compensate for atmospheric conditions. The Met Office also correlated the radar data with observations from rain gauges to further improve accuracy. This Nimrod corrected data provides the best estimation of rainfall using radar techniques.

Guidance on rainfall radar data published by the Met Office² identifies that there are limitations on the use of rainfall radar data. The data can be affected by non-meteorological echoes and there are other technical and meteorological causes of error. However, in the absence of reliable local rain gauge data, it is considered that the Met Office rainfall radar data is the best available information for understanding rainfall distribution and intensity on 5th and 6th July at Goole.

3.5 Internal Drainage Board Rainfall Data

A & F Consulting Engineers are retained as engineers to the board for the Goole & Airmyn IDB. At the time of the flooding event on 5th July their engineers were responding to the rainfall event in Goole on behalf of the IDB.

A note³ prepared for the LLFA by A & F Consulting Engineers records that a thunderstorm started at approximately 14.00 on 5th July and in their view the maximum rainfall intensity was greater than 32mm per hour and lasted for up to an hour in places. The thunderstorm was preceded by moderate to heavy rainfall earlier in the day.

3.6 Eyewitness Accounts of Rainfall

Eye-witness accounts of the 5th July are available from various sources including; YWS contractors, ETM, and ETM's subcontractors, SPU, Council officers, HF&RS and local residents. All accounts are consistent in that a thunderstorm started in the early afternoon of 5th July.

Similarly eye-witness accounts of the 6th July are available and are consistent in that light rainfall started around 06:00 including a short sharp shower, but the remainder of the day was a mix of light to moderate rainfall.

3.7 Rainfall Interpretation

3.7.1 East Riding of Yorkshire Council data

The Goole rain gauge was struck by lightning at 12:41 on 5th July. Data from this point up to its replacement on 24th July is not reliable. Figure 4 below shows a combined plot of all the rain gauge data that is available, with the unreliable data highlighted in red.

The Goole rain gauge recorded that no rainfall occurred at the site between 03:30 and 09:30 on 5th July. Both the Met Office Rainfall Radar datasets and the EA's Broomfleet rain gauge did record light rain at this time.

² http://www.metoffice.gov.uk/media/pdf/j/h/Fact_sheet_No._15.pdf

³ Bate, R.F. (2012) Goole Rainfall Event – Flooding 5th July 2012. A & F Consulting Engineers on behalf of Goole & Airmyn IDB.

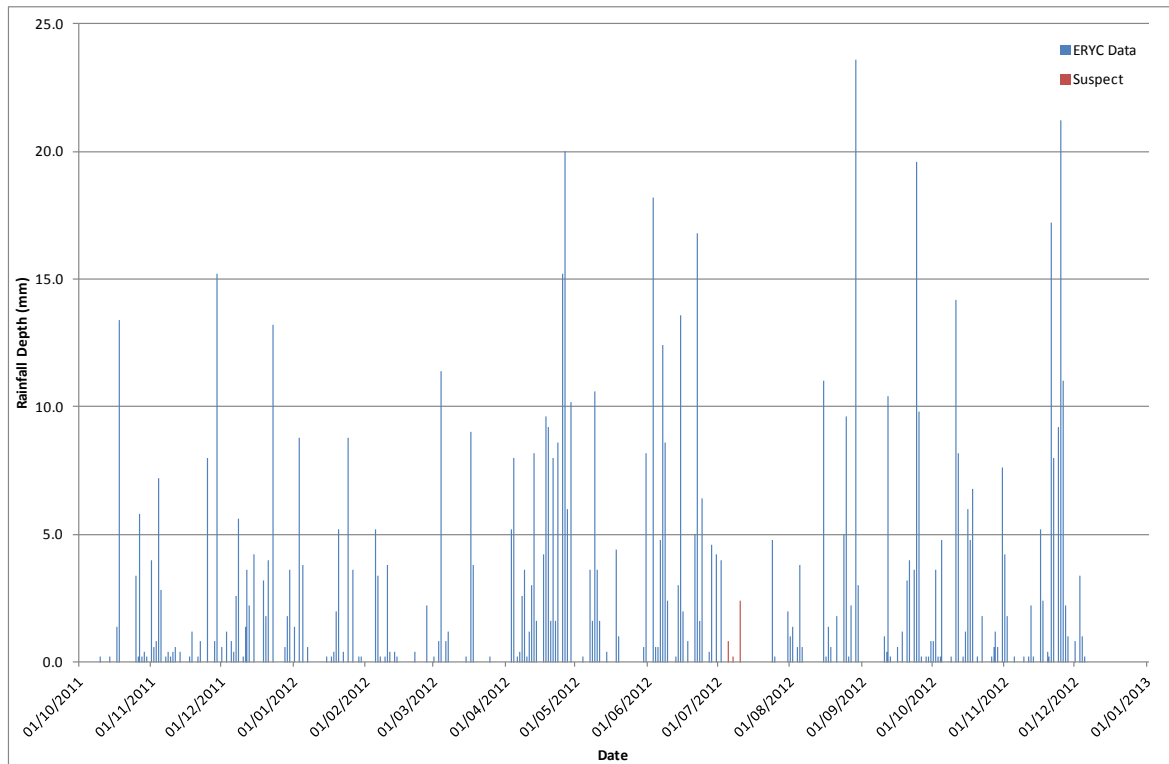


Figure 4 : Goole Rain Gauge daily observed rainfall

Key statistics recorded by the Goole rain gauge are as follows:

- The most significant event (in terms of volume) recorded in Goole since the installation of the rain gauge was an 80mm rainfall event covering a 10 day period starting on 17th April 2012. The estimated annual probability of this event is 1 in 7.4 years; and
- The most intensive rainfall event recorded was a 15-minute period during which 11.2mm (equivalent to 44.8mm/hr) was observed on the morning of 18th October 2012. The estimated annual probability of this event is 1 in 4.0 years.
- The Goole rain gauge station was struck by lightning at the start of the event and as a consequence, high resolution, localised data is not available for analysis.

The data collected since the installation of the Goole rain gauge indicates that there were no equivalent rainfall events within Goole beforehand.

During 2012 in the months before the flooding event, the Goole rain gauge recorded a total of 350.2mm of rain, as shown in Figure 5 below.

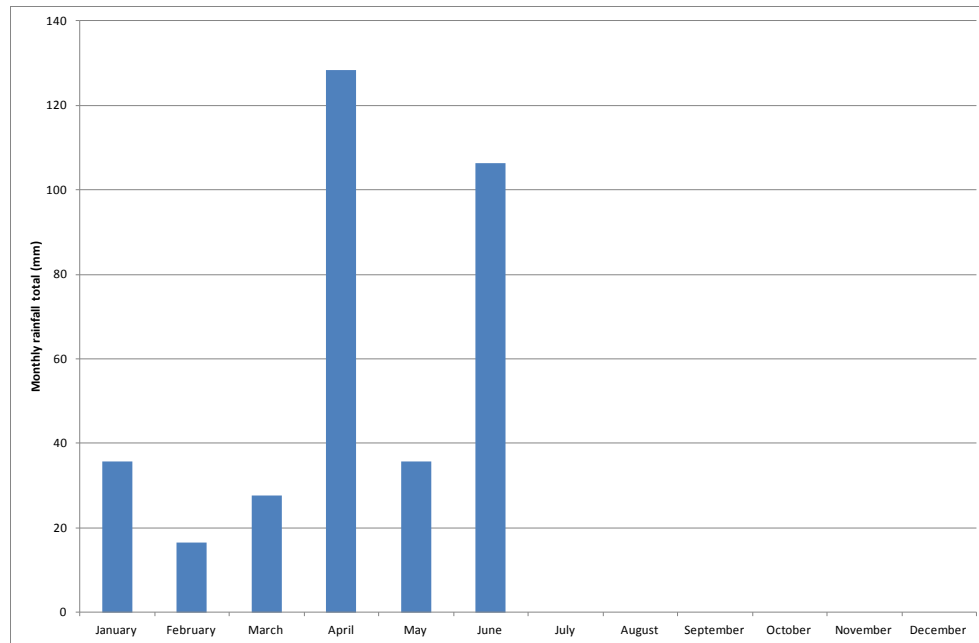


Figure 5 : 2012 Monthly rainfall totals at Goole rain gauge

The Flood Estimation Handbook v3 (2011)⁴ indicates that Average Annual Rainfall for this location is 595mm. Unfortunately a full 12 months data is not available at the Goole rain gauge site, but from the 6 months data shown in Figure 5 it does suggest that Goole had received more than the average January to June rainfall prior to the flooding.

The EA's monthly Water Situation Report (WSR)⁵ indicates that June 2012 was provisionally the wettest June since records began in 1910. The WSR indicates that in June the area received more than 190% of the long term average for the month. Across the EA's Yorkshire and North East region 150mm of rainfall was recorded in June.

Goole experienced higher than average rainfall in the 6 months before the flooding with June being the wettest on record.

⁴ CEH (2009) Flood Estimation Handbook CD-ROM version 3.0

⁵ Environment Agency (2012) Water Situation Report: Monthly Bulletin for England and Wales - June 2012

3.7.2 Environment Agency data

The daily rainfall totals recorded by the EA's four most relevant storage rain gauges is tabulated below for the period 4th, 5th, 6th and 7th July.

Station	Grid Reference	Recorded rainfall depth (mm/day)			
		4 th July	5 th July	6 th July	7 th July
Harswell	SE 82637 40815	0.5	13.2	16.1	
North Cave	SE 89819 32757	3.2	2.4	22.2	
Kirk Bramwith	SE 61839 11461	1.0			
Gale Common	SE 53358 21680	7.3	24.2	24.0	5.2

Table 2 : EA Storage rain gauge daily totals

Based on this recorded rainfall it is estimated that these events had an annual probability of less than 1 in 1.3 years. However the distance of these gauges from Goole means that they did not capture the rainfall event that was experienced in Goole.

The EA's nearest tipping bucket rain gauges are further from Goole. They recorded very similar patterns of rainfall to those recorded by the storage gauges.

The distance of the tipping bucket rain gauges from Goole means that the sub-daily record from these stations does not provide a good understanding of the intensity of rainfall experienced in Goole on 5th and 6th July. Summer storm events such as this are often a result of convective storms that result in highly localised rainfall events.

3.7.3 Met Office Radar data

The Met Office rainfall radar data provides the most comprehensive dataset for the event. The rainfall radar dataset is the best information available with respect to the distribution and intensity of rainfall on 5th and 6th July.

Table 3, below, shows the total rainfall recorded for the period 5th, 6th and 7th July from the Met Office. The data shows that there was a greater total depth of rainfall in the two cells to the east (Cells 87 and 103) than was experienced within the four cells covering Goole.

Station	Grid Reference	Recorded rainfall depth (mm/day)			
		5th July	6th July	7th July	Total
Cell 85	SE 720 260	34.1	22.0	1.0	57.0
Cell 86	SE 740 260	40.6	26.5	0.0	67.1
Cell 87	SE 760 260	43.4	27.3	0.1	70.7
Cell 101	SE 720 240	26.2	25.6	1.7	53.5
Cell 102	SE 740 240	36.4	26.8	1.0	64.2
Cell 103	SE 760 240	42.5	28.7	0.8	71.9

Table 3 : Met Office rainfall radar daily totals

The total rainfall depths derived from the radar data are of the same order of magnitude as those recorded by the EA's storage rain gauges. However the radar data indicates the total rainfall depth recorded on 5th July is larger than from other records.

The sub-daily data from the Met Office radar record for Cell 86 indicates that light rainfall on 5th July commenced at 04:00, briefly increasing to moderate rainfall at 04:30 and again at 05:45 until 07:45 when the intensity of rainfall briefly increased to heavy rainfall of 13.8mm/hr before falling back to moderate rainfall that lasted for over an hour before tailing off.

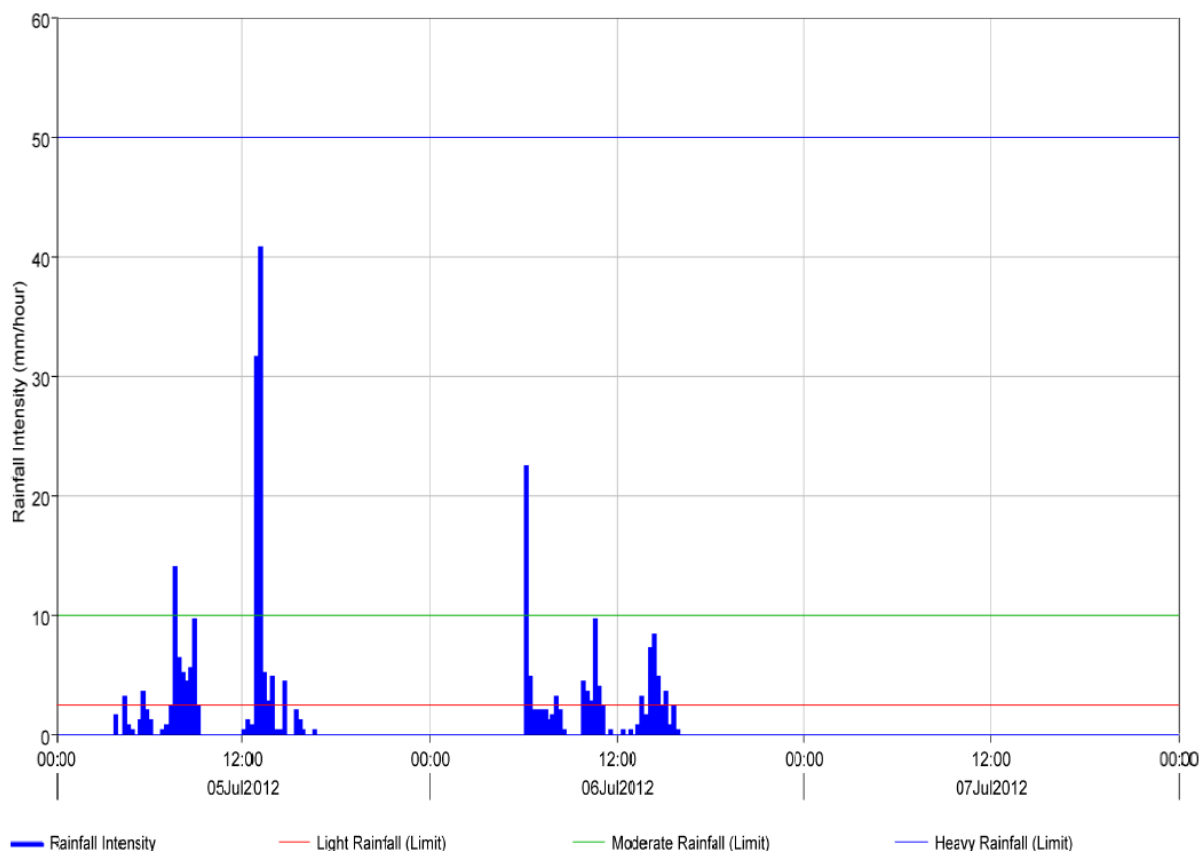


Figure 6 : Rainfall Event

This first period of rainfall stopped at 09:45 and at no point did the rainfall in any 15-minute period exceed that expected from a 1 in 1 year return period event. Considering the cumulative rainfall that fell during this 5.75 hour period the event only marginally exceeded a 1 in 1 year event.

A second period of rainfall commenced at 12:15 with light rain that lasted for 45 minutes. This rapidly increased to heavy rainfall that lasted for 30 minutes before easing to moderate rainfall for 45 minutes and then dropped down to light rain for a further 30 minutes. A last 15 minute flurry of moderate rain followed before a 30 minute period with no rain after which there was an hour of light rain.

There were reports of flooding within Goole to the HF&RS from 14:03 and similar reports to EYRC from 14:19. This second period of rainfall stopped at 17:00, though reports of flooding and requests for assistance to EYRC did not cease until 17:42 and to the HF&RS at 22:31.

At its heaviest, the rainfall radar shows an intensity in excess of 41mm/hr. For this 15 minute period of heaviest rainfall the return period can be calculated as 1 in 3.2 years. The calculated return period for the cumulative rainfall leading up to the flooding event is 1 in 8.6 years.

The most extreme part of the storm event occurred in the 30 minute period from 13:00 during which 18.1mm of rain fell. This equates to an event with a return period of 1 in 9.4 years.

Following a period of 13 hours during which there was essentially no rainfall, light rain commenced at 06:00 on 6th July. This was followed shortly afterwards by 15 minutes of heavy rain which then reverted back to light rain for a further two hours. For the remainder of the 6th July there were periods of mixed light and moderate rain with the occasional periods of no rain. Nevertheless reports of flooding on the 6th July were received by HF&RS between 07:34 and 19:29 and by ERYC between 07:07 and 21:56.

At its heaviest, the intensity of the rainfall on 6th July was only 22.4mm/hr. This equates to a 1 in 1 year event and is considerably less than that experienced in Goole on 5th July. Cumulatively, the rainfall on 6th July was not itself significant, with a return period of only marginally above 1 in 1 year. However, the cumulative rainfall that fell on Goole during the 36 hours spanning the two days of the floods has a calculated return period of 1 in 20.8 years.

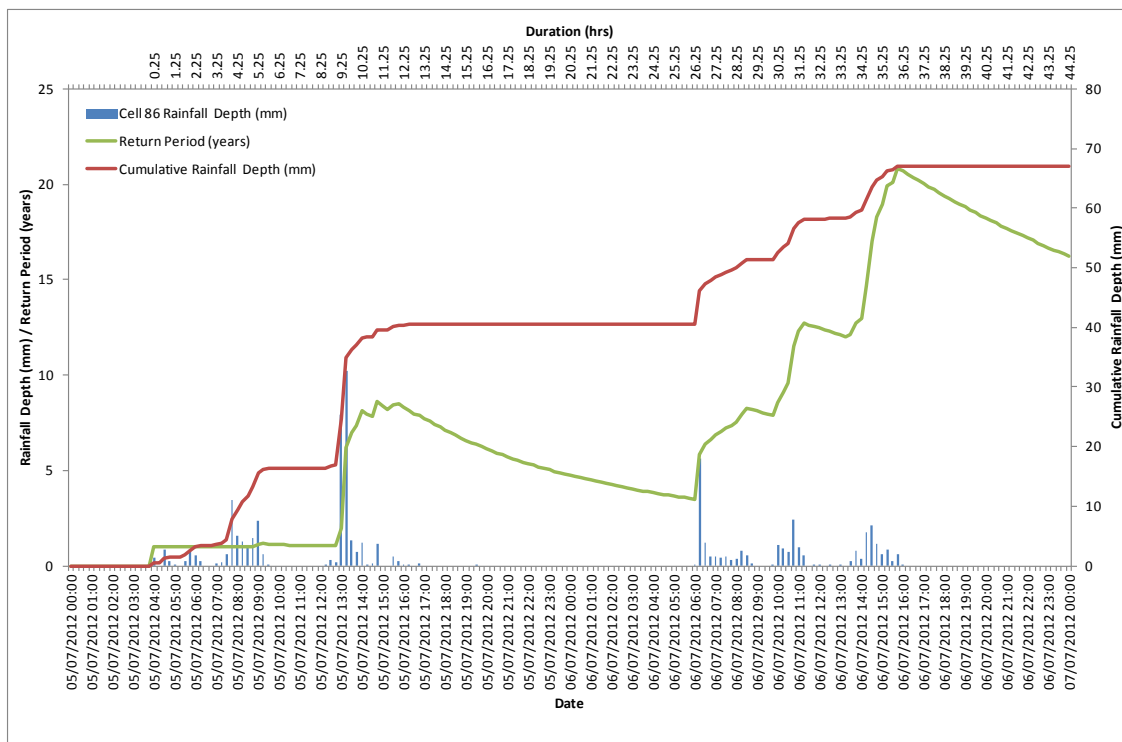


Figure 7 : Cell 86 rainfall depth, cumulative depth and return period

Figure 7, shows a plot of the rainfall depth versus time from the radar data in radar Cell 86. The figure also shows the cumulative rainfall depth and the calculated return period on the same time axis.

It is clear from Figure 7 that the severity of the rainfall event in terms of return period only develops once the second storm on the 6th July starts. During the 5th July the rainfall is notable but not exceptional, with a severity not exceeding a 1 in 9.4 year event.

Whilst there are limitations associated with weather radar data, the information available from the Met Office's rainfall radar is consistent with eye witness accounts and with rain gauges elsewhere.

The radar data recorded a 1 in 9.4 year return period event starting at 13:00 on 5th July.

There was a second rainfall event on the 6th July, consisting of three phases of rainfall that in isolation would not have been significant.

However the combination of all the rainfall events in Goole over the two days produced an event with a 1 in 20 year probability.

3.8 Tidal Data during the Event

The River Ouse is tidal from Naburn Lock (south of York), to its point of confluence with the Trent where it becomes the River Humber.

On 5th July, high tide at Blacktoft occurred at 07:40 and 20:10 with water levels of 4.4m AOD and 4.19m AOD. On 6th July, the high tides occurred at 08:20 and 21:00 with water levels of 4.52m AOD and 4.04m AOD.

The high tide early on 5th July coincided with the early rainfall of that day but the main body of rainfall starting at 13:00 occurred near to low tide in the River Ouse. The following day, the initial rainfall event at 06:15 on 6th July took place mid cycle on the rising tide with relatively light rainfall during the subsequent high tide.

The timing of the rainfall events relative to the tide levels on the 5th and 6th July did not add to the likelihood of flooding.

4 Flooding, July 2012

The investigation into the extent and causes of flooding has been based on the information collated from residents, local members, council officers and engineers, YWS's staff, subcontractors and consultants, from the Goole & Airmyn IDB and from a review and assessment of that information.

4.1 General description of event

Rainfall information from numerous sources shows that a minor rainfall event occurred early on the morning of 5th July. In response to that rainfall water levels within the drainage systems across Goole (surface water systems, Goole & Airmyn IDB drains and YWS sewers) rose. All the systems essentially operated as they should e.g. with water levels within the IDB drains being maintained by pumping at Hook Clough PS. Similarly the FFT and storm pumps at Carr Lane PS managed the flows delivered by the YWS sewer system.

At approximately 13:00 another more intense period of rainfall occurred. The heavy rain lasted approximately 30 minutes after which light to moderate rainfall persisted until late afternoon. The calculated return period for this rainfall is a less than 1 in 10 year event.

As a result of this heavy rainfall there was a gradual increase in flow to Hook Clough PS via the Goole & Airmyn IDB drains, which was effectively managed by the IDB pumps operating to capacity. In the centre of Goole water levels rose rapidly within the culverted section of Hook Drain and the YWS sewer system was also affected. Level records from Carr Lane PS show that the water levels in both the FFT wet well and storm well increased at this time prompting the start of storm pumping.

At approximately 14:15 a manhole cover lifted from the roof of the storm pumpset wet well in Carr Lane PS. Thereafter wastewater started to flood into the dry well of the pumping station.

Following the flooding of the dry well, telemetry data shows that the FFT pumps continued to operate for a short period. The control function that limits the maximum flow to Goole WwTW was manually overridden, resulting in increased wastewater being pumped to the Goole WwTW. This in turn caused some overtopping at the works and flooding was recorded in the area.

The telemetry data does not show any FFT pumpsets running between 14:51 on 5th July and approximately 19:47 on 5th July.

The same telemetry data shows that the storm pump operations started correctly in response to water levels rising in the wet well and spilling over into the storm well during the event. It also shows that shortly after the manhole cover lifted and wastewater spilled through the opening into the pumping station dry well, that 3 storm pumpsets were operational.

At 14:21 a storm pumpset failed as flood water levels continued to rise in the dry well. A second storm pumpset failed at 14:39 on 5th July and the third failed at 15:09 whilst the dry well was over 80% flooded.

The failure of each of the storm pumpsets reduced the outflow capacity of the pumping station, decreasing its ability to remove water from the Goole sewer system. It is this mechanism that resulted in water levels rising sufficiently high to add to the flooding in some areas of the Goole catchment.

The flooding of Carr Lane PS dry well and the subsequent impact on the pumping capacity of this terminal pumping station were not the only factors in the flooding in Goole on 5th July. Between 09:00 and 14:00 the Council received a dozen calls reporting blocked gullies, blocked drains and highway flooding. These calls included locations on Marlborough Avenue, Ivy Park Avenue, Mayfield and Pasture Road where local drainage system problems and capacity restrictions surcharged the sewers and drains.

ERYC and HF&RS received a further 93 calls from residents between 14:00 and 22:30 on 5th July. These calls related to blocked gullies and drains, but also referred to sewage in flood water and toilets not flushing. This is also consistent with local sewer capacity problems. Surcharging of the sewer system resulting from reduced pumping capacity at Carr Lane PS also had a minor effect on the initial flooding incidents. The distribution of properties affected after 14:00 is widespread, though there are 'hotspots' in the vicinity of Westbourne Grove, Jacksonville, Elsie Street and Attlee Drive, in Belvedere Crescent and Airmyn Road/Parklands, alongside Kingsway and in the Millennium Way area.

YWS arranged for emergency pumps to be delivered and installed at Carr Lane PS to remove water from the sewer system and the flooded dry well. These overpumping operations commenced using two 8" pumps to pump from the dry well into the field to the west Carr Lane PS. The majority of this water eventually drained into the Goole & Airmyn IDB drains to the north.

This overpumping eventually reduced the water levels in the dry well sufficiently for work to be undertaken within the dry well to raise junction boxes and to access the storm pumps. Repair and recovery work continued until approximately 06:00 on the morning of 6th July when a second period of rainfall took place.

In isolation the rainfall on the 6th July was not particularly excessive, lasting only 15 minutes then reducing to light / moderate rainfall for much of the morning until clearing in mid-afternoon. Nevertheless, what followed was a second period of flooding that resulted in a further 241 flooding incidents reported to ERYC and an additional 47 recorded by HF&RS across the Goole area.

Many of the locations flooded on the 5th July were flooded again but to a higher level on the 6th July. This included properties on Parklands, Airmyn Road, Hook Road, Roche Drive and Belvedere Crescent.

When this period of rainfall took place on 6th July, YWS had not been able to replace the dislodged manhole cover. Consequently, when the capacity of the emergency pumps plus the operational permanent pumps was exceeded by the rainfall event, the pumping station flooded again.

Recorded water levels within the culverted Hook Drain increased from 06:00 on 6th July, though not as high as the previous day. Water levels also increased substantially within the Goole & Airmyn IDB drains and the pumps at the IDB's Southfield Lane PS were eventually switched off because water levels had risen sufficiently to prevent them working effectively.

YWS installed three 12" pumps at Carr Lane PS on the afternoon 7th July to replace the failed storm pumps. From this point onwards the water levels across Goole reduce and reports of flooding cease. These reductions in water level can be seen in telemetry data from Hook Clough PS and Hook Drain from 13:00 on 7th July onwards.

4.2 Carr Lane Pumping Station

4.2.1 Carr Lane FFT Pumpsets

There are four FFT pumpsets within Carr Lane PS designed to pump to Goole WwTW. However at the time of the flooding one of the FFT pumpsets was connected via temporary pipework to the storm pumpsets discharge manifold. This FFT pumpset was not connected to the YWS telemetry system and SCADA. There are no records within the telemetry data relating to the fourth FFT pumpset. The telemetry data is shown in Appendix C.

The telemetry data shows that one of the FFT pumpsets was running before the event. A second pump switched on just before 07:00 on 5th July when the water levels in the wet well rose from 40% to 65% full as a result of the rain earlier.

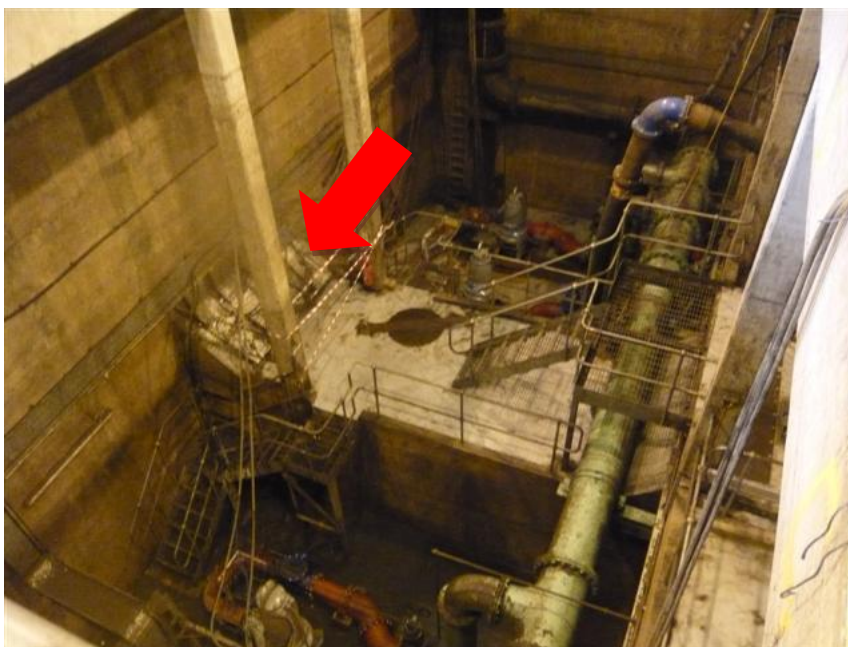


Figure 8 : Normal location FFT pumpsets junction boxes.

At approximately 14:15 and at the same time as the manhole cover becomes dislodged, the wet well water level in Carr Lane rose quickly to around the 95% level.

The telemetry data shows the two FFT pumpsets operating appropriately until just after the flooding of the dry well on 5th July after which they both stopped or failed in succession. These failures are understood to have been due to water ingress into the main junction boxes, where the power cables from each of the FFT pumpsets connect to the main power cables. These junction boxes were located within the dry well area as shown on the Figure 8.

YWS contractors attempted to relocate these junction boxes during the flooding event but were inhibited because of the length of cable from each of the FFT submersible pumpsets.

The telemetry shows that one of the FFT pumpsets was restarted at 19:47 on 5th July and it remained operational until 22:27. The same pump was reset and started again at 01:52 on 6th July, and telemetry records show it was running up to 03:45.

4.2.2 Carr Lane Storm Water Pumpsets

The four storm pumps are designed to operate when the inflow into Carr Lane PS exceeds the outflow rate of the FFT pumpset and the excess wastewater overflows into the storm wet wells.

Telemetry data shows the storm pumps were connected to SCADA and onto the YWS telemetry system.

At approximately 9:00 on 5th July the storm pumps operate in quick succession as the storm well water levels rise following the earlier rainfall. Various pumps switched on and. This is all as would be expected with a correctly working system in an automatic mode of operation.

The peak of the rainfall on the 5th July occurred around 13:00. An hour or so later the telemetry data shows that the storm pumps switch on again in quick succession and the storm wet well water levels rise to over 80% full.

At around 14:15 on 5th July a “bang” was heard by the contractors on site from within the dry well at Carr Lane PS. This “bang” was the sound of the cover over manhole B either coming out of its frame or the falling to the slab level within the dry well. Thereafter the contractors observed wastewater surcharging from the storm pump wet well into the main dry well through this manhole.



Figure 9 : Location of Manhole Cover B

Storm Pump 4 was running at this time and it continued to operate until 02:22 on the 6th July. Following the “bang” Storm Pump 2 was called into operation and started running at 14:13. Telemetry records show that from 15:09 this pumpset failed.

Storm Pump 3, which was standing ready to pump, was called to operate at 14:17 as the wet well levels rose. This pumpset subsequently failed at 14:39.

Storm Pump 1, which was also standing was called to run at 14:21 and immediately failed. At 14:25 Storm Pump 1 telemetry data shows an illegal status alarm. The telemetry itself can not show if the pumpset was running during this alarm state, which lasted until the morning of 8th July. When the pumpset was switched back from “illegal” it immediately recorded a failed status. YWS have stated that during this timeframe the pump was actually “put in-hand” and was operating.

Details of all the telemetry records can be found in Appendix C.

4.2.3 Manhole Cover B

Figure 10 below shows a typical manhole cover within Carr Lane PS, but not manhole cover B. The cover in the photograph has 8 holding down bolts correctly installed.



Figure 10: Typical manhole cover detail within Carr Lane PS

The following details have been confirmed by YWS and their contractors following the incident leading to the flooding of the dry well at Carr Lane PS:-

- 1) That there was no visible damage to manhole cover B after it was subsequently found in the dry well when the pumping station was eventually pumped out.
 - 2) There was no evidence of any corrosion on the cover or the cover frame associated with manhole B,
 - 3) There were no stripping of the threaded holes within the frame (or the manhole cover) of manhole B,
 - 4) That there was no evidence of any sheared bolts as a result of the failure of manhole B.
- YWS and their contractors have confirmed that there was no evidence of any bolts having been in the cover at the time.

Based on the available evidence the most probable failure mechanism is that manhole cover B was not bolted into its frame when the inflow of waters passed into the storm pump wet well and surcharged it to soffit level.



Figure 11 : Dry Well at Carr Lane PS flooded

4.2.4 Temporary Pumping, Remedial Repairs & Repeated Flooding of Dry Well

At around 19:20 on the 5th July YWS started tankering operations to extract flood water from Carr Lane PS dry well.



Figure 12 : Overpumping operations of the Carr Lane PS dry well

Following the initial flooding of the dry well, YWS arranged for two 8" temporary diesel pumpsets to be brought to the Carr Lane PS. These pumps were located at the front of the pumping station (see Figure 13) and commenced over pumping operations at 00.25 on the 6th July. Overpumping using the two 8" temporary diesel pumpsets continued as required until approximately 14:00 on the 7th July.



Figure 13 : Temporary
Selwood S200 pumpset

These pumps were fitted with 8" flexible pipe discharging into the field some 20m west of the pumping station. This operation was done following YWS's confirmation to the EA.

The effects of this overpumping on the land drainage system have not been examined in detail as part of this investigation. If significant volumes entered the land drainage system they would ultimately arrive at the IDB maintained Hook Clough PS. The discharge capacity of Hook Clough PS is more than three times that of the 8" temporary diesel pumpsets. Any additional flow volumes in the land drainage system would prolong the time for which drain levels were higher than normal. However this mechanism did not affect the flooding on the 5th and 6th of July.



Figure 14 :
Temporary 12"
pipework being laid
to River Ouse

ETM (YWS retained contractors at Carr Lane PS) were able to start undertaking repair works within the station's dry well once overpumping started on the 6th July. Initially ETM's efforts were focussed on the moving and drying out the flooded junction boxes that controlled the FFT pumpsets. An attempt was also made to repair one of the line shaft bearings on a storm pumpsets that had failed.

At this time it would have been possible to replace and bolt down the manhole cover that had come off.

Later on 6th July, three larger diesel driven pumpsets were also delivered to the Carr Lane site. ERYC provided support to YWS to install three parallel sets of 12" Bauer connected discharge pipework along the footpath to the south of the pumping station and across Westfield Lane discharging to the River Ouse. See Figure 14.

Once the pipework was completed, overpumping operations started using the three 12" temporary pumpsets to pump out Carr Lane dry well for a second time. The three 12" temporary diesel pumps were operational in the afternoon of Saturday, 7th July and thereafter discharged water directly to the River Ouse.

4.3 Goole Waste Water Treatment Works (WwTW)

The control functions that limits the maximum flow of the FFT pumps at Carr Lane PS was manually overridden to increase flows to Goole WwTW during the event. Consequently, flows above the EA consented level were delivered to Goole WwTW and the works experienced some overtopping.

The most probable drainage path for the overtopping water eventually discharges into Towns Drain North Central. This drain forms part of the network that ultimately feeds into the Hook Clough PS, operated by the Goole & Airmyn IDB.

4.4 Lock Hill Pumping Station

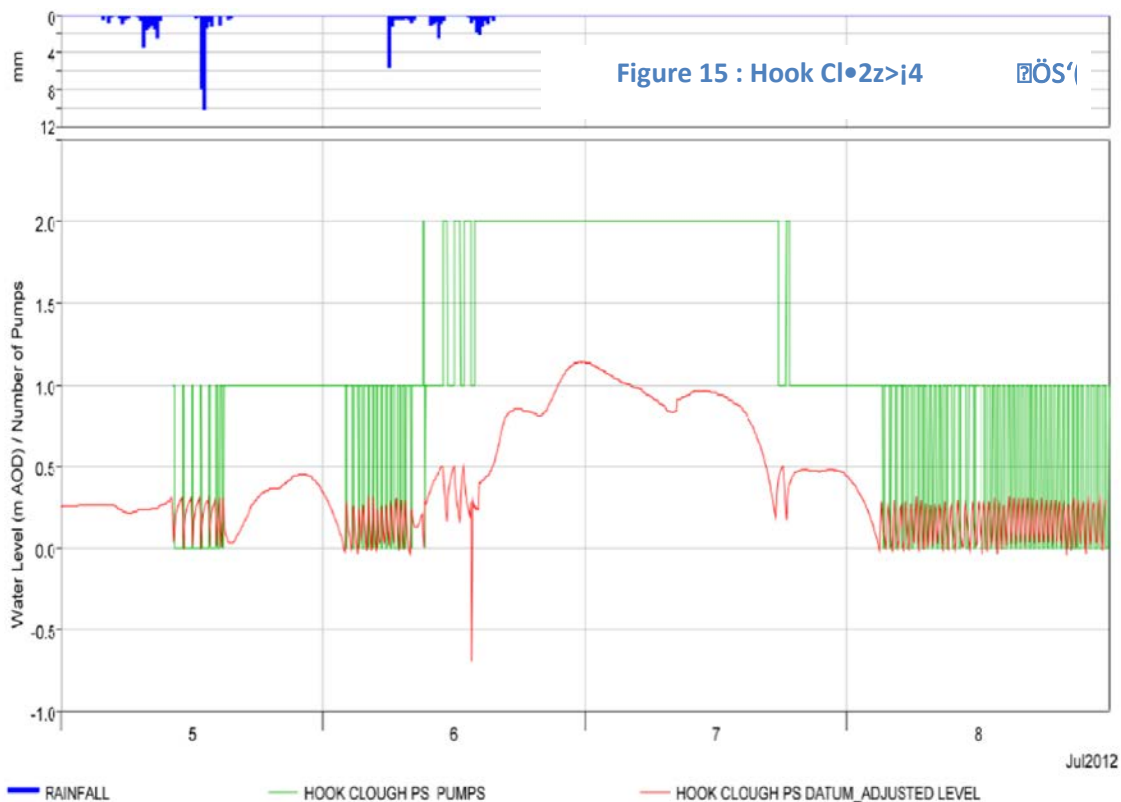
Under normal storm conditions the Lock Hill FFT pumpsets pump flows through to the Carr Lane PS catchment and the storm pumpsets operate as required to pump any water that overflowed into the storm wet well to the river.

YWS has advised that during this event the FFT pumpsets were manually isolated at around 19.00 of the 5th July. This prevented further flows passing into the combined sewer system downstream of the Sandhall Detention Tank and exacerbating localised flooding from 19:00 onwards. Prior to this, however, the operation of the Lock Hill FFT pumpsets contributed to the flow volumes and subsequent surcharging of the network in the areas south of the railway line around Millennium Way and Sandhall Drive.

4.5 IDB Pumping Stations

4.5.1 Hook Clough Pumping Station

The IDB's Hook Clough PS is situated to the north of Goole, in the vicinity of the M62 bridge over the River Ouse. Hook Clough PS is the principle means of discharging land drainage into the River Ouse for the area in which Goole lies and is a critical drainage asset. Discharge into the River Ouse is via a gravity system when the tide level allows or a pumped outfall when the gravity outfalls are drowned.



IDB telemetry data for Hook Clough PS (see Figure 15) shows that a pumpset started operating from around 09:45 on the morning of 5th July to manage water levels from the rainfall. The pumpset operated normally (i.e. oscillating on and off to maintain levels at 0.5m AOD or lower) except for a steady on period between 14:45 and 02:00 on the morning of 6th July.

At about 08:00 on 6th July a pumpset switched on in response to water levels that would not drop below the initial 0.3m AOD cut off point. This pumpset stayed operational until 09:15 when the two pumpsets swapped duty rotation.

A single pumpset ran continuously until the water level continued to rise above 0.5m AOD within the Hook Drain and a second pumpset operated. From 13:30 on 6th July, both pumpsets remain on until the evening of 7th July. During this period the water levels at Hook Clough PS rose to 1.14m AOD, peaking in the early hours of 7th July.

4.5.2 Southfield Pumping Station (Internal Drainage Board)

The IDB's Southfield Pumping Station is located in the east of Goole, adjacent to the railway line. Southfield PS has two submersible pumps that transfer water from riparian watercourses south of the railway and into the IDB drainage system north of the railway line.

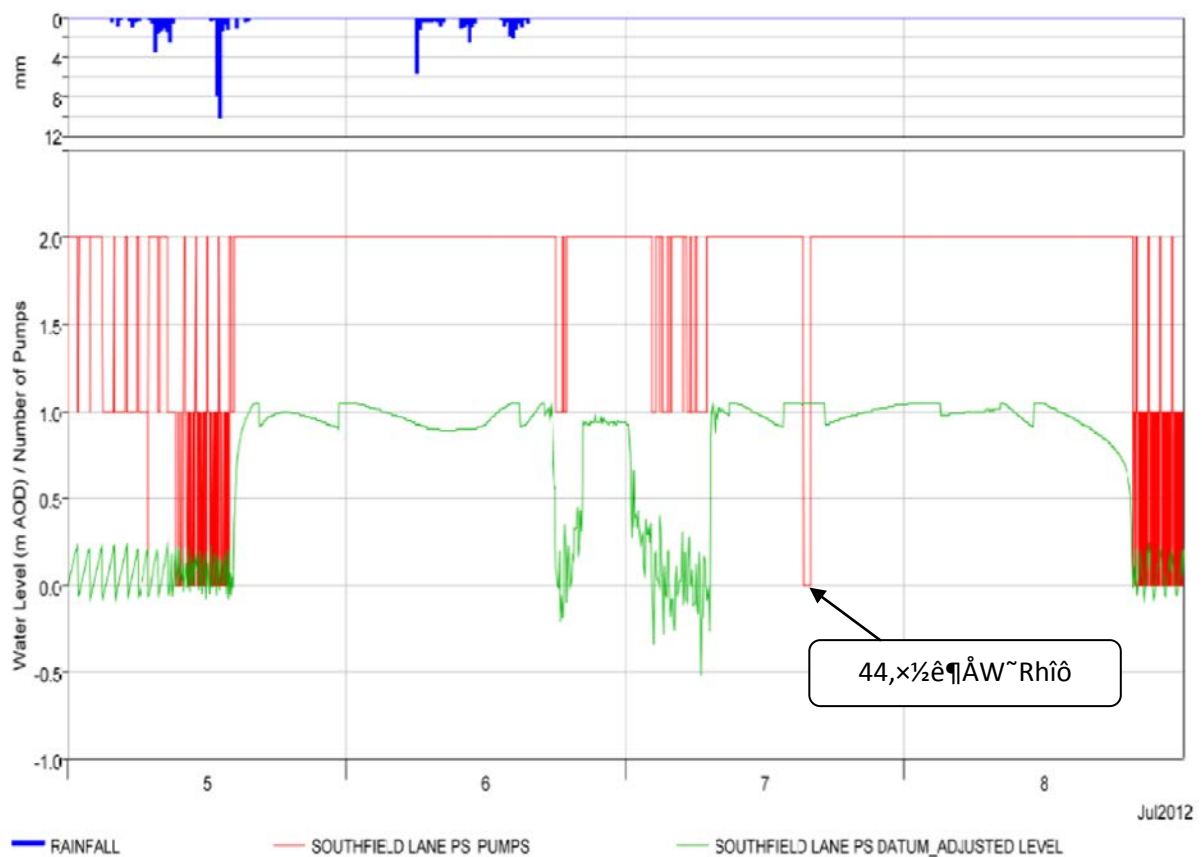


Figure 16: Southfield Lane PS data

IDB telemetry data for Southfield PS (see Figure 16) shows that the pair of 26 l/s pumpsets were operating normally in a regular saw-tooth pattern prior to the event.

At approximately 09:15 and in response to the first rainfall on the morning of 5th July, the speed of oscillation in the saw-tooth pattern increased. At this time typically only a single pump is working for one or two minutes before switching off. Occasionally, however, the second pump is also needed, but no more frequently than before the event.

From 14:00 on the 5th July both pumps stay on constantly to manage water levels locally. Water levels remained high until 17:45 on the 6th July but start rising again at approximately 20:30. At about midnight water levels dropped once again. Then from 07:17 on the morning of the 7th July water levels rose quickly and remain high until the next day.

On the 7th July water levels were so high in the receiving drains that the pumping station could not discharge; shown by the flat line in Figure 16 above. Consequently, to save energy the pumps were switched off at approximately 15:30 and it can be seen from Figure 16 that this made no difference to the levels in the pumping station.

Hydraulic modelling of the Goole & Airmyn IDB system shows that pumped water entering Hook Drain flows both east and west. Flows to the west are managed by Hook Clough PS, whilst flows to the east cause levels to increase in watercourses in the vicinity of Southfield Lane PS. Level increases in these receiving watercourses eventually prevent discharge from Southfield Lane PS.

4.6 Hook Drain

ERYC maintains a water level telemetry monitoring system in Hook Drain near Marlborough Avenue. The relevant data is shown in Figure 17 below.

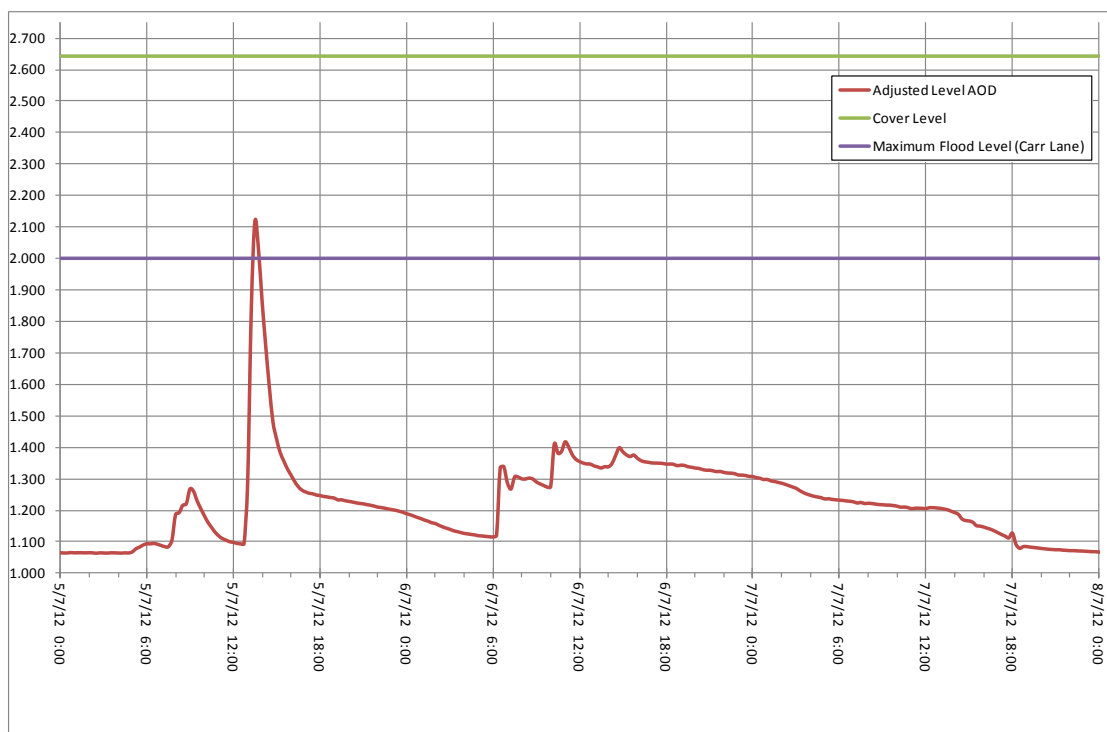


Figure 17 : Hook Drain telemetry data

The level records are from the southern extent of the culverted watercourse, in the centre of Goole, and in an area where it receives predominantly overland flow.

The data shows there was a small increase in water level in response to the early rainfall on 5th July. This was followed by a more prominent response around 07:30 shortly after the initial intense rainfall peak. The short response time and close correlation between rainfall and water level is as expected from a drain receiving runoff from a very urban area. Following this peak of 1.25m AOD at 09:00, water levels within Hook Drain gradually fell back to 1.12m AOD (slightly above normal levels).

Water drains from this culvert to the north via a flap valve into the Goole & Airmyn IDB's drains. It also drains to the south via a connection to a YWS combined sewer which in turn flows to YWS's Lock Hill PS.

Following the period of heavy rainfall that lasted for 30 minutes from 13:00 on the 5th July, the levels in the drain rose rapidly to a peak of 2.11m AOD. As ground levels are approximately 2.5m AOD in this area no flooding resulted from this rainfall. Once this period of intensive rainfall had ceased the levels dropped rapidly, reaching almost normal water levels of 1.1m AOD by 06:00 on 6th July.

The records for Hook Drain following the rainfall experienced on the 6th July again show a short response period typical of a highly urban run-off. Levels however only dropped back to normal gradually over an extended period. This is indicative of surcharge in the downstream system. The levels only drop to normal once the Hook Clough PS has cleared significant volumes by late afternoon on the 7th July.

The impact of downstream water levels and flow restrictions affects surcharging and flooding throughout the various drainage systems in the town.



Figure 18 : Flap valve installation at the northern end of Hook Drain

4.6.1 Slade Drain

The line of an historical field drain, known as Slade Drain, runs approximately parallel to Elsie Street and Colonel's Walk, as shown on Figure 22 in Appendix A. This field drain used to tie into Hook Drain and flow was originally to the south. Historical maps from 1891 to 1895 indicated the presence of a sluice at the junction with Hook Drain.

An investigation was carried out by ERYC to locate the Slade Drain. The investigation established that the drain had been piped along its course at the rear of Churchill Walk with an existing connection into the Hook Drain at Chiltern Rd.

The route of the upper length of the drain was identified between Elsie St and Jacksonville. Slade Drain runs under the front gardens of properties on Westfield Ave to the junction of Elsie Street / Westfield Avenue where there is a connection into the YWS combined sewer that flows north to Carr Lane PS.

The route of Slade Drain across Westfield Ave appears to have been abandoned at some time in the past and the investigation identified a collapsed section of culvert on this line.

Flooding occurred in this area during the July event and it is therefore recommended that this old field drain and its connections be investigated further to see if it is possible to restore a connection to the surface water drainage system rather than to the YWS sewer system.

4.7 Flooding at Westbourne Grove

Along Westbourne Grove about 40 properties experienced internal flooding on 5th July. When the flood water rose again on 6th July this area was flooded again. However on the 6th July this was mainly external flooding.

4.8 Flooding at Attlee Drive

Attlee Drive has been subject to recurring flooding incidents since the 1970s. The street is located off Pasture Road and average ground levels are some 500 mm lower than those at Pasture Rd. It is one of the lowest lying streets in the centre of Goole. As the capacity of the public sewer system serving this area is heavily dependent on the levels within the main sewer on Westfield Avenue the pumped outfalls at Carr Lane influence sewer surcharging during rainfall events.

YWS has acknowledged that there is a capacity issue within the public sewer that drains the Attlee Drive/Churchill Walk area. In recent years YWS has undertaken a regular programme of jet cleaning this sewer to maintain its operational efficiency.

Several properties in the Attlee Drive/Churchill Walk area were flooded internally on both the 5th and 6th July. However two properties only flooded on 6th July following the relatively routine rainfall that day.

4.9 Flooding at Elsie Street and Jacksonville

In the area of Elsie Street and Jacksonville 12 properties experienced internal flooding starting on 5th July. Several other properties in the area also experienced external flooding. This flooding persisted through the 6th July.

This area is served by an extensive system of combined, foul and surface water sewers that discharge into the main public sewer in Westfield Avenue.

4.10 Flooding at Millennium Way and Maple Drive

About 20 properties experienced internal flooding on both the 5th and 6th July.

The properties on Millennium Way and Maple Drive are significantly lower than the highway, and the threshold levels of some properties are only 300mm above the sewer soffit level. Sewers thus only require a slight surcharging before back-flowing into the property drainage network and causing flooding. This is exacerbated as the properties are built in a low spot that prevents flood water flowing along a preferable escape channel such as the public highway.

However it is unlikely that surcharging from Carr Lane PS had any effect in this area. As a higher risk area for flooding the highway gullies are more frequently cleaned and there is no indication that they contributed to the flooding here.

4.11 Other Flooded Areas

4.11.1 Flooding at Thirlmere Walk

There are no recorded instances of flooding at Thirlmere Walk following the main rainfall event on the 5th July. However, several properties in this area did experience external flooding on 6th July.

4.11.2 Flooding at Belvedere Avenue and Ilkeston Avenue

Records show that 10 properties experienced external flooding on the 5th July following the main rainfall event. On the 6th July, however, one of these properties also suffered internal flooding. Highway drainage issues can not be linked to this flooding.

4.11.3 Flooding at Parklands and Airymn Road

Five properties suffered internal flooding on both the 5th and 6th July in the Parklands and Airymn Road area. Records show that several additional properties suffered external flooding on 6th July.

4.11.4 Flooding at Grange Road

In the Grange Road area several properties suffered both internal and external flooding on 5th and 6th July. The investigation found no link between flooding in this area and Carr Lane PS, nor were highway drainage issues linked to this flooding.

4.11.5 Flooding at Marshfield Avenue / Kingsway

Many of the surface water sewers in this area drain to Lock Hill, however many of the combined sewers in the area discharge into the trunk sewer and on to Carr Lane PS. On the 5th July ten properties were flooded, six of which were flooded before the manhole was dislodged at Carr Lane PS. On 6th July a further six properties in the Marshfield Avenue and Kingsway area reported flooding for the first time.

4.11.6 Flooding at Ivy Park Road

Properties in Ivy Park Road reported external flooding after the rainfall events on 6th July.

4.11.7 Flooding at Centenary Road / Jackson Street

There were a number of defective gullies in this area over the 5th and 6th July. Properties on Jackson Street reported highway and internal flooding on the 5th. The flooding on Centenary Road occurred after the rainfall on the 6th July.

4.11.8 Flooding near the Clock Tower and central Goole

A number of flooding incidents were reported in the centre of Goole including internal flooding to properties and highway flooding. All these incidents followed the main rainfall event on the 5th July. This would indicate a combination of sewer capacity and gully defect issues.

4.11.9 Flooding in Old Goole and the Isolated Dock Area

These areas are drained by their own pumping stations and a number of properties reported flooded in these catchments. There were no defective gullies recorded in the area.

5 Conclusion

Widespread flooding occurred in Goole on 5th and 6th July following a series of notable but not exceptional rainfall events. The rainfall event that occurred on 5th July had a calculated return period of 1 in 9.4 years. The second period of rainfall took place in the early hours of 6th July which was less intense with a return period of 1 in 1 year. However, the cumulative rainfall that fell on Goole over the two days of the floods had a calculated return period of 1 in 20.8 years.

Flooding followed the storm on the 5th July. Despite the fact that the rainfall on the 6th July was relatively modest, it resulted in a considerable number of reported flooding incidents. A number of properties only reported flooding to ERYC or HF&RS following the rainfall on the 6th July.

The flooding in Goole on 5th and 6th July was widespread, with different factors affecting the various locations. Different factors including sewer capacity issues, defective highway gullies, and other specific local drainage problems were identified.

Investigations established that an unsecured manhole cover became dislodged at 14:15 on 5th July within the Carr Lane PS. This led to the flooding of the pumping station dry well, which in turn led to the failure of pumpsets at Carr Lane PS. This subsequently reduced the pumping capacity of Carr Lane PS which caused additional surcharging of the sewerage system that significantly added to the flooding in the town on the 6th July. The problems within Carr Lane PS had only a minor effect on the initial flooding in the town on the 5th July.

During the flooding event other YWS assets, including Lock Hill PS and the Sandhall Detention Tank operated as they were designed to do.

Following the flooding event YWS has undertaken considerable refurbishment and improvements works at the pumping station; investing over £4m to date. As a result the pumping capacity of Carr Lane PS has been increased and emergency overpumping arrangements have been put in place. Additionally YWS are producing a Drainage Area Study for Goole including building a detailed hydraulic model of the sewerage system, to help them direct future investment.

The land drainage infrastructure including Hook Clough PS, which is owned and operated by the Goole & Airmyn IDB, ran as it was designed to do throughout the flooding event.

This report has identified some actions and measures that should be considered to improve the flood resilience in Goole. These actions and measures are listed as recommendations in section 6.

6 Recommendations

6.1 YWS Drainage Area Study

Immediately prior to the July flooding event YWS contractors were undertaking repair, maintenance and improvement works at the Carr Lane PS. The effective operation of this terminal pumping station is critical for managing the pluvial flood risk within the Goole catchment.

The investigation has identified the possible throttling effects of the current entry configuration at Carr Lane PS as a contributing factor to surcharging effects within the sewer system. This in turn influences flooding within the town.

It is recommended that: YWS complete its Drainage Area Study of the Goole sewerage system (including Carr Lane PS) and use the finding to direct appropriate investment to improving the flood resilience for residents and businesses. Further, if the DAS identifies local capacity or other problems in the catchment, viable solutions should be developed by YWS and funding secured for them through their normal internal approval processes.

6.2 Attlee Drive area

The investigation has identified that the properties in the area of Attlee Drive, Churchill Walk and Kennedy Drive are particularly vulnerable to flooding exacerbated by surcharge in the public sewerage system. YWS is the flood risk management authority with principal responsibility for managing this source of flooding.

It is recommended that: YWS develop proposals for a specific localized flood resilience scheme at Attlee Drive to improve the capacity of the public sewerage system in the immediate area. If a viable proposal is developed YWS should look to secure funding for it through their normal internal approval / prioritisation processes.

6.3 Develop an integrated model

It is recommended that: the EA, ERYC, YWS and the Goole & Airmyn IDB work in partnership to complete an integrated drainage/catchment model for Goole and the local watercourses to identify weaknesses in the drainage system and to assist in the targeted development of future improvement schemes.

6.4 Measures to reduce surface water inflows to the sewerage system

Any measures that reduce the amount of highway or surface water drainage entering the YWS sewerage system will relieve pressure on the combined sewer system in the town. Such measures will reduce flows to Carr Lane PS, reduce surcharging locally and improve the flood resilience to rainfall events.

A number of specific options for removing surface water inflows from the combined sewer system were identified as part of this investigation:

6.4.1 Slade Drain

It is recommended that: the riparian owners re-commission the existing infrastructure of Slade Drain.

This will offer a degree of improvement for the area by removing surface water from the sewer system by reconnecting the upper length of Slade Drain across Westfield Avenue. This and other enhancements as necessary will enable surface water to be discharged from the Elsie Street / Jacksonville area into Hook drain. ERYC will investigate whether it can offer a level of assistance in the re-commissioning.

6.4.2 Parklands and Airmyn Road

It is recommended that: ERYC review the option of connecting the highway surface water drainage system at Parklands and Airmyn Road into the existing riparian land drainage system serving West Park.

This will reduce the amount of highway drainage entering the YWS sewerage system and relieve pressure on the combined sewer system in the area.

6.4.3 Hook Drain

It is recommended that: ERYC and Goole & Airmyn IDB assist the riparian owners to investigate the feasibility of splitting Hook Drain at Thorntree Lane and Malborough Avenue.

This will enable surface water to drain from the public sewer in flood conditions. This could reduce the volume of water discharging into the public sewer system and push the water north into the IDB open ditch section of Hook Drain system.

6.5 Highway gully repair works

Although the number of highway gullies cleaned prior to the July 2012 event was higher than any previous event, a very small number of gullies were not operating correctly.

It is recommended that: ERYC instigate a programme of repairs to the defective assets.

6.6 Riparian gully repair works

There are a large number of privately owned gullies and similar drainage points that are not recorded throughout Goole. The number of privately owned gullies blocked or defective has not been established and responsibility for their maintenance rests with riparian owners.

It is recommended that: Private gully owners instigate a programme of repairs to their defective assets.

6.7 Water level management

It is recommended that: the EA and Goole & Airmyn IDB undertake a review of the operation of the land drainage system to ensure that Hook Drain water levels can be maintained in the lowest possible level.

By providing as greater catchment storage volume as possible the flood risk in the urban catchment can be reduced. The required pump capacity of Hook Clough PS could also be affected by other recommendations in this report.

6.8 Further Overview and Scrutiny

It is recommended that: ERYC's Overview and Scrutiny Committee invites the relevant flood risk management authorities back, 12 months after the publication of this report, to scrutinise the progress made on the recommendations and the management of flood risk within Goole.

7 Contact Details

Requests for information shall be from the following authorities :-

Lead Local Flood Authority

East Riding of Yorkshire Council

County Hall
Cross Street
Beverley
East Yorkshire
HU17 9BA

Contact: Michael Metzler, Assistant Principal Engineer, Tel.: 01482 887700

www.eastriding.gov.uk
land.drainage@eastriding.gov.uk

Statutory Sewerage Undertaker

Yorkshire Water Services Ltd

Western House,
Halifax Road
Bradford
BD6 2SZ

0845 1 242424
www.yorkshirewater.co.uk

Internal Drainage Board

Goole & Airmyn IDB

Lower Aire & Don Consortia of Drainage Boards
Halcyon House
Landing Lane
Newport
Brough
HU15 2RU

01430 441765
<http://www.loweraire-idbs.org.uk/board.php?boardid=3>
loweraire@googlemail.com

Environment Agency

Environment Agency

General Enquiries 08708 506506 (Mon-Fri, 8am - 6pm)
Incident Hotline 0800 807060 (24hrs)

www.environment-agency.gov.uk

8 Website Addresses

Flood & Water Management Act 2010:

<http://www.legislation.gov.uk/ukpga/2010/29/contents>

Land Drainage Act 1991:

<http://www.legislation.gov.uk/ukpga/1991/59/contents>

Water Resources Act 1991:

<http://www.legislation.gov.uk/ukpga/1991/57/contents>

Highways Act 1980:

<http://www.legislation.gov.uk/ukpga/1980/66/contents>

EA - 'Living on the Edge' a guide to the rights and responsibilities of riverside 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>

Appendix A : Plans and Maps

This appendix contains the following plans and maps referred to within the report:-

Figure 19 : Plan of flooded areas

Figure 20 : Plan of Major urban drainage infrastructure

Figure 21: Plan of main land drainage drains

Figure 22 : Historic map showing Slade Drain

Figure 19 : Plan of flooded areas

Figure 20 : Plan of Major urban drainage infrastructure

Figure 21: Plan of main land drainage drains

Figure 22 : Historic map showing Slade Drain

Appendix B : Timeline – July 2012 Flooding

Date / Time	Observation	Source
1st January 2012 to 30th June 2012	ERYC Lock Hill rain gauge records 350.2mm of rainfall with peaks of more than 125mm in April and 105mm in June.	ERYC
1st January 2012 to 30th June 2012	Carr Lane PS rain gauge records 195.2mm of rainfall in the year to the end of June, approximately 55% of that recorded at Lock Hill.	YWS
June 2012	Environment Agency provisionally record June 2012 as the wettest on record.	EA
July 1st to July 4th	Lock Hill rain gauge records 4mm of rainfall, mainly on the 2nd July. Carr Lane PS rain gauge records 8.6mm of rainfall, mainly on 4th July.	EYRC, YWS
July 5th 03:30	Radar data indicates that light rain starts (Cell 101).	Met Office (MO)
July 5th 03:45	Approximate time of low tide at Goole.	
July 5th 03:45	Rain gauge at South Elmsall indicates light rain starts.	EA
July 5th 04:00	Radar data indicates that light rain starts (Cells 85, 86 and 101).	MO
July 5th 04:15	Rain gauge at Broomfleet indicates light rain starts.	EA
July 5th 05:00	Water levels within Hook Drain started rising from a level of 1.067m in response to the earlier rainfall.	EYRC
July 5th 07:15	Storm wet well level gradually rises to approximately 50% then fluctuates.	CLT
July 5th 07:45	Radar data indicates that rainfall intensity peaks (Cells 85, 86 and 101).	MO
July 5th 08:00	Storm wet well levels drop but then start rising.	CLT
July 5th 08:35	Approximate time of high tide at Goole.	
July 5th 08:45	Radar data indicates that rainfall intensity peaks (Cell 102).	MO
July 5th 09:00	Water levels peaked at 1.269m within Hook Drain. They quickly drop to 1.096m.	EYRC
July 5th 09:18	Southfield Lane PS, one pumpset oscillates between on and off.	IDB
July 5th 09:30	Radar data indicates that rainfall stops (Cells 85, 101 and 102).	MO
July 5th 10:00	Hook Clough PS, one pumpset oscillates between on and off.	IDB
July 5th 10:30	Storm wet well level reaches 100%.	CLT
July 5th 10:45	Call in due to low flow alarm at Carr Lane PS, SBU attended.	ETM
July 5th 11:00	FFT Pumps 2 and 3 briefly switch off again as level in wet well drops back to 65%. In the next two hours they either both or one switches on and off a number of times but wet well level remains at 65%.	CLT
July 5th 11:00	Call in due to laser levels on the screen compactor, SBU still on site.	ETM
July 5th 12:15	Radar data indicates that light rainfall starts (Cells 85, 86, 101 and 102).	MO
July 5th 12:41	Goole rain gauge struck by lightning and data becomes unreliable.	EYRC

Date / Time	Observation	Source
July 5th 12:45	Water levels drop to 1.096m within Hook Drain.	EYRC
July 5th 13:00	Radar data indicates that rainfall intensity peaks (Cells 85, 101 and 102).	MO
July 5th 13:00	ETM's contractor, SBU, still on site and noted start of storm with lightning and torrential rain.	ETM
July 5th 13:15	Radar data indicates that rainfall intensity peaks (Cell 86).	MO
July 5th 13:30	Water levels peaked at 2.118m within the Hook Drain. They quickly and constantly fall until 06:00 on July 6th.	EYRC
July 5th 14:00	Goole & Airmyn IDB note the start of the thunderstorm.	IDB
July 5th 13:52	FFT Pump 2 switches on. Wet well levels increase over the hour to 95%.	CLT
July 5th 14:00	Storm wet well level rapidly increases to 80%.	CLT
July 5th 14:10	Storm Pump (SP 4) switches on.	CLT
July 5th 14:13	Storm Pump (SP 2) switches on.	CLT
July 5th 14:15	'Bang' heard by staff (SBU) at Carr Lane PS, which has subsequently been put down to the cover 'blowing' when water was observed surcharging out of Manhole B. Carr Lane PS floods for the first time.	ETM
July 5th 14:17	Storm Pump (SP 3) switches on. Dry well levels remain at approximately 85%.	CLT
July 5th 14:21	Storm Pump (SP 1) operates and immediately fails.	CLT
July 5th 14:22	Water levels at Southfield Lane PS rise rapidly. Both pumps switch on permanently	IDB
July 5th 14:25	Storm Pump (SP 1) indicating an 'illegal' status.	IDB
July 5th 14:30	Flooding reports start relating to highways and properties.	EYRC
July 5th 14:30	Hook Drain flow monitoring indicates that the system locally is surcharged momentarily.	EYRC
July 5th 14:39	Storm Pump (SP 3) fails.	CLT
July 5th 14:40	FFT Pump 3 fails.	CLT
July 5th 14:51	FFT Pump 2 switched to 'illegal' status	CLT
July 5th 14:56	Hook Clough PS, one pumpset switches on permanently.	IDB
July 5th 15:09	Storm Pump (SP 2) fails.	CLT
July 5th 15:30	Councillor Moore receives call about flooding from a Hook resident who had reported it to YWS.	EYRC
July 5th 16:00	Goole Town Councillor Harrison sees workmen at Carr Lane PS. and notes pumps are audibly in operation.	Goole Town Council
July 5th 16:30	Approximate time of low tide at Goole.	
July 5th 16:45	Radar data indicates that rainfall stops (Cells 85, 101 and 102).	MO
July 5th 17:00	Councillor Harrison sees YWS emergency pump arrive at Carr Lane PS. It is approximately this time that ERYC became aware of the issues at Carr Lane PS.	GTC
July 5th 18:20	Dry well levels start to rise and within the hour are close to 100%.	CLT / ETM
July 5th 19:00	YWS records the manual isolation of all FFT pumpsets at Lock Hill PS.	YWS

Date / Time	Observation	Source
July 5th 19:10	Wet well levels still 95%.	CLT
July 5th 19:16	FFT Pump 2 switched back from 'illegal' status and immediately records a 'failed' status.	
July 5th 19:19	FFT Pump 3 reset and immediately fails.	CLT
July 5th 19:20	YWS started above ground tankering operations from Carr Lane PS.	YWS
July 5th 20:00	Storm wet well levels drop suddenly but return to previous levels just as quickly.	CLT
July 5th 20:30	Storm wet well levels drop to approximately 55% but twice rise to 70%.	CLT
July 5th 20:35	Approximate time of high tide at Goole.	
July 5th 22:00	Tankers are noted arriving at Carr Lane PS. YWS confirm to ERYC that they are working on a problem.	EYRC
July 5th 23:00	Wet well levels still 95%.	CLT
July 5th 23:30	Storm wet well levels rise again to 80% then again to nearly 100% at 01:00 on 6th July.	CLT
July 6th 00:25	YWS start overpumping operations to attempt to drain the Carr Lane PS dry well.	YWS
July 6th 01:45	Wet well levels briefly drop to 0%. Wet well levels fluctuate over next 5 hours.	CLT
July 6th 02:00	Hook Clough PS, one pumpset oscillates between on and off.	IDB
July 6th 02:22	Storm Pump (SP 4) stops.	CLT
July 6th 03:13	FFT Pump 3 switched to 'illegal' status.	CLT
July 6th 04:30	Approximate time of low tide at Goole.	
July 6th 06:00	Radar data indicates that light rainfall starts (Cells 86, 101 and 102).	MO
July 6th 06:00	Dry well levels rise again to 100%.	CLT
July 6th 06:15	Radar data indicates that rainfall peaks (Cells 85, 86, 101 and 102).	MO
July 6th 06:30	Flooding of Carr Lane PS occurs for the second time, staff evacuated from dry well.	ETM
July 6th 07:00	Water levels in the wet well still fluctuating but then they rise at 07:30 to 95%.	CLT
July 6th 07:07	ERYC records flooding in the area around Carr Lane PS with water surcharging from low points in the sewer system.	EYRC
July 6th 08:05	Approximate time of high tide at Goole.	
July 6th 09:20	Hook Clough PS, one pumpset switches on permanently, second oscillates on and off as required.	IDB
July 6th 11:00	Councillor Moore notes Attlee drive under 2 ft of water.	EYRC
July 6th 11:45	Dry well levels fluctuating at about 80% full.	CLT
July 6th 12:00	Water levels in wet well have fallen to a level of approximately 85%.	CLT
July 6th 13:36	Hook Clough PS, both pumpsets switch on permanently.	IDB
July 6th 16:00	Radar data indicates that rainfall stops (Cells 85, 86, 101 and 102).	MO
July 6th 17:15	Approximate time of low tide at Goole.	
July 6th 17:45	Southfield Lane PS water level drops.	IDB

Date / Time	Observation	Source
July 6th 18:30	Westminster Court area flooded to approximately 2.5ft deep.	EYRC
July 6th 19:29	Last record of flooding received.	HF&RS
July 6th 20:00	Dry well levels start to fall.	CLT
July 6th 20:30	Southfield Lane PS water level increases.	IDB
July 6th 21:20	Approximate time of high tide at Goole.	
July 7th 00:30	Southfield Lane PS water level drops.	IDB
July 7th 07:17	Southfield Lane PS water level increases again.	IDB
July 7th 15:30	Southfield Lane PS switched off.	IDB
July 7th 17:31	Hook Clough PS, one pumpset remains on permanently, second oscillates on and off as required.	IDB
July 7th 18:31	Hook Clough PS, one pumpset remains on permanently.	IDB
July 8th 03:00	Hook Clough PS, one pumpset oscillates between on and off.	IDB
July 8th 03:58	Storm Pump (SP 1) switched back from 'illegal' status and immediately records a 'failed' status.	CLT

Appendix C : Carr Lane PS – Telemetry Data

Appendix D : Plan of Carr Lane PS

Appendix E : Gulley Fault Log for Goole

Street/Road Name	Landmark/Reference	Date defected	Cars	Fast Lid	Broken Lid	Blocked Outlet	Dig Out Rqd
Queensway Acc Rd	n/a	13/02/2012				1	
Acc Rd between	24, 58	13/03/2012			1		
Acc Rd between	Dunhill Rd/ Parliament St - 39	13/03/2012			1		
Acc Rd between	Parliament St/ Carter St - 45	13/03/2012		1			
Acc Rd between	Jefferson St/ Gordon St - 33	13/03/2012			1		
Acc Rd between	Gordon St/ Montague St - 25	13/03/2012					1
Acc Rd between	Milton St/ Byron St - 16	13/03/2012		1			
Acc Rd between	Milton St/ Byron St - 28	13/03/2012			1		
Weatherhill Street Acc Rd	Weatherhill St/ Jackson St - 45	13/03/2012			1		
Cecil Street Acc Rd	x2 50	13/03/2012			1		
Cobbler Hill	2	10/04/2012	1				
Hood Grove	4	10/04/2012	1				
Charles Drive	59	10/04/2012	1				
Gatesby Road	35-37	10/04/2012		1			
Whincroft Avenue	12	10/04/2012	1				
Whincroft Avenue	54-18-15	10/04/2012				1	
Nab Drive		10/04/2012					
Westfield Square	46266	10/04/2012	1				
Westfield Square	42	10/04/2012			1		
Beaumont Court		10/04/2012					
Epsom Avenue	51	10/04/2012	1				
Epsom Avenue	6	10/04/2012				1	
Western Road	o/s 11-29-39-43D-123-142-62	11/04/2012	1				
Western Road	o/s 141	11/04/2012					1
Western Road	o/s 160	11/04/2012					1
Airmyn Road	Service Rd o/s The Vikings	11/04/2012	1				
Airmyn Road	Service Rd o/s 70B	11/04/2012			1		

Street/Road Name	Landmark/Reference	Date defected	Cars	Fast Lid	Broken Lid	Blocked Outlet	Dig Out Rqd
Westfield Avenue	36-30 (SR Newsagents)	12/04/2012	1				
Jacksonville	5-14- opp L/post 01	12/04/2012	1				
Rutland Road	72-50-36	12/04/2012	1				
Rutland Road	01 (SR) 64	12/04/2012				1	
Carrfields	Rear of no 2	12/04/2012				1	
Newclose Lane	10	12/04/2012				1	
Mount Pleasant Road	88-4-7-19	12/04/2012	1				
Mond Avenue	20 (SB)15	12/04/2012	1				
Pasture Avenue	19	12/04/2012	1				
Sundrew Avenue	1	13/04/2012	1				
Butterbur Drive	15-20-6	13/04/2012	1				
Brough Street	19-29-37-42	13/04/2012	1				
Churchill Walk	9	13/04/2012	1				
Ilkeston Avenue	110-100-92-76	16/04/2012	1				
Ilkeston Avenue	35	16/04/2012					1
Ilkeston Avenue	35	16/04/2012			1		
Northway	11-25-33-opp36-opp44 - opp50	16/04/2012	1				
Northway	26	16/04/2012					1
Belvedere Crescent	Opp 4	16/04/2012	1				
Belvedere Crescent	44	16/04/2012					1
Belvedere Crescent		16/04/2012					
Eton Road	8	16/04/2012	1				
Winsor Drive	21	16/04/2012				1	
Devonshire Drive	9	16/04/2012					1
Red Lion Street	Gas Corner	17/04/2012				1	
Oxford Road	38	17/04/2012	1				
Oxford Road	61	17/04/2012		1			
Murham Avenue	45748	17/04/2012	1				
Kingsway	70-59-6-opp 47	18/04/2012	1				
Lime Tree Avenue	77	18/04/2012				1	
Lime Tree Avenue	2	18/04/2012					1
Montague Street	5-opp 24	18/04/2012	1				

Street/Road Name	Landmark/Reference	Date defected	Cars	Fast Lid	Broken Lid	Blocked Outlet	Dig Out Rqd
Lower Bridge Street	o/s West Dock Shed 22	18/04/2012				1	
Stanhope Street	o/s Vision Night Club	18/04/2012				1	
Elsie Street	o/s Londis Shop L/post 16	19/04/2012				1	
Elsie Street	102-40-67-115	19/04/2012					1
Elsie Street	32-18-01	19/04/2012	1				
Newland Road	21	19/04/2012				1	
Newland Road	41420	19/04/2012	1				
Gordon Street	25	20/04/2012		1			
Gordon Street	8 - o/s Goole Times	20/04/2012	1				
Gordon Street	o/s 69 and 4 x marked yellow	20/04/2012				1	
Moorland Road	12B-L/post 7-22-34-86-81	20/04/2012	1				
Moorland Road	52-68-76-82-61-L/P 14-L/P 3	20/04/2012				1	
Moorland Road	60	20/04/2012				1	
Moorland Road	L/Post 14	20/04/2012		1			
Park Avenue	8	23/04/2012	1				
Shaftesbury Avenue	45	23/04/2012	1				
Grosvenor Avenue	37559	23/04/2012	1				
Lansdown Road	6	23/04/2012	1				
Chiltern Road	38-53	23/04/2012	1				
Chiltern Road	49	23/04/2012					1
Colonels Walk	o/s 40 Chiltern Road	23/04/2012		1			
Colonels Walk	62-16A-L/P 01-15-25-55-69	23/04/2012	1				
Colonels Walk	Opp40 Chiltern Road-52 (debris)	23/04/2012				1	
Centenary Road	5-35-147-opp L/P 8	23/04/2012	1				
Centenary Road	Opp 114	24/04/2012				1	
Centenary Road	Opp 82, opp 138, opp 146	24/04/2012			1		
Centenary Road	Opp 147	24/04/2012		1			
Centenary Road	Opp 98	24/04/2012				1	
Cambridge Avenue	18	24/04/2012					1
Airmyn Avenue	8	24/04/2012					1
Cheviot Avenue	o/s no6	24/04/2012					
Victoria Street	Old post office - opp 42-o/s	25/04/2012	1				

Street/Road Name	Landmark/Reference	Date defected	Cars	Fast Lid	Broken Lid	Blocked Outlet	Dig Out Rqd
	42						
Jefferson Street	7-31-45-16-6-o/s Hargreaves	25/04/2012	1				
Jefferson Street	89	25/04/2012				1	
West Street	28	25/04/2012	1				
Adeline Street	Opp81- o/s 74-32-23-71-81	25/04/2012	1				
Adeline Street	Opp81-o/s74-32-20-23-29-71-81	25/04/2012	1				
Amy Street	1	25/04/2012	1				
Laura Street	Opp L/post 3	25/04/2012	1				
Carlise Street	66-72	26/04/2012	1				
Carlise Street	61	26/04/2012			1		
Carlise Street	o/s museum on rbt - 87-opp 52	26/04/2012				1	
Marlborough Avenue	21-24	26/04/2012	1				
Marlborough Avenue	58-10	26/04/2012		1			
Marlborough Avenue	70	26/04/2012				1	
Malvern Road	68-17-51-83	26/04/2012	1				
Malvern Road	1	26/04/2012				1	
Malvern Road	31	26/04/2012					1
Pentland Avenue		26/04/2012					1
Cotswold Avenue	41275	26/04/2012	1				
Mendip Avenue	19	26/04/2012				1	
Parliament Street	1A-24-opp 1A	27/04/2012	1				
Parliament Street	34	27/04/2012					1
Parliament Street	34	27/04/2012				1	
Burlington Crescent	L/P 11-Elite Fitness-opp Singp. Sams-40-36-30	27/04/2012	1				
Burlington Crescent	The Landing Strip	27/04/2012			1		
Burlington Crescent	Opp44	27/04/2012					1
Coniston Way	33-26	30/04/2012					1
Thirlmere Walk	1	30/04/2012	1				
Roche Drive	41461	30/04/2012					1
Mayfield	20	30/04/2012					1

Street/Road Name	Landmark/Reference	Date defected	Cars	Fast Lid	Broken Lid	Blocked Outlet	Dig Out Rqd
Ullswater Grove	13	30/04/2012	1				
Ullswater Grove	2	30/04/2012	1				
Estcourt Terrace	Gotch's Store	30/04/2012		1			
Estcourt Terrace	o/s police station x 2	30/04/2012	1				
St John's Street	o/s 01 (J Puntons)	01/05/2012	1				
Thorntree Lane	25	01/05/2012	1				
Thorntree Lane	5	01/05/2012					1
Thorntree Close	10	01/05/2012	1				
Jackson Street	118-62-107-131	02/05/2012	1				
Jackson Street	2	02/05/2012		1			
Jackson Street	o/s Layburn Tools - 85 - 95	02/05/2012				1	
Jackson Street	85	02/05/2012					1
Queens Close	Opp Class Cleaners	02/05/2012				1	
Stanley Street	Flast 25 & 13	02/05/2012	1				
Gouvernement Street	2,	02/05/2012				1	
Estcourt Street	Car park	02/05/2012					
Aire Street	o/s 37 - Taste of China	03/05/2012	1			1	
Aire Street	o/s Walthams	03/05/2012				1	
Adam Street	L/P 02	03/05/2012		1			
Cross Street	M.O.T Station	03/05/2012				1	
Chapel Street	o/s R.A.O.B Club	03/05/2012					1
Marcus Street	81A-Opp81A-o/s Scouts	03/05/2012	1				
Marcus Street	Opp L/P 9-o/s L/P 11-25-opp80	03/05/2012				1	
Marcus Street	Opp 20	03/05/2012					1
Henry Street	12 - L/P 01 - o/s 5-33-41-45-57	03/05/2012	1				
Henry Street	46-21	03/05/2012					1
Henry Street	21,	03/05/2012				1	
Carter Street	68-30-27-37-65	03/05/2012	1				
Carter Street	59-77	03/05/2012					1
Carter Street	77,	03/05/2012				1	
Carter Street	16,	03/05/2012			1		

Street/Road Name	Landmark/Reference	Date defected	Cars	Fast Lid	Broken Lid	Blocked Outlet	Dig Out Rqd
Elm Avenue	13-26-14	03/05/2012	1				
Elm Avenue	37,	03/05/2012					1
Newport Street	Opp31 - o/s45-59	03/05/2012	1				
Newport Street	7,	03/05/2012				1	
Clifton Gardens	Opp The Moorings. o/s Guide HQ-Valletta-28-4	03/05/2012	1				
Calder Street	o/s Morgan & Quinn	04/05/2012	1				
Calder Street	o/s The Jail House P.H.	04/05/2012				1	
Weatherill Street	o/s 84-68-opp22, o/s 75	04/05/2012					1
Weatherill Street	o/s 58	04/05/2012					1
Weatherill Street	Junc of Wilco Motosave-o/s35	04/05/2012				1	
Weatherill Street	Opp Wilco fitting bay	04/05/2012				1	
Milton Street	Opp 34	04/05/2012	1				
Milton Street	o/s 22	04/05/2012					1
Tennyson Street	Opp 33	04/05/2012		1			
North Steet	o/s 52	04/05/2012	1				
North Steet	Opp Burlington House	04/05/2012				1	
Alexandra Street	o/s 53-23	04/05/2012	1				
Bartholomew Avenue	Opp L/P 4	04/05/2012	1				
Bartholomew Avenue	At L/p 4	04/05/2012					1
Edinburgh Street	69-83-95-72-Opp 53	08/05/2012	1				
Edinburgh Street	o/s Flat no 97	08/05/2012				1	
Ivy Park Road	25,	08/05/2012					1
Broom Park Road	25,	08/05/2012	1				
Broadway	40-21	08/05/2012				1	
Broadway	7,	08/05/2012	1				
First Avenue	L/Post 01	09/05/2012	1				
First Avenue	Acc Rd - Opp78, opp90, opp92	09/05/2012				1	
Third Avenue	o/s 15	09/05/2012	1				
Third Avenue	o/s 5	09/05/2012					1
Cross Street West	Opp L/Post 3 x2	09/05/2012				1	

Street/Road Name	Landmark/Reference	Date defected	Cars	Fast Lid	Broken Lid	Blocked Outlet	Dig Out Rqd
Kent Road	o/s 56, 9, 17 & 39	09/05/2012	1				
Kent Road	o/s 2 & 55	10/05/2012					1
Hook Road	Opp 121	10/05/2012					1
Hook Road	Opp 121	10/05/2012				1	
Lime Tree Avenue	129, 101, 53, 52, 58	10/05/2012	1				
Lime Tree Avenue	L/post 22, opp 163	10/05/2012	1				
Lime Tree Avenue	74, 90	10/05/2012	1				
Lime Tree Avenue	21, 24	10/05/2012				1	
Lime Tree Avenue	104,	10/05/2012					1
Lime Tree Avenue	Olive Hunts	11/05/2012			1		
Lime Tree Gardens	68, 5	11/05/2012	1				
Second Avenue	14,	11/05/2012	1				
Forth Avenue	1, 15, 22, 2	11/05/2012	1				
Fifth Avenue	7, 64, 38, 22	11/05/2012	1				
Fifth Avenue	56, 46	11/05/2012					1
Queens Way	59, 45, 17, 48, Opp 1	11/05/2012	1				
Wentworth Drive	At L/post 11 amd o/s no 11	11/05/2012					1
Total			85	13	14	45	37

SCE&ç



East Riding of Yorkshire Council, County Hall, Cross Street, Beverley, East Yorkshire HU17 9BA