



North Yorkshire
County Council

Flood Investigation Report Knaresborough



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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 the plans for clarity.

Purpose

This document has been prepared specifically for the purpose of meeting the requirements of Section 19 of the Flood and Water Management Act 2010.

The purpose of this report is to investigate which Risk Management Authorities (RMAs) had relevant flood risk management functions during the flooding incident, and whether the relevant RMAs have exercised, or propose to exercise, their risk management functions (as per section 19(1) of the Flood and Water Management Act 2010). It does not address wider issues beyond that remit, nor include recommendations for future actions.

The supporting data has been put together based on records of internal property flooding and road closure information from a variety of sources. While every effort has been made to verify the locations of the Section 19s identified, the nature of the data and the methods used to collate this information mean that it does not include every occurrence of flooding. This data only identifies where flooding has been reported and is indicative only.

Acknowledgements

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North Yorkshire County Council Flood Risk Management Team

North Yorkshire County Council Highways Department

North Yorkshire County Council Emergency Planning Unit

The Environment Agency

Yorkshire Water Services Ltd

Harrogate Borough Council

Knaresborough Flood Committee

Site Inspection: Thursday 8th September 2016

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1 Executive Summary

On the 26th of December 2015, flooding from the River Nidd associated with Storm Eva inundated a significant number of properties in Knaresborough.

Widespread and substantial rainfall had fallen over West and North Yorkshire in late December 2015. In this event, rainfall in the middle reaches of the catchment was proportionately more significant than over the Pennines, and this pattern of rainfall had particular consequences for communities in the Nidd catchment area, both in terms of the scale of flooding and the lead times available for issuing warnings.

Data shows that in November 2015 the Nidd Catchment was third wettest November since 1909. In addition the Nidd catchments received approximately three times the December Long Term Average rainfall before the rain started to fall again on Christmas Day and Boxing Day.

The rainfall event that occurred between the 23rd to the 26th December 2015 was characterised by two distinct rainfall systems. The rainfall which caused the flooding at Knaresborough was brought on by the second rainfall system on the 25th and 26th December.

Flooding occurred and caused internal damage to properties in the central and eastern areas of Knaresborough on 26th December 2015. The areas affected are predominately located alongside the banks of the River Nidd. In central Knaresborough properties flooded along Waterside and Abbey Road as the River Nidd overflowed its banks between the A59 to the A658. In Eastern Knaresborough flooding was caused by high water levels in both the River Nidd and its tributary (The Rampart) which affected properties at Riverside Park and Nidderdale Park.

The flooding mechanisms during the event were:

- Heightened river levels in the Nidd causing the river to over top and inundate properties.
- A number of properties may have been affected by surface water run-off caused by the heavy rainfall events and associated overwhelming of drainage systems.

This report has identified the actions and responses of the Risk Management Authorities who have responsibilities during a flood event in the Knaresborough area. It is understood that all Risk Management Authorities have undertaken appropriate activities in response to the flood event, in line with their duties and responsibilities under the Flood and Water Management (2010) Act.

2 Introduction

2.1 Flood and Water Management Act (2010)

In his review of the summer 2007 floods, Sir Michael Pitt recommended that local authorities should be given a duty to investigate flooding.

The Flood and Water Management Act 2010 (FWMA), defines the roles and responsibilities of 'Risk Management Authorities' and designates the unitary or upper tier authority for an area as Lead Local Flood Authority (LLFA).

The LLFA has responsibility for leading and co-ordinating local flood risk management. Local flood risk is defined as the risk of flooding from surface water runoff, groundwater and small ditches and watercourses (collectively known as ordinary watercourses). The responsibility to lead and co-ordinate the management of tidal and fluvial flood risk remains that of the Environment Agency (EA).

The Act also implements the recommendations made by Sir Michael Pitt that local authorities should have a duty to investigate flooding from all sources.

2.2 Section 19 Investigation Requirement

North Yorkshire County Council (NYCC), as LLFA, has a responsibility under Section 19 of the FWMA to investigate significant flood incidents in its area. Section 19 States:

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.

Section 14 of the FWMA grants the LLFA power to request information associated with its functions. These powers have been exercised in the preparation of this report.

2.3 Trigger for Section 19 Report

The incident has been assessed in line with the criteria set out in Section 3 of the North Yorkshire County Council Local Flood Risk Strategy (2015) and has been judged to warrant a formal Section 19 investigation on the basis of:

- Number of properties internally flooded
- The depth, area or velocity of flooding reported
- The frequency of flooding
- The nature and extent of critical infrastructure impacted by the flood
-

2.4 Location

Knaresborough is a market town situated in the Harrogate Borough Council Authority area, in the county of North Yorkshire, with an approximate population of 15,500. Knaresborough (grid reference: SE 34764 57352) is located 5km east of the centre of Harrogate and 6km West of the Junction 47 of A1M as shown in Figure 2.1.

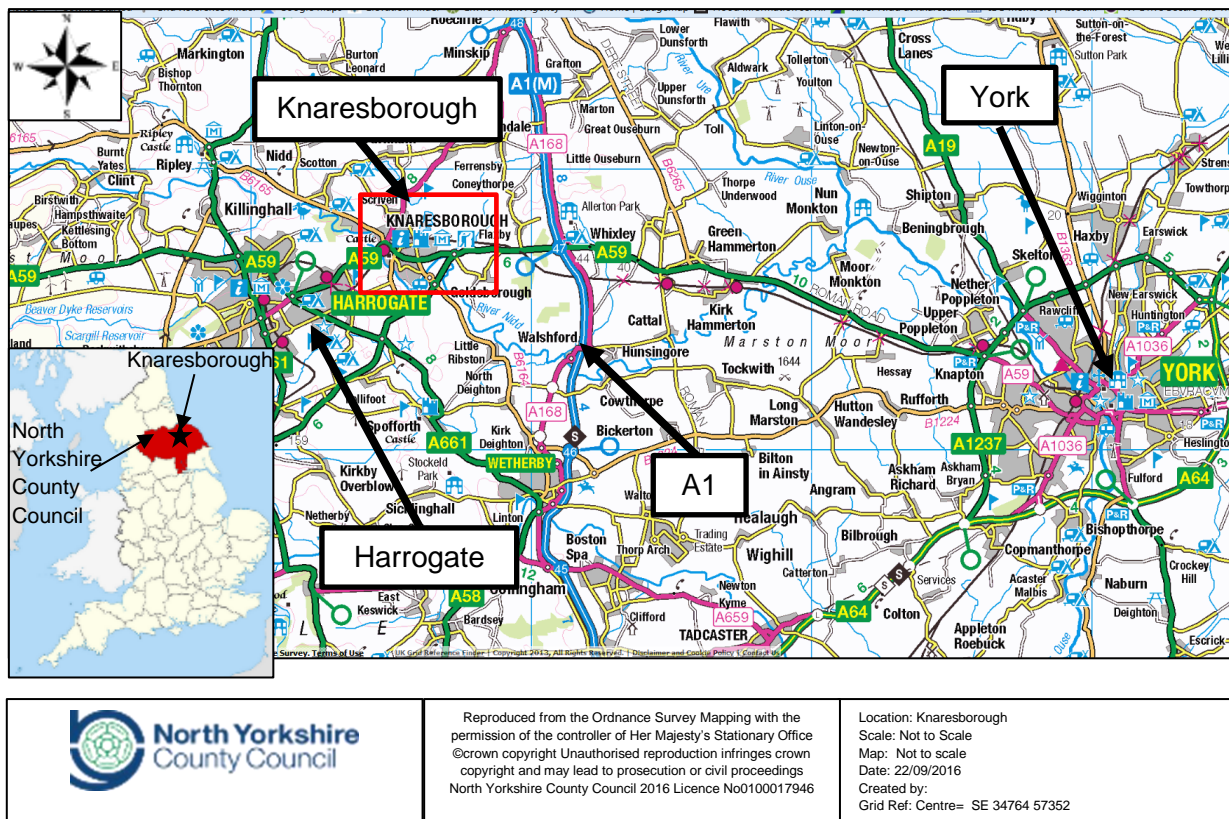


Figure 2.1 Knaresborough location map (Source: NYCC)

Within Knaresborough there are two distinct areas that were affected by flooding in December 2015 and these are referred to as the Central and the East areas. The locations of interest are defined in Table 2.1, and shown in Figure 2.2, along with the number of properties affected. The areas of interest are predominately located alongside the banks of the river Nidd.

Location	No. of properties	Property Type	Area description
Waterside	12	Mixed	Central
Spital Croft	3	Residential	Central
Abbey Road	6	Residential	Central
Abbey Court	3	Residential	Central
Riverside Park	20	Residential	East
Nidderdale Park(Nidderdale Lodge, Ashwood Place and Alder Avenue)	25	Residential	East
Dispersed in Knaresborough (includes the King James's School)	4	Mixed	Central
Total	73		

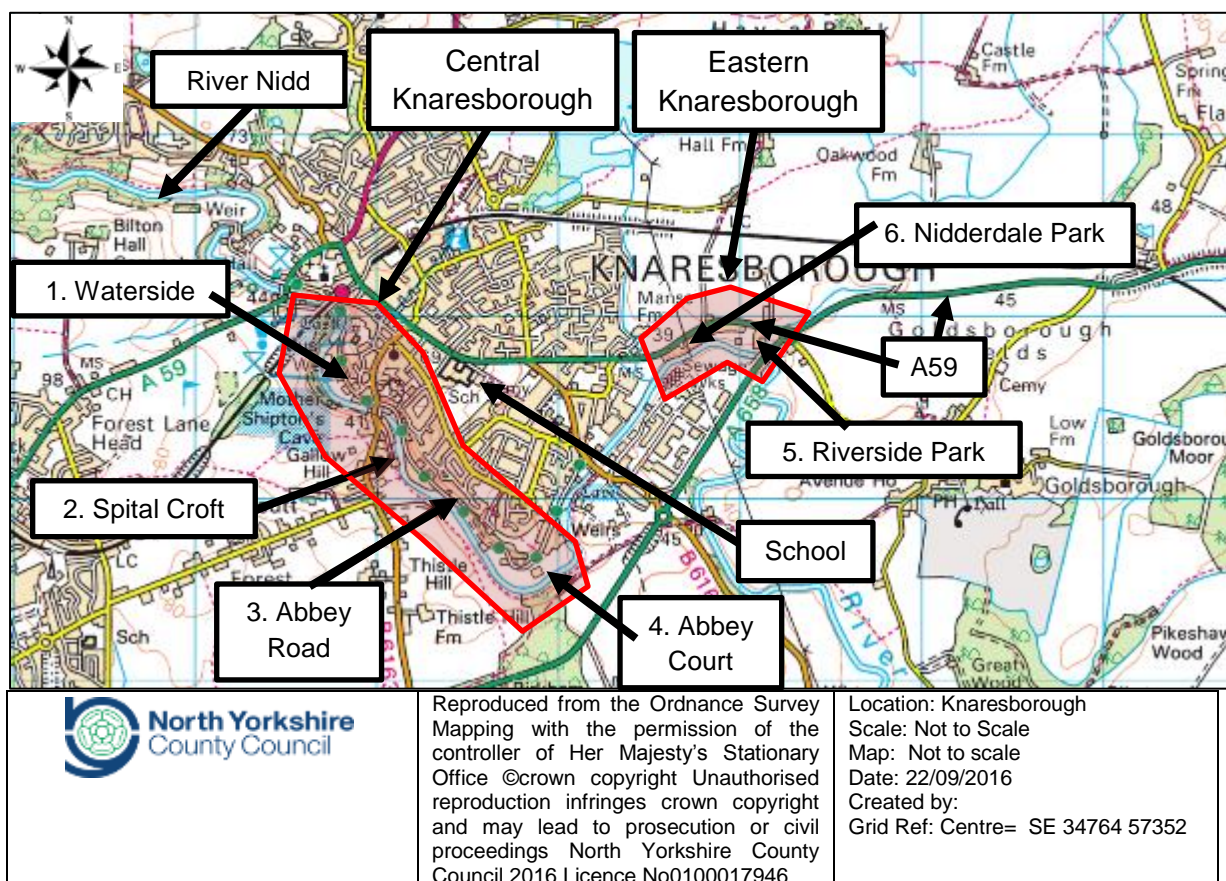


Figure 2.2 Knaresborough local map (Source: NYCC)

2.5 Topography

The River Nidd has over time cut a channel through the sandstone in Knaresborough, resulting in steep escarpments on either side of the river, as illustrated in Figure 2.3. Further downstream, on the eastern side of Knaresborough,

the terrain opens out and the River Nidd meanders through lowlands of the Vale of York.

The built up area of Knaresborough exists at two elevations. The main town is at a high level above the River Nidd and generally flat. The narrow area close to the River Nidd is also flat and low lying as shown in Figure 2.3.



Figure 2.3 Photograph showing escarpment next to the River Nidd (Source: Google Maps)

The average height above sea level of the key flooding locations in Knaresborough range between 58m on Waterside adjacent to Marigolds Cafe and 32m at Riverside Park.

2.6 The River Nidd

The River Nidd is classified as a Main River running 94.45km from its source at Nidd Head Spring (595m above sea level), in the Yorkshire Dales, to its confluence with the River Ouse at Nun Monkton.

The River Nidd catchment is primarily rural and agricultural except for Harrogate and Knaresborough, which are urban. Knaresborough is located in the mid to lower Nidd catchment area, as shown in Figure 2.4.

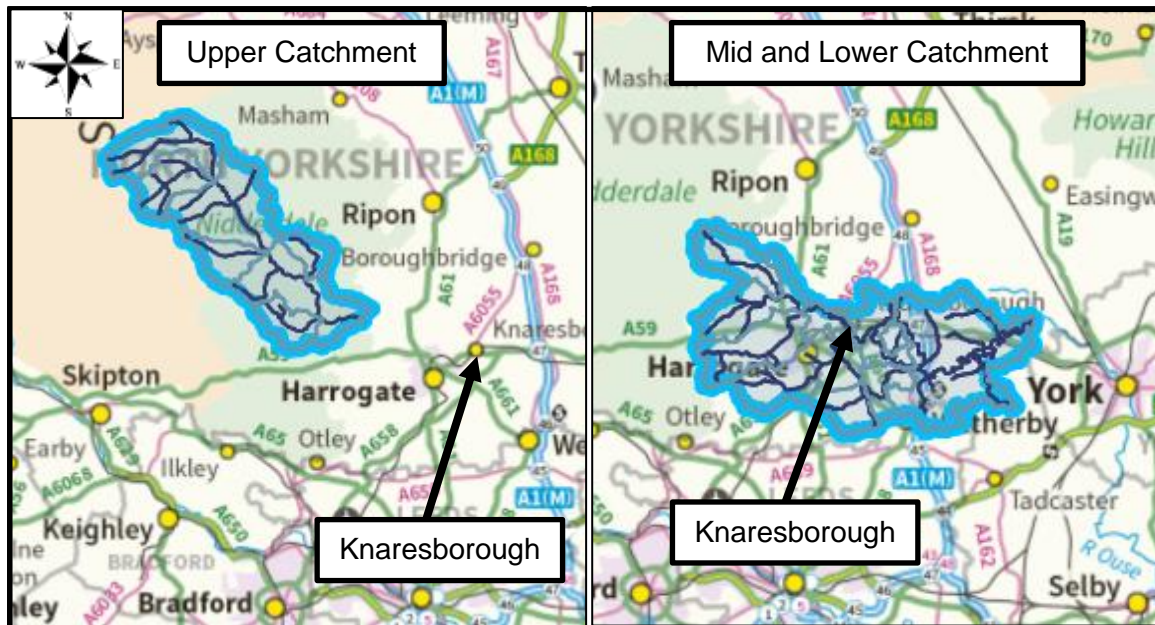


Figure 2.4 River Nidd catchment map (Source: EA)

The river meanders through Knaresborough through a series of right angled bends and under the A59, B6163, 6164 and A658. River Nidd levels are gauged at Knaresborough downstream of the Railway viaduct, where the normal range of water level is described between 0.43m and 0.5m. The Environment Agency records indicate that when the Nidd rises above 1.3m river flooding is possible. There is no tidal influence on any part of the River Nidd.

The Environment Agency flood maps confirm that the areas alongside the River Nidd in Knaresborough are at risk of flooding, as shown in Figure 2.5. Flood Zone 2 represents land assessed as having between a 1 in 100 and 1 in 1,000 annual probability of river flooding (1% – 0.1%); Flood Zone 3 a probability of 1 in 100 or greater annual probability of river flooding (>1%)¹.

¹ River Flood Risk Map, Environment Agency

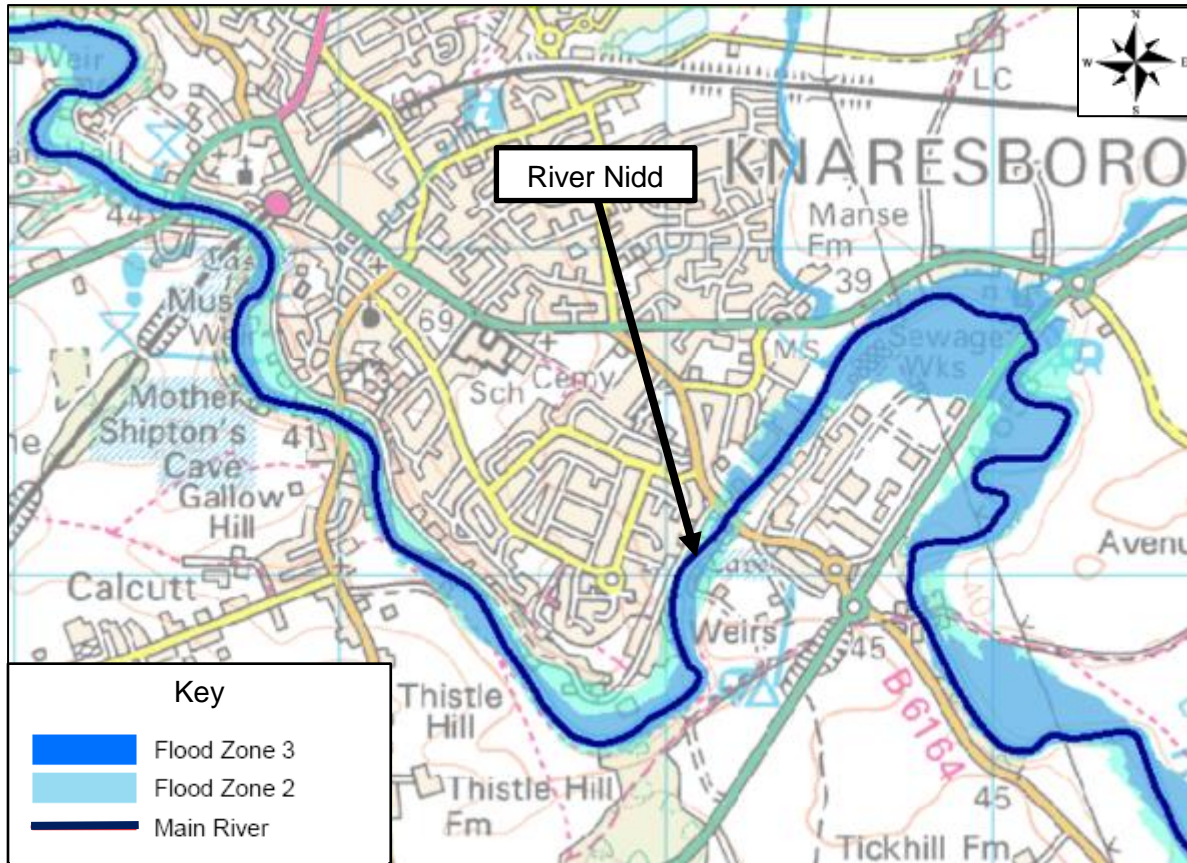


Figure 2.5 EA River flood risk map for Knaresborough (Source: EA)

2.7 Reservoirs

There are three reservoirs located in the upper catchment of the Nidd, close to the Nidd’s source, these are Angram, Scar House and Gouthwaite, as shown in Figure 2.6, details of which are shown in Table 2.2.

Name	Grid Reference	Purpose	Owner
Angram	SE 03927 76055	Water supply Bradford and west Yorkshire	Yorkshire Water
Scar House	SE 25743 77017	Water supply Bradford and west Yorkshire	Yorkshire Water
Gouthwaite	SE 13797 68368	Compensation Reservoir for River Nidd	Gouthwaite Board of Management (operated by Yorkshire Water)

Table 2.2 Reservoir Details

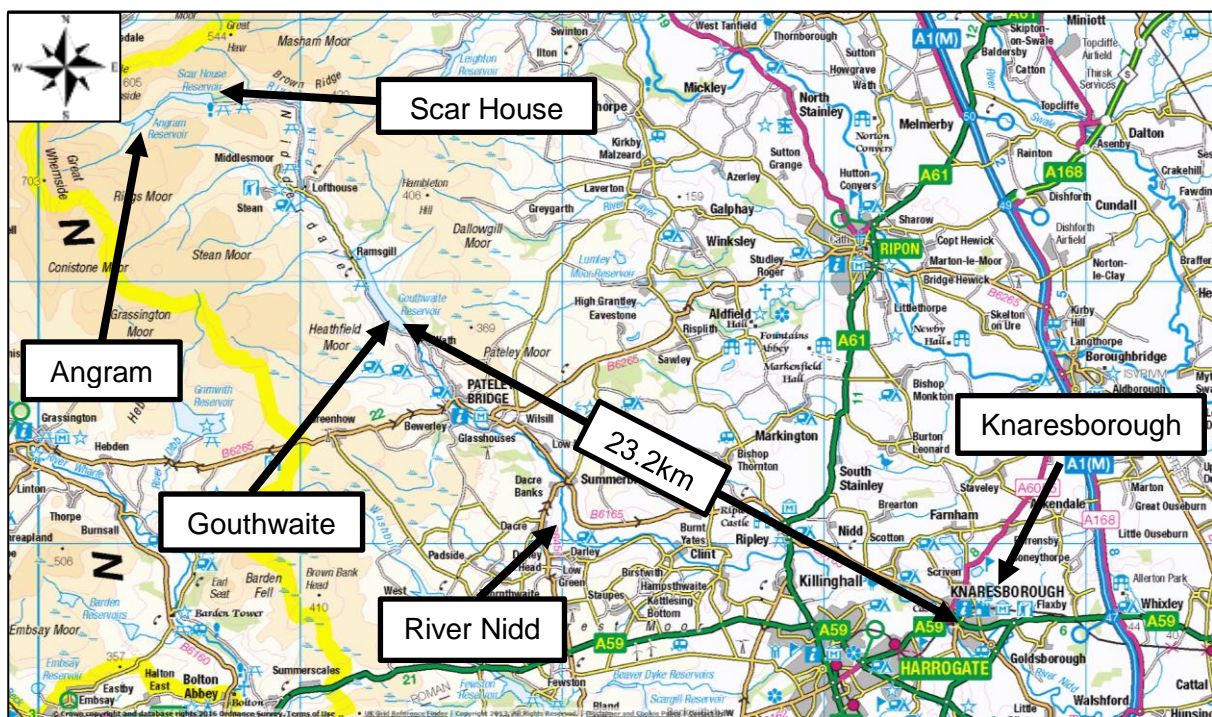


Figure 2.6 River Nidd reservoirs with respect to Knaresborough (Source: Google Maps)

The catchment area of the River Nidd at Knaresborough is 330km², whilst the catchment to Gouthwaite reservoir is 115km² hence the reservoir accounts for 34% of the Nidd Catchment to Knaresborough.

Gouthwaite reservoir supplies water to the River Nidd in compensation for loss of water for public water supply from Scarhouse and Angram reservoirs. It is operated by Yorkshire Water on behalf of the Board of Management and its operation of the reservoir has been designed to meet the needs of the catchment.

Current reservoir operation management rules increase the compensation flow as the reservoir levels rises, but only until it reaches the level of the spillway. When the reservoir is full, a release of 664 tcmd (thousand cubic metres per day) is made from the reservoir. If the reservoir is spilling, flow discharges from the valve outlets into the River Nidd. Releases through valves are aimed at reducing the risk of damage to the retention walls at times of over spilling.

2.8 Highway gullies

Local road gullies are owned and maintained by NYCC as the local Highways Authority. The gullies collect surface water from rainfall and are connected to the local public sewer systems, which are owned and maintained by YWSLL.

Highway gullies are present in Waterside and Abbey Road. No testing has been carried to determine whether these are connected to the combined system or discharge to the nearby river, although the latter is more likely. As the affected sites in the Knaresborough East area are away from the public highway, there are no highway authority maintained gullies in the area.

2.9 Public sewers

Sewer records from YWSL show that the central Knaresborough are predominantly served by a combined sewer system, as shown in Figure 2.7. This largely follows the route of Waterside and Abbey Road to convey combined flows beneath the River Nidd and into Knaresborough Waste Water Treatment Works (WWTW). There is also a substantial surface water sewer system present in the more elevated areas of Knaresborough, as shown in Figure 2.8. From the network records provided by YWSL it is noted that there are no public sewers in the eastern part of the study area. In addition records show no combined sewer overflows (CSO) or sewer pumping stations in the study area.

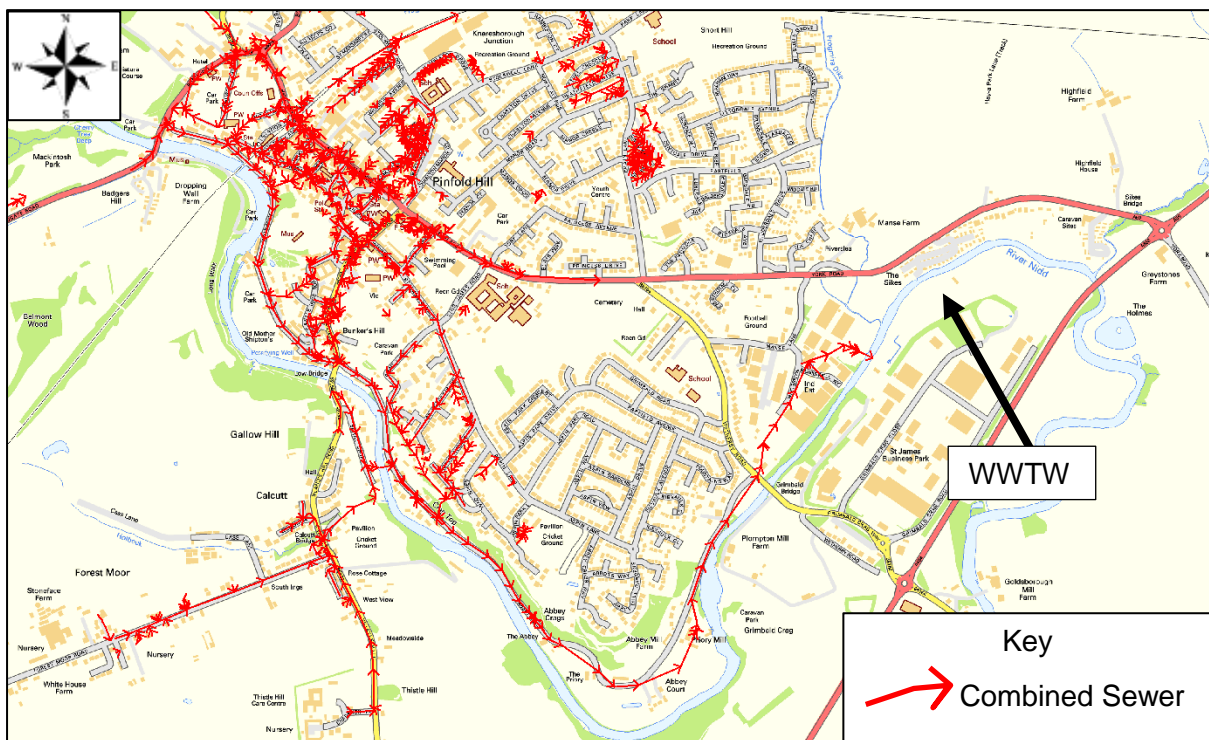


Figure 2.7 Combined sewer network in Knaresborough²

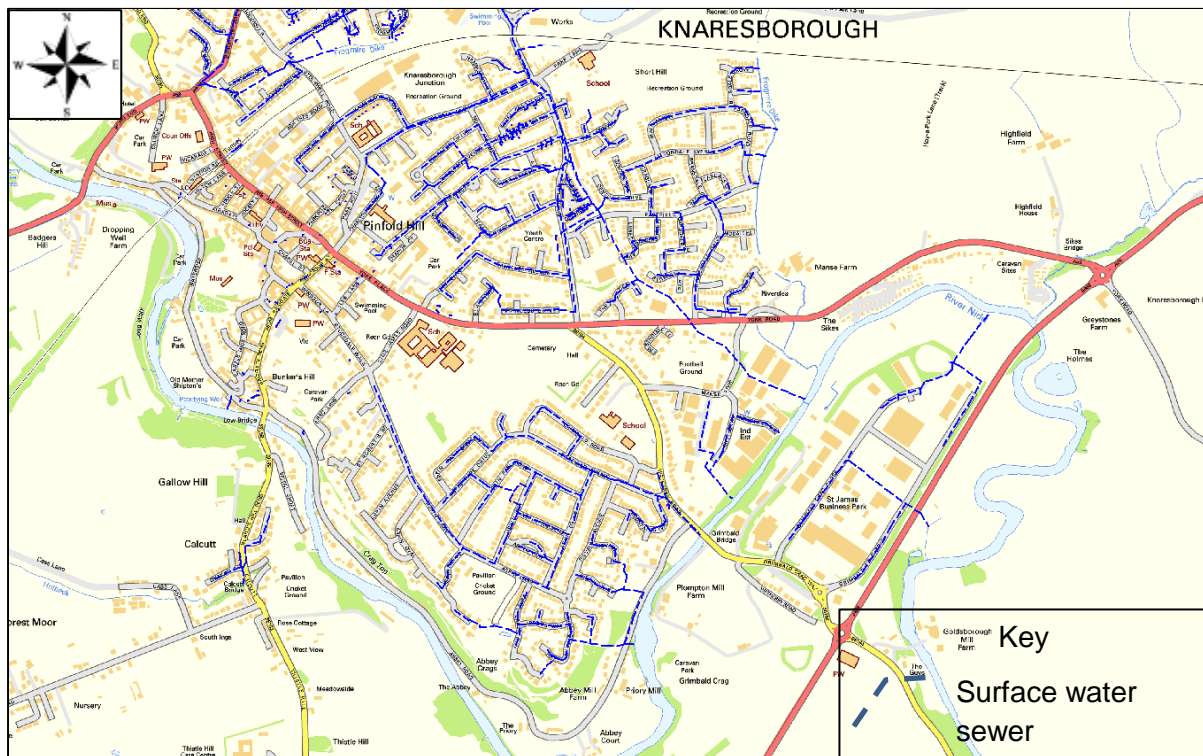


Figure 2.8 Surface water sewer network in Knaresborough³

2.10 Swale and Ure Drainage Board

Parts of east Knaresborough fall within the drainage district for the Swale and Ure Drainage Board as shown in Figure 2.9. The Board operates as the Land Drainage Authority within their district and is responsible for the management of water levels in respect of Flood Risk Management within the area. The Board is also directly responsible for the maintenance of a number of local watercourses. With respect to this report the most relevant being Frogmire Dike and The Rampart which discharge into the River Nidd in the vicinity of the Riverside Park and Nidderdale Park in East Knaresborough.

² Public Sewer Network, YWSL

³ Public Sewer Network, YWSL

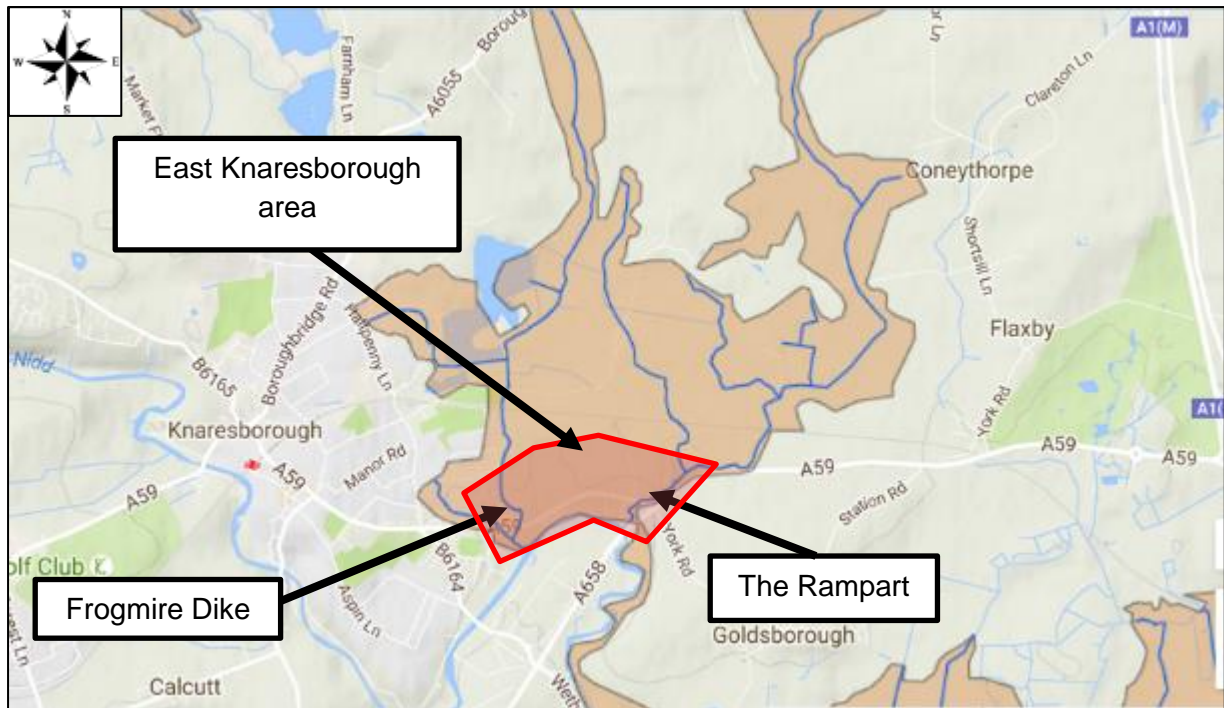


Figure 2.9 Extents of Swale and Ure Drainage Board in Knaresborough (Source: Google Maps)

3 Flood Event

3.1 Rainfall data

3.1.1 Meteorological Conditions

The rainfall event was characterised by two distinct rainfall systems. The first rainfall system was Storm Eva which brought high winds and a band of rain which spread across the country on the 23rd & 24th December 2015.

The second system was a slow moving low pressure system and warm frontal zone, moving across the region from the west, on the 25th and 26th of December. The rainfall which caused the flooding was brought on by the weaker second low pressure system.

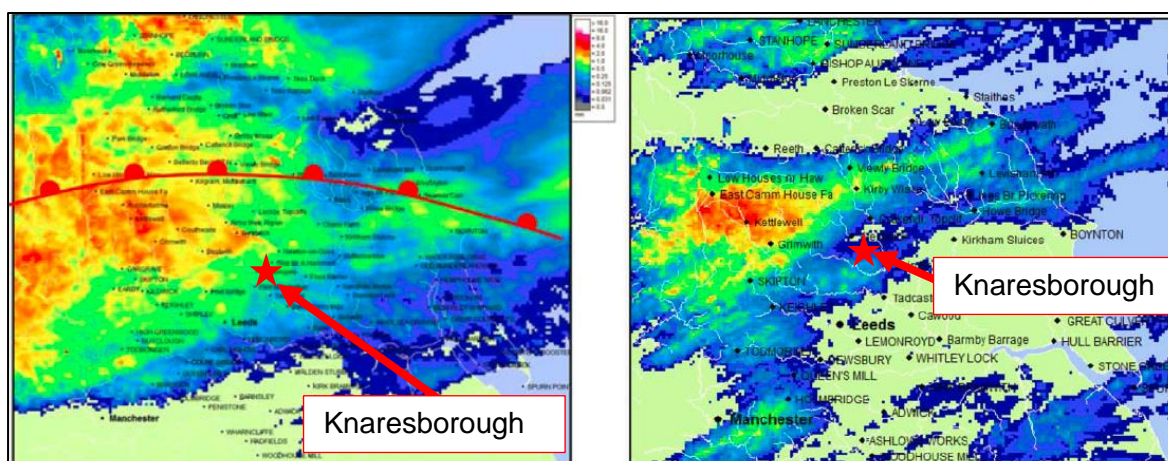


Figure 3.1 Radar image with overlaid front as of 18:00 on 25th December 2015 (left) and 01:00 on 26th December 2015 (Right) Copyright Meteorological Office

A warm frontal zone passed over the UK during the morning of 25th December, bringing scattered showers with it, and by midday there was a blanket of rainfall covering Yorkshire. During the evening of the 25th December an occluded front had set over the north west and north east and it was this front which produced the more intense storms. There were two main pulses of heavy rainfall that led to the flooding experienced in Knaresborough. The total rainfall for 25th - 29th December 2015 is shown in Figure 3.2.

The first pulse occurred once the occluded front had formed during Christmas Day afternoon and evening. The second pulse occurred in the early morning of Boxing Day. The two main pulses of heavy rainfall were mainly confined to the upper catchment of rivers Aire, Calder, Wharfe and Swale.

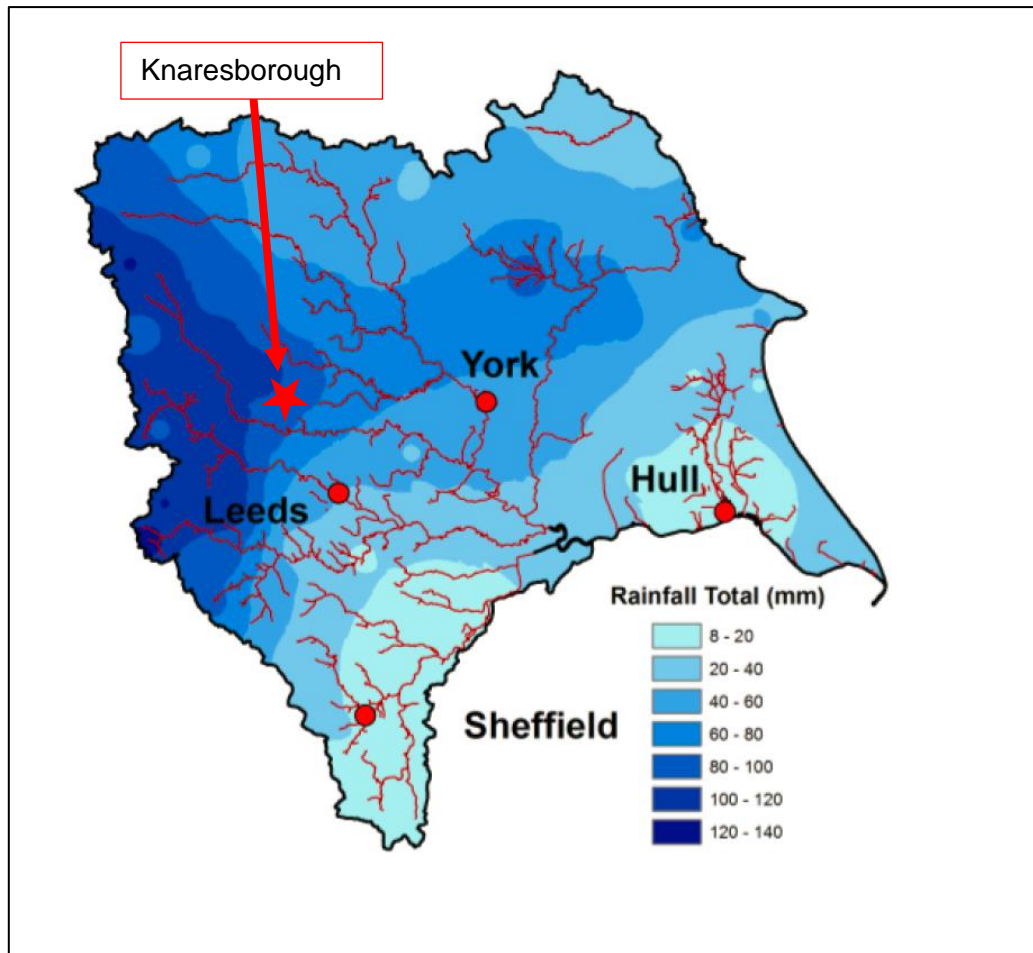


Figure 3.2 Total rainfall (mm) between 25th to 29th December 2015 (Source: EA)

3.1.2 Antecedent conditions

A data set from the National Climate Information Centre (NCIC) shows that in November 2015 the Nidd Catchment was third wettest November since 1909. It reached 230% of its long term average (LTA), which is equivalent to nearly five times the LTA for November. This indicates that the ground was already saturated from rainfall in November, prior to the exceptionally wet December 2015. In addition the Nidd catchments received approximately three times the December LTA rainfall before the rain fell on Christmas Day and Boxing Day.

Soil Moisture deficit is a measure that indicates the dryness of a catchment and hence its capacity to absorb rainfall. According to the EA their modelled Soil Moisture Deficit (SMD) was indicating that the soil in the Nidd catchment area had zero available storage at the beginning of October and the nature of the rainfall ensured that the ground remained fully saturated leading up to Christmas 2015.

3.1.3 Knaresborough Rainfall Event

YWSL has provided rainfall radar data for the rainfall event in the Knaresborough area. The data shows that the two significant rainfall events one on the 25th and 26th December. On Christmas Day the first event produced a rainfall depth of 19mm which accumulated in 5.5hrs. The peak rainfall came on Boxing Day, when a rainfall depth of 28mm fell in 10.5 hours. Environment Agency tipping bucket rain gauge

(TBR) rainfall data has been provided for Scargill (15 minute interval), as illustrated in Figure 3.3. The data from the Scargill TBR shows two significant rainfall events on the 25th and 26th December. The rainfall event on the 25th started at 12:00 and finished at 23:30 reaching successive peaks at 16:15 and 20:00. The rainfall event on the 26th started at 00:45 and finished at 13:00 reaching a peak at 06:45.

The return period for the accumulation of rainfall over the peak 24hour period was 20 years at Scargill.

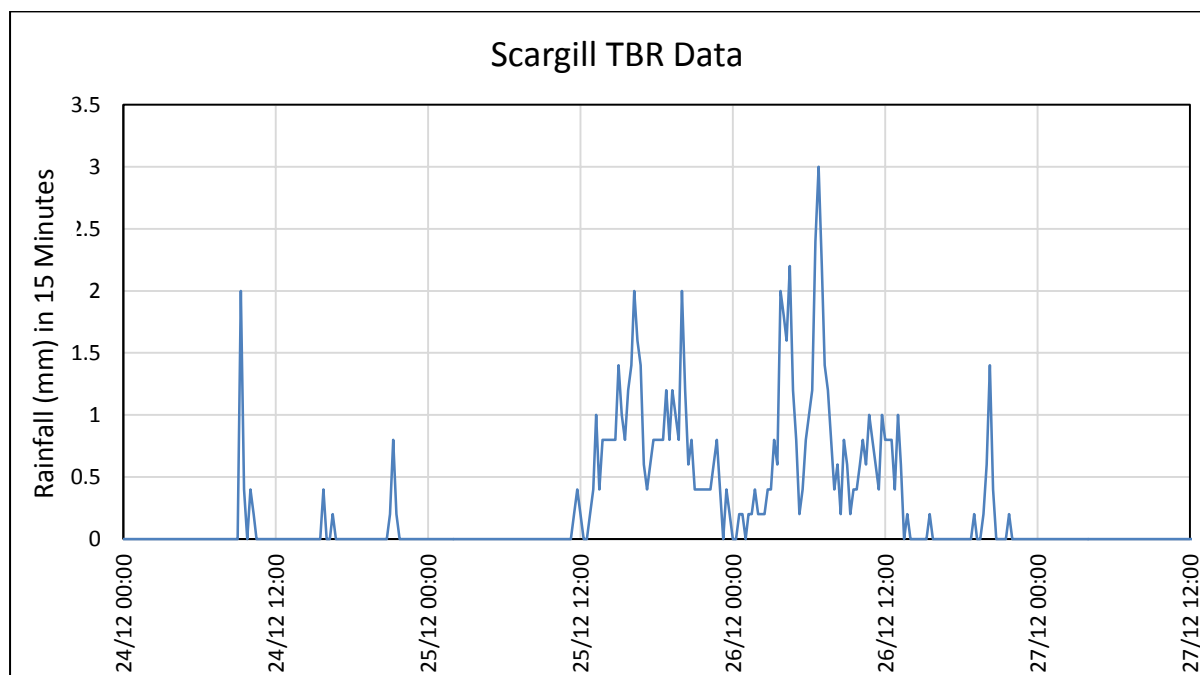


Figure 3.3 Rainfall Data for Scargill on the 25th and 26th of December.

3.2 River Nidd Levels

Low flows dominated the late spring and early autumn, with flows increasing above normal in late November. During November near continuous wet weather already falling on saturated ground, ensured river flows increased between “above normal” to “exceptionally high”. Immediately before Christmas Day the Yorkshire Rivers were notably “high” or “exceptionally high”.

Record peak river levels were evident along the west Pennine catchments, with near record peaks tracking northeast over North Yorkshire. The response of the west Yorkshire Rivers levels (Aire & Calder) were driven from the rainfall in the uppermost catchments, whilst many of the North Yorkshire (Wharfe, Nidd and Ure) river peaks occurred in the middle and lower reaches of the catchment

Following weeks of rainfall the River Nidd levels rose on 26th December 2015 to overtop its banks in Knaresborough. The highest recorded level at 2.33 metres occurred on 26th December 2015. The datum for the Knaresborough gauge is 36.86 metres AOD (Refer *Station 8121* in Knaresborough). Figure 3.4 shows the levels of the River Nidd in Knaresborough from the 24th to 29th December. Birstwith is 11km upstream and Hunsingore is 10km downstream of Knaresborough.

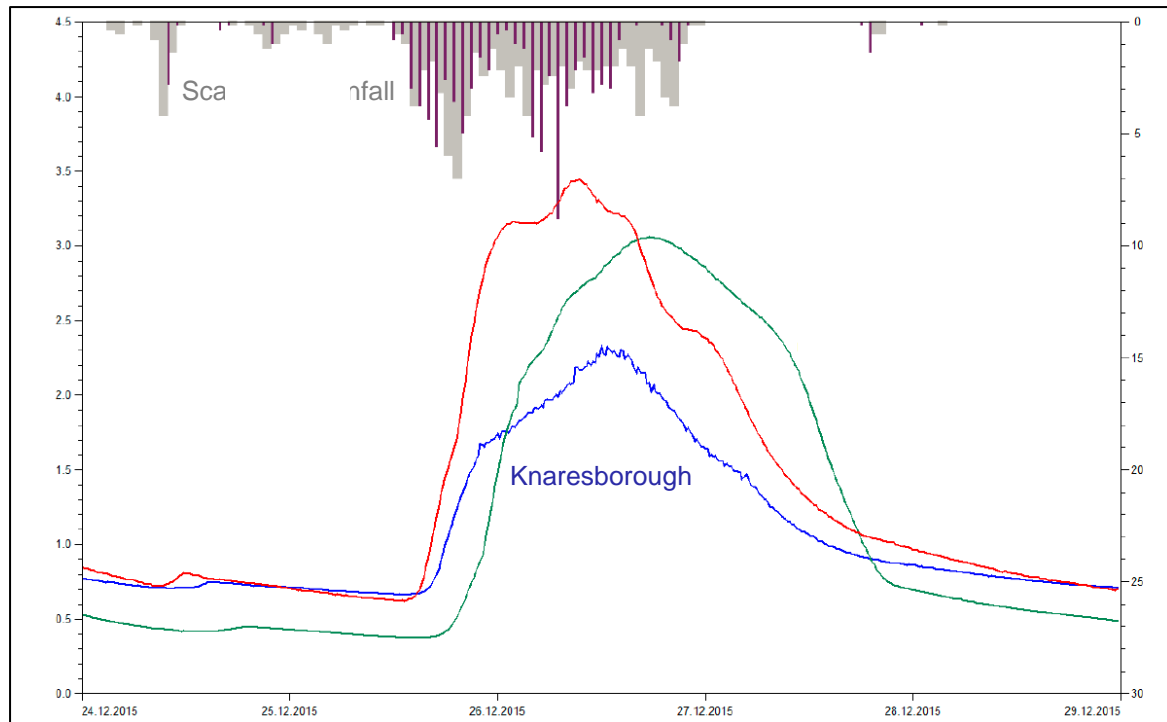


Figure 3.4 River levels and rainfall data for the River Nidd (Source: EA)

3.2.1 River Nidd Response

The rainfall in the Nidd catchment was proportionately more significant than that over the Pennines. River levels amongst some of the highest recorded annual maximum (AMAX) levels. The river levels in the mid and lower catchments were exceptional with the Nidd catchment seeing some of the highest ever recorded levels. These high levels in the mid and lower catchment are likely to be as a result of flows from the upstream coinciding with still intense rainfall and the capacity of the River Nidd being exceeded.

On the Nidd catchments river levels were the highest recorded AMAX, in 17 years of records, from Knaresborough downstream due to rain in the mid catchment at Scargill. Gouthwaite reservoir, upstream of Pateley Bridge was already full and spilling days prior to the peak river levels in both November and December. Hence there was no capacity to attenuate flows through the reservoir.

Environment Agency analysis shows water levels rose rapidly in all parts of the catchment, but this happened at a slightly slower rate at Knaresborough. Two peaks were observed at Birstwith, one on Christmas Day night and another in the middle of Boxing Day. As the flows progressed downstream, the water levels rose to a single peak at Hunsingore and Knaresborough. In the early hours of Boxing Day the rate of rise at Knaresborough is reduced and shows a less smooth trace as shown in Figure 3.4. It is considered that this may indicate water spilling out of bank or that the gauge may have been bypassed.

The peak levels recorded on the River Nidd at Knaresborough were 2.33m on 26 December 2015 at 12:45. These are the highest recorded levels for this location. The datum for the Knaresborough gauge is 36.86m AOD. Hence the peak level at

Knaresborough was 39.19m AOD. Comparing this level to output data provided by the EA from their hydraulic model for node NIDD035 it can be seen from Table 3.1 that this level has an estimated return period of 100 years.

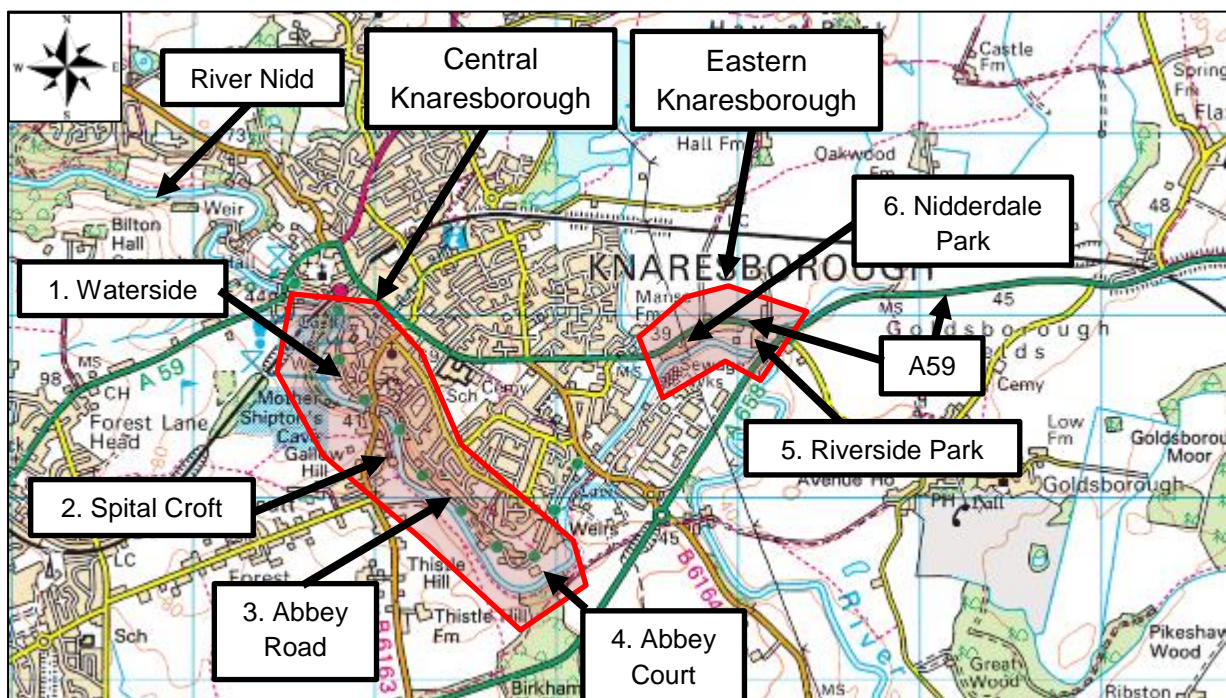
NFCDD Node Point	Return Period	Water Level MAOD
NIDD035	5	38.67
	10	38.80
	25	38.95
	50	39.06
	75	39.14
	100	39.19
	101*	37.41
	200	39.31
	1000	39.81

Table 3.1 Modelled water levels for Knaresborough (Source: EA)

(* The 101 year return period is the 100 year plus an allowance for Climate Change.)

3.3 Description of Events

Flooding occurred and caused internal damage to properties in the central and eastern areas of Knaresborough on Boxing Day 2015. In central Knaresborough properties flooded along Waterside and Abbey Road as the River Nidd overflowed its banks between the A59 to the A658. In Eastern Knaresborough flooding was caused by high water levels in both the River Nidd and its tributary (The Rampart) which affected properties at Riverside Park and Nidderdale Park. The flooded locations are shown in Figure 3.5.




 North Yorkshire County Council	Reproduced from the Ordnance Survey Mapping with the permission of the controller of Her Majesty's Stationary Office ©crown copyright Unauthorised reproduction infringes crown copyright and may lead to prosecution or civil proceedings North Yorkshire County Council 2014 Licence No0100017946	Location: Knaresborough Scale: Not to scale Map: Not to scale Date: 22/09/2016 Created by: Grid Ref: Centre= SE 34764 57352
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Figure 3.5 Areas where flooding causes internal damage

3.3.1 Waterside

Some surface water runoff is credible from the steeply falling access drives and pedestrian walkways down the escarpment onto Waterside and Abbey Road. In addition, in the vicinity of the boat hire location, some limited surface water run off may have occurred through the partially blocked linear drain in the adjacent Waterside. However in relation to the volume of water in the River Nidd these surface water runoff volumes are not significant.

At the Boat Hire Yard and cafes located between the River and Waterside three properties have a history of flooding prior to the 2015 Boxing Day floods. The cause of flooding is the rising level of the River Nidd causing the river over spill at the Waterside properties.

Marigolds Café and the Boat Hire Yard were flooded, as shown in Figure 3.6, by overspill river water at 0430 hrs on Boxing Day 2015. Residents report that a flood warning was broadcast at 0400hrs but gave insufficient time for items in the café to be removed to safe places distant from inundation.



Figure 3.6 Photographs showing the Marigold Café flooding (Source: Harrogate Advertiser)

3.3.2 Courtyard Dwellings

Near the weir there is a courtyard containing three linked dwellings which have been developed in buildings that were part of a former mill at the weir. These are adjacent to Waterside Car park, which has pedestrian access falling away on a downwards gradient from Waterside. Connections from each were seen to connect to the combined sewer but a limited number of surface water runoff collection gullies exist in the courtyard suggesting a likelihood of ingress of surface water into the properties located at the lowest level via gaps under the doors, air bricks and unsealed gullies that receive household waste water.

By inspection of EA Flood maps it can be seen how the Flood Zone 3 coincides with the riverside building walls and that the flood zone 2 reaches as far as Waterside. It appears these properties were flooded from the River Nidd rather than the capacity of the surface water system being exceeded.

3.3.3 Waterside Car Park

Waterside is closed to through road traffic by bollards near the Courtyard described above. There is a car park off Waterside, prior to these bollards, with a surface constructed from unbound materials. The surface appears to be slightly raised in elevation but it falls away from Waterside towards the River Nidd and is principally intended for use by visitors. The car park has access to riverside footpaths. By inspection of EA Flood maps this area is designated Flood Zone 2, with some areas nearer the river being in Flood Zone 3.

3.3.4 Other Waterside Properties

Other isolated premises (for example, adjacent to A59 Bond End & near railway) have external levels that are only slightly higher than average river levels. Consequently they became inundated by rising river levels on Boxing Day 2015.

3.3.5 Abbey Road

The vertical alignment of Abbey Road near its cross road junction with the B6163 / Waterside Road has a depression that causes the collection of surface water to form ponds when intense rainfall occurs. In addition the proximity of properties to the River Nidd meant they were directly affected as river levels rose.

Water was reported as coming over river facing boundary walls and coming up through the floor of one of these properties. The water level rose to approximately 1m inside the property. As evidenced during the site visit on Thursday 8th September 2016, the dwellings on the east side suffered extensive internal flood damage with repairs and resilience works seen ongoing on the day of the site visit some nine months later. One owner described having to spend 3 months in a Hotel before his dwelling became habitable following essential repair work. The owners have now raised the height of walls, constructed a new solid floor and added non

return valves on their domestic drainage outlets as measures to protect their property against any future floods of similar intensity.



Figure 3.7 Photograph showing flooding to property in Knaresborough

Four dwellings along the east bank between Abbey Road and the river and three dwellings along the west bank at the head of Spitalcroft also experienced significant internal flooding on Boxing Day.

3.3.6 Nidderdale Park

To the east of Knaresborough, Nidderdale Park is situated within Flood Zone 3 and has a high risk of flooding from the River Nidd as shown in Figure 3.8. As a park home for permanent residential use the site is classed as “highly vulnerable” to flooding.⁴

⁴ *Planning Practice Guidance Table 2: Flood Risk Vulnerability Classification Paragraph 066 ID 7-066-20140306*

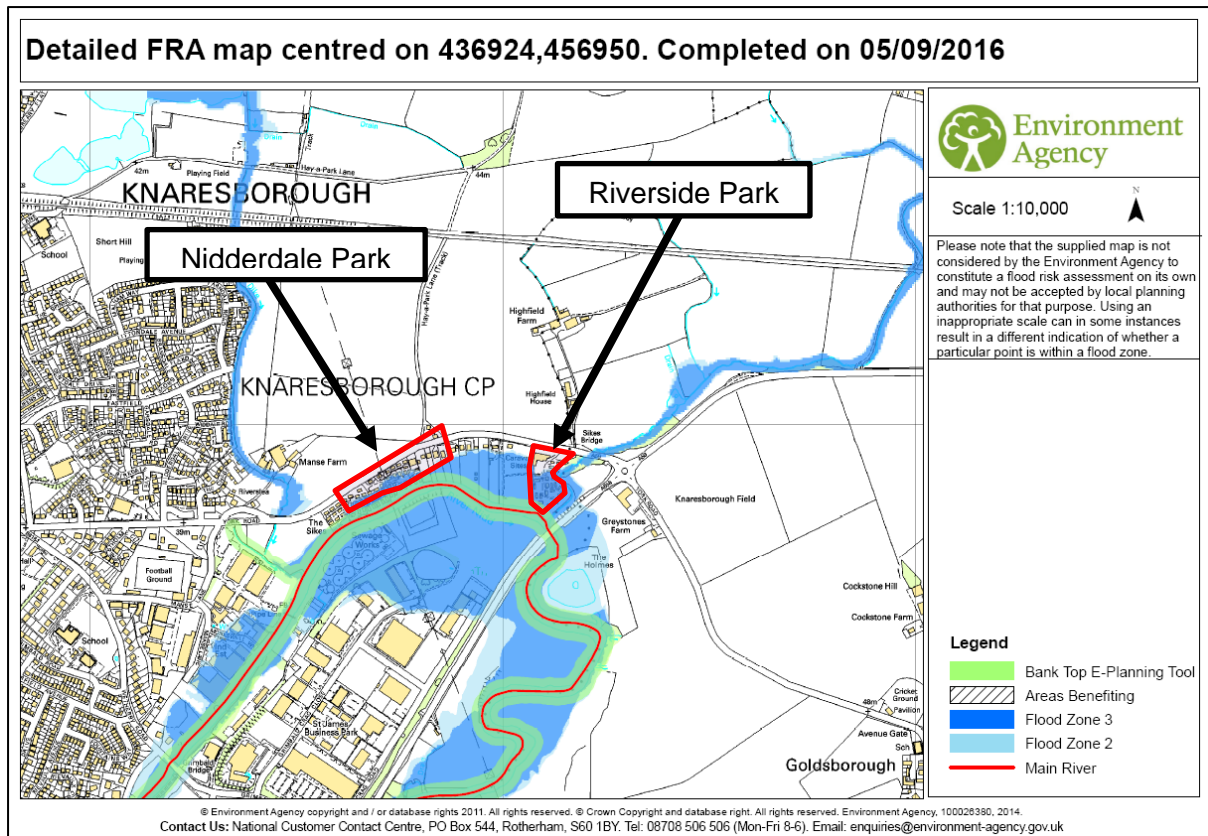


Figure 3.8 EA Flood risk map for eastern Knaresborough

Surface water flooding is not identified as a risk in this area in the flood map defined by the Environment Agency, as shown in Figure 3.9. The boundary of the site to the south runs alongside the River Nidd. Frogmore Dike to the west is a tributary of the River Nidd.

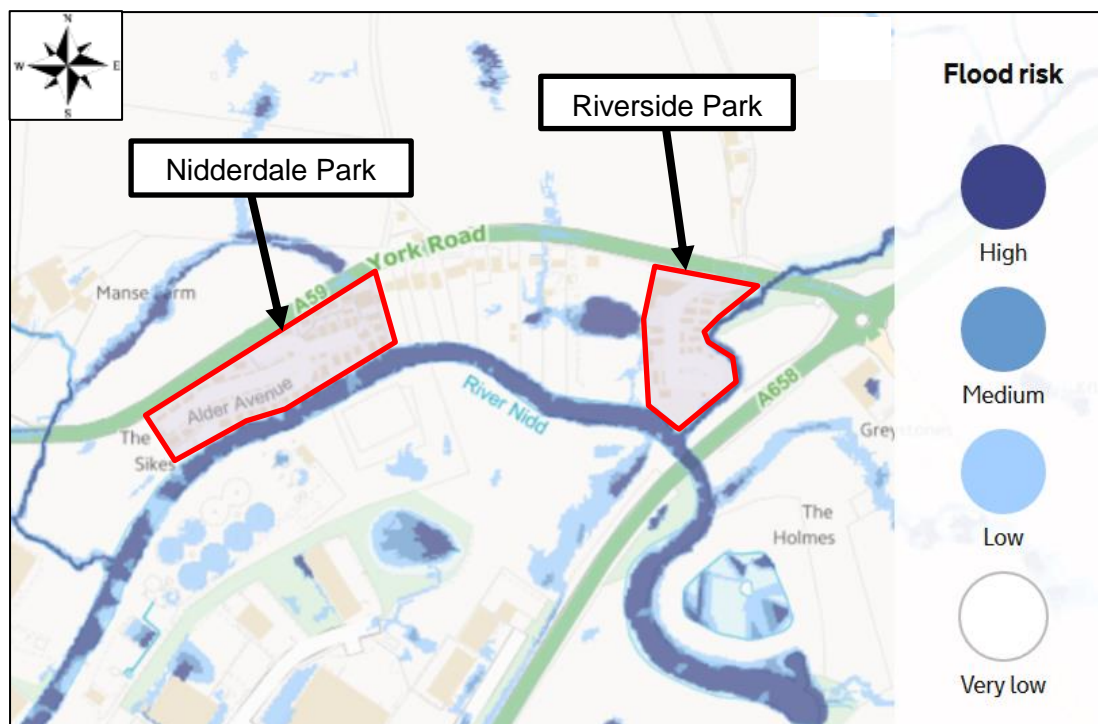


Figure 3.9 Surface water flood Risk for Nidderdale Park⁵

Fifteen properties in Nidderdale Park flank the river Nidd. On Boxing Day 2015 these properties were flooded to a depth of around 1 metre from the river Nidd. A further row of ten properties were also flooded. The site has a history of flooding (e.g years 2000, 2007) but not to the same extent as the 2015 flood.

The banks along the side of the River Nidd have partly been reinforced with “gabions” to prevent further erosion. The roots of mature trees assist in strengthening the river bank but the roots of some trees are exposed and are at risk of collapse as a result of future erosion of soil around them.

Repair works have been ongoing to allow residents to inhabit their homes. The start of the repair works was in January 2016, with 14 properties rectified by the time of the site visit on 8th September 2016. Resilience measures have been installed during the repair works. This has include the raising of floor levels and relocating electrical connections above the flood level.

Between the two rows of properties, along the bank of the River Nidd, the surface of unbound access road was not eroded as in the previous floods. Flood Zone 2 and 3, as shown in Figure 3.8, match closely the actual extent of river flooding on Boxing Day 2015.

The peak river level of the Boxing Day 2015 flood is reported to have occurred at around 1600hrs and began to subside after approximately five hours. An evacuation

⁵ Surface Water Flood Map, Environment Agency

plan was successfully put in operation led by Harrogate Borough Council during the event.

3.3.7 Riverside Park

Also in the east area of Knaresborough is Riverside Park. The site is located between the A59 highway and the River Nidd. A tributary (The Rampart) passes under the A59 near the roundabout and leads into the River Nidd. During the site visit a vacant area of grassland was observed immediately to the west and adjacent to this site. This site has been used for touring caravans, but due to the extent of this flood it has gone out of business.

Riverside Park is within Flood Zone 3 and has a high risk of flooding from rivers and sea, As a park home for permanent residential use the site is classed as “highly vulnerable” to flooding⁶. Part of the site is identified as being at risk from surface water flooding, as shown in Figure 3.8 and 3.9 above.

The sources of the flooding were the River Nidd and The Rampart tributary

The flood flow paths entering the site are twofold, as shown in Figure 3.10. Firstly flow in the tributary The Rampart was restricted by the stronger flow in the River Nidd. As a result the flows in the tributary backed up overtopping at the point where the bank is lowest. Then overtopping the bank occurred, allowing river water to flood into the site. The flood level within the site reached approximately 1 m above the existing ground, as shown in Figure 3.11.

⁶ *Planning Practice Guidance Table 2 : Flood Risk Vulnerability Classification Paragraph 066 ID 7-066-20140306*

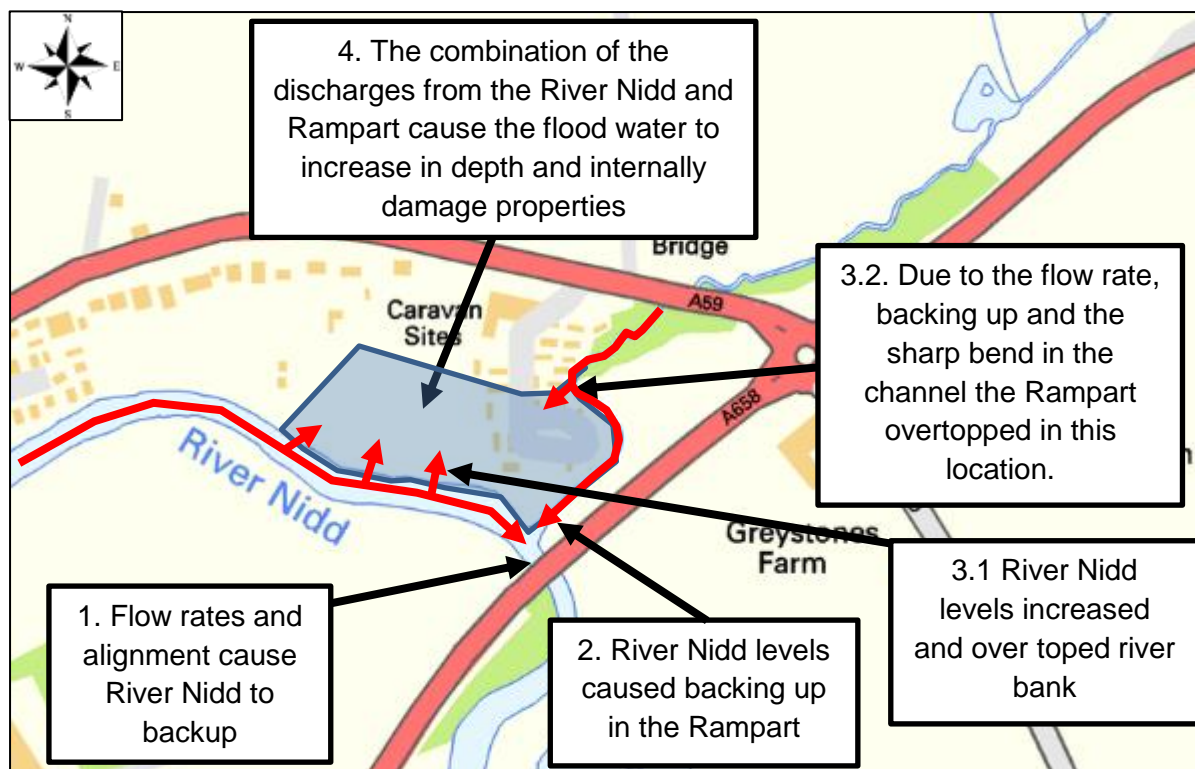


Figure 3.10 Flood mechanisms for Riverside Park



Figure 3.11 Photograph showing caravan flooding in Knaresborough East (Source: Daily Mail)

The alignment of the River Nidd under the A658 highway is not conducive to free flow. As a result the River Nidd waters back up to the point on its bank which allowed a flow path to form and allow overtopping river water to enter the site from the adjacent grassed area. Consequently there were two flow paths where flood water entered the site causing the flooding of 20 individual properties. These residences were already constructed with raised floor levels based of their experience of previous floods. However the flood levels in Knaresborough were the highest ever recorded and hence the flood water rose above the existing raised floor levels.

Because of the Boxing Day 2015 floods the caravans are in the process of being raised to a higher elevation (a further 400 mm (16 inches)) , as shown in Figure 3.12 to provide a free board of 75 mm (3 inches) Each caravan is accessed by newly created steps constructed from heavy blockwork. In addition the electrical connections for each property has been raised above flood level to sustain the electrical supply in future flood events.



Figure 3.12 Photograph showing the increase in elevation of caravans in Knaresborough East

Apart from the obvious cause of extreme rainfall intensity over a prolonged period of time there is little doubt that the alignment of the River Nidd being on a bend contributes to the backed up water that overspills both the banks of the river and its tributary.

3.4 Reservoirs

The River Nidd flows through the reservoirs to continue on through Pateley Bridge and Knaresborough.

In their Report “*Hydrology of the December 2015 Flood in Yorkshire*” (dated April 2016) the Environment Agency view was that the heavy rainfall led to the reservoirs becoming “virtually” full prior to the Boxing Day event.

Local residents have expressed concerns that additional flows from Gouthwaite were being discharged and that these contributed to the rapid rise in river level at Knaresborough on Boxing Day. Gouthwaite reservoir was already spilling days prior to the peak river levels in both November and December. (Ref; “*Hydrology of the December 2015 Flood in Yorkshire*” EA April 2016).

Information received from YWSL has confirmed that Gouthwaite was full and spilling prior to and throughout the flooding of Boxing Day in Knaresborough as shown in Figure 3.13

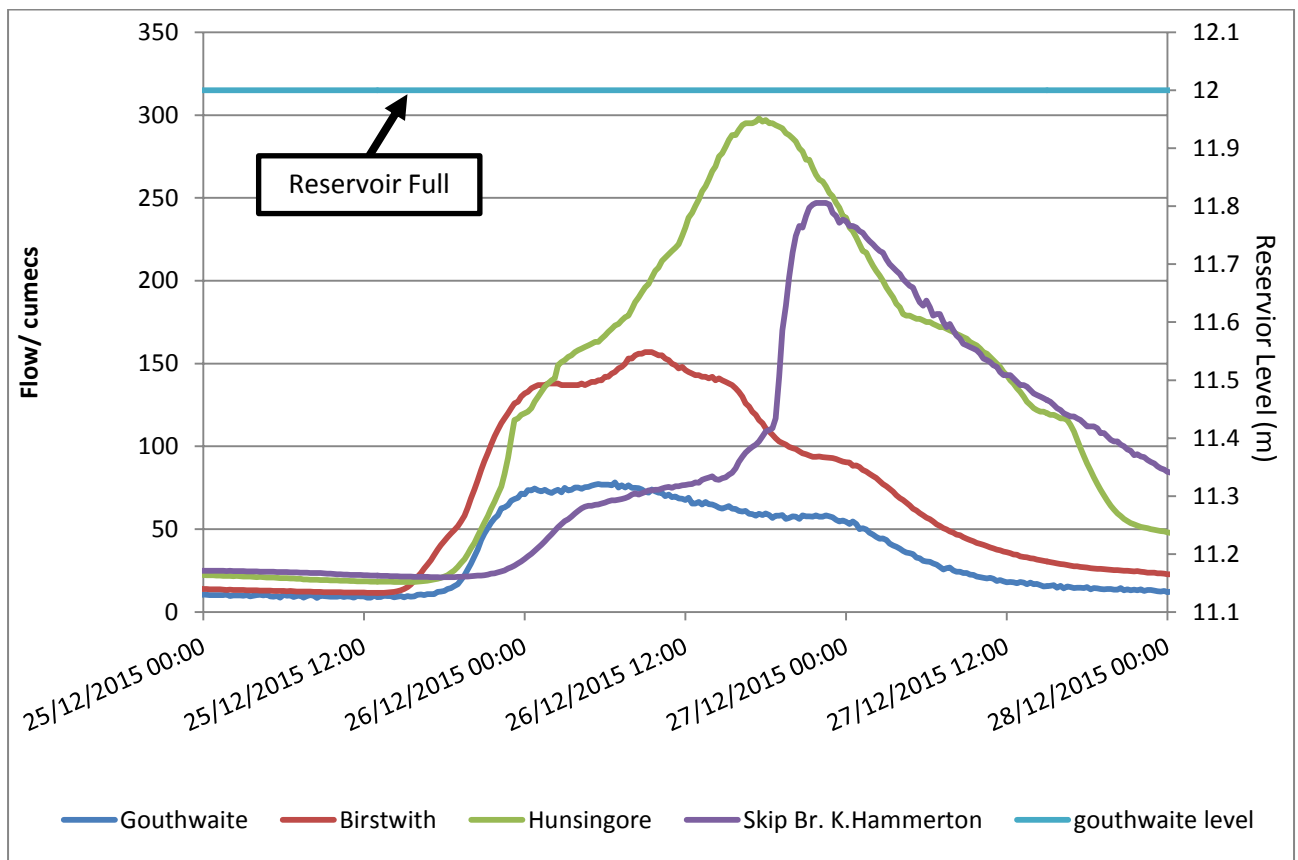


Figure 3.13 Flow gauges on the River Nidd and water levels at Gouthwaite reservoir (Source: YWSL)

The amount of water released from Gouthwaite through its control valves is dependent on a set of operating rules, which are defined by the Board of Management. These rules define how much water should be released into the downstream river, and this flow varies according to the time of year and how full the

reservoir is. A maximum of 664 Ml/d is released from the reservoir under this arrangement. Once the reservoir is full, however, the fixed overflow spillway will begin to operate, passing forward further flows to the downstream river. This spillway is designed to ensure that the reservoir operates safely and in accordance with the requirements of the Reservoirs Act 1975.

The high discharge flows from Gouthwaite for late December 2015, shown in Figure 3.14, reflect the fact that the reservoir was full and spilling over its fixed spillway. However, it is worth noting that even when a reservoir is full it will reduce the peak flow rate into the downstream river (compared to there being no reservoir at all) due to the attenuating effect arising from the large surface area of the reservoir.

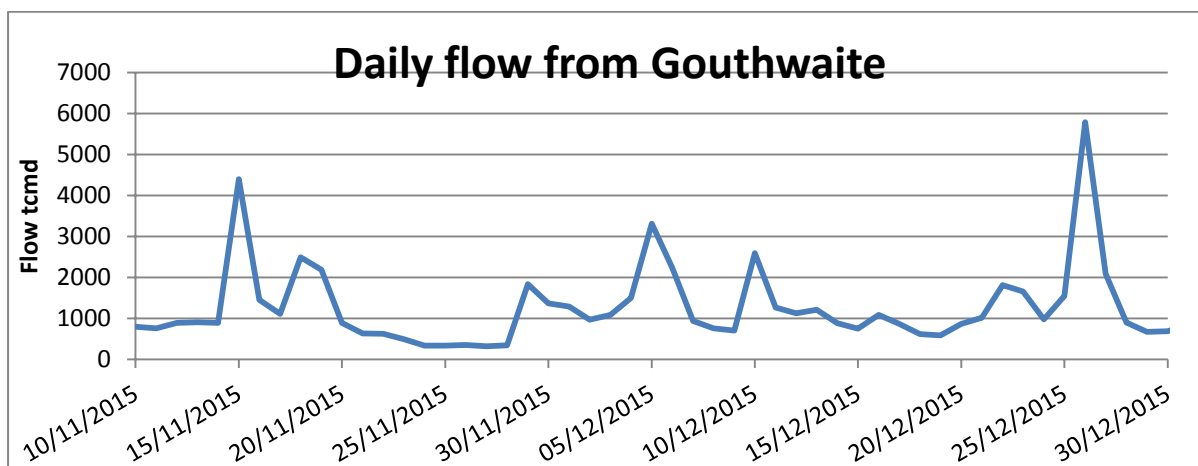


Figure 3.14 Daily flows from Gouthwaite for November and December 2015 (Source: YWSL)

YWSL and EA were asked to consider whether it is possible to operate Gouthwaite Reservoir differently, in order to reduce flood risk to Knaresborough. The EA has subsequently completed a screening assessment of all reservoirs in Yorkshire to understand whether they could provide a flood risk benefit to downstream communities. The work completed by EA has concluded that there is very little potential for Gouthwaite to provide a benefit to Knaresborough and no further investigation is merited.

Following a period of very dry weather in 2003, when reservoir levels dropped to 13% full, the operating rules for Gouthwaite were reviewed and subsequently revised, taking into account a range of stakeholder concerns including flooding. A number of options were considered which took account of seasonal levels, spring draw downs, winter flood buffering and the long term water resource management. New rules were implemented in 2005 and were trialled for two years. The Gouthwaite Board of Management decided against implementing spring and winter drawdowns because these could not be maintained in wet periods, and the risk of low reservoir stocks was too high in dry periods.

However the EA, YWSL, Gouthwaite Board of Management and the Knaresborough Flood Committee continue to work together to come to a mutual understanding and to resolve any issues identified.

3.5 Flood Warnings

There are two individual warnings that cover the Knaresborough Area. These two warning coincide with the central and eastern areas of the town defined in this report. The flood alert and warning areas for Knaresborough are shown in Figure 3.15. Alerts and warnings are issued to emergency responders businesses and householders who have registered for the flood warning service. It can be seen in Table 3.2 that there are over 6 hour’s difference in the times between the warning being issued for the east and central areas of Knaresborough.

The EA has defined levels within the upstream catchment and at Knaresborough at which flood warnings are triggered. When gauge levels at Pateley Bridge reach 3.5m, or Birstwith reaches 3.2m, a flood warning for the River Nidd at Knaresborough is issued. When the gauge at Knaresborough reaches 1.4m they consider issuing a flood warning for the River Nidd at Knaresborough caravan parks and when it reaches 1.9m they consider issuing a flood warning River Nidd at Knaresborough.

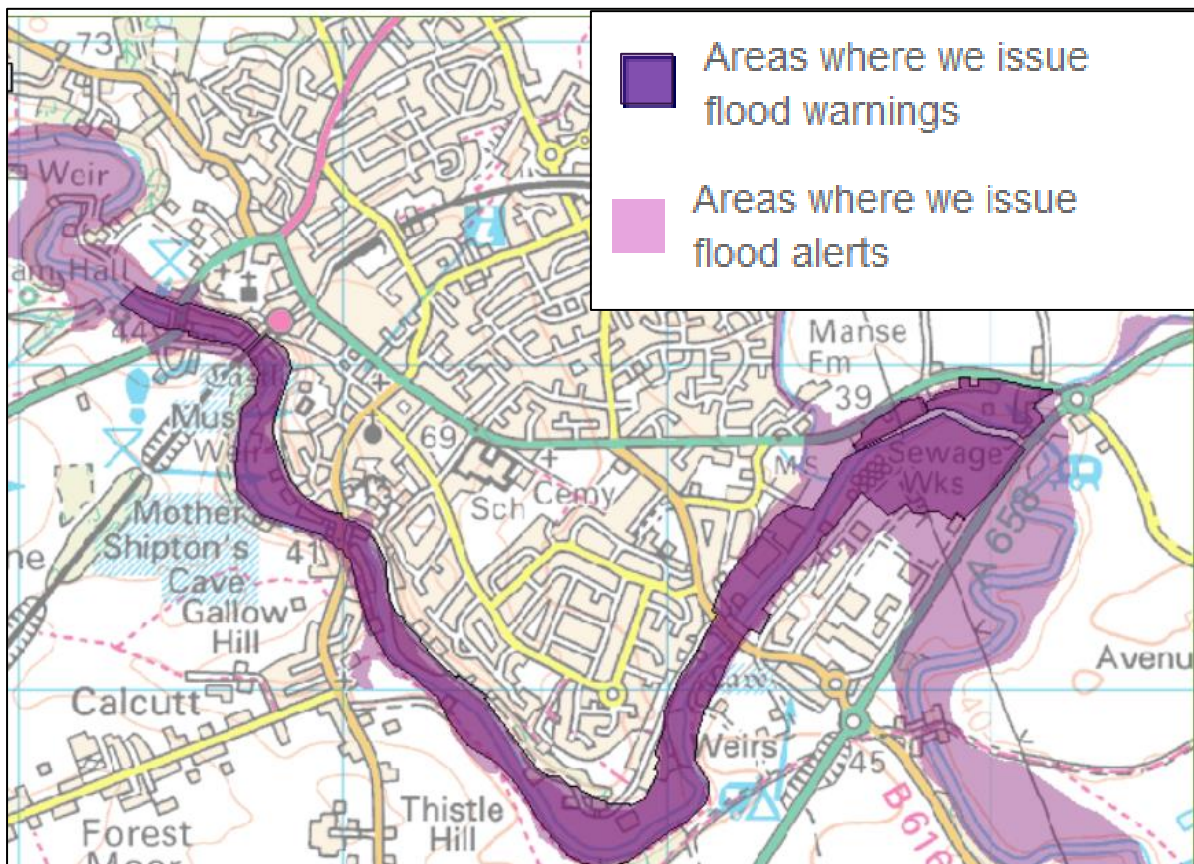


Figure 3.15 Flood warning and alert areas in Knaresborough (Source: EA)

Warning Name	Location Description	Flood Warning	Flood Warning no longer in

			force
River Nidd at Knaresborough	Riverside areas in Knaresborough including Waterside, Abbey Road and part of Manse Lane Industrial Estate	04:23 26/12/15	11:29 27/12/15
River Nidd at Knaresborough Caravan Parks	Riverside properties at Nidderdale Lodge, Lorisholme and Riverside Caravan Parks off York Road	21:53 25/12/15	11:29 27/12/15

Table 3.2 Knaresborough Flood Warning summary (source: EA)

The warning for the Caravan Parks were issued on the evening of Christmas Day. This allowed the owners and residents to take action to vacate their properties and move to a higher level before their exits was prevented by high water levels.

The warning for Knaresborough central areas was issue in the early hours of Boxing Day and some property owners have claimed that by the time they responded to the warning it had already become inundated, so they did not have the opportunity to limit the damage.

The details of flood warning triggers are been provided by the EA this has shown that the flood warning for central Knaresborough was issued at 04:23 when the River Nidd level at Knaresborough was 1.9m. The flood warning for eastern Knaresborough was issued at 21.53 when the River Nidd level was 1.6m. The EA are continuing to work with impacted residents and land owners to ensure the flood warnings are appropriate and timely.

3.6 Highways gullies

On 25th/26th December 2015 the storm intensity is likely to have been well in excess of a 1 in 100 year event and road gullies would have insufficient capacity. Typically the historic design criteria for surface water drainage networks is a 1 in 30 year event.

3.7 Public sewers

No reports have been received in relation to the flooding from the public sewer network. There was flooding to parts of the Knaresborough WWTW. YWSL have advised that temporary mitigation was placed on site during the event for any damaged equipment. Currently YWSL are in the process of replacing equipment that was damaged during the flood. No further details are available at this time.

4 Risk Management Roles, Responsibilities and Actions

4.1 RMA Responsibilities

4.1.1 Environment Agency

Under the FWMA the Environment Agency (EA) has a strategic overview role for all sources of flooding as well as an operational role in managing flood risk from Main Rivers, reservoirs and the sea. As part of this role the EA have developed a National Flood and Coastal Erosion Risk Management Strategy for England – ‘Understanding the Risks, Empowering Communities, Building Resilience.’

This national strategy outlines the EA’s strategic functions as:

- Ensuring that flood risk management plans (FRMPs) are in place and are monitored to assess progress. The plans will set out high-level current and future risk management measures across the catchment.
- Publishing and regularly updating its programme for implementing new risk management schemes and maintaining existing assets.
- Supporting risk management authorities’ understanding of local flood risk by commissioning studies and sharing information and data.
- Supporting the development of local plans and ensuring their consistency with strategic plans.
- Managing and supporting Regional Flood and Coastal Committees and allocating funding.

The EA’s operational functions include:

- Risk-based management of flooding from main rivers including permissive powers to do works including building flood defences.
- Regulation of works in main rivers through the consenting process.
- Regulation of reservoirs with a capacity exceeding 10,000m³.
- Provision of a flood forecasting and warnings service, working with the Met Office Hazard Warning Service.
- The maintenance and operational management of Main River assets including flood defences.
- Statutory consultee to the development planning process.
- The power to serve notice on any person or body requiring them to carry out necessary works to maintain the flow in Main Rivers.

‘Main Rivers’ are defined through an agreed map which is updated 2-3 times per year to reflect changes in the designation of a watercourse or in the environment. These Main Rivers tend to be the larger rivers in the country, though some smaller watercourses in sensitive locations are also defined as ‘Main Rivers’.

The EA are also category 1 responders regarding flood risk (Civil Contingencies Act 2004). They are required to warn and inform of flood risk.

4.1.2 Water Company

Water companies in England and Wales are named as a Risk Management Authority under the Flood and Water Management Act 2010 and must have regard to the Local Strategy of the LLFA. They are required to manage risks associated with assets or processes that may cause or be affected by flooding, and must share relevant data with other flood risk authorities.

They also have flood risk management functions under the Water Resources Act (1991). Relevant actions of water companies include: the inspection, maintenance, repair and any works to their drainage assets which may include watercourses, pipes, ditches or other infrastructure such as pumping stations.

The Civil Contingencies Act 2004 (CCA) also designates water and wastewater undertakers as statutory category 2 responders to national disasters and emergencies, placing on them duties to share assured information with other responders in an appropriate manner.

4.2 North Yorkshire County Council (NYCC)

NYCC, as LLFA, has flood risk management functions which include (but are not limited to);

- Provision of a Local Flood Risk Management Strategy (LFRMS).
- Designation and maintenance of a register of structures or features that have a significant effect on flood risk.
- Consenting and enforcement works on Ordinary Watercourses
- Responding to statutory consultations on drainage proposals in planning applications.
- Undertaking Section 19 investigations.

NYCC also has responsibilities as a Highways Authority and as an Emergency Responder (under the Land Drainage Act 1991 and the S19 Flood Investigation Report Civil Contingencies Act 2004 respectively) which may relate to flooding.

Highway Authorities are responsible for providing and managing highway drainage which may include provision of roadside drains and ditches, and must ensure that road projects do not increase flood risk.

The Highways Authority has a duty under the Highways Act 1980 to maintain highways that are maintainable at public expense. This includes a duty to maintain existing highway drainage. Highway drainage systems are designed to take highway surface water. Highway drainage systems are not designed as “storm drains”, and do not have the capacity for the level of rainfall from an extreme flash flood. The Highway Authority has powers to improve drainage systems but no duty to do so.

Roadside gullies are subject to routine maintenance in accordance with the NYCC Highway Asset Management Plan. The frequency of cleaning is dependent on an evidence based categorisation of risk, determined by factors relating to the consequence of failure and a range of other operational factors.

4.2.1 District or Borough Council

District and Borough Councils are named as Risk Management Authorities within the Flood and Water Management Act 2010, and are required to comply with the LLFA Local Strategy. Through the planning processes, they control development in their area, ensuring that flood risks are effectively managed.

In addition, in relation to the Civil Contingency Act (2004), the District and Borough Council:

- Category 1 Responder and may lead recovery work if specific to the Harrogate District area.
- Develop specific Multi Agency Flood Plans for known flood risk areas within the district.
- On a priority basis, they may provide sandbags to impacted residents and businesses where property is at risk of flooding.
- Support the Emergency Services on request by providing Incident Liaison Officers.
- Participate in identifying vulnerable people within affected areas.
- Provide emergency accommodation – i.e. set up rest centre as required and other welfare provision.
- Assist with arranging transport or evacuating areas.

4.2.2 Internal Drainage Board

Internal Drainage Boards (IDBs) are local operating authorities established in areas of special drainage need (typically low lying areas) in England and Wales. Their primary role is to manage water levels and reduce the risk from flooding within their designated drainage districts. Their work includes;

- Maintenance and improvement works on watercourses and related infrastructure.
- Consenting works on Ordinary Watercourses.
- Responding to consultations on drainage proposals in planning applications.
- Exercising permissive powers to undertake works where appropriate.

In managing water levels IDBs also have an important role in reducing flood risk in areas beyond their administrative boundary.

4.2.3 All Risk Management Authorities

All RMAs under the Flood and Water Management Act (2010) have a responsibility to cooperate and coordinate with regards to their flood risk management functions, including raising awareness of flood risk and the sharing of information.

4.2.4 Riparian Owners

Landowners whose land is adjacent to a watercourse are known as 'riparian owners'.

A landowner can be an individual e.g. home owner or farmer, private business or an organisation e.g. the district council as park owner, on school grounds the county council as property owner.

A watercourse is defined as every river, stream, ditch, drain, cut, dyke, sluice, sewer (other than a public sewer) and feature through which water flows, but which does not form part of a Main River.

Riparian owners have legal duties, rights and responsibilities under common law and the Land Drainage Act 1991 for watercourses passing through or adjoining their land. These responsibilities are to:

- Pass on the flow of water without obstruction, pollution or diversion affecting the rights of others
- Accept flood flows through their land, even if these are caused by inadequate capacity downstream.
- Maintain the banks and bed of the watercourse and keep structures maintained
- Keep the bed and banks free from any artificial obstructions that may affect the flow of water including clearing litter, heavy siltation or excessive vegetation.

Guidance on the rights and responsibilities of riparian ownership are outlined in the Environment Agency publication 'Living on the edge', available at

<http://www.environment-agency.gov.uk/homeandleisure/floods/31626.aspx>

4.3 Actions and Responses to December 2015 Floods

4.3.1 North Yorkshire County Council as Lead Local Flood Authority

The Flood Risk Management Team coordinates local multi-agency flood risk management.

NYCC has provided support to flood businesses and resident about the way which they can make their properties more resilient to flooding and provided government grants toward the cost of implementing resilience measures in their properties. Typical measures implemented in Knaresborough are the installation of flood prevention doors, construction of solid concrete floors, installation of air brick covers and connecting non-return valves on household drains.

NYCC FRM team has liaised with the EA and YWSL to confirm the operation of Gouthwaite Reservoir.

NYCC has undertaken clearance of debris accumulated in the River Nidd on the upstream face of Low Bridge.

4.3.2 North Yorkshire County Council as Highway Authority

The Highway Authority carries out regular gully pot cleaning and will continue to do so. No alterations to the highway drainage system in Knaresborough are proposed.

4.3.3 The Environment Agency

The following activities have been completed or instigated following the December 2015 event;

- EA staff carried out a flood patrol on the 1st January, collecting data and information immediately after the flood event.
- Staff have attended community meetings and provided guidance to resident on flood resilience measures.
- working with the Knaresborough Flood Committee, Yorkshire Water Services and Gouthwaite Board of Management to investigate the impact of Gouthwaite Reservoir on river levels at Knaresborough
- considering improvements to the flood warning service and will be commissioning a consultant to carry out a 'flood warning improvement study'
- Work to update the mapping and modelling in the area has been included in the Medium Term Plan for FCERM funding.
- After feedback from the Marigold Café the EA will be reviewing the service they receive.
- Working in partnership with HBC 3 new flood wardens have been recruited and trained

4.3.4 Yorkshire Water Services

YWSL has been carrying out repairs within Knaresborough WWTW where equipment was damaged during the flood event

Meetings, in September, have been held with the EA and the Knaresborough Flood Committee to discuss concerns raised in the local community about the operation of Gouthwaite Reservoir. YWSL delivered a presentation to the Committee which described the conditions and operating rules in place at Gouthwaite during the event.

YWSL has continued a dialogue with EA regarding use of reservoirs for flood risk management across a number of Yorkshire catchments.

4.3.5 Harrogate Borough Council

Harrogate Borough Council has undertaken the following activities

- Identified those properties affected by flooding during Storms Desmond and Eva
- Supported affected residents with council tax relief payments
- Supported affected residents with initial £500 flood payments
- Supported residents in the post flood event clean-up activities.

4.4 Conclusions

On the 26th of December 2015, significant rainfall in the middle reaches of the Nidd, falling on an already saturated catchment resulted in river levels in Knaresborough to rise causing flooding to a significant number of properties.

Both the antecedent ground conditions and the pattern of the rainfall in the catchment had particular consequences, both in terms of the scale of flooding and the lead times available for issuing warnings.

Although there may have been some impact from surface water flooding, the most significant flood source was from the River Nidd, with some impact in the east from The Rampart.

Impacted residents have raised concerns, individually and through the Knaresborough Flood Committee (KFC) regarding:

- The timing of flood alerts and warnings on the Nidd in Knaresborough
- The impact of the operation of Gouthwaite reservoir in River levels in Knaresborough.

Since the December 2015 event the EA have been working with local residents to refine the triggers for the warning in the centre of Knaresborough, and will be undertaking a flood warning improvement study in the area.

YWSL have provided details of the operation of the reservoir during the event which confirm there was no single release of water from the reservoir. With regard to the suggestion that the operation of Gouthwaite could be altered to provide flood risk benefit downstream, the screening assessment completed by the EA has concluded that there is very little potential for Gouthwaite to provide a benefit to Knaresborough.

Hand in hand with the timely and appropriate flood warnings are the community resilience plans developed with support of Harrogate Borough Council Emergency Planning Team. The communities at Riverside and Nidderdale Lodge to the east of Knaresborough where over 40 homes were flooded have established flood plans in place, and recent works carried out with the support of the Flood Resilience Grant scheme have further improved the resilience of these communities.

4.5 Recommendations

To reduce the risk of future flooding in the location, the following recommendations are made:

- Risk management authorities to cooperate in the assessment of catchment wide measures, including natural flood management, to reduce flood peaks in Knaresborough.
- The EA to report the outcome of the flood warning improvement study back to the KFC.
- HBC emergency flood planning to be reviewed in light of the 2015 flood event and any lessons learnt incorporated.

NYCC, as LLFA will continue to work with RMA's, and local stakeholders to develop action plans, both locally and on a catchment wide scale, to address the issues raised in this report.