21st November 2016 Flood Investigation Report

Oldham Council

Monday 24 April 2017

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Glossary and Abbreviations

Annual Probability	Throughout this document, flood events are defined according to their likelihood of the chance of a particular flood occurring in any one year. This can be expressed as a percentage. For example, a flood with an annual probability of 1 in 100 can also be referred to as a flood with a 1% annual probability. This means that every year Annual Probability there is a 1% chance that this magnitude flood could occur.
Catchment	The watershed of a surface water river system
LLFA	Lead Local Flood Authority
Flood Risk Management Function	These 'functions' are powers or responsibilities listed in the Act (or related Acts) which may be exercised by a risk management authority for a purpose connected with flood risk management.
Internal property flooding	Flooding to ground floors of properties, including attached garages or outbuildings, and basements/cellars only if used as living accommodation.
River flooding (Fluvial flooding)	Occurs when water levels in a channel overwhelms the capacity of the channel.
Surface water flooding (Pluvial flooding)	Flooding from rainwater (including snow and other precipitation) which has not entered a watercourse, drainage system or public sewer.
Risk management authorities (RMAs)	Organisations that have a key role in flood and coastal erosion risk management as defined by the Act. These are the Environment Agency, Natural Resources Wales, lead local flood authorities, district councils where there is no unitary authority, internal drainage boards, water companies, and highways authorities.
Riparian owner	Owner of land adjoining, above or with a watercourse running through it.
Groundwater flooding	Occurs when water levels in the ground rise above the natural surface. Low-lying areas underlain by permeable strata are particularly susceptible.
Main river	A watercourse shown as such on the main river map, and for which the Environment Agency and Natural Resources Wales has responsibilities and powers
Ordinary watercourses (OW)	All watercourses that are not designated Main River, and which are the responsibility of Local Authorities or, where they exist, Internal Drainage Boards.
Reservoir	A natural or artificial lake where water is collected and stored until needed. Reservoirs can be used for irrigation, recreation, providing water supply for municipal needs, hydroelectric power or controlling water flow.
uFMfSW	Updated Flood Map for Surface Water
DCLG	Department for Communities and Local Government

1. Executive Summary

The impact of intense and prolonged rainfall on 21st November 2016 caused widespread flooding in the Borough of Oldham.

This flood investigation report has been produced by the Oldham Lead Local Flood Authorities (LLFA), working in partnership with the Environment Agency and United Utilities under the duties set out in Section 19 of the Flood and Water Management Act, 2010. This report is a factual record of the flooding event that happened during 21st November 2016 and how the relevant risk management authorities responded.

This flooding event had a significant impact on local communities, affecting homes, businesses, local infrastructure and the environment. The number of incidents of flood water entering the habitable space of a property (internal property flooding) was 142. In addition to this, the reported number of incidents of flood water entering a property garden and/or outbuilding (non-habitable space) was 160.

One of the most significant causes of the flooding in November 2016 resulted from multiple flooding mechanisms occurring and interacting dynamically. In brief this interaction can be summarised as follows:

- The intensity of the rainfall was unable to infiltrate into the ground, resulting in surface water flooding.
- The design standard of the local drainage networks was exceeded by the severity of the rainfall.
- Water levels rose within the rivers, preventing the local drainage networks from discharging.

Although the purpose of the report is to provide a factual account of the contributing factors, impacts and responses to the flooding, it also includes a number of recommendations about how to manage the future flood risk. It will require the involvement of a number of organisations and communities working together in partnership. Many locations require further detailed investigations and engagement with the affected communities to make sure the full range of flood risk management options are considered and explored.

2. Purpose of Investigation

2.1 Section 19 Investigation requirement

Section 19 - 'Local authorities: investigations' of the Flood and Water Management Act, 2010 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.

In accordance with Section 19(2), Flood and Water Management Act, 2010, Oldham LLFA will provide access to this published investigation report via a link on its website.

2.2 Purpose

This document has been produced as a factual record of the flooding to meet the requirements of Section 19 of the Flood and Water Management Act, 2010. Flooding on the scale experienced takes time to investigate and between November 2016 and publication of this report the Authority has focused much of its activity on supporting those most affected by the flooding. The report does not include options and actions to reduce flood risk for every location that flooded. However, such work is ongoing and the Risk Management Authorities (RMAs) involved in this report will continue to work together, engaging with communities to identify all potential options for each location. It is important that this is done thoroughly to ensure the full range of flood risk management options is explored and the right solutions brought forward.

Information has been collated from the following sources:

- site visits and assessments by RMA staff.
- topographical surveys of flood levels and extents.
- door knocking.
- details collected at 'Community Drop-in' events and from residents and businesses in the weeks after the flood.
- records of properties flooded.
- use of photos, from various sources, taken during or after the flood.
- viewing some online or other video footage.
- information provided by Fire and Rescue Service, such as call-out logs.
- information from some utility companies.
- road closure information.
- personal observations from initial responders and Council/Utility company staff.

Whilst every effort has been made to verify flooding at the locations identified, the nature of the data and the methods used to collate this information means that it does not include every occurrence of flooding. This data only identifies where flooding has been reported and is indicative only.

2.3 Scope

This report covers the flooding that occurred on 21st November 2016 and describes what happened when 'significant' flooding occurred. The definition of 'significant' is provided within a policy adopted by the Greater Manchester Combined Authority (GMCA) on behalf of all 10 Greater Manchester Lead Local Flood Authorities (LLFAs). This policy provides the following thresholds:

- five or more residential properties flooded internally, and/or;
- economic disruption from commercial property flooding – it could be just one property if sizeable enough and/or;
- flooding to critical services such as hospitals, care homes, schools and emergency services.

The occurrence of 'significant flooding' as defined above triggers the production of an Investigation Report under section 19 of the Flood and Water Management Act (2010).

3. Roles and Responsibilities

The Flood and Water Management Act (2010) defines flooding as any case where land not normally covered by water becomes covered by water. Flood risk is a combination of two components: the chance (or probability / likelihood) that a location will flood from any source or type of flooding, and the impact (or consequence) that the flooding would cause if it occurred. The table below describes different sources of flood risk.

Table 1 Source and description of food risk

Source	Description
Fluvial flooding	Fluvial flooding (from either a main river or an ordinary watercourse) occurs when the flow capacity of a watercourse is exceeded, causing water to spill out of the channel into nearby areas of floodplain. These may or may not have been developed or have flood compatible uses Culverts and narrow channels in built-up areas can make flooding more likely.
Surface Water Flooding	Surface water flooding is caused by overland flow during periods of sustained or heavy rainfall, causing ponding of water where it becomes obstructed or collects in low lying areas. Local drains and infiltration into the ground are unable to cope with the volume of water present. More impermeable areas can increase the risk of surface water flooding occurring, which is mitigated by drainage systems, but these have a design capacity which may be overwhelmed in times of heavy rainfall.
Groundwater Flooding	Groundwater flooding occurs when the water held underground rises to a level where it breaks the surface in areas away from watercourses and drainage pathways. It is generally a result of extended periods of very heavy rain, but can also result from reduced abstraction, underground leaks or the displacement of underground flows.
Highway Flooding	Highway flooding occurs when the highway drainage system or the sewers they discharge into cannot cope with the amount of rainfall entering the system. This can be due to the size of the pipes or a blockage in the system.
Sewer Flooding	Flooding from a public or transferred sewer (including former Section 24 sewers) which enters a building or passes below a suspended floor'. A sewer is classed as overloaded (hydraulic flooding) when the flow from a storm is unable to pass through it due to a permanent problem (e.g. flat gradient, small diameter). Temporary problems such as blockages, siltation, collapses and equipment or operational failures are classed as "flooding other causes" (FOC).
Other Sources of Flood Risk	Canals can flood by overtopping or from a breach of a structure, or collapse of a culvert beneath a canal. Risk of flooding from a canal is managed by the responsible organisation. Reservoir flooding is very rare but occurs when a dam is breached. The owners of reservoirs with an above ground capacity of 25,000 cubic metres or more have a legal duty to have their reservoirs supervised and inspected regularly by experts.

3.1 Relevant Risk Management Authorities

The responsibility for managing flooding in the UK is divided between different Risk Management Authorities (RMAs) as defined in the Flood and Water Management Act, 2010. RMAs have powers and duties to manage the different forms of flooding that can occur. The Environment Agency is responsible for taking a strategic overview of the management of all sources of flooding and coastal erosion.

Managing flood risks and flooding requires RMAs to work together. The table below sets out responsibilities (relevant to Greater Manchester).

Table 2 Oldham RMAs responsibilities

Flood Source	**Environment Agency**	**Lead Local Flood Authority** Oldham Council	**Water Company** United Utilities	**Highway Authority** Oldham Council
Main River[1] (Fluvial Flooding)	✓			
Surface Water (Pluvial runoff)		✓		
Highway Drainage Flooding				✓
Public Sewer Flooding			✓	
Ordinary Watercourse[2]		✓		
Groundwater		✓		
Reservoirs[3]	✓	✓	✓	✓
Water Supply Infrastructure			✓	
Strategic Overview of All	✓			

[1] Rivers designated as Main Rivers by Environment Agency
[2] Ordinary Watercourses are all other rivers and streams not classified as Main Rivers
[3] RMAs have different responsibilities for reservoirs such as regulation, asset management and flood incident response.

3.2 United Utilities

United Utilities (UU) have a duty to provide and maintain a system of public sewers so that the areas for which they are responsible are effectually drained (Water Industry Act, 1991). Sewerage systems are not, however, designed to accommodate flows from severe weather events. During severe weather the capacity of the sewerage network may be exceeded and result in localised surcharging and/or flooding. UU classify severe weather as rainfall that has an annual probability of occurrence of 1 in 30 or greater. Larger, more intense storms would therefore be expected to result in surcharging of the sewer network.

UU are required to deliver a significant reduction in sewer flooding incidents by 2020. Their performance commitment includes flooding caused by hydraulic inadequacy of sewers, and other causes of flooding such as blockages, collapses and equipment failure. This commitment does not differentiate between the causes as they have the same impact on the customer.

UU investigates all flooding incidents that are reported to them and undertakes a verification exercise to understand the issues and flooding mechanisms. This may include a site visit and CCTV survey to determine if there were any blockages in the network. Any blockages encountered during the investigations are cleared to ensure that the sewer has maximum capacity.

3.3 Highways England

Highways England is the highway authority responsibility for all motorways and trunk roads throughout England.

3.4 Environment Agency

The Environment Agency has a strategic overview of all sources of flooding and coastal erosion. They are responsible for flood and erosion risk management activities on Main Rivers and the coast, regulating reservoir safety, and working in partnership with the Met Office to provide flood forecasts and warnings.

3.5 Highway Authority

Oldham Council as the Highway Authority has the lead responsibility for providing and managing highway drainage and roadside ditches under the Highways Act 1980. The owners of land adjoining a highway also have a common-law duty to maintain ditches to prevent them causing a nuisance to road users.

- Highway Gully Cleaning
  Oldham Council aim to cleanse all highway gullies at least once a year, in accordance with a scheduled programme, subject to access. Obstruction by parked vehicles is the main cause of gullies not being regularly cleaned.

  The scheduled programme is continually being updated by intelligence gathering on the type and location of the highway and the likely flood risk in the locality.

  Working to a scheduled programme the Council is able to work efficiently and ensure that every gully is cleaned, as soon as practicably possible. The programme takes seasonal variations into account in different parts of the borough i.e. leaf fall in rural areas. Ad-hoc visits delay the programme and therefore the Council does not currently accept reports of blocked gullies, except if a blocked gully is putting a property at risk of flooding.

- Sandbags
  Sandbags are not generally effective in preventing water entering properties. The Council does not provide sandbags directly to property owners, occupants or businesses.

4. Flood Impacts November 2016

4.1 The Borough's Geography

Oldham has a total area of approximately 142km2, with a resident population of 224,900 (2011 Census). The borough's geography is diverse and ranges from the high density urban areas and suburbs surrounding Oldham town centre in the west and central part of the borough, to the semi-rural and rural outlying villages in Saddleworth, and Pennine moorland in the east of the borough.

The Pennine moorland dominates the eastern side of the borough, part of which falls within the Peak District National Park. It consists of a large area of countryside with a pattern of densely settled river valleys, dispersed farmsteads and open moorland.

The west and central part of the borough generally has an urban character reflecting its industrial legacy and proximity to Manchester. It was originally developed at high densities, with less green spaces, which are often a precious asset to the local community. The most densely populated towns are Oldham, Failsworth, Hollinwood, Chadderton, Royton, Shaw, Crompton and Lees and Springhead.

As well as being heavily urbanised, parts of the borough are characterised by steep catchment slopes and narrow river valleys, which means that large volumes of floodwater travel quickly through the confined river system causing flash flooding. Many areas are problematic in respect to drainage capacity and flooding sources can be complex and exacerbated during the summer and autumn months, when rainfall intensities are high and ground conditions are dry. This increases run off (especially from the Moors and surrounding areas) and build-up of debris including leaf litter can be a major factor in the amount of water unable to drain away in highly urbanised areas.

Saddleworth by the nature of its topography and proximity to the Pennine Hills will always be more vulnerable to flash flooding, when compared with the rest of the borough.

The main rivers in the borough include the River Beal, Irk, Medlock and Tame; some tributaries of these rivers also have been assigned main river status. There are two working canals in the borough, the Rochdale Canal and the Huddersfield Narrow Canal. The Rochdale Canal passes through the Chadderton district of Oldham, before joining the Bridgewater Canal in Central Manchester. The Huddersfield Narrow Canal passes through Saddleworth along the Tame Valley to the Ashton Canal at Ashton-under-Lyne. There is also the Manchester to Ashton under Lyne Fairbottom branch - disused canal in the Failsworth district of Oldham.

4.2 Flood Events 21st November 2016

The Environment Agency (EA) monthly water situation report stated that the November 2016 monthly rainfall in England was normal. As a result Soil moisture deficits remained static cross most of England through November. Soil moisture deficit is the difference between the amount of water actually in the soil and the amount of water that the soil can actually hold.

Overland flow and run off from higher land in a catchment area, will contribute to flooding events occurring from high intensity prolonged rainfall during the summer months.

When river levels are high, it will prevent local drainage discharge and explains why flooding from ordinary water courses occurs.

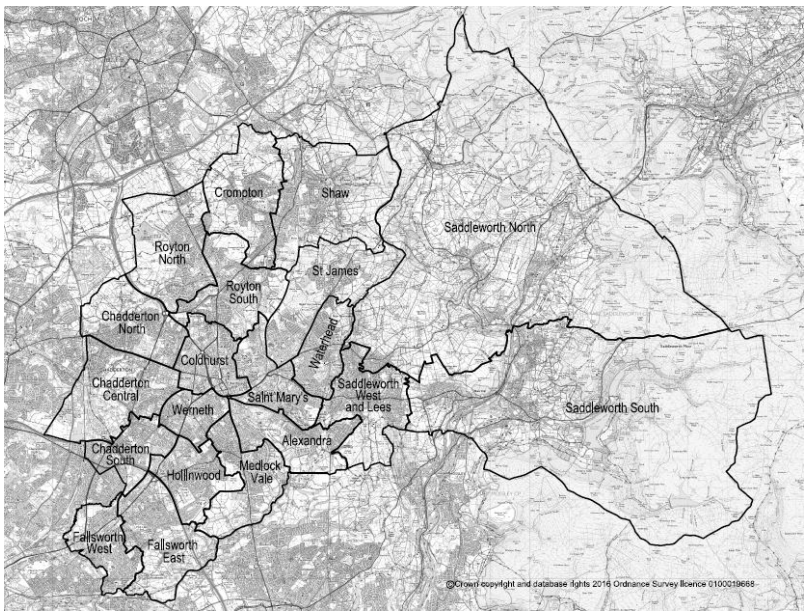


Figure 1: Oldham Ward Map

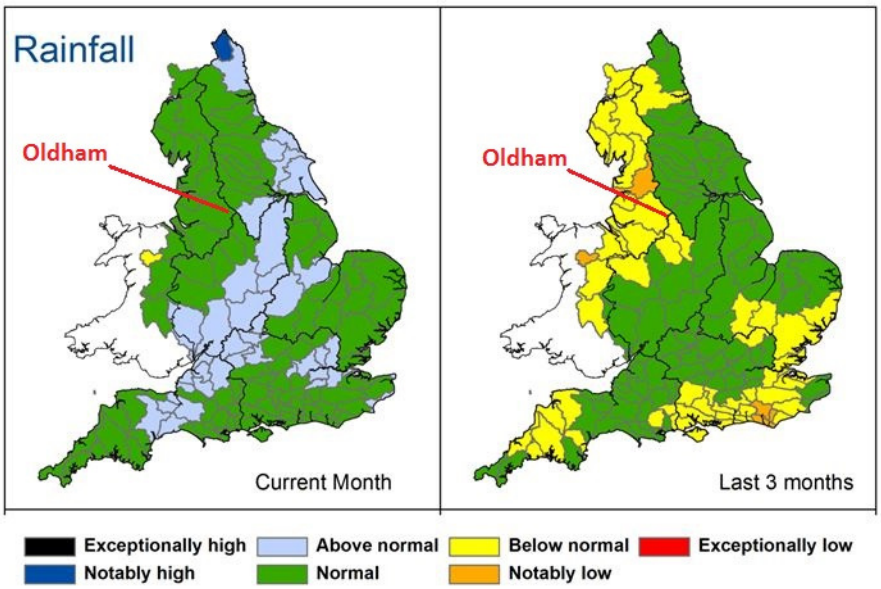


Figure 2: EA monthly water situation report

4.3 Rainfall Records

The Environmental Agency rain gauge in Greenfield recorded 3.75mm of rain on 21st November 2016, with 3mm of rain falling during the previous three days.

Gauge readings showed that on the 21st November 2016 intensive rainfall fell within a one hour period in the later afternoon.

The mechanism of flooding was due to heavy down-pours and flash flooding, causing high run off of water.

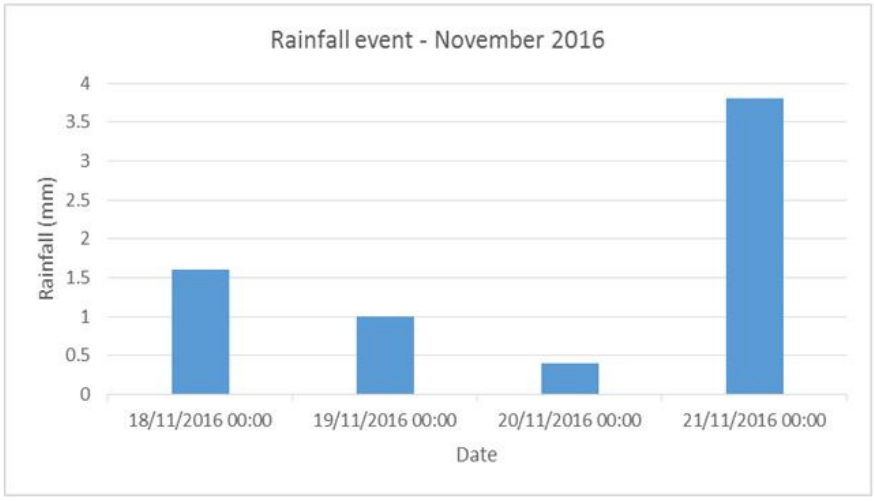


Figure 3: Rainfall (mm) in Rainfall event

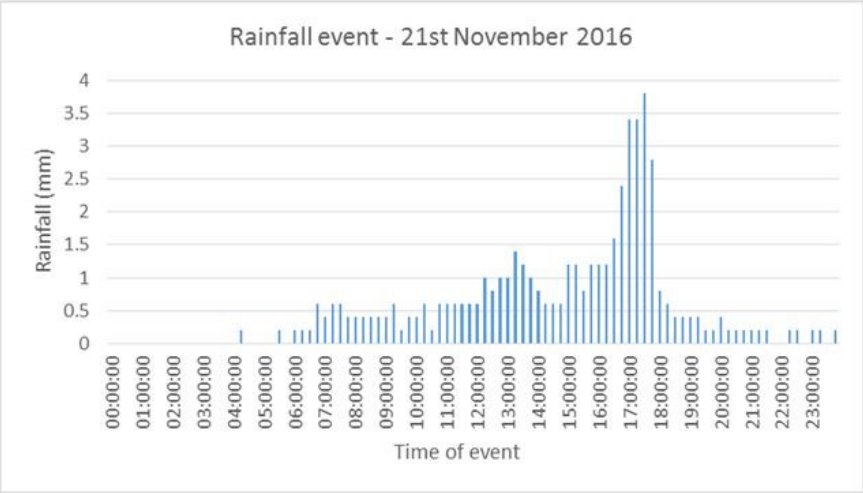
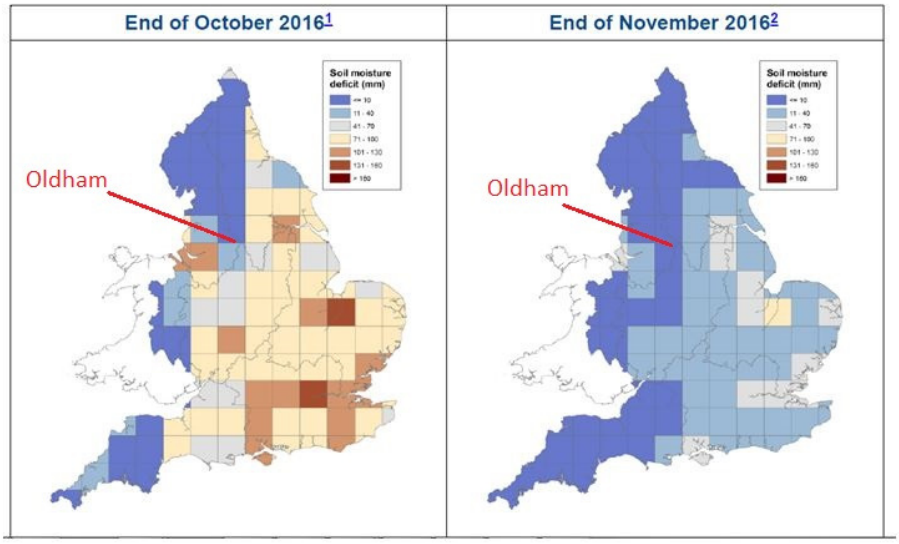


Figure 4: Rainfall (mm) in Rainfall event

4.4 Soil Moisture Deficit (SMD)

Soil moisture deficit is the difference between the amount of water actually in the soil and the amount of water the soil can hold, expressed in depth of water (mm). By the end of October 2016, the soil moisture deficit was already low and by the end of November there had been a further decrease across in the region.



Soil moisture deficits for weeks ending 1st November 2016 [1] (left panel) and 29 November 2016 [2] (right panel) shows actual soil moisture deficits (mm). MORECS data for real land use (Source: Met Office © Crown Copyright 2016). Crown copyright. All rights reserved. Environment Agency, 100026380, 2016

Figure 5: Soil moisture deficit

4.5 Flooding Mechanism

Twelve out of the twenty Borough Wards in Oldham reported flooding incidents during this period. The south-west parts of the borough (Failsworth East and Hollinwood Wards) were affected the worst, reporting the most incidents of flooding.

The common flooding mechanism was surface water flooding caused by intense rain falling within a short space of time on already saturated catchments leading to flash flooding. Given the exceptional intensity and severity of the rainfall in November 2016,

the hydraulic capacity of the sewer networks was exceeded in multiple locations across the Borough. This consequently led to localised flooding of highways which, in places, resulted in the flooding of residential properties, which was particularly prevalent in the district of Failsworth.

Sewer flooding can either be standalone or because of an event such intense rainfall. It is often difficult to differentiate between the sources. If the sewer capacity is exceeded flooding is bound to occur, but it is not a failure of the system as its design capacity would have been exceeded.

Combined sewers spread extensively across urban areas serving residential homes, business and highways, conveying waste and surface water to treatment works. Combined Sewer Overflows (CSOs), provide an Environment Agency consented overflow release from the drainage system into local watercourses or large surface water systems during periods of high flows. Some areas may also be served by separate waste and surface water sewers which convey wastewater to treatment works and surface water into local watercourses.

Flooding from the sewer network mainly occurs when flow entering the system, such as an urban storm water drainage system, exceeds its available discharge capacity, the system becomes blocked or it cannot discharge due to a high water level in the receiving watercourse. Pinch points and failures within the drainage network may also restrict flows. Water then begins to back up through the sewers and can surcharge through manholes, potentially flooding highways and properties. It must be noted that sewer flooding in 'dry weather' resulting from blockage, collapse or pumping station mechanical failure (for example), is the sole concern of the drainage undertaker.
UU is the water company responsible for the management of the majority of the drainage network across Greater Manchester.

5. Communities Affected

This report will focus on key flooding locations in the Failsworth, Saddleworth and Shaw districts of Oldham.

5.1 Locations Affected

A total of 302 properties were flooded in the Borough:

142 properties were flooded internally due to surface water and from effluent from combined sewers. **1**

Internal Property Flooding on 21st November					
Ward	Main River	Ordinary Watercourse	Sewer	Surface Water	Internal
Oldham	0	0	0	7	7
Chadderton Central	0	0	0	0	0
Chadderton North	0	0	0	1	1
Chadderton South	0	0	0	0	0
Crompton	0	4	2	10	16
Failsworth East	0	0	0	2	2
Failsworth West	0	0	1	1	2
Hollinwood	0	0	0	0	0
Medlock Vale	0	0	0	0	0
Royton	0	3	1	12	16
Saddleworth North	0	2	0	10	12
Saddleworth South	2	4	1	63	70
Saddleworth West & Lees	0	1	0	1	2
Shaw	0	3	5	4	12
St James	0	0	0	1	1
Waterhead	0	0	0	0	0
Werneth	0	1	0	0	1
TOTAL	**2**	**18**	**10**	**112**	**142**

Table 3 Number properties that flooded internally

Description/Main Issues

- Oldham Council and United Utilities are working in partnership to lead investigations at these locations, as flooding was from multiple sources.
- Internal property flooding affected 142 properties of which 6 were businesses and 40 were residential properties.
- 1 property flooded from the River Medlock.
- 18 properties flooded internally from ordinary water courses, 36 properties flooded internally due to surface water and 19 properties from sewer flooding.
- Flooding occurred due to intense rainfall over a short period of time causing surcharging of road gullies and manholes.
- It has been concluded from a review of the evidence collected; that the mechanism of the flood in the combined sewer was is inconclusive, although it is suspected that it was running at full capacity.

- The River Medlock overtopped its bank causing flooding to Stannybrook Road, which is an adopted highway in Woodhouse Green. The flooding event was exacerbated because the highway drainage outfall pipe by the River Medlock was submerged by river water at this time. High silt levels contributed to the problem.
- Surface water flooding was mainly due to existing road gullies surcharging because they were over capacity. Numerous ordinary watercourses also contributed to flood
- Numerous ordinary watercourses also contributed to flooding

5.2 Oak View Road, Greenfield

Figure 6: Internal Property flooding

Site Overview and Flooding Impacts

The total number of incidents of flood water entering the habitable space of a property at this location is 8. The total number of incidents of flood water entering a property garden and/or outbuilding at this location is 6.

Flooding Analysis

Evidence gathered as part of an investigation indicates that Oak View Road, Greenfield flooded on 21st November from surface water runoff and the hydraulic incapacity of the existing drainage system. During a period of heavy intense rainfall, highway gullies surcharged with flood water overspilling from the highway and entering nearby properties.

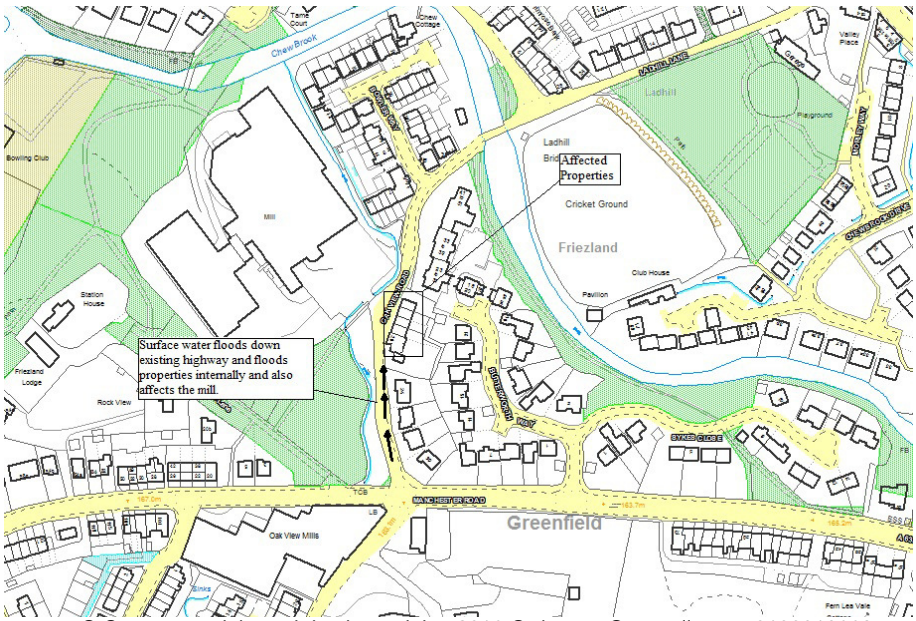


Figure 7: Flood mechanism

RMA responses

Prior to the flood event:

Highways gullies on Oak View Road were cleared on 15th December 2015 and did not contribute to the flooding event.

During the flooding event:

1. A request for service was received from residents via the Oldham Council Contact Centre.
2. Highway gullies in the vicinity were cleared.

Following the flooding event:

1. Further investigations were carried out.
2. A S19 Report was commissioned.
3. The highway and drainage systems have been cleared (using a road sweeper where necessary).
4. Contact was made with an adjacent landowner regarding a culvert. Improvement works to the culvert have been undertaken to reduce the risk of it contributing to future flooding events at this location.

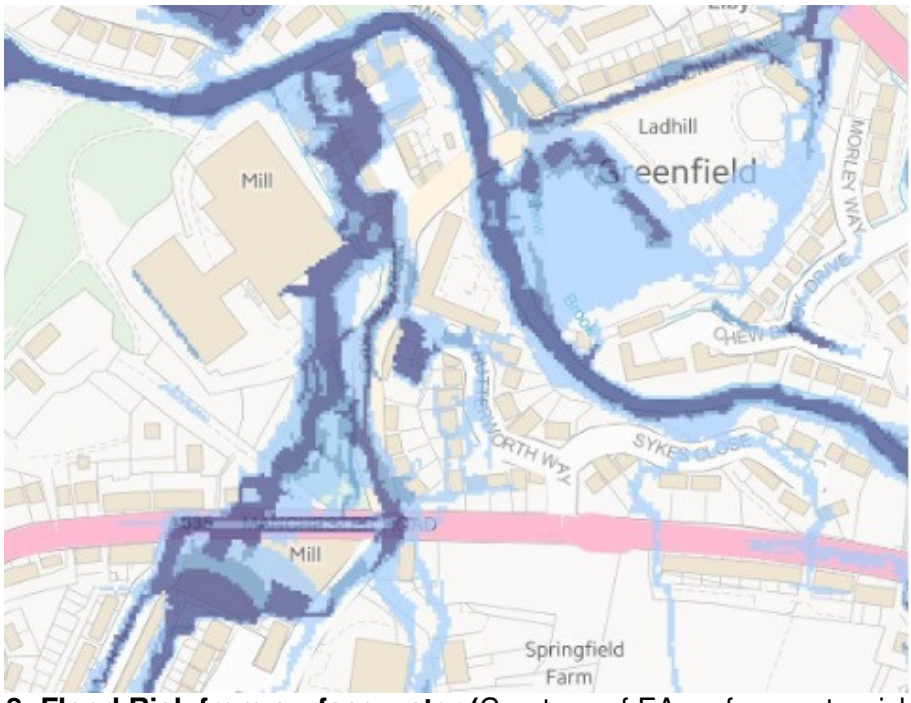


Figure 8: Flood Risk from surface water (Courtesy of EA surface water risk maps)

5.3 Shaws Lane/ Back Lee Street, Uppermill

Figure 9: Shaws Lane Culvert & Trash Screen

Site Overview and Flooding Impacts
The total number of incidents of flood water entering the habitable space of a property at this location is 7. The total number of incidents of flood water entering a property garden and/or outbuilding at this location is 10.

Flooding Analysis
Evidence gathered as part of an investigation indicates that Shaws Lane/ Back Lee Street, Uppermill flooded on 21st November 2016 as a result of surface water, a culvert and the hydraulic incapacity of the existing drainage system. During a period of intense rainfall a trash screen on the culverted watercourse on Shaws Lane became blocked with debris - due to its poor design. Flood water collected and overspilled onto an adjacent highway and flowed along Shaws Lane and Station Road, before entering properties at a low point on Back Lee Street, Uppermill.

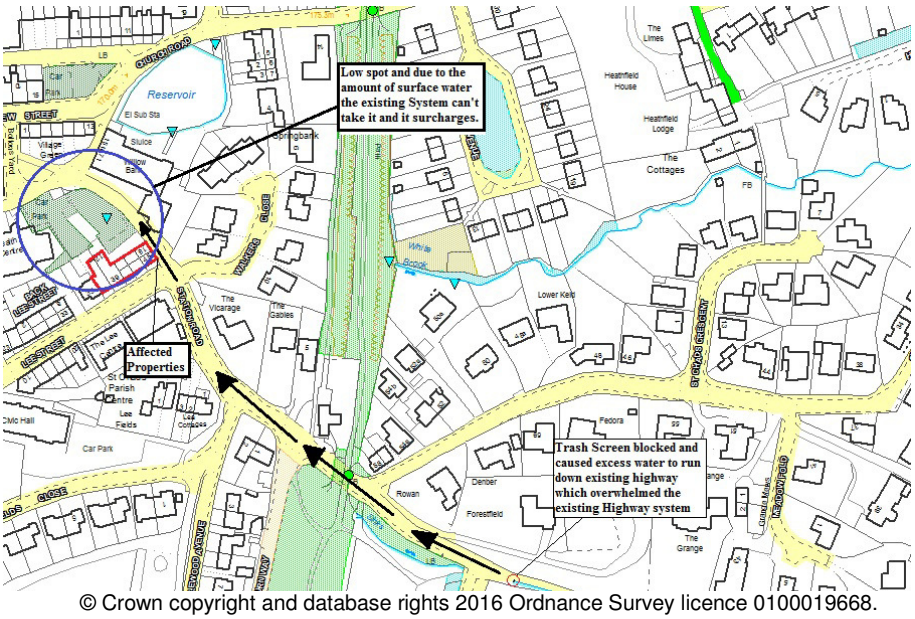


Figure 10: Flooding mechanism

RMA responses

Prior to the flood event

Highway gullies in the vicinity were cleared on 6th April 2016 and did not contribute to the flooding event.

During the flooding event

1. Highway gullies in the locality were cleared. The culvert trash screen on Shaws Lane was cleared of debris.
2. A request for service was received from residents via the Oldham Council Contact Centre.

Following the flooding event

1. Further investigations were carried out.
2. A S19 report was commissioned.
3. Potential solutions were identified that can be implemented to reduce the risk of a similar flooding event happening again in this locality.
4. The highway and drainage systems have been cleared (using a road sweeper where necessary).
5. Works have been completed for a replacement trash screen on the culvert together with the construction of a new headwall.

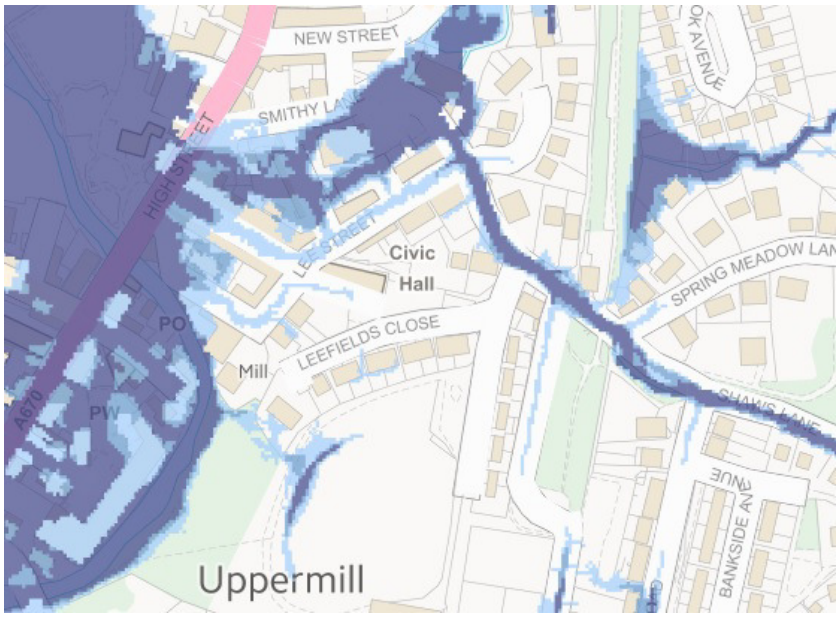


Figure 11: Flood Risk from surface water (Courtesy of EA surface water risk maps)

5.4 Wellington Road & Arthurs Lane, Greenfield

Figure 12: Arthurs Lane, Greenfield

Site Overview and Flooding Impacts
The total number of incidents of flood water entering the habitable space of a property at this location is 3. The total number of incidents of flood water entering a property garden and/or outbuilding at this location is 21.

Flooding Analysis
Evidence gathered as part of an investigation indicates that Arthurs Lane, Greenfield flooded on the 21st November 2016 from surface water, a culvert and the hydraulic incapacity of the existing drainage system. During a period of intense rainfall a trash screen on Golborne Clough (a culverted watercourse) became blocked with debris - due to its poor design. Flood water collected and overspilled onto a nearby bridle path and ran along its length following the existing drainage channels. Overspilling water cascaded down onto Arthurs Lane and flooded numerous properties. The capacity of Golborne Clough was overwhelmed and resulted in a manhole located on the Bridle path surcharging, which contributed to the flooding at Arthurs Lane.

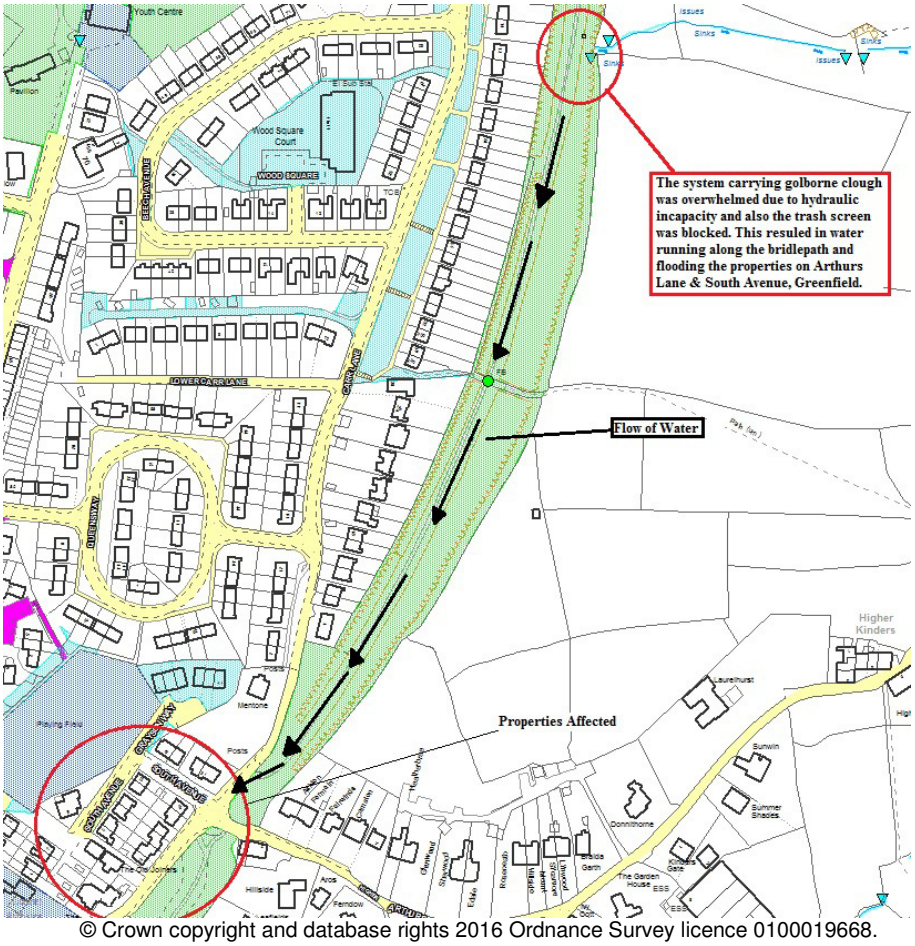


Figure 13: Flooding mechanism

OMBC responses

Prior to the flood event

Highway gullies in the vicinity were cleared on 16th December 2015, and did not contribute to the flooding event.

During the flooding event

1. A request for service was received from residents via the Oldham Council Contact Centre.
2. Highway gullies in the area were unblocked and the trash screen was cleared of debris.

Following the flooding event

1. Further investigations were carried out.
2. A S19 report was commissioned.
3. Potential solutions were identified that can be implemented to reduce the risk of a similar flooding event happening again in the locality.
4. The highway and drainage systems have been cleared (using a road sweeper where necessary).
5. The existing culvert leading to Wellington Road, Greenfield has been camera surveyed.
6. Works have been completed for a trash screen replacement on the culvert together with the construction of a new headwall.

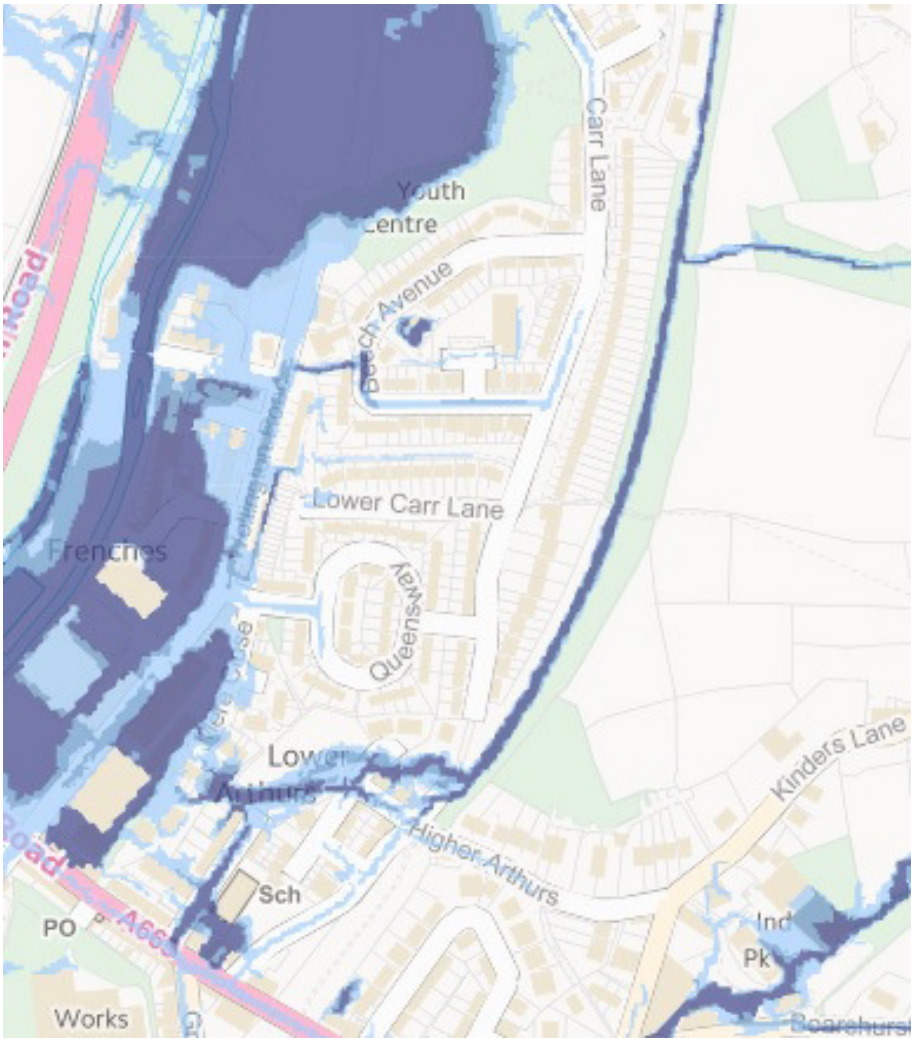


Figure 14: Flood Risk from surface water (Courtesy of EA surface water risk maps)

5.5 Beal Lane, Shaw

Figure 15: JD Williams building, Shaw

Site Overview and Flooding Impacts
The total number of incidents of flood water entering the habitable space of a property at this location is 9. The total number of incidents of flood water entering a property garden and/or outbuilding at this location is 5.

Flooding Analysis
Evidence gathered as part of an investigation indicates that Beal Lane, Shaw flooded on 21st November 2016 from surface water runoff and a culvert that had not been maintained properly. During a period of heavy intense rainfall flash flooding resulted in a high volume of surface water runoff leading to the hydraulic capacity of culverts and combined sewers being exceeded.

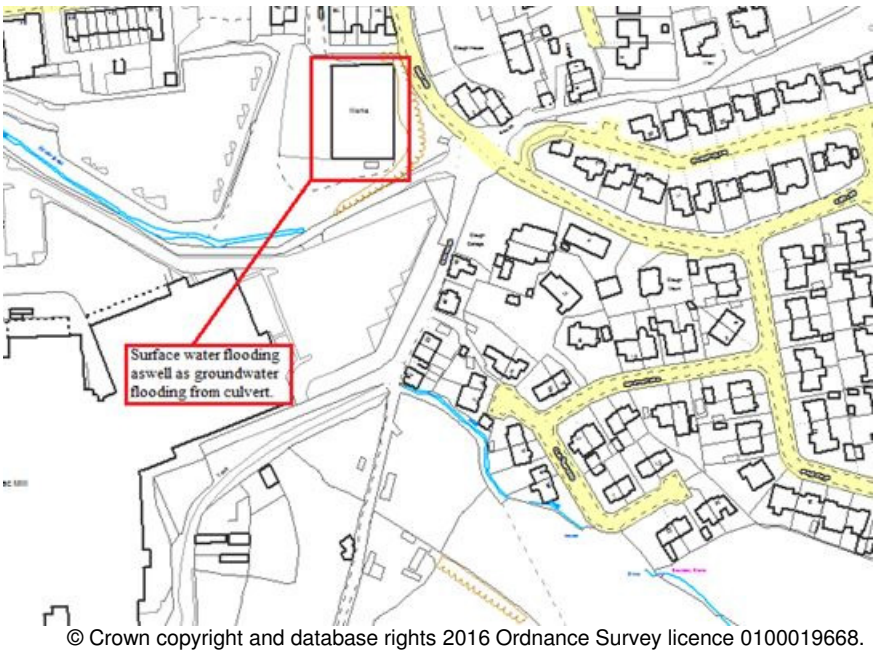


Figure 16: Flooding mechanism

OMBC responses

Prior to the flood event

Highway gullies in the locality were cleared on 6th February 2016, and did not contribute to the flooding Event.

During the flooding event

A request for service was received from residents via the Oldham Council Contact Centre.

Following the flooding event

1. Further investigations were carried out.
2. A S19 Report was commissioned.
3. Solutions have been identified to reduce the risk of this type of flooding incident occurring again in this vicinity.
4. Discussions with Riparian owners have been held to express the requirement for the culverted watercourse to be: inspected regularly, properly maintained and kept clear of debris.

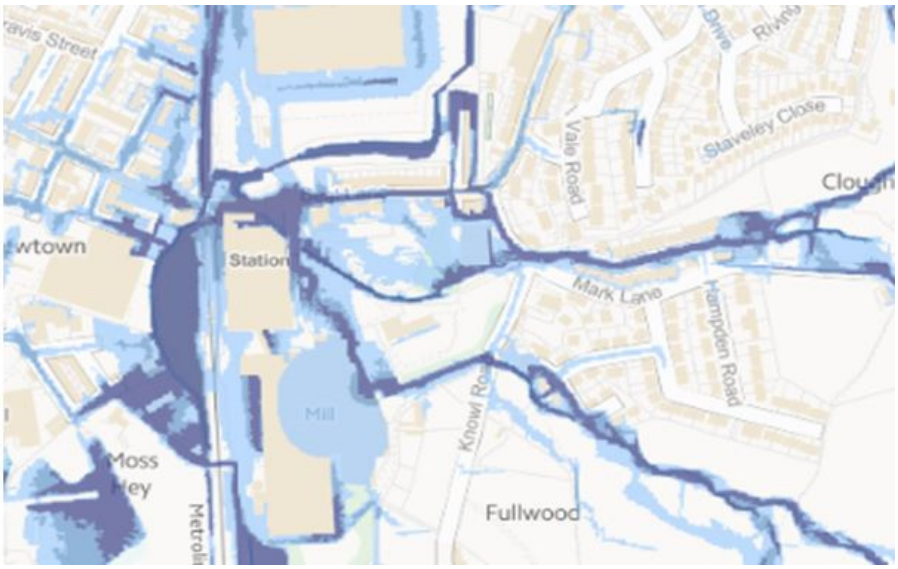


Figure 17: Flood Risk from surface water (Courtesy of EA surface water risk maps)

6. Risk Management Authorities Responses

6.1 Communications and Community Engagement

Communications within the community will be undertaken via Elected Members and Parish Councillors. Local residents will be encouraged to form Flood Forums to ensure community engagement.

7. Recommendations

	Action	Responsible Authority / Party
1	Ensure maintenance of highway drains.	OMBC - Highways
2.	Identify locations to direct run off from properties at flood risk, such as raising of kerbs.	OMBC - LLFA
3.	Identify potential projects to apply for Defra's flood and coastal erosion risk management project funding after confirming properties that have suffered internal flooding.	OMBC - LLFA
4.	Maintain efficient operation of combined sewers and other relevant assets.	United Utilities
5.	Consider installation of Property Level Protection.	Property Owners
6.	Register for flood alerts	Property Owners
7.	Continue to ensure that 'main river' watercourses are suitably maintained and trigger levels for Flood Alerts in this area are functional.	Environment Agency

8. Summary and Conclusions

The recommendations and ongoing actions within this report will be taken forward by the identified responsible Risk Management Authority. Recommendations and actions will be prioritised in line with other commitments and subject to available funding and resources, any major works requiring capital investment will be considered through the Defra funding programme.

- Oldham Council will identify funding allocation for minor schemes that are short to medium term solutions not in high value. Funding for medium to long term solutions that are high in value will be sought externally from bodies such as the Environment Agency.
- Project Appraisal Reports will identify viable cost effective solutions.
- Investigate ownership of existing Assets i.e. Highway Gullies to determine the cause and remedy of the flooding mechanism.
- Flood mechanism upstream upland catchment areas to be investigated for the implementation of decelerating the flow of water. Funding is to be sought for these measures.

8.1 Future prioritisation of work

Golburn Clough in Greenfield and Grasmere Road in Royton are to be given a high priority on getting funding for a business case to be undertaken in order for project options to be established and a viable option identified and funding sought.

8.2 Ongoing action / Next steps

The prioritisation process is mainly based on the number properties at risk from internal flooding and the frequency properties are experiencing flooding.

One of the most significant causes of the flooding in November 2016 resulted from multiple flooding mechanisms occurring and interacting dynamically. In brief this interaction can be summarised as follows:

- The intensity of the rainfall was unable to infiltrate into the ground, resulting in surface water flooding.
- The design standard of the local drainage networks was exceeded by the severity of the rainfall.
- Water levels rose within the rivers, preventing the local drainage networks from discharging.

As the November 2016 flooding demonstrates that this combination of flooding mechanisms is technically very difficult to predict and to develop effective flood warnings. The management of combined flooding mechanisms also requires input from all of the Risk Management Authorities as it cannot be attributed to a single source.