NORTH YORKSHIRE COUNCIL

FLOOD INVESTIGATION REPORT

Storm Darragh Flooding on Rye Tributaries December 2024

Report Issued December 2025

Acknowledgements:

North Yorkshire Lead Local Flood Authority Team would like to thank the following for their cooperation and assistance in this investigation:

Local residents for their knowledge and assistance

Yorkshire Water Services Ltd

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North Yorkshire Council Highways Department

North Yorkshire Council Bridges Team

North Yorkshire Council Resilience & Emergencies Team

North Yorkshire Council Major Incident Response Team

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

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1. Executive Summary

On the 7th of December 2024, as a result of Storm Darragh over 87 properties were affected by flooding, with 81 experiencing internal flooding across the River Rye catchment. Storm Darragh brought intense rainfall and damaging winds across the UK and Europe, resulting in significant flooding across North Yorkshire. This report focuses on the communities of Kirkby Mills, Keldholme, Sinnington, and Marton.

The report draws on the best available data, including hydrological records and resident accounts, to assess flood risk and response. Analysis shows that while local rainfall totals were moderate (15–16 mm), saturated ground conditions and intense upstream rainfall (up to 80 mm) led to rapid runoff and high river levels. River level records were broken at Kirkby Mills and Sinnington, with the River Dove peaking at 2.454 m and the River Seven at 2.614 m.

Each village experienced distinct flooding mechanisms:

- Kirkby Mills: Combined surface water and River Dove fluvial flooding, exacerbated by pumping station failure.
- Keldholme: River Dove overtopping and surface water accumulation, with concerns over highway drainage and surface water flows.
- Sinnington: River Seven overtopping, surface water runoff from surrounding land, and gaps in flood warning system uptake.
- Marton: Breach of flood defences due to tree uprooting, blocked field drainage, reduced channel maintenance from the Environment Agency, a build-up of wrack affecting overland flows, and wind-driven water movement.

Considerations have been made as to the condition and performance of local drainage networks, using data from North Yorkshire Council and Yorkshire Water to assess whether infrastructure issues contributed to the severity of flooding.

Emergency response efforts were swift and effective, with rest centres, welfare support, and coordinated recovery operations deployed across affected areas. Medium and long-term resilience measures are underway, including a Property Flood Resilience (PFR) scheme and a Natural Flood Management (NFM) project aimed at reducing overall flood risk to some communities.

This report provides a comprehensive account of the December 2024 flood event and makes several recommendations to improve future flood resilience across the River Rye catchment.

2. Scope/purpose of report

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 on 7th December 2024, 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. The report focusses on the flooding in Kirkby Mills, Keldholme, Sinnington, Marton, Nunnington, Pickering and surrounding areas, it does not extend to other parts of the district or county.

The supporting data has been put together based on reports of flooding from a variety of sources. Whilst every effort has been made to verify the locations that were flooded, the nature of the data and the methods used to collate this information mean that it does not include every occurrence of flooding. Private individual properties which flooded are not identified in this report. This data only identifies general areas where flooding has been reported to the Lead Local Flood Authority (LLFA) and is indicative only.

3. 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.

4. Section 19 Investigation Requirement

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

(1) On becoming aware of a flood in its area, a lead local flood authority must, to the extent that it considers it necessary or appropriate, investigate —
   a. Which risk management authorities have relevant flood risk management functions, and
   b. Whether each of those risk management authorities has exercised, or is proposing to exercise, those functions in response to the flood.

(2) Where an authority carries out an investigation under subsection (1) it must —

a. publish the results of its investigation, and

b. notify any relevant risk management authorities.

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.

5. 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 based on:

- The relationship with the functions of other Risk Management Authorities.
- Number of properties internally flooded.
- The depth, area or velocity of flooding reported.
- The nature and extent of critical infrastructure impacted by the flood.

6. Event background

6.1.Location of this investigation

This report investigates flooding incidents relating to Storm Darragh, on the 7th of December 2024, causing widespread wind damage, power outages and flooding across the UK and Europe. In North Yorkshire, the Lead Local Flood Authority (LLFA) were made aware of internal property flooding in Kirkby Mills, Keldholme, Sinnington, Marton, Nunnington and Pickering. The flooding in Nunnington and Pickering involved an isolated number of properties, whilst equally devastating, this would not in isolation meet the trigger levels for a Section 19. Furthermore, looking at these locations in more detail would risk identifying individual properties. In accordance with section 3 of the North Yorkshire Local Flood Risk Strategy, all reported properties have been recorded and this report will therefore focus on the areas where significant levels of property flooding were reported to the council, these are: Kirkby Mills, Keldholme, Sinnington and Marton.

6.2.Kirkby Mills

Kirkby Mills (X: 470411, Y: 485945) is a small linear village roughly 0.7km east of Kirkbymoorside, with the A170 road running through the middle of Kirkby Mills. The River Dove flows to the east of Kirkby Mills, from the north in a southerly direction. Towards the north of Kirkby Mills, The Dove is split at a weir, into the Mill Race – a watercourse historically used by The Cornmill.

The etymology of Kirkby Mills likely comes from the Old Norse for “Church by the Mills”, with Kirk often relating to a place of worship.

LLFA records indicate that the drainage system in Kirkby Mills is a Yorkshire Water combined system. This combined system generally runs to the south, towards the Kirkbymoorside Waste Water Treatment Works. Yorkshire Water records note two Combined Storm Overflow outfalls in the River Dove, these both spilled in 2024, with Yorkshire Water noting this was due to "Hydraulic Capacity Issues"[1].

The local bedrock geology of Kirkby Mills is split between the north and the south. The north predominately comprises of the Upper Calcareous Grit Formation, of which sandstone is the most common constituent. To the south, the bedrock geology predominately comprises of the Ampthill Clay Formation and the Kimmeridge Clay Formation, generically formed of mudstone. Kirkby Mills has a layer of superficial deposits, compromising of Alluvium, clays, silts, sands and gravels, associated with The River Dove.

The annual rainfall from the nearest Met Office weather station, Fylingdales, is 979.68mm. [2]

6.3.Keldholme

Keldholme (X: 470958, Y: 486189) is a small village that is just to the northeast of Kirkby Mills. Grey Lane/Village Street runs from the north of Keldholme, connecting to the A170 to the south. The River Dove flows into Keldholme from the north, passing below Keldholme bridge, before bending towards the west 150m downstream of the bridge.

Keldholme is thought to be Scandinavian in origin, translating to island or river meadow near the spring. Historically, Keldholme was home to a Cistercian Nunnery named Keldholme Priory, which was situated on the northern bank of the River Dove in the west of Keldholme. Nothing remains of The Priory, save its namesake in some of the properties that exist on the site.

The foul water system in Keldholme appears to be primarily privately owned, with residents managing septic tanks. Yorkshire Water have no records of foul services in the area.

The local bedrock geology of Keldholme, is similar to Kirkby Mills as above.

The annual rainfall from the nearest Met Office weather station, Fylingdales, is 979.68mm.

6.4.Sinnington

Sinnington (X: 474428, Y: 485596) is a small linear village located approximately 3 miles to the east of Kirkbymoorside. The A170 connects the town to the wider highways network to the south of the village. The River Seven flows along the west of Sinnington, from north to south. At Sinnington Bridge, in the centre of Sinnington, The Seven meanders to the west, before continuing to flow towards the south.

[1] https://theriverstrust.org/key-issues/sewage-in-rivers
[2] Fylingdales Location-specific long-term averages

The name Sinnington is likely derived from the name of the river the settlement resides on the banks of, such as farm or homestead on the Seven.

The drainage system in Sinnington appears to be a mix of Yorkshire Water foul, combined and private networks.

Figure 1 Yorkshire Water waste network map of Sinnington

The local bedrock geology of Sinnington predominately comprises of the Ampthill Clay Formation and the Kimmeridge Clay Formation, generically formed of mudstone. Sinnington has a layer of superficial deposits, compromising of Alluvium, clays, silts, sands and gravels, associated with The River Seven.

The annual rainfall from the nearest Met Office weather station, Fylingdales, is 979.68mm.

6.5.Marton

Marton (X: 473476, Y: 483241) is a small village approximately 2.87 miles to the southeast of Kirkbymoorside and 1.77miles to the south of Sinnington.

Marton resides in a bend of the River Seven, which runs from the north of Marton, under Marton Bridge towards the south/southeast. Marton Bridge separates the east and west of Marton.

The local bedrock geology of Marton predominately comprises of the Ampthill Clay Formation and the Kimmeridge Clay Formation, generically formed of mudstone. Above this lies a superficial deposit of lacustrine deposits of clay, silt and sand.

The annual rainfall from the nearest Met Office weather station, High Mowthorpe, is 771.16mm[3].

7. History of flooding

A review has been undertaken of existing records of historical flooding including sources from, North Yorkshire Council Highways and Lead Local Flood Authority records, the Environment Agency's historic flood event outlines, historical newspaper records[4] and various correspondence from members of the public. The following flood history has been compiled from the information that has been made available to NYC.

It should be noted that the history of flooding is not exhaustive. North Yorkshire Council Lead Local Flood Authority team can only hold records when we are made aware of flooding.

7.1.History of flooding – River Dove

- July 1872 - Kirkby Mills: Streams rose 36 inches in a few minutes, causing significant flooding – York Herald
- July 1930 - Keldholme: Local properties flooded – Malton Messenger
- 1946 - Keldholme: Houses damaged by flooding with 3-4 ft of water – Yorkshire Post
- Autumn 2000 - Keldholme: Several properties flooded
- August 2002 - Kirkby Mills: Several properties flooded
- September 2008 - Kirkby Mills: Several properties flooded

[3] High Mowthorpe Location-specific long-term averages
[4] https://www.jbatrust.org/wp-content/uploads/2020/09/Yorkshire-Rye-and-N-York-Moors.pdf

- October 2020 - Kirkby Mills: Several properties flooded

7.2.History of flooding – River Seven

- May 1864 - Sinnington: Streams rose with unexampled rapidity carrying down trees and rocks – Yorkshire Gazette
- 1866 - Sinnington: Village flooded – Yorkshire Gazette
- 1866 - Marton: Water was 5ft deep in the village – Yorkshire Gazette
- Summer 1872 - Sinnington: Summer thunderstorms lead to many houses being flooded – York Herald
- August 1878 - Marton: All access to Marton suspended – York Herald
- November 1878 - Sinnington: Floodwater covered the village green – Malton Messenger
- September 1880 - Sinnington: Railway station was an island amongst floodwater, with some stating the flooding was worse than the 1878 flood event – Yorkshire Gazette
- June 1895 - Sinnington: The whole village was flooded from the Seven – Yorkshire Post
- September 1931 - Marton: Floodwater 10ft deep, in some places the flood water reached bedroom windows – Yorkshire Gazette
- September 1931 - Sinnington: The village was speedily inundated with many of the houses invaded by flood water. It is noted that all the records of flooding on the River Seven were broken – Yorkshire Gazette
- Autumn 2000 - Sinnington: Several properties flooded
- August 2002 - Sinnington: Around 10 homes were flooded and flood water cut off both ends of the village – York Press
- June 2007 - Sinnington: River Seven broke its banks, flooding the village – York Press and resident records
- June 2007 - Marton: Village was flooded with sandbags deployed – York Press
- September 2008 - Sinnington: The River Seven flooded homes with homeowners wading through three feet of water – York Press

7.3.Flooding summary

The River Dove and River Seven catchments have a long and well documented history of flooding, with events dating back to the 19th century and continuing into the 21st century. These flood events have repeatedly impacted communities including Keldholme, Kirkby Mills, Sinnington, and Marton, often causing significant property damage and disruption.

The most recent event occurred on the 7th December 2024, associated with Storm Darragh. This brought high rainfalls levels, resulting in both fluvial and surface water flooding.

8. Current understanding of flood risk

This section focuses on the perceived level of flood risk based on the current best available data and flood mapping.

The Rivers Dove and Seven run generally to the south from their sources in the North York Moors National Park. They both run into the River Rye, 4km apart from each other, which in turn joins the River Derwent 11km to the east. The difference in elevations between the northern steeper catchment and more southerly flatter catchment has a strong influence on the flood generating capacities of rivers. In the steeper north, rainfall will turn rapidly into surface runoff flowing quickly down into steep watercourses. Steeper river gradients and therefore higher flow velocities in the upper parts of the catchment also give greater erosive power to the rivers. In contrast the flat nature of the south of the catchment will generally mean that the onset of any flooding will be less rapid and flow velocities lower.

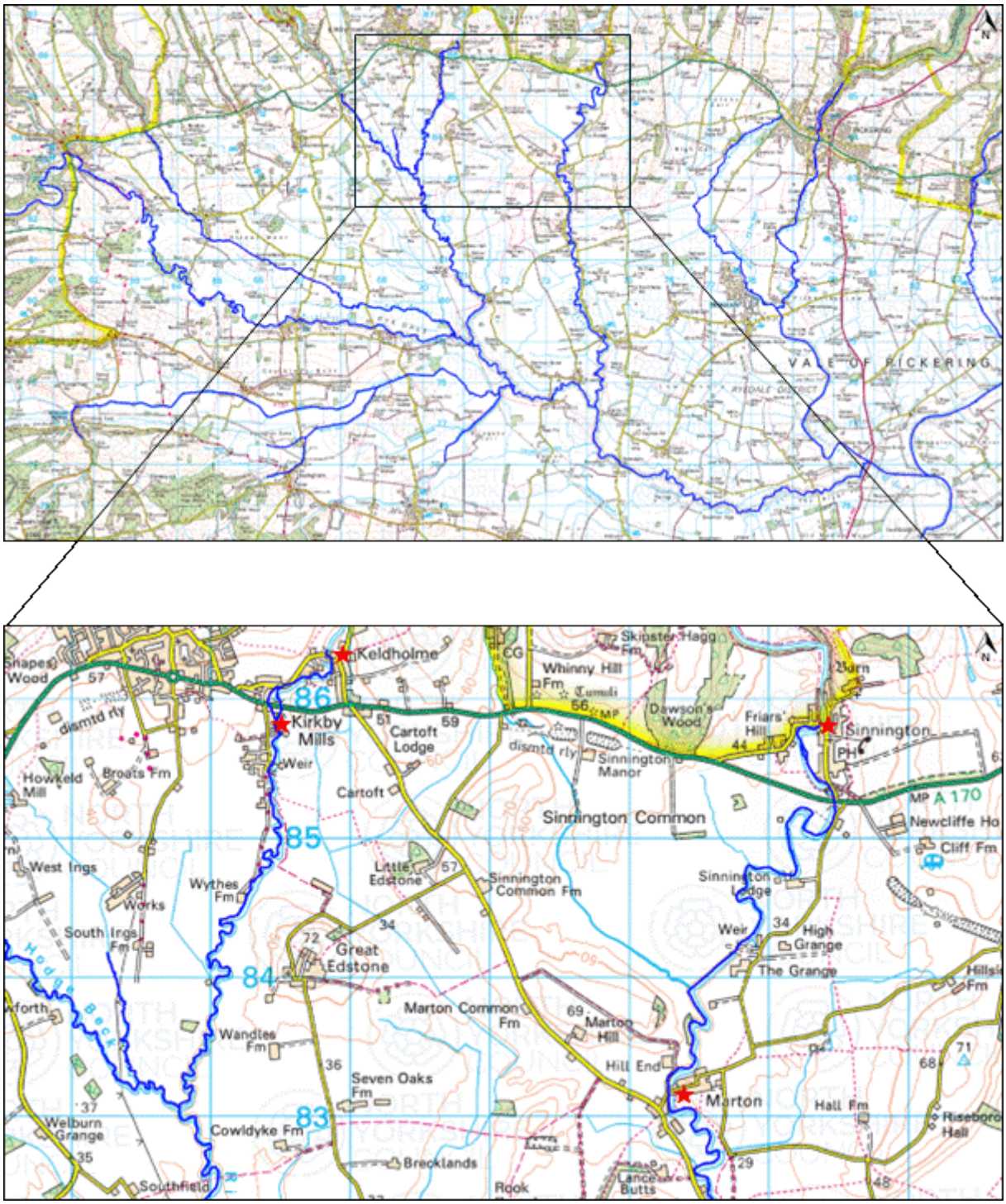


Figure 2 Fluvial map, showing the location of Keldholme, Kirkby Mills, Sinnington and Marton. Keldholme and Kirkby Mills are located on the River Dove and Sinnington and Marton are on the River Seven. Both rivers flow downstream to join the River Rye.

In general, Keldholme, Kirkby Mills and Sinnington are located on the "toe" of the North York Moors, on the transition between the steeper northern catchments and the flatter southern catchments. Due to the location of these villages, the rivers are likely to respond quickly to rainfall events higher up the catchment. Marton is located South of Sinnington, with topographically high points of Marton Hill, Golden Hill and Riseborough Hill surrounding the village.

A review of the Scarborough Borough and Ryedale Level 1 Strategic Flood Risk Assessment (SFRA), November 2021 has been undertaken. In the SFRA the villages of Kirkby Mills, Keldholme, Sinnington and Marton were identified as having residential properties at risk of flooding.

Further information regarding the risk of flooding can be found on the publicly available Flood Map for planning[5]. The Flood Map for planning Flood Zones have been created by the Environment Agency to be used within the planning process as a starting point in determining how likely somewhere is to flood. There are 3 flood zones as defined by the Environment Agency for river flooding:

1) Flood Zone 1 – Land having a less than 0.1% annual probability of river or sea flooding. (Shown as 'clear' on the Flood Map for Planning – all land outside Zones 2, 3a and 3b)
2) Flood Zone 2 – Land having between a 1% and 0.1% annual probability of river flooding; or land having between a 0.5% and 0.1% annual probability of sea flooding. (Land shown in light blue on the Flood Map)
3) and Flood Zone 3 – Land having a 1% or greater annual probability of river flooding; or Land having a 0.5% or greater annual probability of sea flooding. (Land shown in dark blue on the Flood Map)

The mapping is also generally limited to watercourses with a catchment area greater than $2km^2$. This means that some of the smaller watercourses may not have an indicative flood extent recorded on the system.

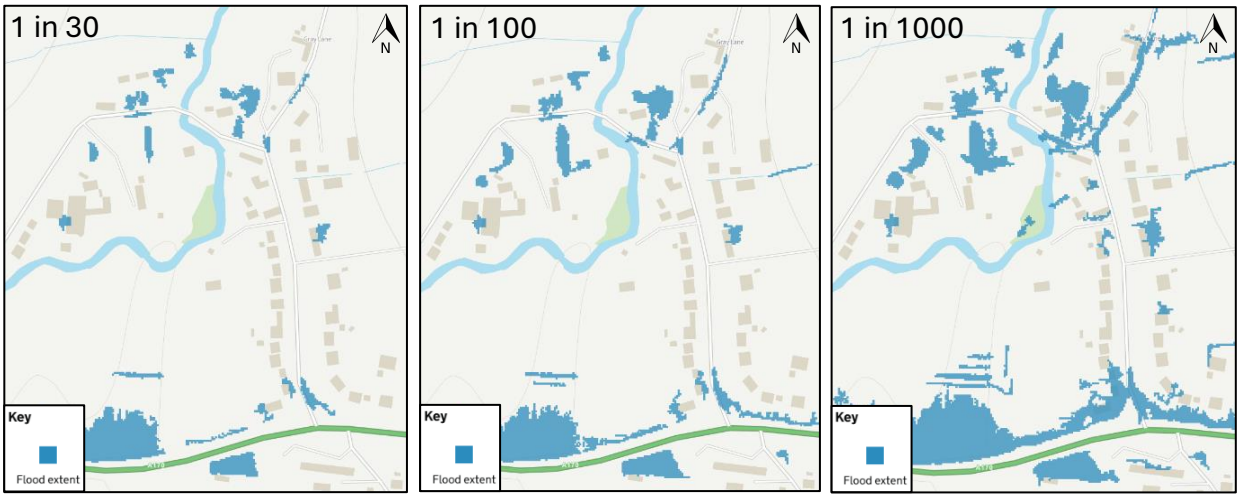
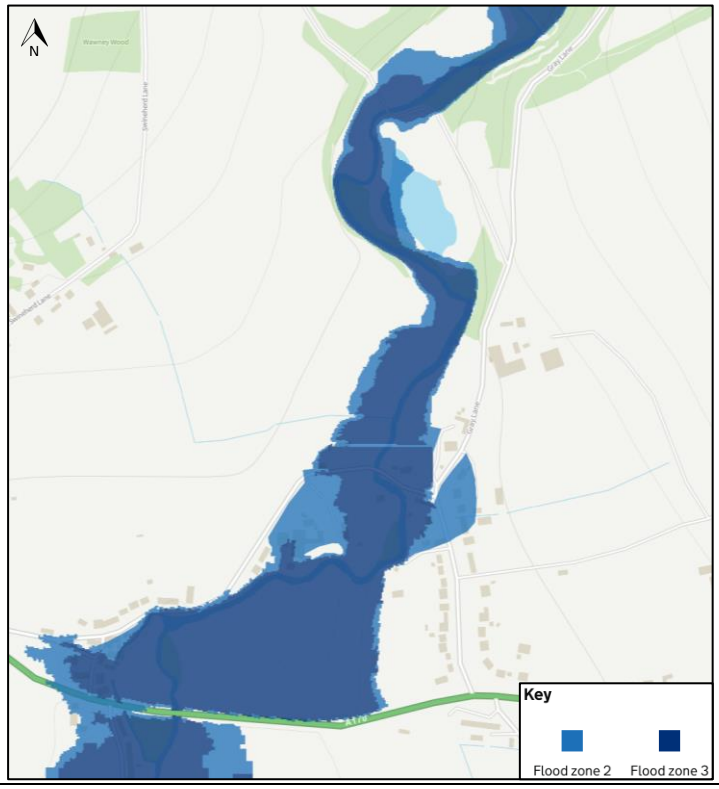
There are also 3 risk categories that breakdown the annual likelihood of surface water flooding:

1) 1 in 30-year – (3.3%) chance of flooding each year
2) 1 in 100-year – (1%) chance of flooding each year
3) 1 in 1000-year – (0.1%) chance of flooding each year

These areas have been defined following a national scale modelling project for the Environment Agency and are regularly updated using recorded flood extents and local detailed modelling. The mapping is largely based on modelled data and the information it therefore provides is indicative of the expected flood extent. The information is not sufficiently detailed to demonstrate risk at individual property level, primarily because the Environment Agency do not hold details about properties and their door thresholds and floor levels. Properties with higher floor levels may not always face the same chance of flooding as the areas that surround them.

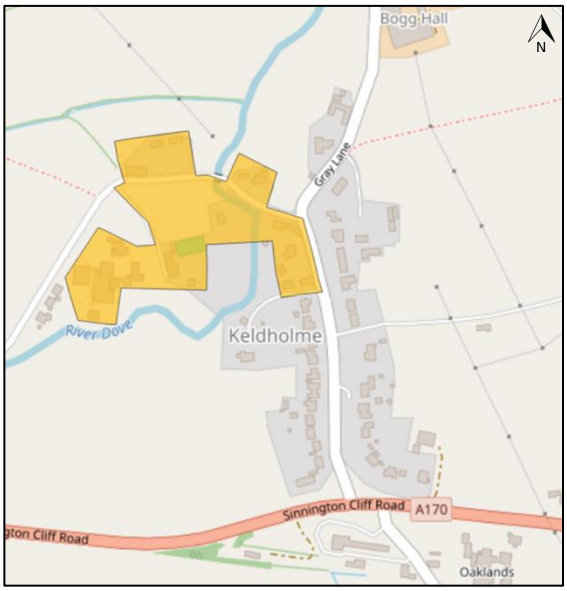
A mapped assessment of risk for each of the investigation areas are set out below.

[5] https://flood-map-for-planning.service.gov.uk/location

	Assessment of Flood Risk
Keldholme Surface water risk	 While the overall risk of surface water flooding to Keldholme is relatively low, there are patches of high risk throughout the village. These are most notable in two sections of the village, to the south where Village Street meets the A170 and the northern end of the village. The south of Keldholme is the lowest point of the village, with multiple overland flow paths converging at this point. To the east there is risk of surface water flooding associated with overland flow routes. Surface water flooding risk is linked to the topography of the land and overland flow routes.
Keldholme Fluvial flood risk	 The Government flood map for planning indicates that the west of Keldholme is in Flood zone 3, with some parts along Gray Lane and Village Street in Flood zone 2.

Keldholme

Flood warning alert areas and known flood defences

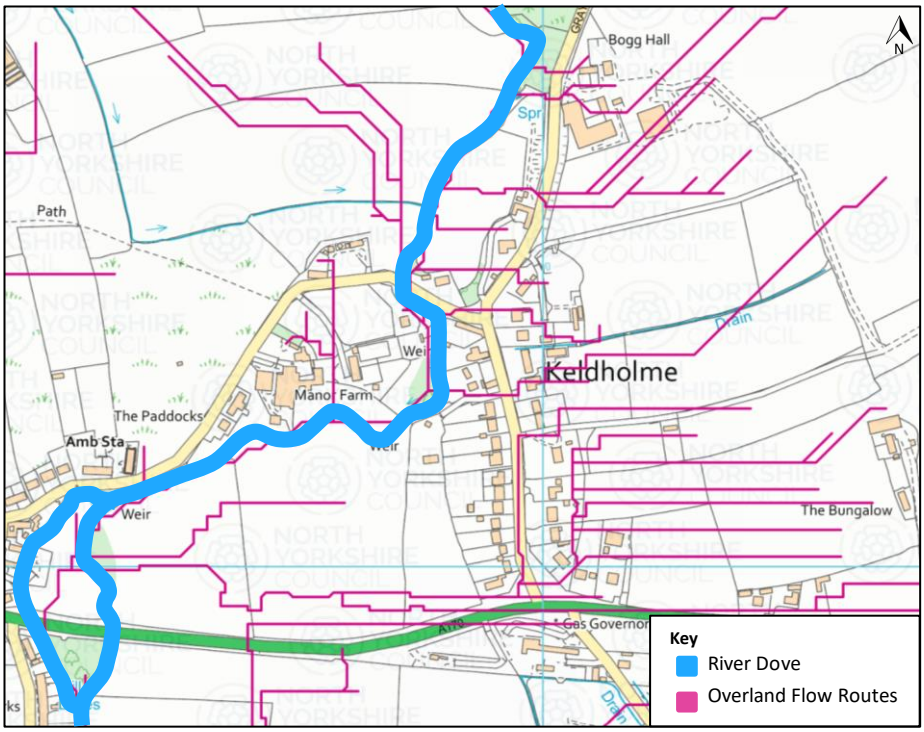


A western section of Keldholme is included within a Flood Warning Area. The warning is known as "122FWF809 Properties on Dove Way, Kirkby Mills, and Keldholme".

There are no known flood defences in Keldholme.

Keldholme

Overland flow Routes



Overland flow paths are the route that water takes over the surface. These are closely linked to the topography of the landscape, however they can also be impacted by physical features such as roadways and properties.

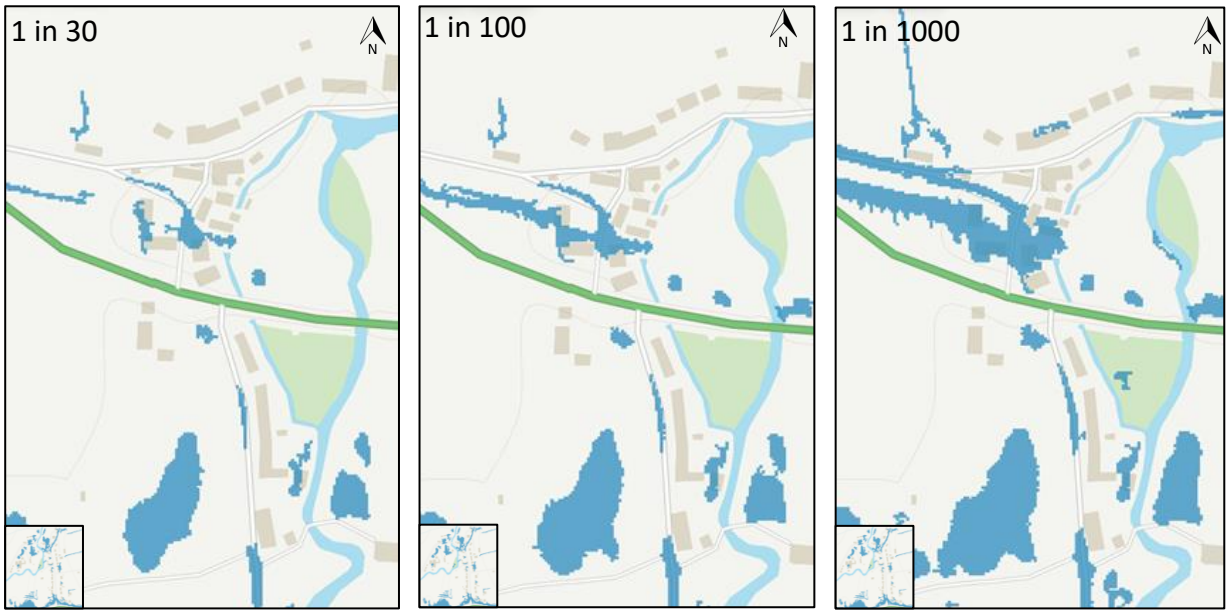
There are multiple prominent routes in Keldholme, most notably on the eastern side of the village flowing from east to west, following the hill side, to the River Dove. These are the paths runoff takes from the surrounding fields.

Overland flow paths can be closely linked to the roadways present, with a path following the southern section of Gray Lane, and a number of paths following the northern border of the A170. This is tied to high surface water flood risk.

Overland flow paths converge along the back of properties to the southern end of Gray Lane, and at points along the northern end of Gray Lane.

Kirkby Mills

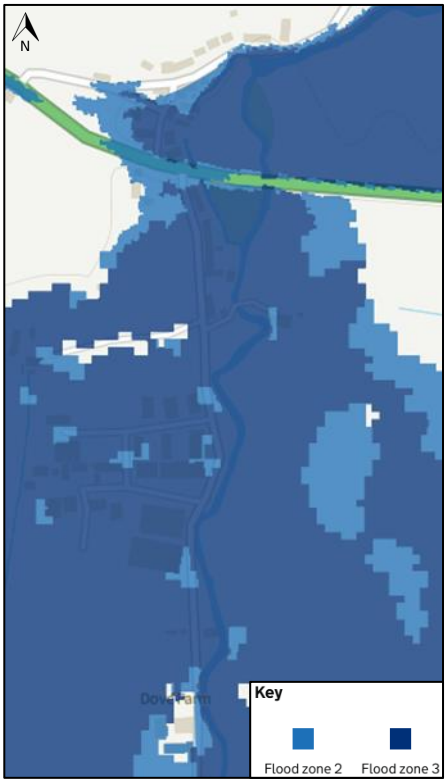
Surface water flood risk



A surface water flow route can be identified in the northwest of the above map, travelling south past the Kirkbymoorside Cricket ground. A further area can be found on the road to the north of the A170. Further areas of risk can be found running along Kirkby Mills Road, to the south of the A170.

Kirkby Mills

Fluvial flood risk



Kirkby Mills is covered fully by Flood zone 2 and 3, except for a small area to the north.

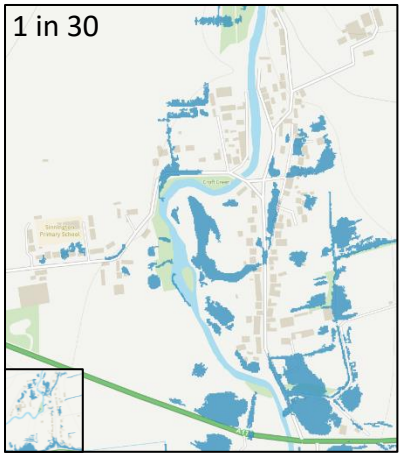
Kirkby Mills

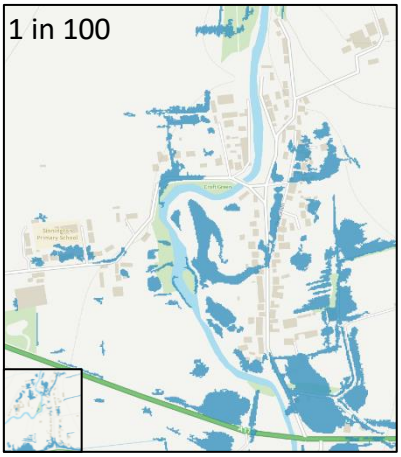
Flood warning alert areas and known flood defences

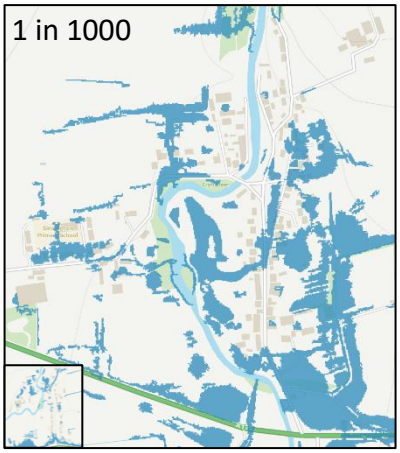
Areas to the west of the River Dove are included within a Flood Warning Area. The warning is known as "122FWF809 Properties on Dove Way, Kirkby Mills, and Keldholme".

Sinnington

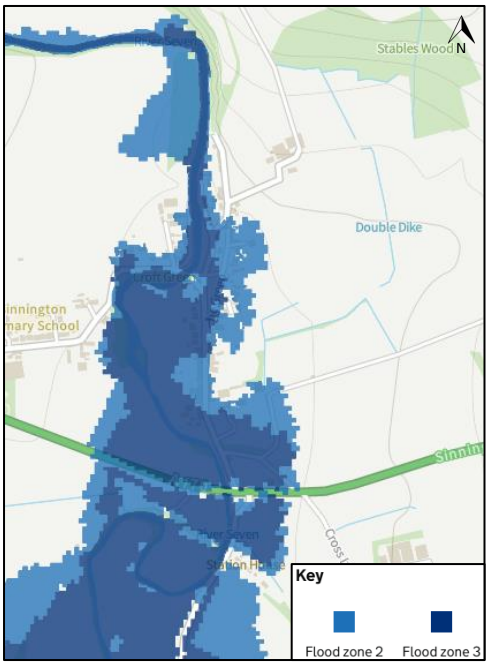
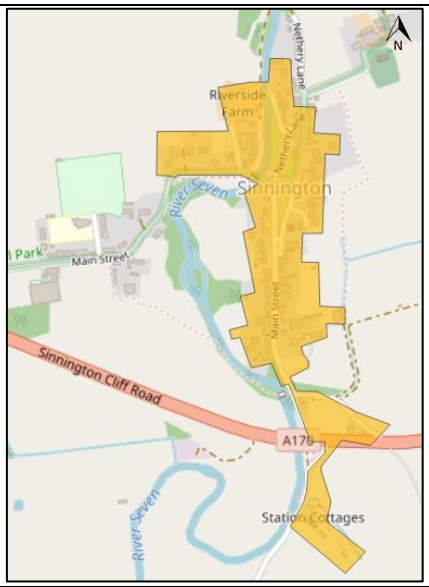
Surface water flood risk





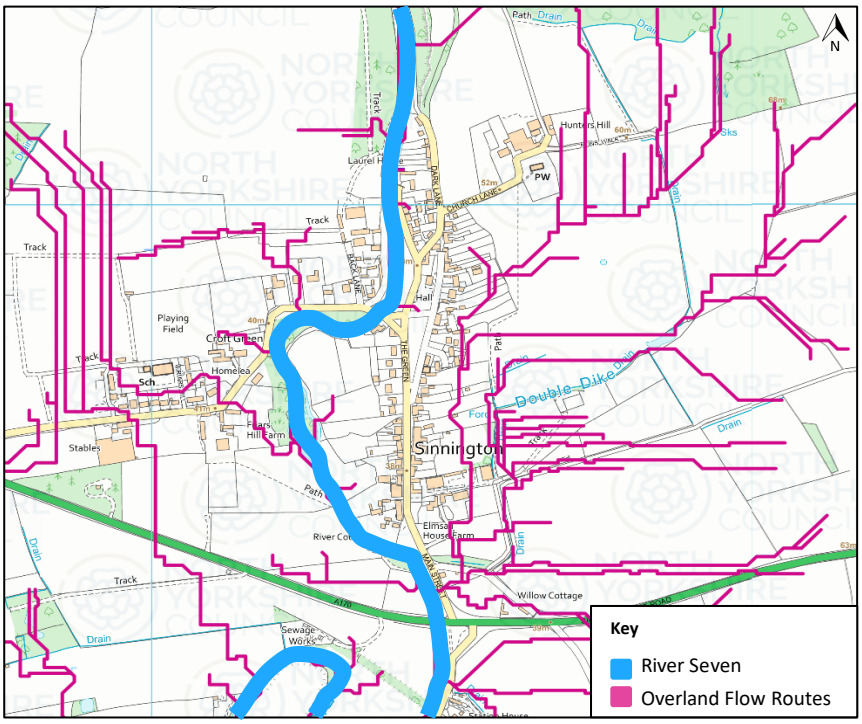


A large portion of Sinnington is at a high risk of surface water flooding. Areas of risk are present throughout the village, the most apparent being to the southeast on the fields behind The Green. This is potentially linked to the drain network present.

Sinnington Fluvial flood risk		As shown on the Government Flood Maps for planning, a large portion of Sinnington is in Flood Zone 2 and 3. The properites along Main Street and The Green, along the eastern edge of the river, are most affected by this. While most properties to the west are in Flood Zone 1.
Sinnington Flood warning alert areas and known flood defences		122FWF627 Properties along Main Street in the village of Sinnington

Sinnington

Overland Flow Routes



Overland flow paths follow the topography of Sinnington.

On the east of the River Seven, water flows northeast to southwest.

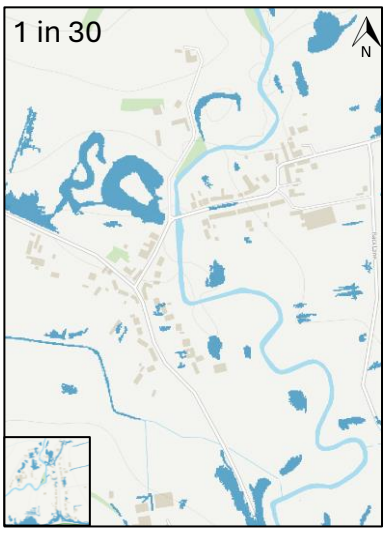
Flows come from Stables wood to the north, and from the fields to the east. All the eastern overland flows converge at one point near The Poplars, to the south of Sinnington, before joining the River Seven.

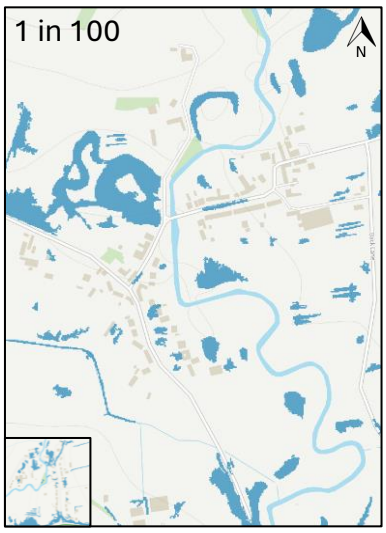
On the west of the River Seven there is a section of parallel overland flow routes that converge near the roadway, this is tied to an area of high surface water flood risk.

Throughout Sinnington a vast number of the areas at risk of surface water flooding, as shown in the flood risk maps above, can be linked to overland flow routes.

Marton

Surface water flood risk

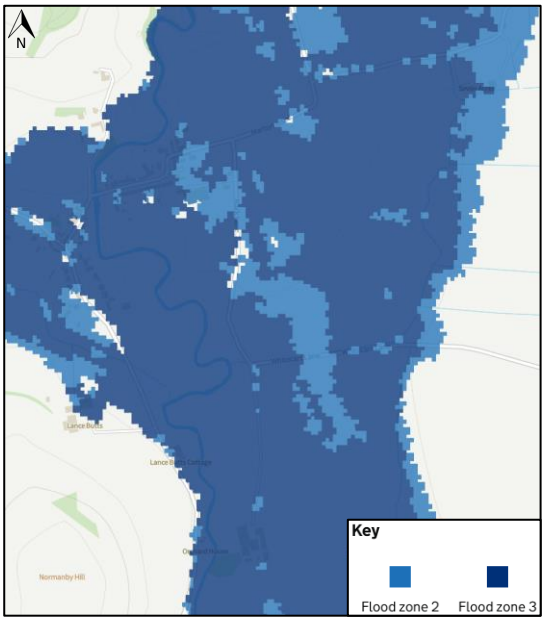


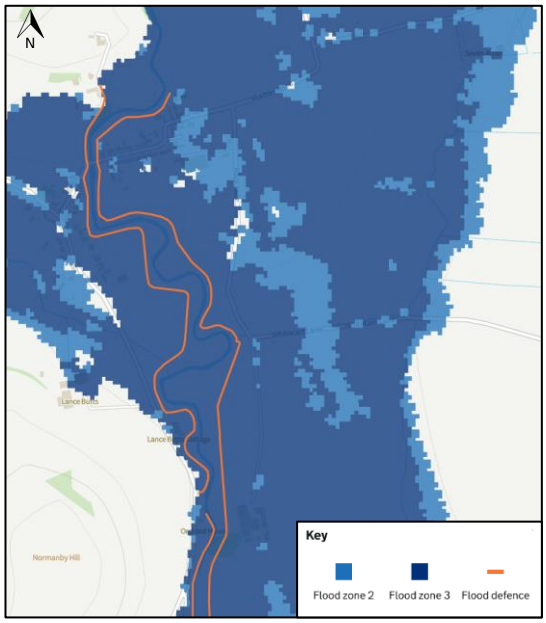


While areas of risk can be seen throughout the town, the most prevalent area is to the north-west. This section is a relatively flat, low point with slopes to the north and southwest, suggesting that the high surface water flood risk is linked to the topography of the landscape.

Marton

Fluvial flood risk



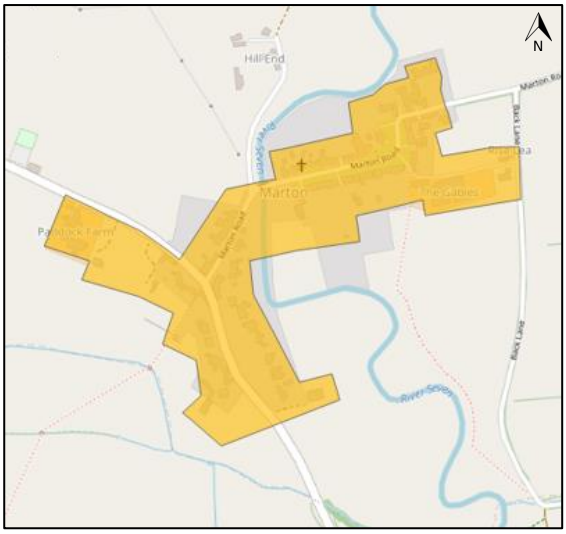


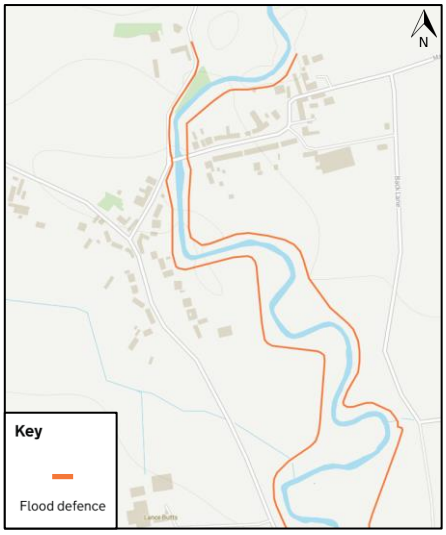
All of Marton is in Flood Zone 2 and 3, with the majority of properties being in Flood Zone 3.

The map to the right shows the location of the flood defences, as described in the map below, however does not display the impact this has on the flood zones.

Marton

Flood warning alert areas and known flood defences





The flood warning for Marton Village is 122FWF818 and includes properties in the village of Marton including Marton Road and Back Lane.

The orange line identifies the current known flood defences for Marton, this is a series of flood embankments along the banks of the River Seven.

9. Maintenance responsibilities

A "watercourse" is any river, stream or channel – including ditches, dikes, drains, culverts, cuts, sluices, sewers (except public sewers) through which water flows either permanently or periodically. Often a watercourse will be the boundary between two adjacent landowners and where this is the case the boundary is deemed to be the centre of the channel, the owner of the land or property on each side being responsible for maintenance of their side. This is referred to as Riparian Responsibility[6]. Culverts under roads are usually the responsibility of the relevant Highway Authority, either National Highways or North Yorkshire Council. Watercourses are designated as either being "main" rivers or "ordinary" watercourses.

The Environment Agency has powers, but not a duty, to carry out maintenance and regulate riparian activities on watercourses which have been designated as "Main" rivers. Where an immediate heightened risk of flooding has been identified, the Environment Agency may choose to act on those powers to remove obstructions to flow or enter into discussion with the riparian land owners to

[6] (Owning a watercourse - GOV.UK).

alleviate the immediate risk. The Environment Agency also has powers to build and maintain flood defences on these rivers where deemed necessary, proportionate and when funding is available. Within the Section 19 Investigation area, the River Dove and River Seven are designated Main rivers.

Watercourses which are not listed above, including Double Dike in Sinnington, are ordinary watercourses, and responsibility for these rests with their riparian owners. North Yorkshire Council as Lead Local Flood Authority has powers to enforce riparian owners to undertake maintenance, which are exercised proportionally according to the degree of flood risk.

Yorkshire Water is responsible for managing and maintaining the network of public sewers throughout the investigation area. Public sewer networks are either combined systems, where foul and surface water drain through the same pipes to the local waste water treatment works, or are separate systems where foul water is conveyed to the sewage works and surface water is conveyed either to a local watercourse or other receiving body of water, or to a point at which it joins the combined sewer network. The villages in this report are mostly served by combined and Foul Sewer systems, however there are some private foul systems in place.

10. Investigation

10.1. Rainfall event – location, depth and duration

The Met Office Seasonal Assessment for Autumn 2024[7] notes that autumn rainfall for the UK was 10% lower than the long-term average rainfall, however, large spatial differences were noted. For England, the autumn average rainfall was 20% higher than the long-term average rainfall. On the 23rd of November, Storm Bert hit the UK as the second named storm of the season. This brought 6 hours of persistent and extensive rainfall on the 23rd of November, with intermittent rainfall continuing into the 24th November[8]. This produced disruptive surface water flows and high river levels, which had a significant impact across Wales, with road flooding present within North Yorkshire. Between Storm Bert and the onset of Storm Darragh, 2 weeks of frequent short duration intermittent rainfall was present in the Rye area. Prior to the onset of Storm Darragh, on Thursday 5th December there were 2 hours of sustained intense rainfall, which maintained high river levels within the Derwent catchment. Storm Darragh, the fourth named storm of the season, began with a low-pressure weather system tracking to the west of Ireland on 6th December 2024. Red warnings for wind and yellow rain warnings were implemented for the UK on the 7th of December, with damaging winds and torrential rainfall predicted.

[7] Microsoft Word - Seasonal Assessment - Autumn24
[8] Microsoft Word - 2024_09_storm_bert_conall.docx

The weather chart (Figure 3) illustrates the location of the weather system over the UK and demonstrated that the UK was hit with a north westerly wind direction. The UK's prevailing wind direction is westerly or south westerly, the wind direction for Storm Darragh is not typical for a winter UK storm in this catchment. The below radar image demonstrates the rainfall that occurred over the region from 06:00 on the 7th December until 00:00 on the 8th December. The higher rainfall totals appear to correlate to the location of higher topography (North York Moors National Park), also known as orographic rainfall. The higher rainfall totals align with the source of the Rivers Dove and Seven, located within the North York Moors National Park.

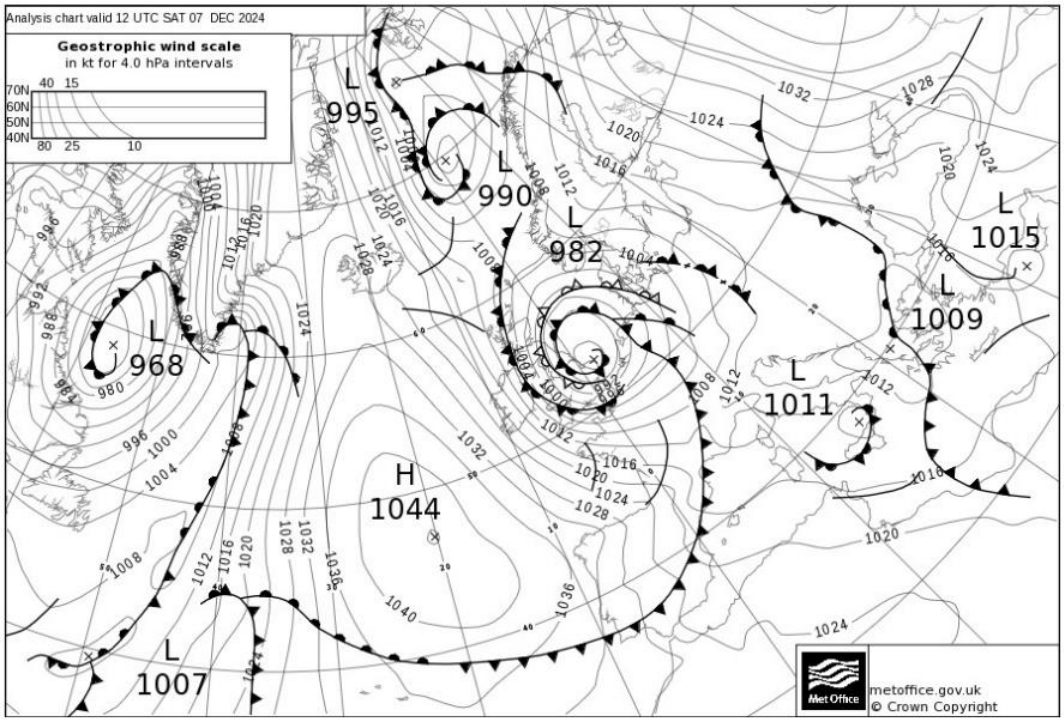


Figure 3 Location of weather system over the UK

For analysis and risk estimation purposes, the magnitude of rainfall is often expressed as return periods. A return period is a statistic derived from historical data and is the average time between events. For example, a rainfall event can be described as a 1 in 100 year rainfall event which means there is a 1% chance of that rainfall occurring in any given year.

Rainfall data provided to the LLFA from Yorkshire Water for the 7th of December 2024 recorded a peak rainfall intensity of 1 in 1 year return period at the areas that suffered flooding. The rainfall event also lasted approx. 12 hours, from roughly 9am to 9pm and totalled at 15.5mm of rainfall. Rainfall data provided by the Environment Agency from the sources of the River Dove and Seven, higher up in the catchment indicated a higher return period of 1 in 25 years, with about 80mm of rainfall accumulated within 25 hours. Met Office total rainfall maps are generally in agreement with the Environment Agency data (FIGURE XX).

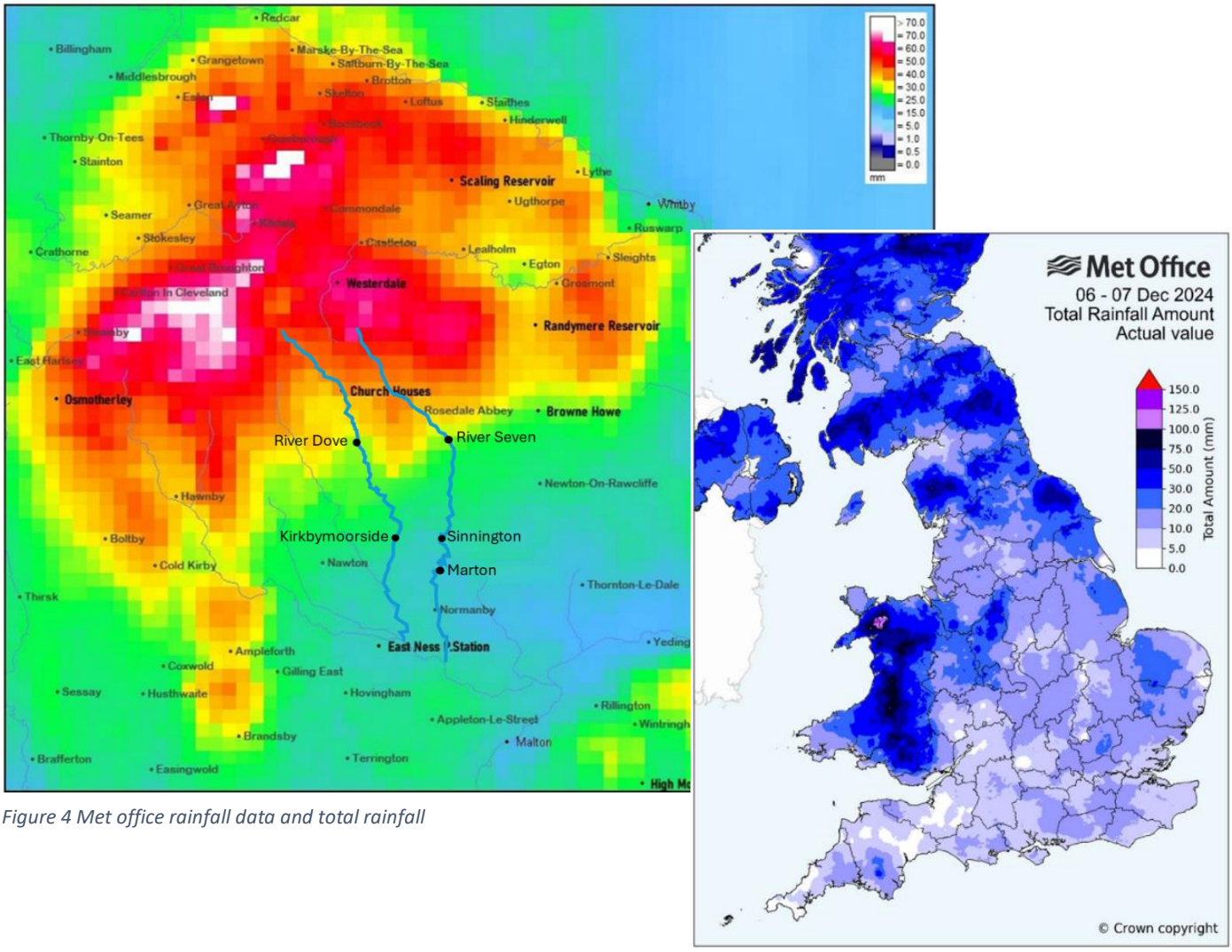


Figure 4 Met office rainfall data and total rainfall

11. Rainfall Gauges

11.1. Local Yorkshire Water Rainfall Gauges

The Yorkshire Water rainfall gauges are located locally within Kirkby Mills, Sinnington and Marton, so provide in situ records for the areas impacted by flooding. The rainfall gauges are corroborated against radar levels. The following graphs demonstrate the hourly rainfall for each area for the time of the Storm Darragh rainfall event.

Peak recorded rainfall for Kirkby Mills and Keldholme occurred at 16:45 with 2.11mm of water falling in an hour, with an accumulated rainfall of 11.3mm. By the end of the night, rainfall accumulations for the Kirkby Mills and Keldholme area had totalled 15.52mm.

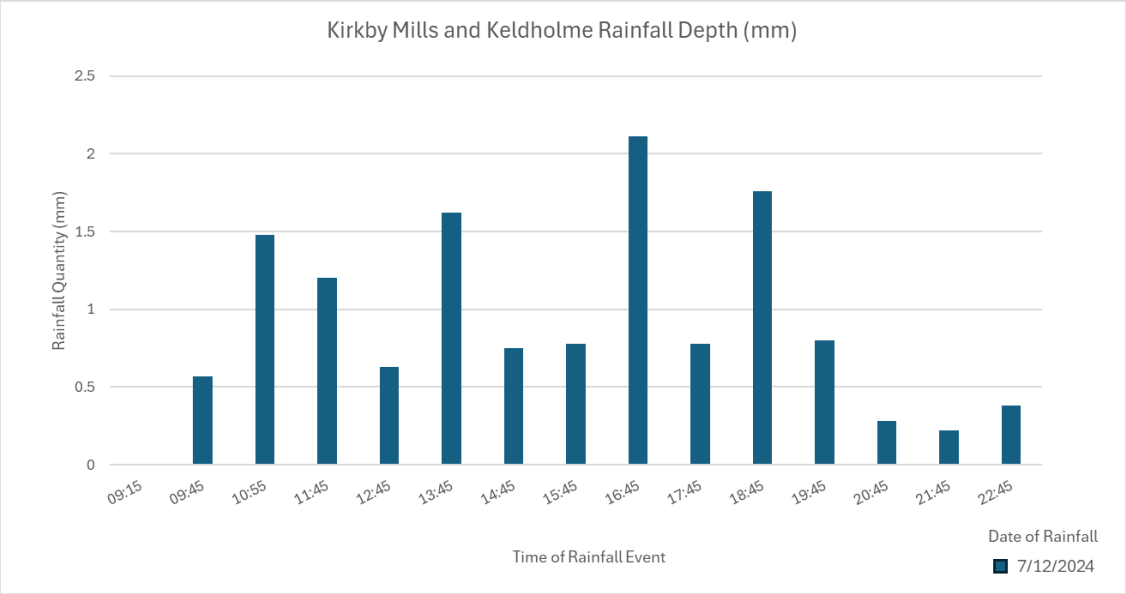


Figure 5 Kirkby Mills and Keldholme Rainfall Depth

The recorded peak rainfall for Sinnington on the 6th of December occurred at 20:50 with a total of 2.25mm for the hour. Peak rainfall on the 7th of December occurred at 10:50 with 1.46mm of rainfall recorded. By the end of the night, rainfall accumulations had totalled 14.55mm.

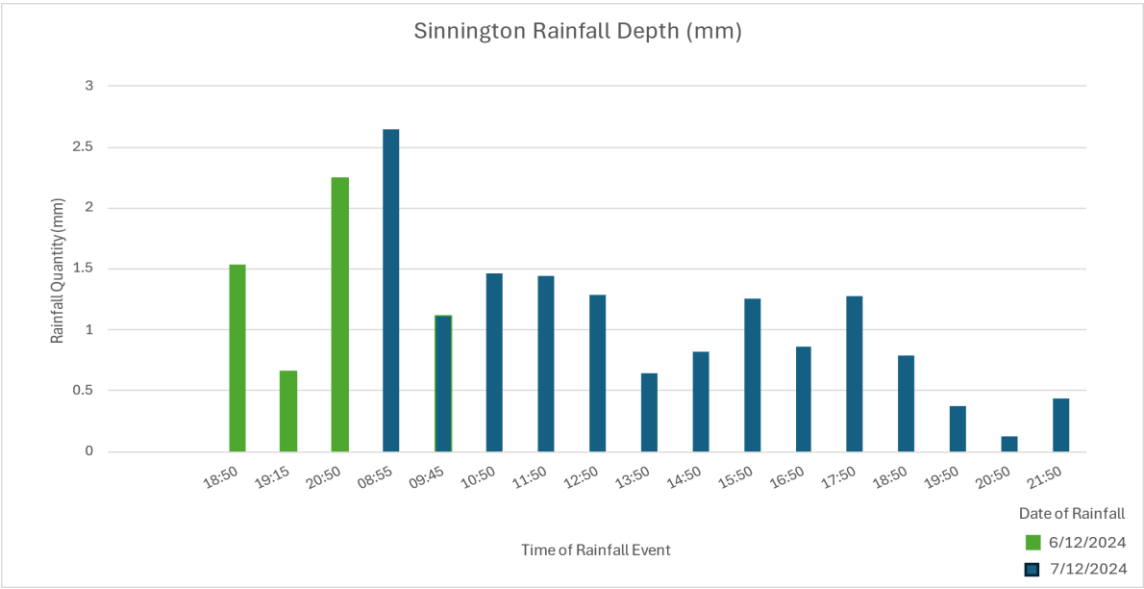


Figure 6 Sinnington Rainfall Depth

The reported peak rainfall for Marton occurred at 11:50 with a total of 1.44mm recorded for the hour. Peak rainfall accumulations totalled 14.34mm by 20:50.

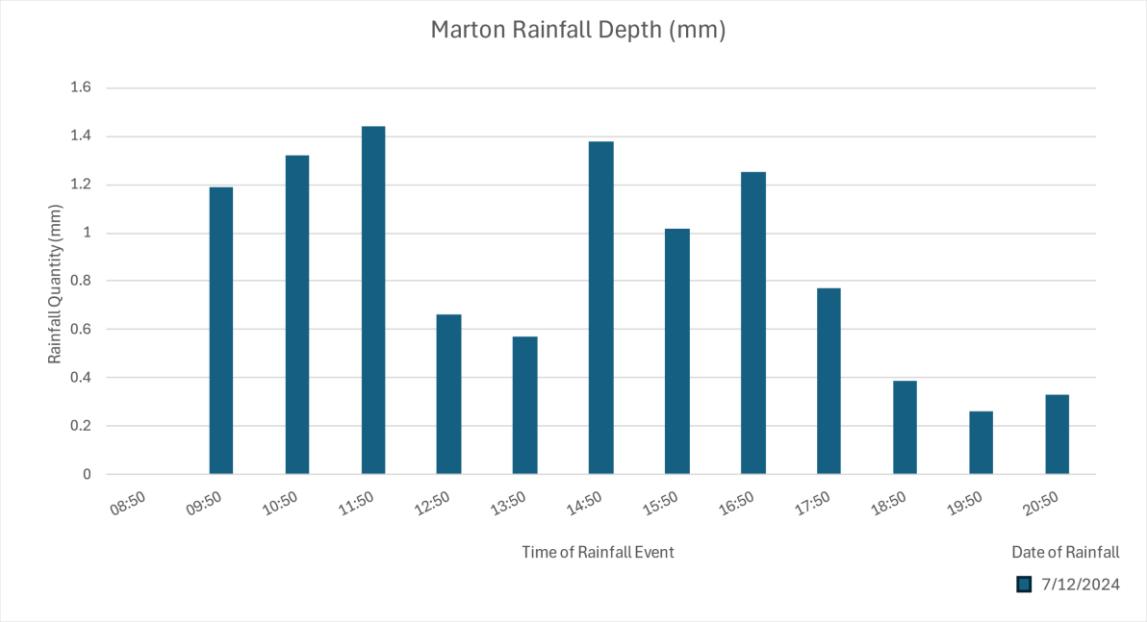


Figure 7 Marton rainfall depth

11.2. Environment Agency Rainfall Gauge vs River Level Data

The Environment Agency provided North Yorkshire Council rainfall data from their gauge at Church Houses, within the North York Moors National Park. The location of the rain gauge covers areas of the upper catchment of the River Dove.

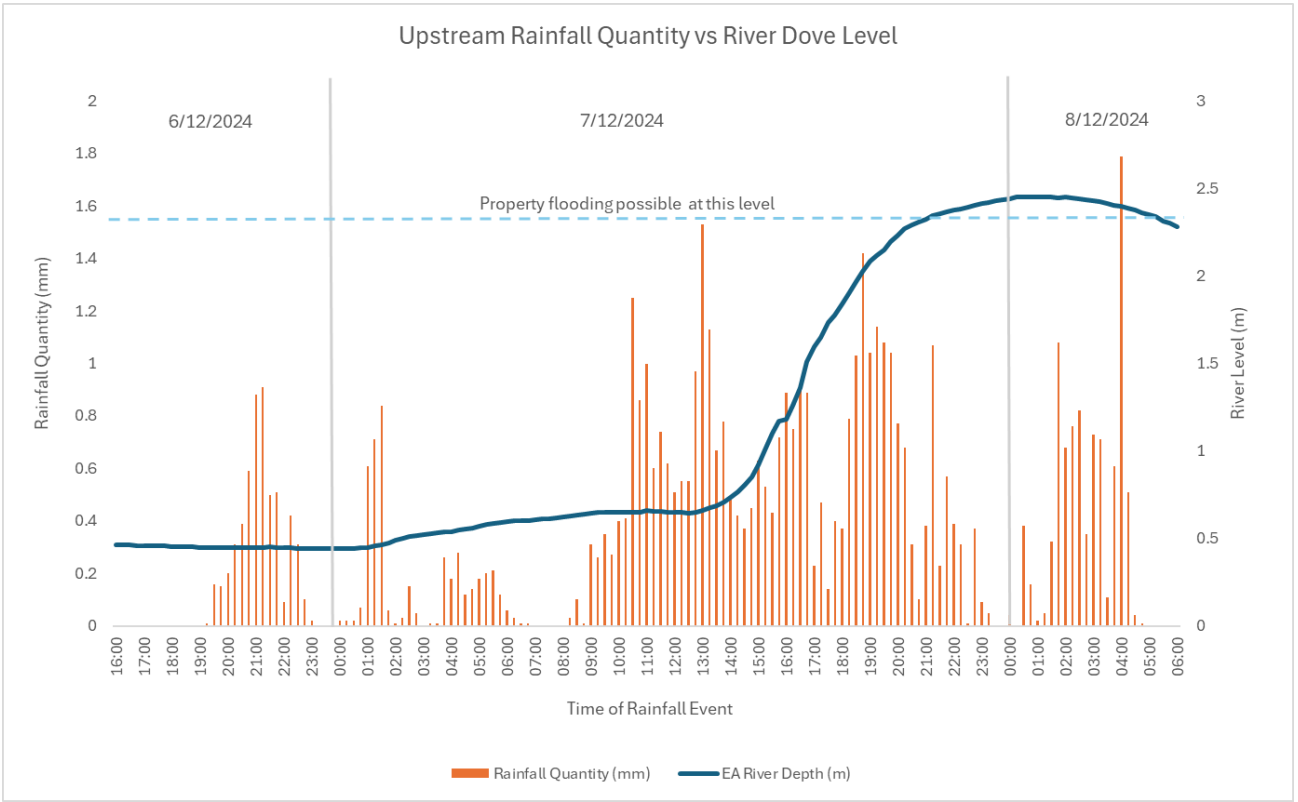


Figure 8 Upstream rainfall quantity vs River Dove level

The graph shows rainfall in the Dove catchment generally continued to fall from 19:00 on the 6th of December through to 04:45 on the 8th of December. Peak rainfall on the 6th of December occurred at 21:15 with a total of 0.91mm. Peak rainfall on the 7th of December occurred at 13:00 with a total of 1.53mm. Peak rainfall with totals of 1.79mm occurred at 04:00 on the 8th of December. In total, 55.07mm of rainfall fell within the gauge. The graph has the river level at Sinnington overlaid, there is an approximate lag time between rainfall and river level change of around 3.5-4 hours for the more intense rainfall spikes.

The Environment Agency provided North Yorkshire Council rainfall data from their gauge at Brown Howe, within the North York Moors National Park. The location of the rain gauge covers areas of the upper catchment of the River Seven.

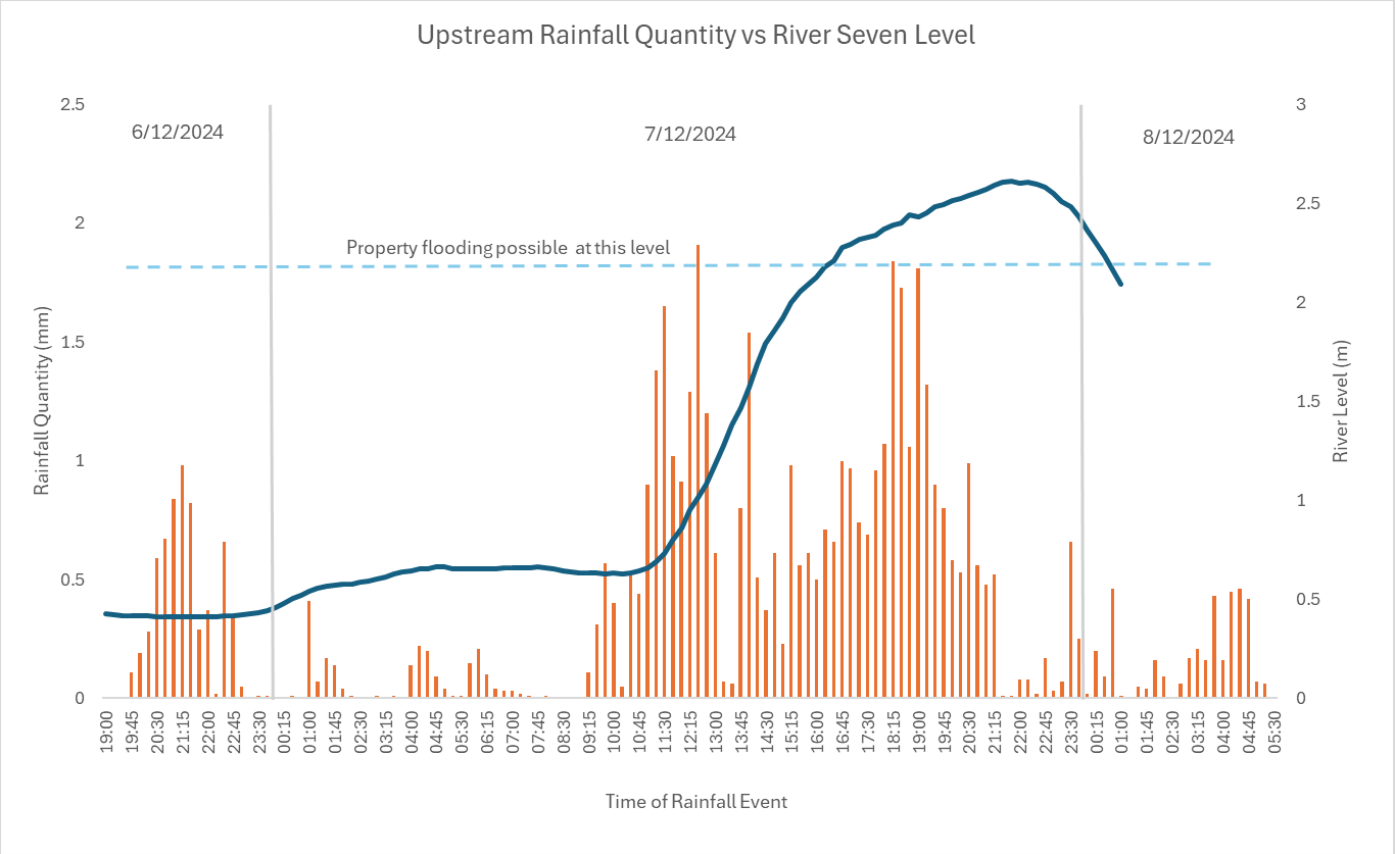


Figure 9 Upstream rainfall quantity vs River Seven level

The graph shows rainfall generally continued to fall from 19:30 on the 6th of December through to 05:30 on the 8th of December. Peak rainfall on the 6th of December occurred at 21:15 with a total of 0.98mm. Peak rainfall on the 7th of December occurred at 12:30 with a total of 0.91mm. Peak rainfall with totals of 0.46mm occurred at 00:45 and 04:30 on the 8th of December. In total, 53.59mm of rainfall fell within the gauge. The graph has the river level at Sinnington overlaid, there is an approximate lag time between rainfall and river level change of around 3.5-4 hours for the more intense rainfall spikes.

11.3. Rainfall discussion

The average rainfall locally for the villages impacted by flooding is around 15mm, which is not an unusually large amount of rainfall, however, it did fall persistently. The rainfall landed on already saturated land, leading to minimal infiltration and surface water flows, via the identified surface water routes within section 7.3.

The Environment Agency rainfall data is taken roughly from 8.5miles north/upstream of Kirkby Mills. The rainfall in this topographically higher area totalled 53.59mm for the entirety of the rainfall event, higher than the rainfall in the locally flooded areas.

12. Average River Level Data

To better understand how the rainfall has impacted river levels, data on the daily average river level of The Dove and Seven was requested from and supplied by the Environment Agency. The following graphs demonstrate the average base level of each river in November, and how the rivers responded to Storm Bert, 2 weeks of intermittent heavy rainfall, a 1 in 5 heavy rainfall event and Storm Darragh.

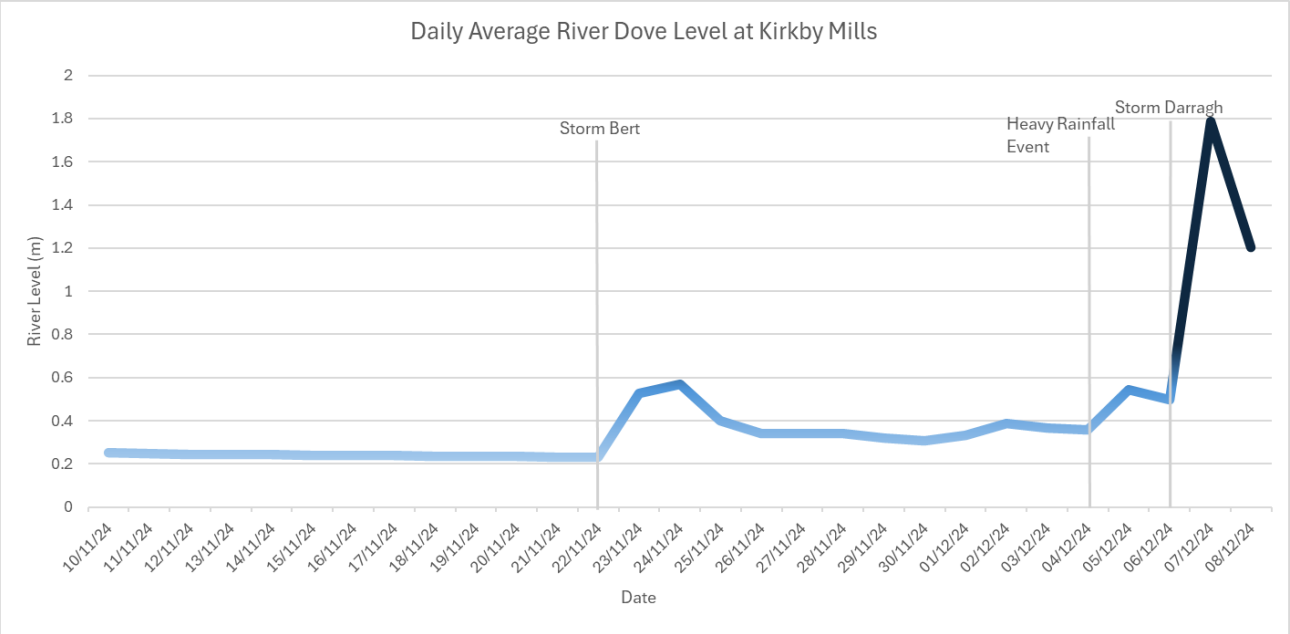


Figure 10 Daily average River Dove level at Kirkby Mills

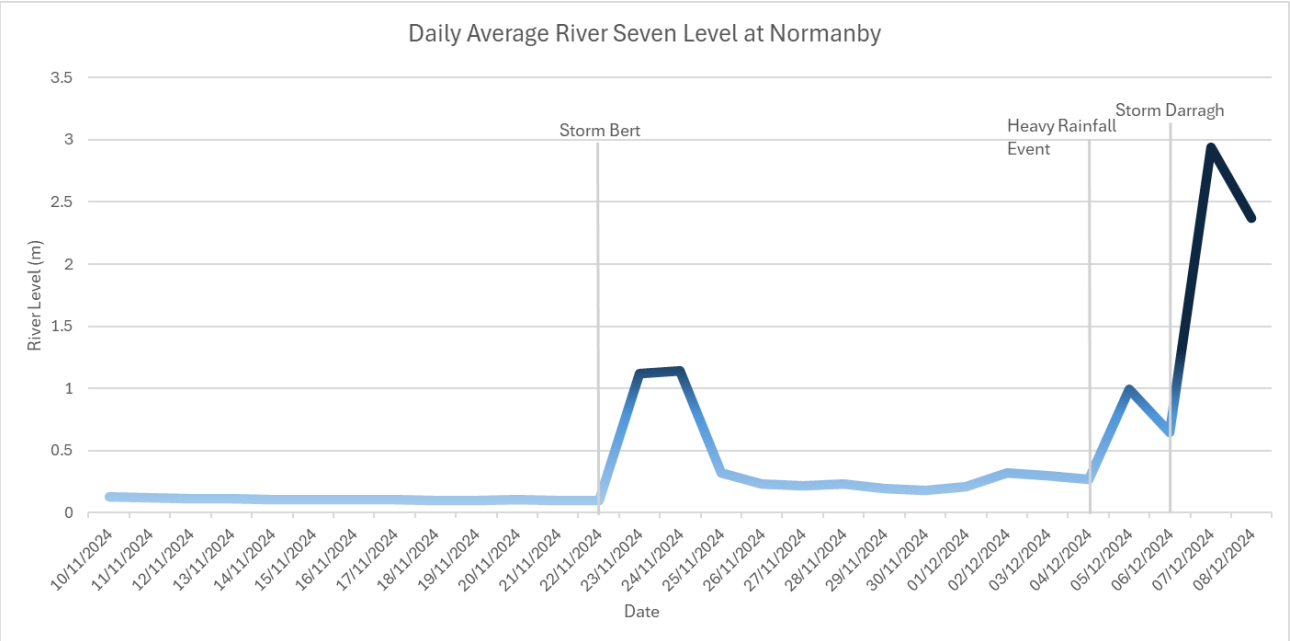


Figure 11 Daily Average River Seven level at Normanby

In general, both rivers responded with similar peaks to Storm Bert, with the rising limb in both cases rising at a similar rate to the heavy rainfall event on the 5th December. Two weeks of intermittent yet heavy rainfall kept the river levels higher than the rivers average base level. Prior to Storm Darragh, neither river level had fallen substantially to the pre 1 in 5 rainfall event levels.

12.1. River Level and Rainfall Discussion

Yorkshire Water's rainfall data was derived from radar observations rather than local in situ measurements. This introduces a degree of uncertainty, as radar-based estimates can differ from ground-based recordings, particularly in complex terrain or during intense storm events.

The Church Houses rain gauge, operated by the Environment Agency, displayed a data quality flag indicating incomplete records during the event. When compared with radar data presented in Section 10.1, it is possible that actual rainfall totals were higher than those recorded by the gauge, this is because the track of a storm can affect how much of the gauges pick up depending on their relative location to the heaviest rainfall. Radar estimates suggest that between 60 mm and 75 mm of rainfall may have occurred in the upper catchments of the Rivers Dove and Seven.

Environment Agency river level data can occasionally be affected by inaccuracies, particularly when river levels exceed bank full conditions, this overtopping can cause a weird effect near monitoring stations. These conditions can interfere with the accuracy of level recordings and should be considered when interpreting peak values.

During Storm Darragh, significant river level records were broken. On 8 December 2024, the River Dove at Kirkby Mills reached a new peak of 2.454 metres, surpassing the previous record of 2.451 metres. Similarly, the River Seven at Sinnington recorded a new high of 2.614 metres on 7 December

2024, exceeding the previous record of 2.595 metres. The hydrograph for this event showed a sharp rising limb, indicative of rapid runoff and intense rainfall.

Prior rainfall events had elevated baseline river levels, and ground conditions were saturated at the time of Storm Darragh. These factors contributed to increased runoff rates and reduced infiltration capacity. Notably, the storm system approached from the north, directing rainfall consistently into the upper catchments of the Rivers Dove and Seven. This contrasts with typical westerly storm tracks, which tend to distribute rainfall more evenly across multiple catchments. The northerly trajectory of Storm Darragh resulted in concentrated rainfall over the Rye catchment, exacerbating flood conditions.

13. Response to Storm Darragh

13.1. Initial

During the response to Storm Darragh, the Resilience and Emergencies Team (RET) deployed Bronze Commanders to liaise with the Emergency Services and a rest centre was opened in cooperation with the Town Council at the Moorside Room for people who had to leave their homes. Again, with help from the Town Council, RET helped co-ordinate the recovery for local residents by opening a Local Assistance Centre (LAC) also at the Moorside Room, where a number of North Yorkshire Council teams based themselves for over 2 weeks. These NYC teams included RET, Social Care, Housing, Highways, Localities, Stronger Communities, Flood Risk Management, and the Major Incident Response Team (MIRT) who were able to give welfare and trauma support. With help from volunteer groups who also based themselves at the LAC, the council provided skips and helped residents with furniture and carpet removal from flooded properties as well as help with insurance claims and general flood advice. Everyone worked very closely with partners such as Northern PowerGrid and the Environment Agency and NYC helped to facilitate several grants awarded by Two Ridings and continued to make welfare checks long after the LAC closed.

Following the immediate emergency response to flooding caused by Storm Darragh, the Flood Risk Management team conducted site visits to affected areas. These visits focused on gathering evidence of flooding impacts and engaging with residents to provide information and invite them to dedicated drop-in sessions scheduled for January 2024.

In Marton, the Environment Agency carried out temporary embankment repairs in December after a tree was uprooted, compromising the bank's integrity. A full repair is required to ensure long-term resilience, this has been bid for by the Environment Agency. In addition, tree clearance operations have been ongoing to reduce future flood risk and improve access for maintenance.

13.2. Medium Term

The Resilience and Emergencies Team is actively working with parish councils across the catchment to strengthen local flood preparedness. This includes supporting the development of community emergency plans, identifying key local risks, and ensuring that residents are aware of response procedures during flood events.

A Property Flood Resilience (PFR) scheme is underway to support residents in Keldholme, Kirkby Mills, and Sinnington. Initial surveys are complete, with installation surveys ongoing. The scheme is funded by North Yorkshire Council, Grant in Aid, and Local Levy, and will deliver tailored resilience measures to reduce property-level flood risk and improve recovery. Progress is being monitored, and residents are being kept informed throughout delivery.

The Environment Agency started a Natural Flood Management project in 2023 in partnership with Yorkshire Wildlife Trust and the Derwent Catchment Partnership. It aims to deliver 11,000m³ of water storage across the 59km² catchment, reducing flood risk to 12 properties in Kirkby Mills.

Measures include leaky barriers, ponds, scrapes, planting, buffer strips, and floodplain reconnection. A key 17-hectare site at Grouse Hall performed effectively during Storm Darragh by storing and slowing a large volume of water that could have made its way downstream. The project also improves 9 hectares of habitat and 5km of watercourse, with additional funding secured for wider environmental benefits. Completion is expected within the current financial year.

13.3. Long term

The long-term response will be guided by the recommendations within this report.

14. Flooding Consequences and mechanisms /Impact of flooding

14.1. Summary

The Lead Local Flood Authority collected data on the impacts of flooding in the following ways; discussions with locals on village walk throughs, flood risk questionnaires submitted by locals, discussions with local residents during the 3 drop in sessions, email correspondence and Section 14 data requests of involved Risk Management Authorities (Yorkshire Water, Environment Agency, NYC Highways, NYC Bridges and NYC Resilience and Emergency team).

In total 87 properties flooded internally or suffered near misses. The properties that suffered near misses, only did so by defending their properties with sandbags, existing property level resilience (flood gates for example) and makeshift defences. The Fire Brigade were called out to a report of a vehicle stuck in flood water in Marton and to redirect water via pump in Kirkby Mills.

14.2. Kirkby Mills

A total of 21 records of internal flooding and near-miss events were reported in Kirkby Mills during the incident. The Environment Agency notes that an alert was issued at 16:00 and the warning at 21:26. According to residents, a flood alert was issued at approximately 20:25, with river water entering properties around 21:00.

Surface water flows were observed travelling from Kirkbymoorside towards Kirkby Mills along the A170 and the access road to Kirkby Mills and Keldholme. These flows accumulated in a topographical low point on Kirkby Mills Road, adjacent to the access road to The Cornmill. In this location, three highway gullies were reported to have surcharged. Residents raised concerns regarding the quantity of surface water runoff they witnessed coming from Swineherd Lane, past the Cricket Ground and into Kirkby Mills, with several residents stating the quantity of surface water during Storm Darragh was more than had been witnessed recently. North Yorkshire Council Highways noted in their Section 14 response that the gullies in this area are cleaned annually and were last cleaned due to a response to Storm Darragh on 23/12/2024.

To the south of the A170, the first property was reported to have flooded at approximately 16:00 due to an overtopping of the Mill Race. This property is situated within a local topographical low spot. Additional properties in the area were affected by flooding from the front, attributed to a combination of water pumped from the north of the A170, surface water runoff from the A170 itself, and river water that had escaped through gaps between properties.

Yorkshire Water reported telemetry data indicating a power failure at their pumping station south of Kirkby Mills at 17:22, with a second failure occurring at 23:11. The latter event also affected the backup system. During pump failure, excess water was diverted to the River Dove via an overflow pipe. Yorkshire Water have noted that this pipe has a low outfall elevation. At 23:11, river levels were recorded at approximately 2.4 metres, likely submerging the outfall and causing surcharge in the vicinity of the pumping station.

Discussions with residents and Yorkshire Water identified a potential hydraulic restriction on the Mill Race caused by a Yorkshire Water Combined Sewer Overflow (CSO) pipe, which crosses in front of a small bridge over the Mill Race. Residents noted seeing water overtop at this location. This pipe may affect conveyance, however, the Dove will have been high and backing up the Mill Race, therefore water would be backing out of channel, nonetheless. A report from the North Yorkshire Council Bridges Team also indicated the presence of silt at this bridge. These two factors may have contributed to a reduction in channel capacity at this location, however, the impact would have small on the overall flooding.

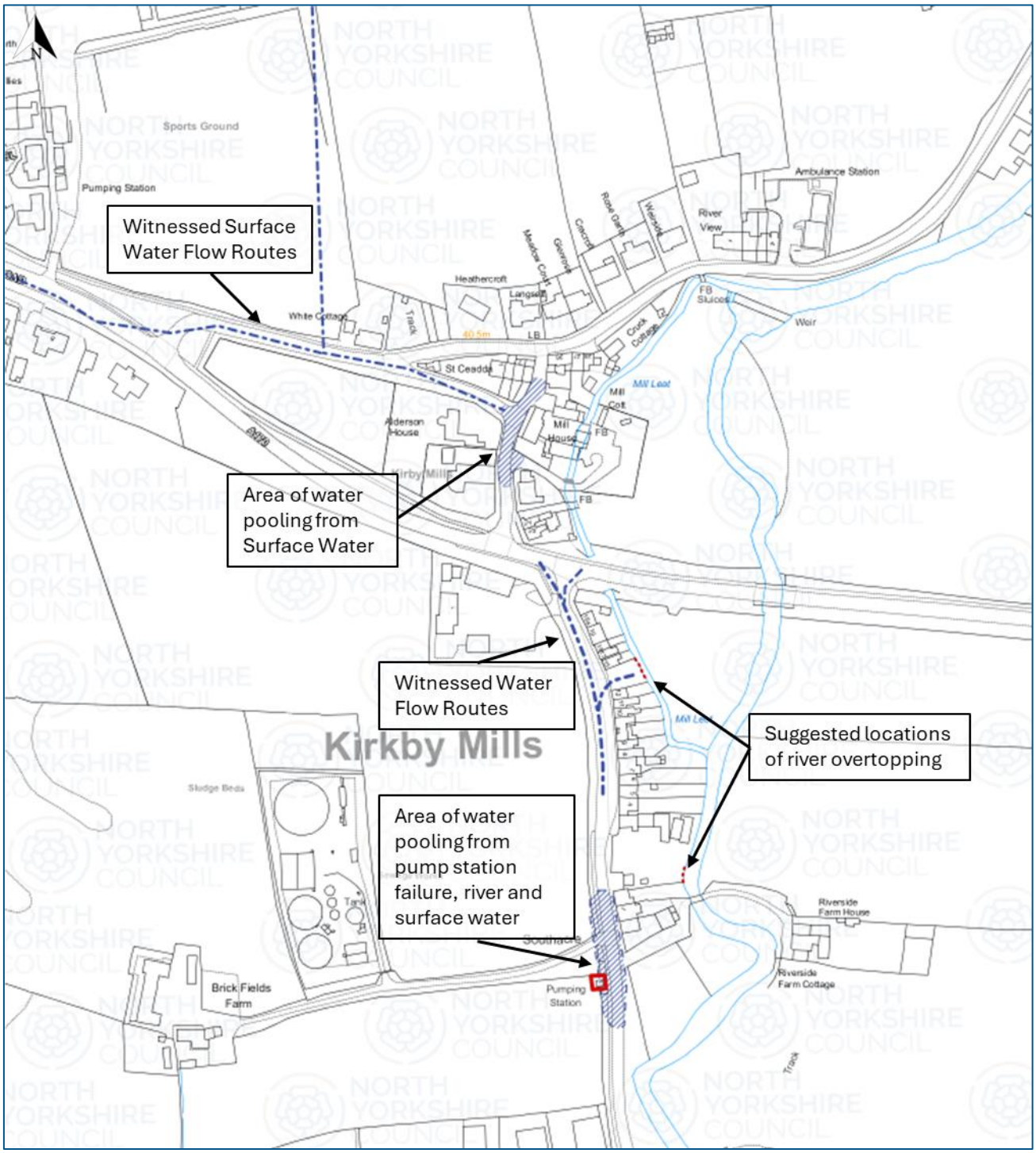


Figure 12 Map detailing observed events in Kirkby Mills

14.3. Keldholme

Eight residential properties in Keldholme were reported to have experienced internal flooding during Storm Darragh. Residents indicated that a flood alert was received at approximately 17:00, followed by a flood warning at around 22:00. The River Dove was observed overtopping its banks between 22:00 and 23:15, with internal property flooding following shortly after. Additionally, surface water was witnessed collecting on the highway at approximately 19:30.

Concerns were raised by residents regarding the condition of Keldholme Bridge and the potential impact of silt accumulation. A review of North Yorkshire Council Highways Bridge inspection reports confirmed that there has been no recorded increase in silt levels over the past six years. Each bridge in the area is subject to inspection on a biennial basis.

Further concerns were expressed regarding surface water flows originating from the north and east of Keldholme, as identified in figure 13. The North Yorkshire Council Highways has acknowledged awareness of flows from the east. Funding is being sought to investigate the issue and where possible, remediate.

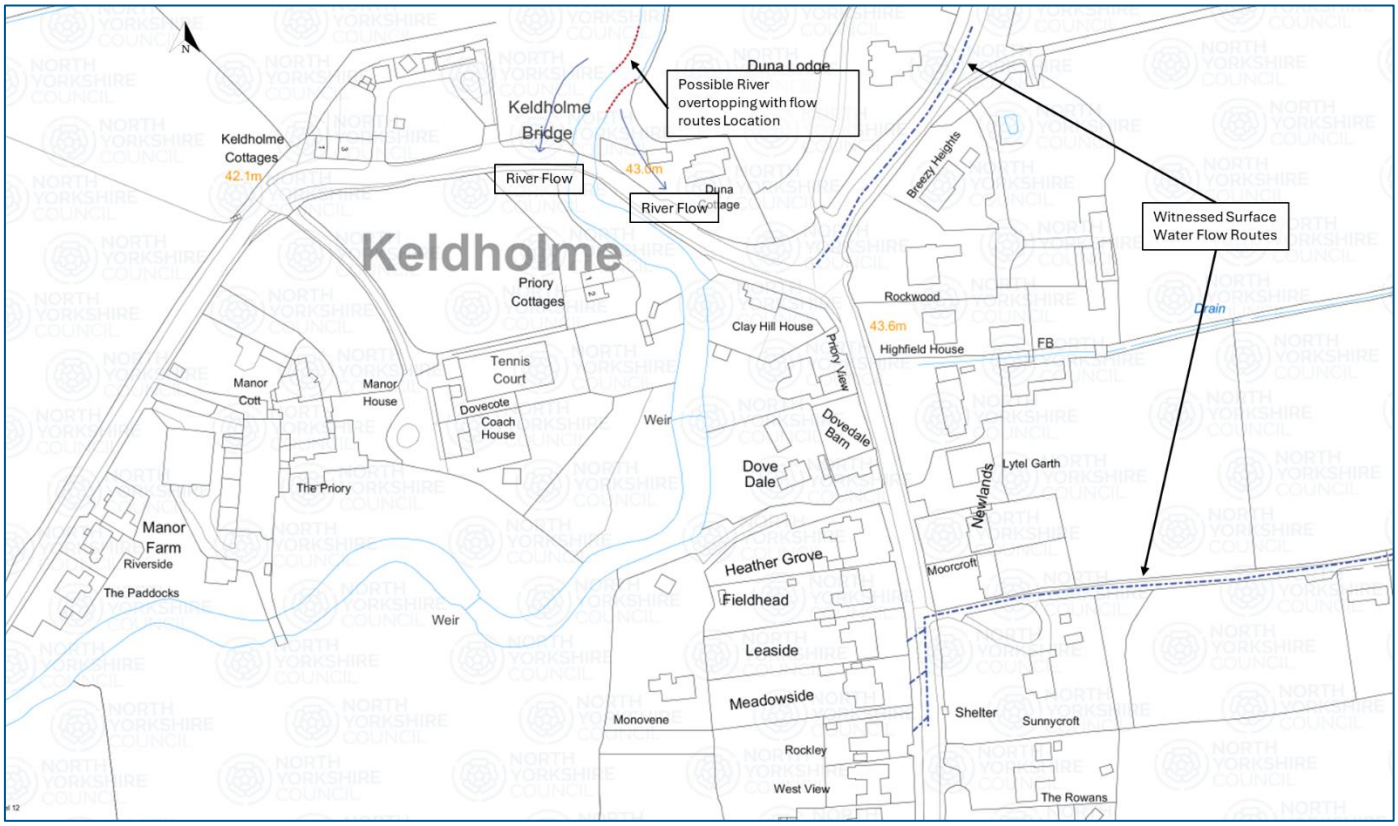


Figure 13 Map detailing observed events in Keldholme

14.4. Sinnington

A total of 21 flood incidents were reported, of which 19 involved internal property flooding. The local community demonstrated strong communication and cooperation, with residents assisting one another in preparing for the event. Many properties avoided internal flooding through the use of improvised flood defences, including sandbags, towels and boards.

The initial overtopping of the River Seven was observed at approximately 17:30 along Main Street. A resident reported a flood warning, followed by a flood alert reported by residents at 19:30. The Lead Local Flood Authority noted that many residents in Sinnington were not signed up to the

Environment Agency flood warning system, or reported that they did not receive appropriate warnings. Residents reported internal flooding between 22:00 and 23:00, with most of the properties flooded from the front by water from the River Seven.

The flood water travelled down Main Street, before being channelled through a gap in houses on the west, before rejoining the River Seven. Some residents raised concerns regarding tree blockages in the river channel, the Environment Agency have stated in their Section 14 response that the field team have cleared trees and blockages in the area.

The local pub, situated on higher ground, served as a refuge for some residents and visitors, who relocated vehicles to its car park and sought shelter there. A handful of residents noted that a tractor transported individuals through floodwaters from the pub down Main Street at a speed sufficient to generate a bow wave, which contributed to flooding at nearby residential properties.

The River Seven also overtopped towards the south of the village. There is a parcel of land adjacent to the watercourse that acts as location where excess river water is stored when the Seven overtops. Site observations indicated that this parcel of land did hold some water back, however, over time the level of the parcel of land has increased. The Environment Agency plan to survey this land to see whether lowering the level would provide some resilience benefits, this is in conjunction with the land owner.

A frequent issue raised by residents was the quantity and frequency of surface water travelling down to Sinnington from the gently sloping land to the east. The watercourse Double Dike is partially culverted, and therefore does not capture surface water flows in that location. Surface water flows accumulate and travel towards properties, contributing to one known reported incident of internal flooding, and several cases of garden flooding. Some of these flows then fall into the open sections of double dike, before out falling into the River Seven at the south of the village. Engagement with landowners has begun involving Natural England, Environment Agency and NYC. The aim of this engagement is to explore opportunities for reducing surface water runoff from adjacent farmland, potentially through modifications to farming practices and improvements to watercourse management.

Concerns were raised by residents regarding the condition of Sinnington Bridge and the potential impact of silt accumulation. A review of North Yorkshire Council Highways Bridge inspection reports confirmed that there has been no recorded increase in silt levels over the past six years. Each bridge in the area is subject to inspection on a biennial basis.

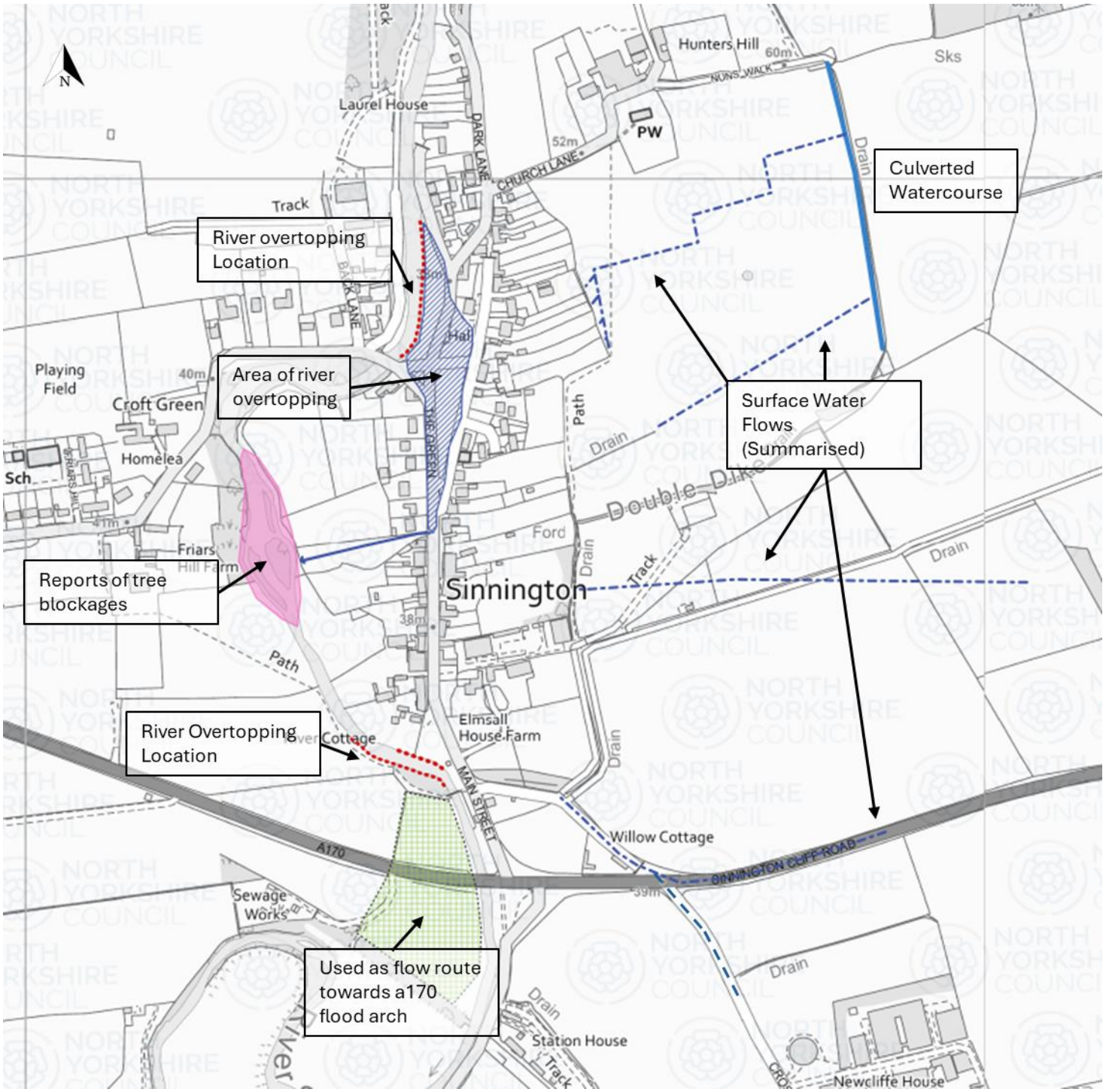


Figure 14 Map detailing observed events in Sinnington

14.5. Marton

Lead Local Flood Authority have 24 records of flooding in Marton, with 20 of these being internal flooding. Marton is partially defended by flood embankments, which stop at the northerly residential extent of the village. During Storm Darragh, the river level was high but was constrained by flood defences until early in the morning of the 8th December. To the north of Marton, where the flood defences are absent, water accumulates in the field as part of the natural flood plain. According to residents, the field normally floods and water exits a gate adjacent to Back Lane and travels down

Back Lane before re-entering the watercourse to the south of the village. Prior to Storm Darragh, the field had recently been worked and was covered in loose vegetation. From the image below, it is apparent flood water mobilised the loose vegetation, which in turn blocked the gate, causing the water to further rise within the field.

Figure 15 Photo of gate with vegetation blockage in Marton

At some time after 01:00, the water level rose to a height that caused it to find a different flow route nearer the village side of Marton Road, causing the flood waters to travel into the village. At a similar time, near to Marton Bridge, two trees were blown down. Unfortunately, one of the trees was located within the flood bank, which went on to cause a 7m wide breach of the flood bank. This caused flood water to damage a house and continue to spill into Marton Road near the bridge. Reports state that flooding along Marton Road reached around 1m in height. The high level of flood water in the village was further pushed into houses on the south of Marton Road by the northerly wind.

The residents raised concerns regarding whether the unusual northerly wind from Storm Darragh may have been a factor that caused the trees to fall. Trees do develop mechanical adaptations over time in response to prevailing wind directions. This process is called thigmomorphogenesis, where

trees strengthen their structure (especially root anchorage and stem flexibility) in response to regular mechanical stress like wind. However, there could also have been several other biotic and abiotic factors at play, like saturated soil or riverbank erosion, or root or trunk damage caused by fungi, or low vitality caused by pests & disease.

It is noted that Yorkshire Water are in the process of separating out the surface water from the combined sewer system, by adding water butts to properties and re-piping the parts of the system to the surface water sewer. The surface water sewer outfalls to the River Seven by Marton Bridge with a flap valve. Yorkshire Water do have concerns that some land drains are connected to the system, which could also be increasing the backlog of water seen in Storm Darragh. However, it is noted Yorkshire Water will investigate the system via CCTV survey to identify any incorrect connections.

The Environment Agency performed a temporary repair of the embankment on the 23rd December 2024 and planned to remove the second tree fallen in April/May. They also carried out tree and blockage work between Marton and Normanby in February 2025.

From site walkovers, and discussions with the Environment Agency and residents, it is clear that the state of the flood banks is in variable condition, such as variable defence height, some defences being built on and vegetation growth within the banks. These factors could be flood risk factors, however, in this case the tree falling and causing a breach of the flood embankment was an important factor, as the defences themselves were never observed or recorded as overtopping. It was fortuitous that the breach did not occur earlier in the night, when the river peaked at 22:30.

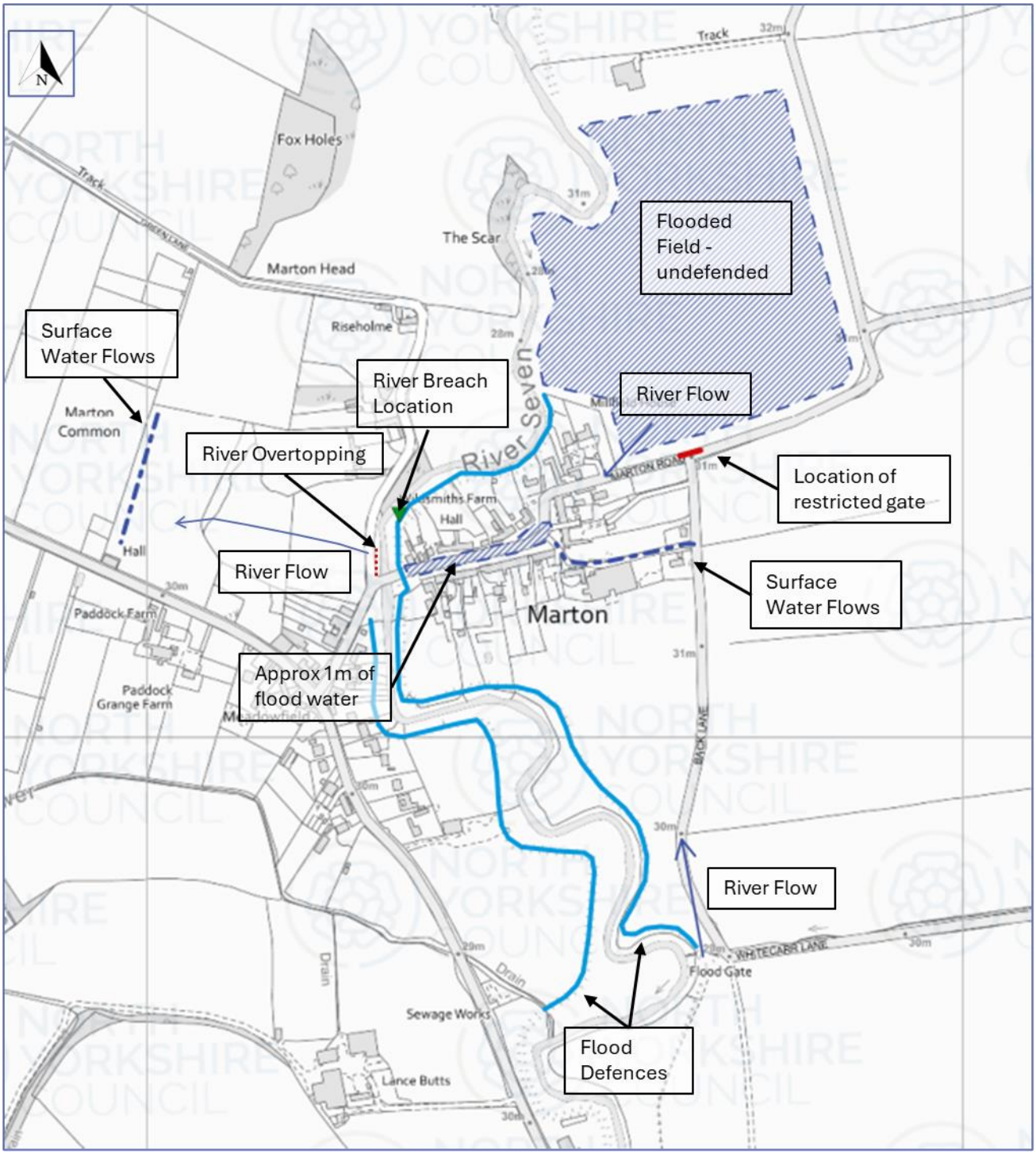


Figure 16 Map detailing observed events in Marton

15. Recommendations

The following recommendations are made in accordance with the North Yorkshire Council Flood Risk Strategy and have been created from the conclusions of this report:

General:

1) The LLFA to continue to deliver the existing property flood resilience scheme that will benefit properties in Keldholme, Kirkby Mills and Sinnington.
2) All risk management authorities to continue responsive engagement and service within the villages.
3) Environment Agency to continue engagement and increase education regarding the flood warning system and landowner and homeowner responsibilities.

Kirkby Mills:

1) North Yorkshire Council Highways and Yorkshire Water to jointly investigate the drainage system north of the A170, focusing on interactions between the Yorkshire Water network, highway gullies, and the river near the Mill, and assess the potential benefit of installing a non-return valve at the outfall.
2) North Yorkshire Council Bridges team and landowners to de-silt and regularly monitor the bridge to maintain flow capacity and reduce flood risk.
3) Yorkshire Water to assess how the Combined Sewer Overflow affects river channel capacity and contributes to flood risk.
4) Yorkshire Water to investigate power failure of pumping station and configure plan to avoid it happening in the future Environment Agency to engage riparian landowners to raise awareness of their responsibilities and take enforcement action on unconsented works, including the weir and Mill Race.

Keldholme:

1) North Yorkshire Council Bridges as part of Local Highway Authority to continue to monitor silt levels under Keldholme Bridge.
2) North Yorkshire Council as Local Highway Authority and LLFA to explore opportunities reduce Surface Water flow impacts on the Highway from the East.

Sinnington:

1) North Yorkshire Council to work with landowners on riparian responsibility and engage in the education of surface water flow management.
2) North Yorkshire Council to explore maintaining the existing flow pathway on Main Street at Land Adjacent to Riverdell is maintained in the event of any future proposals to develop the land.

3) North Yorkshire Council Resilience and Emergencies Team to assist in setting up a community action group with the assistance of Sinnington Parish Council.
4) Environment Agency to investigate land levels on the right bank upstream of the A170 to assess whether any reinstatement of the flow path is required.

Marton:

1) Environment Agency to review flood defence and tree management regime, work with landowners on educating riparian responsibility and undertake enforcement where needed.
2) Environment Agency to submit funding bids to further repair the breach and carry out other maintenance of the flood embankments and river channel where a business case for investment can be made and where funding is available. This includes bank surveys to assess for low spots, embankment repairs and tree and vegetation clearance to aid conveyance.
3) Yorkshire Water to demonstrate how separating out the surface water from the Combined system will not increase surface water flood risk if the river level is high and reduce bad connections as an output of the CCTV survey.
4) North Yorkshire Council Resilience and Emergencies Team to help set up a community action group with the assistance of Marton Parish.

16. Appendices

11.1 Useful contacts and links

1) Flood Forecasting Centre

The Flood Forecasting Centre (FFC) is a partnership between the Environment Agency and the Met Office, combining our meteorology and hydrology expertise into a specialised hydrometeorology service. The centre forecasts for all natural forms of flooding - river, surface water, tidal/coastal and groundwater.

Flood Forecasting Centre - GOV.UK

2) Online Flood Risk Mapping

This service uses computer models to assess an area's long term flood risk from rivers, the sea, surface water and some groundwater.

https://flood-warning-information.service.gov.uk/long-term-flood-risk/map

3) National Flood Forum

A charity to help, support and represent people at risk of flooding.

https://nationalfloodforum.org.uk/

4) North Yorkshire Local Resilience Forum

NYLRF is a partnership of local agencies working together to prepare for, respond to and recover from potential major incidents and emergencies via the duties stated in the Civil Contingencies Act 2004 (CCA).

http://www.emergencynorthyorks.gov.uk/

5) NYC Resilience & Emergencies Unit

The resilience and emergencies unit is responsible for planning for a wide variety of potential incidents and emergencies that could affect the population of North Yorkshire.

https://www.northyorks.gov.uk/resilience-and-emergencies-unit

6) NYC Flood & Water Management

As lead local flood authority, we investigate and assess flood risks, including flooding from surface water, groundwater and existing watercourses. We work with partners involved in flood and water management to protect communities from the impact of flooding.

https://www.northyorks.gov.uk/flood-and-water-management