BURY ROCHDALE AND OLDHAM STRATEGIC FLOOD RISK ASSESSMENT

VOLUME III – Level 2 SFRA

November 2009

FINAL REPORT

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Structure of the Bury, Rochdale and Oldham SFRA

The Bury, Rochdale and Oldham (BRO) SFRA is supplied as four Volumes, described in the table below. Readers should refer to Volume I: SFRA User Guide for guidance on how to use the information provided in the SFRA.

SFRA Volume	Title of volume	Contents
I	User Guide	The BRO SFRA Volume I has been developed to provide guidance on the use of the SFRA for Local Authority Spatial Planning, Regeneration, Development Management and Emergency Planning officers and Developers.
II	Level 1 SFRA	The BRO SFRA Volume II has used mostly existing data to make an assessment of flood risk from all sources now and in the future and builds on the Association of Greater Manchester Authorities (AGMA) Sub-Regional SFRA. It provides evidence for LPA officers to apply the Sequential Test and identifies the need to pass the Exception Test where required.
III	Level 2 SFRA	The BRO SFRA Volume III provides evidence on a key community basis where the Exception Test may need to be applied. It considers the detailed nature of flood hazard taking account of the presence of flood risk management measures such as flood defences. The additional detail can also inform a sequential approach to development allocation within flood risk areas and mitigation options where appropriate.
IV	Rochdale Preliminary Mitigation Review	The BRO SFRA Volume IV provides a preliminary review of mitigation options for delivering regeneration for sites that are part of the East Central Rochdale Pathfinder Housing Market Renewal and Town Centre East initiatives.

REVISION HISTORY

Revision Ref./ Date Issued	Amendments	Issued to
Draft Report 3rd July 2009		Bury MBC (David Hodcroft) Rochdale MBC (Francis Comyn) Rochdale Development Agency (Richard Duddell) Oldham MBC (Georgina Brownridge) Environment Agency (Chris Waring) Digital copy
Draft Final Report 21st August 2009	LPA and EA Comments	Bury MBC (David Hodcroft) Rochdale MBC (Francis Comyn) Rochdale Development Agency (Richard Duddell) Oldham MBC (Georgina Brownridge) Environment Agency (Chris Waring) Digital copy
Final Report 13th November 2009	LPA and EA Comments	Bury MBC (David Hodcroft) Rochdale MBC (Francis Comyn) Rochdale Development Agency (Richard Duddell) Oldham MBC (Georgina Brownridge) Environment Agency (Chris Waring) Digital and hard copies

CONTRACT

This report describes work commissioned by Bury, Rochdale and Oldham Councils under Contract Number 918-701 of 03/03/2009. The Client's representative for the contract was Francis Comyn. Chris Isherwood and Hannah O'Callaghan of JBA Consulting carried out the work.

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PURPOSE

This document has been prepared solely as a Level 2 SFRA for Bury MBC and Rochdale MBC. JBA Consulting accepts no responsibility or liability for any use that is made of this document other than by the Client for the purposes for which it was originally commissioned and prepared.

ACKNOWLEDGMENTS

JBA would like to acknowledge the support of Housing Market Renewal (HMR) and the SFRA steering group Francis Comyn (Rochdale MBC), David Hodcroft (Bury MBC), Pauline Goodhall and Georgina Brownridge (Oldham MBC), Adrian Millward, Richard Duddell and Janet Brooks (Rochdale Development Agency) and Chris Waring and Andy Cameron (Environment Agency).

We would also like to thank Neil D'Arcy at British Waterways for his contribution in understanding the risk of flooding from canals.

EXECUTIVE SUMMARY

Level 2 SFRA Purpose and Approach

Flood risk in Bury, Rochdale and Oldham is a complex issue and arises from many potential sources. It is, rightly, a constraint to development, and great care is needed over the type and form of new development in these flood risk areas.

The Rivers Irwell, Roch and Beal provide the greatest risk, whilst surface water flooding and canals, reservoirs and flood risk management (FRM) assets have a residual risk of flooding to current communities and future developments. Residual risk refers to the risk that remains after flood risk management measures have been implemented, for example, from overtopping or breach of a flood defence.

Whilst the BRO Level 1 SFRA provided detail to assist Bury, Rochdale and Oldham Councils in applying the **Sequential Test** to its proposed development sites as set out in PPS25, it did not provide the understanding and the level of detail required to carry out the **Exception Test** i.e. can the site be developed safely, without increasing flood risk elsewhere, and, where possible, reduce flood risk overall?

In order to achieve the level of detail and understanding of flood risk required, carrying on from the findings and recommendations of the Level 1 SFRA (Volume II), a Level 2 SFRA has been produced (this report). To gain this understanding of fluvial flood mechanisms, detailed 1D-2D modelling of the River Roch and Irwell were developed in key communities (Littleborough, Rochdale, Ramsbottom and Bury-Radcliffe) to assess the complex risks associated with urban floodplains and the presence of FRM assets. A number of scenarios were investigated to assess these residual risks, including defence breaching and overtopping.

Other sources of flooding have also been investigated through detailed modelling including surface water flood risk and the residual risks associated with canal breaching.

By reviewing the flood risk and development pressures at a community level, the need for strategic flood risk mitigation and the likelihood of sites passing the Exception Test has been identified. Following on from these recommendations, flood risk management strategies have been discussed for central Rochdale and Bury-Radcliffe.

Flood Risk in Bury, Rochdale and Oldham – A Summary

The spatial distribution of risk is very different in each of the communities investigated. Current FRM assets are critical in the understanding of fluvial risk throughout Ramsbottom, Radcliffe, Rochdale and Littleborough. Surface water flooding is also a key source of risk in each community and is known to be exacerbated by the presence of FRM assets. Other potential sources of flooding such as the Rochdale Canal, the Manchester, Bury and Bolton Canal, reservoirs and other smaller water bodies present their own residual risks. Whilst the probability and extent of these sources of flooding are difficult to analyse, residual risk is still present and should be considered within the design and placement of new development. The main findings of the Level 2 SFRA with reference to each community are discussed below.

Ramsbottom

The main source of flooding in Ramsbottom is fluvial flooding from the River Irwell. Current defences in Ramsbottom provide a 1 in 100 year standard of protection (SOP). However, a key flood flow route originating upstream in Rossendale places a large area of Ramsbottom at risk west of the railway. Drill Hall, north of Bridge Street, collects the majority of flood waters from the overland flow route resulting in large flood depths. Bridge Street overtops during the 1 in 100 year plus climate change and 1 in 1000 year event, flooding the Mill Site south of the road. There are key areas of Functional Floodplain along the right (west) bank, including the football and cricket pitches at Acre Bottom which flood to large depths over a range of return periods. Defences will overtop during the extreme 1 in 1000 year flood event.

There are a number of key surface water flow paths that have been identified which pose risk to properties within central Ramsbottom. Ramsbottom is surrounded by steep hillsides that will encourage water to runoff quickly into the settlement and as such has been defined as a Critical Drainage Area (CDA). Current fluvial flood defences will potentially trap this surface water.

In the first instance all proposed development should be allocated through the Sequential Test. However, Bury MBC should work closely with the Environment Agency and Rossendale Borough Council through the Upper Irwell Strategy to develop options to manage the flow path into Ramsbottom. If the flow path is removed, without increasing risk elsewhere, a large area of existing and future development sites will be

removed from the risk of flooding during the 1 in 100 year event. This flow path may still be present during extreme events and will have to be taken into account when considering residual risk.

Carefully considered mitigation measures should be developed when assessing new development sites against during the 1 in 100 plus climate change and 1 in 1000 year fluvial flood events, and in particular, flood awareness, flood warning and evacuation planning.

There is no requirement to undertake a specific flood risk management strategy for Ramsbottom. However, development should not continue on a piecemeal basis and should be taken forward strategically as there is significant potential for individual development to impact the wider community, especially if located adjacent to current defences or within the flow path from Rossendale.

Bury-Radcliffe

The main source of flooding in the Bury-Radcliffe area is fluvial flooding from the River Irwell, with up to 650 existing properties flooded in a 1 in 100 year event, as a result of insufficient channel capacity. The risk of fluvial flooding is widespread, with significant flood extents and depths covering the majority of the natural floodplain. Although the natural floodplain is urban in form, there are no formal flood defences and those informal defences present provide little protection to adjacent residential and commercial areas. For each flood event investigated, flood depths are high, reaching over 2m in some areas.

The area is also susceptible to flooding from a number of other sources including surface water, the Manchester, Bury and Bolton Canal, Elton Reservoir and a number of smaller disused mill reservoirs. Radcliffe has also been defined as a CDA and it is known to have sewer network capacity problems, which may cause sewers to surcharge and increase the occurrence of surface water flooding.

The interactions between different sources of flood risk, including the River Irwell and River Roch and their tributaries, alongside Hutchinson's and Bealey's Goit plus the Manchester, Bury and Bolton Canal, Elton Reservoir and surface water in Bury-Radcliffe is complex. Developing sites in a piecemeal manner without a wider and strategic approach to development in these areas would be likely to affect flow paths, alter the pattern of flooding and make flooding worse for some of the existing communities. An integrated and engineered solution for the whole area would be most sustainable and help to deliver reductions in flood risk to both new and current developments.

However, in this critical flood risk area of the River Irwell, there may be a strong case for allowing previously developed sites to return to Functional Floodplain in urban areas where they can act to convey and store flood water and reduce risk to current development, rather than continuing the cycle of placing development in flood risk areas that could be present for the next 50-100 years.

If development is required for the regeneration of the area and no alternative land is available in Flood Zone 1, the Exception Test will need to be passed for housing allocations and even less vulnerable development should accompanied by a significant and detailed FRA. The sequential approach to development layout should always be applied within the development site itself. Development should follow the strategic mitigation strategy set out in this report and the impact of extreme events, beyond those used for the protection of the new development, should be assessed on existing development. A very precautionary approach should be applied to new single site development. The sensitivity of flow routes and how they can cause significant changes to the risk within this floodplain system will be a constraint to development. However, keeping floodwaters constrained within the channel is not possible without causing further increases in flood levels. Making room for the River Irwell and working with the risks it poses in the layout and design of new development is essential. Net developable area and the type of development possible in this area is heavily constrained by flood risk.

Further upstream in the area of Chamberhall in Bury, flood risk is well understood and current FRAs reviewed suggest appropriate mitigation techniques. Development at Western Waterside needs to be carefully considered in terms of flood risk, due to risk to the site from the River Irwell, a minor watercourse and a minor reservoir.

Littleborough

The main source of flooding in Littleborough is fluvial flooding from the River Roch. Smaller watercourses such as Ealees Brook, Featherstall Brook, Lydgate Brook and Town House Brook also pose a risk.

The defences along the River Roch provide a 1 in 100 year SOP and have a number of associated areas that benefit. There are also some defences with a 1 in 50 year SOP (estimated) which overtop during the 1 in 100 year flood event, flooding properties along the A6033. The A6033 is an important flow route for flood water entering Littleborough from further upstream and conveys the majority of water towards Church Street

where it collects behind defences further downstream. However, in these cases flood depths are low and are potentially manageable through urban design and the sequential approach to site layouts.

The Rochdale Canal is a potential source of flooding in the area and residual risk should be considered when making spatial planning decisions. Littleborough has also been defined as a CDA as it is surrounded by steep hillsides that will encourage water to runoff quickly into the settlement.

The overall flood mechanisms in Littleborough are understood and the actual risk of flooding is expected to be relatively low due to the presence of current flood defences. Some areas are still exposed to residual risk, although the risk is expected to be manageable through the implementation of appropriate mitigation measures. Future development can occur on a site by site basis but sites surrounding defences with lower SOPs should consider the impact of their development on flood risk downstream through site layout or other mitigation methods such as land raising or improving defence standards.

Rochdale

The main source of flooding in Rochdale is fluvial flooding from the River Roch. The majority of flood defences along the River Roch are in good condition, providing a 1 in 100 year SOP to adjacent areas. During detailed modelling which included improved hydrological estimation, it was found that these defences also managed the 1 in 100 year plus climate change event, albeit with a reduced freeboard or factor of safety. There are a number of locations along the Roch in Littleborough and Rochdale and along Buckley Brook in Rochdale where defences are at a lower standard and are at risk of overtopping in the 1 in 100 year event. The immediate hazard is relatively small, however during larger events, flood flow paths form placing a number of key residential and proposed development sites at greater risk. In the instance of Buckley Brook, these flow paths contribute heavily to the overall risk in that community and especially for the East Central Rochdale Housing Market Renewal area. There are informal defences upstream of the Esplanade Culvert in central Rochdale that are at risk of breaching during a flood event.

During the 1 in 1000 year flood event, defences along the left bank of the Roch downstream of Belfield Road overtop, flooding properties along Stanney Road. The same mechanisms are exacerbated along Buckley Brook. The Esplanade Culvert is also highlighted as a flood risk issue as it has become blocked in the past and the upstream defence, as above, is in poor condition.

Flood risk management strategies have been discussed in Rochdale, identifying the need to improve the quality of defences along Buckley Brook to reduce the impact of defences overtopping and the possibility of leaving proposed development sites upstream of central Rochdale open for flood storage. A strategic flood risk management strategy is required in central and east Rochdale, with all proposed development adhering to the recommendations. Development cannot continue on a piecemeal basis as sources of flooding and important flow paths are situated outside of proposed development sites. Proposed development land may have to be re-allocated for flood storage and a sequential approach to site layout will have to be applied within development sites.

Shaw

The main source of flooding in Shaw is fluvial flooding from the River Beal. No detailed modelling was undertaken in this area as fluvial risk is already relatively well understood and there is limited residual risk associated with flood defences.

There is the potential for future development to impact on river flows along the Beal and the Roch if surface water discharges are not controlled from development sites. As a worst case scenario, this could be an increase in the order of 85mm on peak water levels in Rochdale. However, this is seen as unlikely and it is expected that a reduction in peak water levels of around 65mm may be achieved in Rochdale with the implementation of sustainable drainage techniques for new development. The impact of development on flows further downstream in Bury is reduced, with minimal impacts in Salford.

There is not a significant risk of surface water flooding in Sholver or Derker, but detailed surface water mapping was undertaken which should be used to help plan future development to reduce any possible negative impact on surface water flood risk downstream and reduce surface water flood risk within the developments. It is recommended that a Drainage Strategy be undertaken for the neighbourhood to identify areas suitable for SUDS, allowable discharges from sites and where surface water flow paths could be opened up in new development.

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Animations of flooding have been provided for the 1 in 100 and 1 in 1000 year flood events for Ramsbottom, Bury-Radcliffe, Rochdale and Littleborough. They will be provided as digital media files with final report.

ABBREVIATIONS

ABD	Areas Benefiting from Defences
AEP	Annual Exceedance Probability
AGMA	Association of Greater Manchester Authorities
BRO	Bury, Rochdale and Oldham Councils
CDA	Critical Drainage Area
CFMP	Catchment Flood Management Plans
CLG	Communities and Local Government
COW	Critical Ordinary Watercourse
CS	Core Strategy
DPDs	Development Plan Documents
EA	Environment Agency
EU	European Union
FAS	Flood Alleviation Schemes
FEH	Flood Estimation Handbook
FCERM	Flood and Coastal Erosion Risk Management
FRA	Flood Risk Assessment
FRM	Flood Risk Management
GMRF	Greater Manchester Resilience Forum
IFM	Indicative Floodplain Map
LDDs	Local Development Documents
LDF	Local Development Framework
LPAs	Local Planning Authorities
MIR	Modelling Inception Report
NFCDD	National Fluvial and Coastal Defence Database
PPG	Planning Policy Guidance
PPS	Planning Policy Statement
RBD	River Basin District
RBMP	River Basin Management Plan
RFRA	Regional Flood Risk Assessment
RPB	Regional Planning Bodies
RPG	Regional Planning Guidance
RSS	Regional Spatial Strategy
RVFD	Receptors Vulnerable to Flooding Database
SA	Sustainability Appraisal
SEA	Strategic Environmental Assessment
SFRA	Strategic Flood Risk Assessment
SFVI	Social Flood Vulnerability Index
SMP	Shoreline Management Plans
SOP	Standard of Protection
SPD	Supplementary Planning Document
SUDS	Sustainable (Urban) Drainage Systems
SWMP	Surface Water Management Plan
UDP	Unitary Development Plan
UU	United Utilities

1 INTRODUCTION

1.1 Background

JBA Consulting was commissioned in March 2009 by Bury MBC, Rochdale MBC and Oldham MBC to undertake a Level 1 and Level 2 Strategic Flood Risk Assessment (SFRA) leading on from the Greater Manchester Sub-Regional SFRA completed in August 2008.

The Level 1 SFRA for Bury, Rochdale and Oldham (BRO) and the BRO Level 2 SFRA has been prepared in accordance with current best practice, Planning Policy Statement 25 Development and Flood Risk (PPS25)[1] and the PPS25 Practice Guide[2].

This document comprises the Level 2 assessment.

1.2 Scope and Objectives

The purpose of this investigation is to provide a spatial assessment of flood risk within key urban areas within Bury, Rochdale and Oldham (Shaw), to develop on the detail included in the Greater Manchester sub-regional SFRA and the BRO Level 1 SFRA. Together these sources will assist the Local Development Framework (LDF) and the policies and proposals produced for the development and use of land within Bury, Rochdale and Oldham.

The BRO Level 1 SFRA (Volume II) has provided sufficient data and information to inform an initial application of the Sequential Test by each Council. This information was based on the then currently available data within:

- Flood Zone Maps
- Flood Risk Management Maps
- Surface Water Flooding Maps
- Climate Change Maps
- Indicative Flood Zone 3 Depth Maps

However, it was acknowledged at the scoping stage of the SFRA work that due to the geographical location of Bury and Rochdale's key urban areas along the River Irwell and Roch and the presence of existing flood risk management measures and development pressures, the flood risk information provided in a Level 1 SFRA would not be detailed enough to carry out each Test in these high risk areas. A more thorough investigation is required to truly understand the mechanisms of flood risk in each council area and apply the Sequential and Exception Test successfully whilst trying to balance the need for continued growth and regeneration.

A key objective of the Level 2 SFRA is therefore to inform the application of the Sequential Test, by interrogating the findings of the BRO Level 1 SFRA and potential development sites at medium and high flood risk, and assist the Council in establishing whether the requirements of the Exception Test can be met as outlined below.

a) It must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk, informed by a SFRA where one has been prepared. If the LDD has reached the 'submission' stage (see Figure 4.1 of PPS12: Local Development Frameworks) the benefits of the development should contribute to the Core Strategy's Sustainability Appraisal (SA),

b) The development must be on developable previously-developed land or, if it is not on previously-developed land, that there are no reasonable alternative sites on developable previously-developed land, and

c) A site-specific Flood Risk Assessment must demonstrate that the development will be safe,

[1] Communities and Local Government (2006) *Planning Policy Statement 25: Development and Flood Risk*

[2] Communities and Local Government (2008) *Planning Policy Statement 25: Development and Flood Risk – Practice Guide*

without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall[3].

Whilst the application of the Exception Test may make it possible to strategically plan the type and form of the development, it must not been seen as an opportunity to place inappropriate development in flood risk areas.

In order to establish whether application of the Exception Test is justified or can be satisfied, (namely part c), the Level 2 SFRA considers the nature of flood hazards, taking account of the presence of flood risk management measures such as flood defences. The detailed nature of the flood hazard within a Flood Zone includes:

- Flood probability,
- Flood depth,
- Flood velocity, and
- Rate of onset of flooding.

These factors can be significantly affected by the presence of flood defences or any other infrastructure which acts as a flood defence. It is already known from the BRO Level 1 SFRA that there are a number of defences along the River Irwell and Roch which present a significant residual risk to urban areas. Flooding behind such infrastructure can occur either as a result of:

- Constructional or operational failure of the defence, either in whole or in part (breach), or
- Water levels rising to exceed the level of the defence (overtopping), or
- Overloading of the surface water drainage system, either due to its own limited capacity, or being unable to discharge due to high water levels outside the defended area.

As there are no significant flood defence structures within the Beal catchment, which would contribute to the residual risk in Shaw, an analysis of flood hazard has not been carried out.

It is the assessment of residual risk associated with low probability but high impact events that is central to the Level 2 SFRA work and the impacts it has on the spatial development in Bury and Rochdale. By facilitating the application of the Exception Test, the Level 2 SFRA technical work will also provide evidence to support allocation of land for specific uses within individual developments within the Flood Zones in Bury and Rochdale and the range of possible mitigation measures that would enable the development to proceed. Accordingly, an outline mitigation strategy has been developed in parallel to the Level 2 SFRA, which informs the later chapters within this Volume.

As additional work, Rochdale Development Agency (RDA) required further analysis for a string of river frontage development sites in central Rochdale including:

- Scenario modelling,
- Indicative mitigation cost estimates,
- A schedule of recommended measures,
- Site development sequence, and
- Guidance on the potential location, status and legal responsibilities for construction and maintenance of any proposed mitigation measures.

This work is discussed in Volume IV of the SFRA.

1.3 Study Area

The study area of the Level 2 SFRA is focused on Bury, Rochdale and the Beal catchment within Oldham and their individual key urban areas; Ramsbottom, Bury, Radcliffe, Littleborough, Rochdale and Shaw as shown in Figure 1-1.

As outlined in the BRO Level 1 SFRA, flood risk is a significant issue in these urban areas and arises from a number of sources and mainly from main river flooding from the River Irwell in Bury, the River Roch in Rochdale and the Beal in Oldham. There are also a number of smaller tributaries which pose significant risks to urban areas downstream, especially around their confluence with the River Irwell and Roch. These include; Buckley Brook, Dearden Brook, Ealees Brook, Townhouse Brook, River Beal and the River Spodden.

[3] The development must be made safe for the lifetime of the development, which would include taking account of climate change risk. UKCP09 scenarios have been produced and are currently being reviewed by the Environment Agency

The extent of flooding identified by the Environment Agency Flood Map is narrow along the rural reaches of the watercourses, although it is significantly wider in the key urban areas of Ramsbottom, Radcliffe and Rochdale. Updated Flood Zones along the River Roch produced in the BRO Level 1 SFRA show a general reduction in the extent of Flood Zone 2 and 3 in Littleborough and Rochdale, but still indicate that a number of important development sites are at risk.

Both Bury and Rochdale Councils benefit from Environment Agency and privately owned flood defence infrastructure which provide a Standard of Protection (SOP) from between a 1 in 2 year to a 1 in 100 year flood event. Whilst providing a certain SOP, defences leave a suite of residual risks including overtopping, breaching or exceedance of culvert capacities.

In addition to Main River flooding, local surface water runoff from surrounding rural/greenfield and urban areas can become trapped behind defences, pooling in low lying areas, or as a result of pumping station failure can produce additional sources of flooding. The BRO Level 1 SFRA identified a number of Critical Drainage Areas in Bury, Rochdale and Oldham including; Littleborough, Heywood, Ramsbottom, Radcliffe, Derker and Sholver.

It was acknowledged that the Sholver and Derker HMR areas would benefit from a more detailed assessment of surface water drainage since they drain wholly or partly to the River Beal catchment and could have an impact on flood risk downstream in Bury and Rochdale. As part of the Level 2 assessment more detailed surface water modelling has been carried out for these and the other CDAs and an assessment has been undertaken of the impact of development sites in the River Beal catchment on flood risk downstream in Rochdale, Bury and Salford.

Figure 1-1: Level 2 SFRA study area

Map shows that the River Beal catchment falls within Oldham and Rochdale

1.4 Outline Methodology

To ensure the scale and nature of the risks are truly understood, the Level 2 SFRA is based on new detailed modelling information as outlined in the initial BRO SFRA Modelling Inception Report (MIR). To ensure that a consistent set of maps have been produced for the SFRA, the Level 1 SFRA has used outputs from the SFRA modelling to inform the Climate Change and revised Rochdale Flood Zone maps.

Flood outlines are normally derived from 1D hydraulic models by extrapolating a predicted water level in the channel across the floodplain using topographical data to estimate those areas that will be inundated. Whilst this method is suitable for creating the Environment Agency Flood Maps, this approach is not always appropriate in instances where there are likely to be complex flow patterns and where water levels in the floodplain may differ significantly from those in the watercourse. More appropriate representation of these characteristics is crucial in urban areas, especially those which are defended (as discussed above), to simulate the conveyance of flood waters across the developed floodplain and to gain a more detailed understanding of flood risk.

New modelling data includes:

1. 2D floodplain modelling of the River Irwell through Ramsbottom and Radcliffe and the River Roch through Littleborough and central Rochdale,
2. Canal breach assessment for the Rochdale Canal,
3. Detailed surface water flooding mapping of Critical Drainage Areas (CDAs) as identified in the BRO Level 1 SFRA, and
4. Scenario modelling of upstream development.

In undertaking the 2D floodplain modelling the scale of residual risks and the flood inundation pathways can be understood and assimilated into the layout of development. This investigation included modelling of a number of scenarios including:

- Flood Zone revisions (undefended) for Rochdale – 1 in 100 year and 1 in 1000 year events
- Defence breaching – 1 in 100 year event
- Defence overtopping – 1 in 1000 year event

Each scenario also included an allowance for the impacts of climate change over the next 100 years as defined in PPS25. The results of the modelling and the mapping outputs are discussed in subsequent chapters of this Volume.

The risk of fluvial flooding to development sites in Oldham was not considered to be high and there is no planned development behind flood defences. Consequently the assessment for these sites was not extended to a Level 2 assessment. A summary of flood risk within the community of Shaw has been provided to help Oldham Council assess the likelihood of sites or future sites passing the Exception Test.

The risk of surface water flooding to regeneration and new development in Sholver and Derker Housing Market Renewal (HMR) areas has been explored as part of the Level 2 assessment, alongside the consideration of multiple sources of flooding and the impact of flooding on critical infrastructure.

The consequences of future development within the River Beal catchment and also across Bury, Rochdale and Oldham (Beal catchment) on flood risk in Rochdale, Bury and downstream into Salford has been investigated.

2 ASSET MANAGEMENT SURVEY

2.1 Bury and Rochdale Defence Assets

As part of the BRO Level 1 SFRA, an asset database was created, building on data supplied by the Environment Agency within the National Flood and Coastal Defence Database (NFCDD).

The NFCDD was initially reviewed to identify key Environment Agency and privately owned flood risk management assets on the River Roch and Irwell systems through Littleborough, Rochdale, Ramsbottom and Bury-Radcliffe, as these were identified as the locations with the highest flood risk and development pressures. In order to gain a greater understanding of the residual risks associated with the flood risk management assets, an asset survey was undertaken by a Chartered Engineer.

The watercourses visited included:

- The lower sections of Littleborough and Rochdale
    - Ash Brook
    - Buckley Brook
    - Hey Brook
    - River Roch
    - River Spodden
    - Stanney Brook
- Ramsbottom and Bury-Radcliffe
    - Cow Trees Farm Brook
    - Cross Bank Brook
    - Dearden Brook
    - Parr Brook
    - River Irwell

Asset locations were visually inspected to gain an understanding of the surrounding topography, the flood risk to the nearby proposed development sites, the areas benefitting from the defences and the natural floodplain. Notes were made of the general condition of structures using the ratings identified in Table 2-1.

Table 2-1: NFCDD condition ratings for flood defences

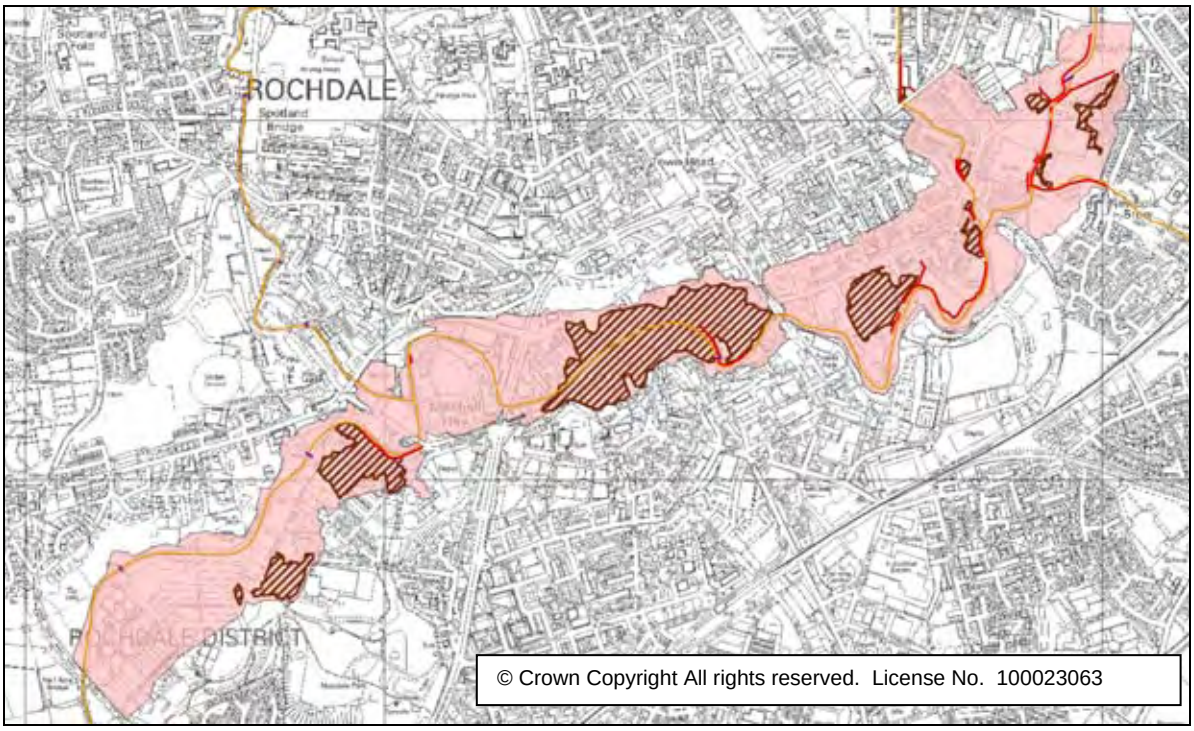
Condition Rating	Condition	Condition Description
1	Very Good	Fully serviceable
2	Good	Minor defects
3	Fair	Some cause for concern. Requires careful monitoring
4	Poor	Structurally unsound now or in the future
5	Very Poor	Completely failed and derelict

Photographs of key structures were taken and notes were also made of the watercourse condition in the vicinity of the structures where weed growth, sediment deposition, or a lack of channel maintenance was evident.

A GIS based database was developed as discussed in the BRO Level 1 SFRA. Flood defence assets (red) were also provided on Flood Risk Management Measure Maps (Figure 2-1) for Bury, Rochdale and Oldham Councils along with the Environment Agency Flood Warning Areas (pink) and Areas Benefiting from Defences (hatched).

Figure 2-1: Example of flood risk management measures map in Rochdale

(A larger FRM map is provided at the back of the Volume II report)



2.2 Possible Spill and Breach Locations

On the back of the asset survey, a number of possible breach and spill locations were identified due to the defence standard, height or due to the location of possible flow paths in or around the defences (Table 2-2).

Table 2-2: Possible breach locations

Location	Spill or Breach	Watercourse	Bank	X	Y
Esplanade Culvert, Rochdale	Breach	River Roch	Right	389887	413416
Car park at Milton Street, Rochdale	Breach	River Roch	Right	389996	413346
Allotments, Rochdale	Breach	River Roch	Right	390673	413569
Red Lane, Rochdale	Breach	Buckley Brook	Right	390565	414614
Warth Road, Bury-Radcliffe	Breach	River Irwell	Left	379396	409394
Paper Mill site, Bury-Radcliffe	Breach	River Irwell	Right	379232	407263
North Street, Radcliffe	Spill	Crow Trees Farm Brook	Right	379023	407918
Cross Lane, Radcliffe	Spill	Crow Trees Farm Brook	Right	379036	407497
Church Street West	Spill	River Irwell	Right	378618	407002
Bus Station, Bury-Radcliffe	Spill	River Irwell	Right	378534	406878
Mill Street, Bury-Radcliffe	Spill	River Irwell	Left	378510	406720
Keswick Drive, Bury-Radcliffe	Spill	River Irwell	Left	379896	409026
Eagle Bleach Works, Rochdale	Spill	River Roch	Left	380734	407707
Rover Garage, Rochdale	Spill	River Roch	Right	380782	407866

Location	Spill or Breach	Watercourse	Bank	X	Y
School on B6222, Mitchell Hey	Spill	River Roch	Right	388798	413113
Entwisle Road culvert, Rochdale	Spill	Buckley Brook	Left	390616	413843
Buckley Road, Rochdale	Spill	Buckley Brook	Right	390587	414800
Dye House Lane, Howarth Cross	Spill	Ash Brook	Left	391271	415115

Careful consideration of the possibility of breaching and defence overtopping and the results of the detailed modelling concluded that significant risk and a high probability of failure existed at only a few locations.

These included a breach at Milton Street car park along the River Roch just upstream of the Esplanade Culvert. Currently the defence is a raised soil and gravel embankment and it is expected that its structural integrity would be called into question during a large flood event.

Figure 2-2: Milton Street car park

A number of locations along Buckley Brook have been identified as at risk of overtopping. The two key locations are along Buckley Road where it would seem a raised defence has been removed or dismantled due to site clearance next to the watercourse. NFCDD and aerial photographs show that a raised defence should follow to right hand bank however, the asset survey photograph of the

location shows that it is no longer present (Figure 2-3).

Figure 2-4 identifies another possible spill location at the upstream face of Entwisle Road culvert along Buckley Brook. Currently the left hand bank raised defence is lower than the right hand bank with metal fences making up the rest of the height. There is also an Environment Agency access ramp which could also provide a flow path onto Entwisle Road during large flood events.

The defences through Bury and Radcliffe are piecemeal and in poor condition and would provide little protection to adjacent areas during large flood events. It was decided therefore that there would be little benefit in investigating defence breaching or overtopping. The locations of these defences are also remote from current development proposals and there is little available data concerning the exact crest levels of these defences. It was therefore decided that a single modelled scenario would be created for the area of current risk, which is effectively an undefended model. The benefits of this are that it provides a precautionary assessment of flood risk in the area, whilst still identifying critical flow paths across the floodplain.

Figure 2-3: Buckley Road missing defence

Figure 2-4: Culvert on Buckley Brook

3 FLUVIAL FLOOD RISK

3.1 Introduction

Following on from the findings of the asset survey and the BRO SFRA Modelling Inception Report (MIR) a number of 2D floodplain models were created across Bury and Rochdale. These included:

- Ramsbottom, Bury MBC
- Radcliffe, Bury MBC
- Rochdale, Rochdale MBC
- Littleborough, Rochdale MBC

1D ISIS models were already available for the River Roch and River Irwell in the above locations and therefore the main body of work was to create 2D TUFLOW links to represent the urban floodplains in both the defended and undefended case. The methodology for creating the 2D TUFLOW models was provided in the MIR. Once developed a number of scenarios were tested, as shown on Table 3-1 to Table 3-4.

(O = Outlines, D = Depths, H = Hazards, A = Animations)

Table 3-1: 2D Modelled scenarios in Ramsbottom

Scenario	Flood Event	Defended	Outputs			
			O	D	H	A
Overtopping	1 in 1000 years	✓	✓	✓	✓	✓
Future Overtopping	1 in 1000 years + 20%	✓	✓	✓	✓	×
Defended	1 in 100 years	✓	✓	✓	✓	✓
Future Defended	1 in 100 years + 20%	✓	✓	✓	✓	×
Flood Zone 3b	1 in 25 years	✓	✓	✓	✓	×

Table 3-2: 2D Modelled scenarios in Radcliffe

Scenario	Flood Event	Defended	Outputs			
			O	D	H	A
Flood Zone 2	1 in 1000 years	×	✓	✓	✓	✓
Future Flood Zone 2	1 in 1000 years + 20%	×	✓	✓	✓	×
Flood Zone 3	1 in 100 years	×	✓	✓	✓	✓
Future Flood Zone 3	1 in 100 years + 20%	×	✓	✓	✓	×
Flood Zone 3b	1 in 25 years	×	✓	✓	✓	×

Table 3-3: 2D Modelled scenarios in Littleborough

Scenario	Flood Event	Defended	Outputs			
			O	D	H	A
Flood Zone 2	1 in 1000 years	×	✓	✓	✓	×
Future Flood Zone 2	1 in 1000 years + 20%	×	✓	✓	✓	×
Overtopping	1 in 1000 years	✓	✓	✓	✓	×
Future Overtopping	1 in 1000 years + 20%	✓	✓	✓	✓	×
Flood Zone 3	1 in 100 years	×	✓	✓	✓	×
Future Flood Zone 3	1 in 100 years + 20%	×	✓	✓	✓	×
Defended	1 in 100 years	✓	✓	✓	✓	×

Scenario	Flood Event	Defended	Outputs			
			O	D	H	A
Future Defended	1 in 100 years + 20%	✓	✓	✓	✓	×
Flood Zone 3b	1 in 25 years	✓	✓	✓	✓	×

Table 3-4: 2D Modelled scenarios in Rochdale

Scenario	Flood Event	Defended	Outputs			
			O	D	H	A
Flood Zone 2	1 in 1000 years	×	✓	✓	✓	×
Future Flood Zone 2	1 in 1000 years + 20%	×	✓	✓	✓	×
Overtopping	1 in 1000 years	✓	✓	✓	✓	✓
Future Overtopping	1 in 1000 years + 20%	✓	✓	✓	✓	×
Flood Zone 3	1 in 100 years	×	✓	✓	✓	×
Future Flood Zone 3	1 in 100 years + 20%	×	✓	✓	✓	×
Defended	1 in 100 years	✓	✓	✓	✓	✓
Future Defended	1 in 100 years + 20%	✓	✓	✓	✓	×
Flood Zone 3b	1 in 25 years	✓	✓	✓	✓	×
Breach	1 in 100 years	✓	✓	✓	✓	×

Hazard maps were produced directly within the modelling package TUFLOW. The formula used is shown below (d = depth, v = velocity and DF = debris factor).

Flood Hazard = d (v + 0.5) + DF

The flood hazards calculated were then catagorised and coloured in accordance with the latest recommendations[4] as illustrated in Table 3-5.

Table 3-5: Flood Hazard rating

Flood Hazard Rating	Hazard to People	Colouring
0	**No Hazard**	
0 to 0.75	**Very Low Hazard**	
0.75 to 1.25	**Dangerous for some**	
1.25 to 2.0	**Dangerous for most**	
Over 2.0	**Dangerous for all**	

PPS25 provides no guidance as to which development type is permitted in certain hazard zones, although it is implicity implied in the vulnerability classification of those developments. The BRO SFRA User Guide (Vol I) goes someway in providing clear guidance on the use of flood hazards within spatial planning and development management.

The outputs of the modelling have been provided as part of the Level 2 SFRA. Where indicated above, animations have been provided for the 1 in 100 and 1 in 1000 year flood events. These have been produced to assess the rate of onset of flooding in these locations but also give a good representation of rapid inundation zones, how flow paths develop, and the development of areas of deep pooled flood waters. These animations can be found on the digital deliverable CD/DVD with all PDFs and GIS of SFRA maps produced.

Detailed explanations of the results are discussed below:

[4]Gibbs, G., Surendran, S., Wade, S. and Udale-Calrke, H. (2008) Supplementary note on flood hazard ratings and thresholds for development planning and control purpose – Clarification of the Table 13.1 of FD2320/TR2 and Figure 3.2 of FD2321/TR1

3.2 Ramsbottom

Ramsbottom is situated in the northern quarter of Bury Council area. The main source of flood risk in Ramsbottom is fluvial flooding from the River Irwell. Both Flood Zone 2 and 3a are extensive in this area with large areas of functional floodplain downstream of Cuba Industrial Estate (left hand bank) and further downstream surrounding Nuttall Park. However, the risk within Ramsbottom is mainly residual due to a number of flood defences along the River Irwell that may be overtopped or bypassed further upstream. Sections of Peel Brow, Mills downstream of Ramsbottom Bridge (off Bridge Street) and a Mill at Nuttall Park are protected to a 1 in 100 year flood event standard. The main areas at flood risk are also covered by the Environment Agency Flood Warning system.

The flood depth and hazard maps for all scenarios are presented at the back of this Volume.

During the 1 in 100 year defended scenario (actual risk), areas benefiting from defences remain dry. Deep flood waters are constrained to functional floodplain. However, the football and cricket ground at Acre Bottom is flooded. A critical flood path has been identified from an area upstream of Ramsbottom where the Irwell overtops its undefended bank at Stubbins, Rossendale. This flow path places a large area of current residential properties at risk, which is not at direct risk from the nearest stretch of the River Irwell. Flood waters then flow underneath the East Lancashire Railway and head south down Stubbins Lane. Flood waters collect around Drill Hall as they are constrained by high road levels along Bridge Street, causing flooding up to 2m deep.

This process is exacerbated further during the 1 in 1000 year defended scenario (overtopping). In this case those defences with a 1 in 100 year SOP are overtopped. The same defences also block water re-entering the system, causing depths from 0.5-2m. The major flow route underneath the railway is identified again, however resulting water levels downstream exceed ground levels along Bridge Street and water flows over into the Mill area south of Bridge Street. Flood depths in these areas would be around 2-2.5m.

Flood risk in Ramsbottom is related to the residual risks associated with current defence overtopping during lower probability events such as the 1 in 1000 year flood event and as a result of the River Irwell overtopping its bank upstream in Rossendale Council area. If this critical flow path can be stopped, without increasing flood risk downstream, it would remove a number of current properties and future development sites on the right hand side of the railway line from the risk of fluvial flooding.

Approximate flood depths are presented below. These have been extracted over large areas and for more detailed depths, the Level 2 SFRA maps should be referred to.

3.2.1 Defended 1 in 100 year flood event

- 1m flood depths along Stubbins Lane
- 1.5m flood depths in Peel Brow (due to flood waters flowing down Stubbins Lane)
- Bridge Street acts as a barrier preventing flood water from entering the mill site. However this results in large depths north of Bridge Street at Peel Brow
- There are a number of areas benefiting from defences (ABDs)

3.2.2 Defended 1 in 100 year plus climate change flood event

- Bridge Street is overtopped from the north resulting in 0.5m of water in the Mill Site south of Bridge Street
- Flood waters also continue down Railway Street and into the depot off Grants Lane
- 0.5m of flooding at Nuttall Lane Mill

3.2.3 Defended 1 in 1000 year flood event

- 1.5m flood depths along Stubbins Lane
- 2m flood depths in Peel Brow (due to flood waters flowing down Stubbins Lane)
- Bridge Street is overtopped from the north and flood water enters the mill site with depths reaching around 2m
- 2m depths of flooding at cricket and football ground
- Previous ABDs are inundated
- Current raised defences act as a barrier to flood waters re-entering the Irwell at Peel Brow and the depot off Grants Lane

3.2.4 Flood Hazards

- During the 1 in 100 year flood event, greater flood hazards are associated with deep flood waters within the functional floodplain
- Higher flood hazards ('Dangerous for Some/Most') are noticed around Stubbins Lane due to faster and deeper flood waters underneath the railway
- During the 1 in 1000 year flood event, 'Dangerous for All' flood hazards have been classified for the majority of Ramsbottom which is inundated. This is due to very deep flood waters and fast flowing inundation zones surrounding defence assets

3.3 Bury-Radcliffe

The area of Bury and Radcliffe is situated along the River Irwell between Buckley Wells and the weir adjacent to Mount Sion Road. The main source of risk is fluvial flooding from the River Irwell. Both Flood Zone 2 and 3a are extensive throughout the meanders of the Irwell representing the wide low lying floodplains. Both banks of the Irwell are heavily developed with residential communities, old industrial and commercial estates and treatment works. The River Roch also contributes to risk in this area as a tributary to the Irwell.

On review of the asset survey, the majority of current defences along this section of the Irwell are in poor condition and sporadic providing little protection to adjacent areas. Therefore a current risk scenario was modelled, which was essentially undefended.

The flood depth and hazard maps for all scenarios are presented at the back of this Volume.

During the 1 in 100 year flood event, the natural floodplain of the Irwell becomes inundated as meanders are bypassed by flood waters downstream of Bury/Radcliffe Road around Redvales, A6053 (Dumers Lane), Blackford Bridge and Close Park. Warth Mills is also inundated by flood waters entering the area underneath the railway from Lower Hinds in the north. The majority of deep flooding surrounds industrial and commercial units directly adjacent to the Irwell with depths reaching up to 2m. Flood depths reach 1m in some residential areas north of Dumers Lane. The area surrounding the East Lancs Paper Mill site (Rectory Lane) also becomes inundated with depths of around 0.5-1m.

An important flood mechanism is the presence of Hutchinson's Goit. During the 1 in 100 year flood event, flood water spilling from the River Irwell enters Hutchinson's Goit downstream of Radcliffe Road. Flows remain low and are contained within bank due to the limited capacity of the culvert underneath Radcliffe Road, which limits the volume of inflow into the downstream reaches. The culvert at Bury Street is exceeded and water overtops the Goit from its left hand bank flooding surrounding residential properties and a school. However, flood depths remain below 0.5m.

The flood mechanisms of the Irwell are only exacerbated during the extreme 1 in 1000 year flood event. For the majority of the area, the channel of the River Irwell is bypassed by floodplain flow reaching over 2m in Redvales, Dumers Lane and the sewage works. The residential area north of Dumers Lane could see flood depths of 1-2m. Shallow flooding extends north of Redvales to residential areas surrounding Redvales Road and Radcliffe Road.

In both scenarios, high ground surrounding Swan Lodge (disused tip) and the railway line constrain flood flows, resulting in deeper flood depths throughout Bury-Radcliffe.

Approximate flood depths are presented below. These have been extracted over large areas and for more detailed depths, the Level 2 SFRA maps should be referred to.

3.3.1 Undefended 1 in 100 year flood event

- 0.5-1.5m flood depths around commercial and residential areas of Warth Mills
- 0.5-1m flood depths at commercial units between the River Irwell and Swan Lodge
- Over 2m of flooding at Redvales
- 1-1.5m flood depths south of Dumers Lane
- 1.5-2m flood depths at Close Park
- 0.5-1m flood depths at East Lancs Paper Mill site
- 0.5m flood depths resulting from Hutchinson's Goit flooding at Bury Street culvert

3.3.2 Undefended 1 in 100 year plus climate change flood event

- Increase in extent of shallow water around Warth Mills residential area

- Over 2m flood depths at Close Park
- 1.5-2m flood depths at Paper Mill site

3.3.3 Undefended 1 in 1000 year flood event

- 1.5-2m flood depths around commercial and residential areas of Warth Mills
- 1.5-2m flood depths at commercial units between the River Irwell and Swan Lodge
- Over 2m flood depths south of Dumers Lane
- 0.5-1.5m flood depths surrounding residential areas north of Dumers Lane
- Over 2m flood depths at East Lancs Paper Mill site

3.3.4 Flood Hazards

- During the 1 in 100 year event, flood hazards throughout the Bury-Radcliffe area are 'Dangerous to Most'. Some key flow paths along Warth Road and around Redvales are 'Dangerous for All'
- During the 1 in 1000 flood year event almost the entire natural floodplain is classified as 'Dangerous for All'. Hazards reduce towards the extent of the floodplain where depths reduce

3.4 Littleborough

Littleborough is situated in the north east extent of Rochdale. The main source of flood risk to Littleborough is fluvial flooding from the River Roch. Smaller watercourses such as Ealees Brook, Featherstall Brook, Lydgate Brook and Town House Brook also contribute to the overall fluvial risk in the area.

Currently, the Environment Agency Flood Zone 3 is confined to areas directly adjacent to Town House Brook, small sections of the A6033 and Stubley Mill Road. Flood Zone 2 is more extensive, covering a number of properties in the area. As part of the BRO Level 1 SFRA, the Flood Zones were updated using a detailed ISIS-TUFLOW model and updated hydrology (using the undefended scenario). The 1 in 100 year flood event extent is more extensive along the Roch in Littleborough, especially in the areas along the A6033 and the confluence of the Roch with Ealees Brook. The 1 in 1000 year flood event extent remains similar to the current Environment Agency Flood Zone 2, with small reductions in extent along Queen Street and Stockton Street.

The risk of fluvial flooding in Littleborough is mainly residual as there are a number of Environment Agency raised defences spanning the River Roch, Town House Brook and Ealees Brook. The defences along the River Roch provide a 1 in 100 year SOP and have a number of associated ABDs. There are also some defences with a 1 in 50 year SOP; however this is often the default value used in the Environment Agency's NFCDD and so this is unconfirmed. There are a number of Environment Agency defences downstream of Green Vale Brook's confluence with the Roch which have a 1 in 25 year or lower SOP. Littleborough is also covered by the Environment Agency Flood Warning system.

The flood depth and hazard maps for all scenarios are presented at the back of this Volume.

During the 1 in 100 year defended scenario, the majority of Littleborough remains dry due to defences with a 1 in 100 year SOP. However, those defences identified with lower SOPs are overtopped on both banks with flood waters entering commercial buildings which flow down the A6033 to Church Street. Flood depths are below 0.5m along this flow path and between 0.5-1m at the A6033/Church Street junction.

During the 1 in 100 year plus climate change event, floodwaters downstream of the Roch confluence with Ealees Brook remain in bank due to the presence of defences. There is also a limited impact on flood depths from defence overtopping further upstream, with peak depths , remaining below 1m.

In a 1 in 1000 year defended scenario the defences further downstream around Stubley are overtopped, causing flood depths of around 1m to 1.5m to properties off William Street. The junction of the A6033 with Church Street and Victoria Street becomes a key risk area as a number of flow paths converge resulting in flood depths reaching up to 1.5m.

Approximate flood depths are presented below. These have been extracted over large areas and for more detailed depths, the Level 2 SFRA maps should be referred to.

3.4.1 Defended 1 in 100 year flood event

- 0.5m flood depths along the A6033
- 1m flood depths at the junction of the A6033, Victoria Street and Church Street
- 0.5m flood depths along Ebor Street
- Defences with a 1 in 100 year SOP are not overtopped

3.4.2 Defended 1 in 100 year plus climate change flood event

- Little change in flood depths throughout
- Extent of shallow flooding increases adjacent to the railway
- 1m flood depths at the junction of the A6033, Victoria Street and Church Street
- 1m flood depths along Ebor Street
- Flood depths also increase around the B6225 over Ealees Brook.

3.4.3 Defended 1 in 1000 year flood event

- 1.5m flood depths along the A6033
- Defences along the Roch at Church Street are exceeded
- 1.5m flood depths around the train station area
- Defences along Cultard Way are overtopped
- 0.5m flood depths at Atherstall Road and Cultart Way
- 1.5m flood depths along William Street

3.4.4 Flood Hazards

- During to 1 in 100 year defended event, flood hazards are relatively low (from 'Very Low Hazard' to 'Dangerous to Some'). Deep floodwaters are likely to pose the highest flood hazard
- Flood hazards increase during the 1 in 1000 year defended scenario. The A6033 becomes 'Dangerous for Most' as well as the area at Stubley and Church Street where defences are overtopped

3.5 Rochdale

According to the current Environment Agency Flood Zones provided in the BRO Level 1 SFRA, Flood Zone 2 and 3a are extensive throughout Rochdale, placing a number of commercial and residential areas at risk. Sections of open land upstream of Albert Royds Street, Mayfield and the allotment gardens off Kellett Street in East Rochdale are also designated as Functional Floodplain.

The 1 in 100 and 1 in 1000 year flood extents were updated in the BRO Level 1 SFRA using the detailed ISIS-TUFLOW model and updated hydrology developed for the SFRA. Both the 1 in 100 and 1 in 1000 year (undefended) flood events have been significant reduced throughout Rochdale, especially land over the Esplanade Culvert and areas surrounding Ramsey Street and Entwisle Road.

There are a number of Environment Agency maintained flood defences along the Roch through Rochdale. The majority of these have been designed to a 1 in 100 year standard apart from those at the allotment gardens which have been designed to exceed for events greater than 1 in 2 years. There are also a few defences along Buckley Brook and Stanney Brook where the SOP is unknown (shown as a standard 1 in 50 years in NFCDD). As discussed in Section 2.2, there are a number of possible breach and spill locations in Rochdale. These include:

- A possible breach upstream of the Esplanade Culvert,
- A missing defence at Buckley Road, and
- Entwisle Road culvert.

The flood depth and hazard maps for all scenarios are presented at the back of this Volume.

During the 1 in 100 year defended scenario (actual risk), peak water levels along the Roch remain in bank apart from those areas designated as functional floodplain. Depths in these areas reach up to 1.5m. During the same event, Buckley Brook overtops its banks at the missing defences at Buckley Road, where flood waters flow south down Buckley Road and onto Park Road. This becomes a

major flow path; however depths are below 0.5m. Flood waters do not pass further than Yorkshire Street and re-enter the Brook. Flooding also occurs around the Mitchell Hey area downstream of the A58 on the Roch where depths reach 0.5m.

During the 1 in 100 year plus climate change event, the same flood mechanisms occur. However, the defence just upstream of Entwisle Road culvert (along Buckley Brook) is exceeded and flood water enters the area flowing south east down Entwisle Road and into the riverside area along the Roch. Depths are generally under 0.5m but they are also constrained by current defences along the Roch from re-entering the watercourse downstream.

As mentioned above, one of the scenarios investigated, breached the defence upstream of the Esplanade Culvert at Milton Street car park. Flooding in this scenario is mainly constrained to the direct area of the car park and Ink Street, with depths reaching around 0.5-1.0m. Smith Street also becomes a critical flow path; however flooding is limited to the road network.

During the 1 in 1000 year defended scenario, a flow path down Buckley Road is identified. Flooding also occurs at Entwisle Road culvert resulting in flood depths of around 0.5m. Flood depths increase up to 1.5m along Nile Street as water becomes trapped behind defences along the Roch. Defences along the left bank of the Roch downstream of Belfield Road also overtop, flooding properties along Stanney Road.

The Esplanade Culvert is also highlighted as a flood risk issue as it has become blocked in the past and surrounding defences are in poor condition. Defences along the right hand bank are overtopped during the 1 in 1000 year flood event causing flood depths of up to 1m on Ink Street. Smith Street also conveys the majority of flood waters west of the bus station, where depths reach up to 2m.

Approximate flood depths are presented below. These have been extracted over large areas and for more detailed depths, the Level 2 SFRA maps should be referred to.

3.5.1 Defended 1 in 100 year flood event

- 1.5m of flooding within functional floodplain areas (Mayfield, Stanney Brook and allotment gardens)
- 0.5m flood depths along Buckley Road and Park Road
- 0.5m flood depths at Mitchell Hey

3.5.2 Defended 1 in 100 year flood event breach at Esplanade Culvert

- 1m flood depths along Ink Street
- 0.5m flooding along Smith Street

3.5.3 Defended 1 in 100 year plus climate change flood event

- 2m flood depths at allotment gardens
- 0.5m flood depths along Entwisle Road due to access ramp of culvert overtopping
- 1m flood depths at Mitchell Hey

3.5.4 Defended 1 in 1000 year flood event

- 2m flood depths at allotment gardens
- 2m flood depths at Stanney Brook and Mayfield
- 1-1.5m flooding along Nile Street due to overtopping of Buckley Brook
- 0.5m flood depths along Entwisle Road
- 0.5-1.5m flood depths to properties along Stanney Road due to defence overtopping
- Esplanade Culvert defence (right hand bank) is overtopped resulting in depths of 1m along Ink Street and 1-1.5m west of the bus station
- 1m flood depths at Mitchell Hey

3.5.5 Flood Hazards

- During the 1 in 100 year defended scenario, flood hazards are relatively high ('Dangerous for Most' and 'Dangerous for All') within the areas designated as functional floodplain. This is due to the depth of flooding rather than the velocity of flood waters
- Flooding along Buckley Road are 'Very Low Hazard'

- During the 1 in 1000 year defended scenario much of the functional floodplain is defined as 'Dangerous for All' due to the extreme flood depths in these areas
- Flooding from Buckley Brook is generally a 'Very Low hazard'; however sections along Nile Street, Kellett Street and Entwisle Road are 'Dangerous for Some' as a result. Mitchell Hey and the area west of the bus station are designated as 'Dangerous for Most'

4 CANAL FLOOD RISK

4.1 Introduction

The BRO Level 1 SFRA identified that there is a residual risk associated with the two canal systems in Rochdale and Bury; the Rochdale Canal and the Manchester, Bury and Bolton Canal. Canals do not pose a direct flood risk as they are a controlled water body. Residual risk is associated with lower probability events such as breaching of embankments. The residual risk associated with canals is unknown as it depends on a number of factors, including the source of water into the canal, materials used within the canal embankments and the condition of those embankments. The risk is limited by continued maintenance by British Waterways and the controlled volume of water within an impounded length. If an event occurs the consequences can be high, especially if people or properties are situated directly below the breached length.

4.2 Direct Canal Hazard Zone

As part of the Level 2 SFRA, a direct canal hazard zone has been produced to identify those areas potentially at risk from the canal systems. This zone is purely indicative and is based on professional judgement of those areas geographically adjacent to the canal system and below the impounded lengths of critical embankments.

This zone only identifies those locations which could potentially be affected by canal flooding if a breach or overtopping should occur. It is not a true identification of inundation zone as the volume and flow paths are unknown. This zone should only be used to identify development sites which should take into consideration the risk of flooding from the canal system during a site specific flood risk assessment (FRA). The FRA should investigate the probability and consequence of the risk further during the assessment and identify the required mitigation measures needed for the development to remain safe.

4.3 Indirect Canal Hazard Zone

Although the regular inspection and maintenance of the Rochdale Canal helps to reduce risk, neither the Rochdale nor the Manchester, Bury and Bolton Canals have been modelled by British Waterways to assess flood risk and there is a possibility that a breach or overtopping will occur.

Consultation with British Waterways indicated that the risk of flooding from the Rochdale Canal is higher than that from the Manchester, Bolton and Bury Canal. Bury MBC should work closely with British Waterways during the restoration of the canal to minimise flood risk from the canal to communities in Radcliffe and Bury. If restored there will be a greater volume of water in the canal in one continuous length, which would increase residual flood risk to the surrounding area.

In order to assist the assessment of residual risk from the Rochdale Canal, breach modelling was undertaken using a HEC-RAS model of a 6.4km impounded stretch of the canal between lock gates north east of Rochdale town centre and along the canal crossing Ealees Brook in Littleborough. These locations were chosen for the purposes of making a strategic assessment and it should be noted that breaching of the canal embankments could occur in many other locations.

It was assumed that the canal would breach at full capacity. Anecdotal evidence of historical breach events in the Rochdale and Oldham area was reviewed, showing that approximate recorded breach widths vary between 30m to 40m. A range of scenarios were run to test the effect of breach widths. The hydraulic model of the canal was unstable for breaches wider than 40 metres, so this was therefore taken as the maximum width. The timing of the breach was also evaluated with breach development times from 5 minutes to 30 minutes. It was expected that breach development will more likely to be very rapid on high sand embankments, therefore the worst case scenario of 5 minutes was chosen.

The worst location for a breach would be in the centre of the 6.4km impounded length, as flow through the breach would be in two directions.

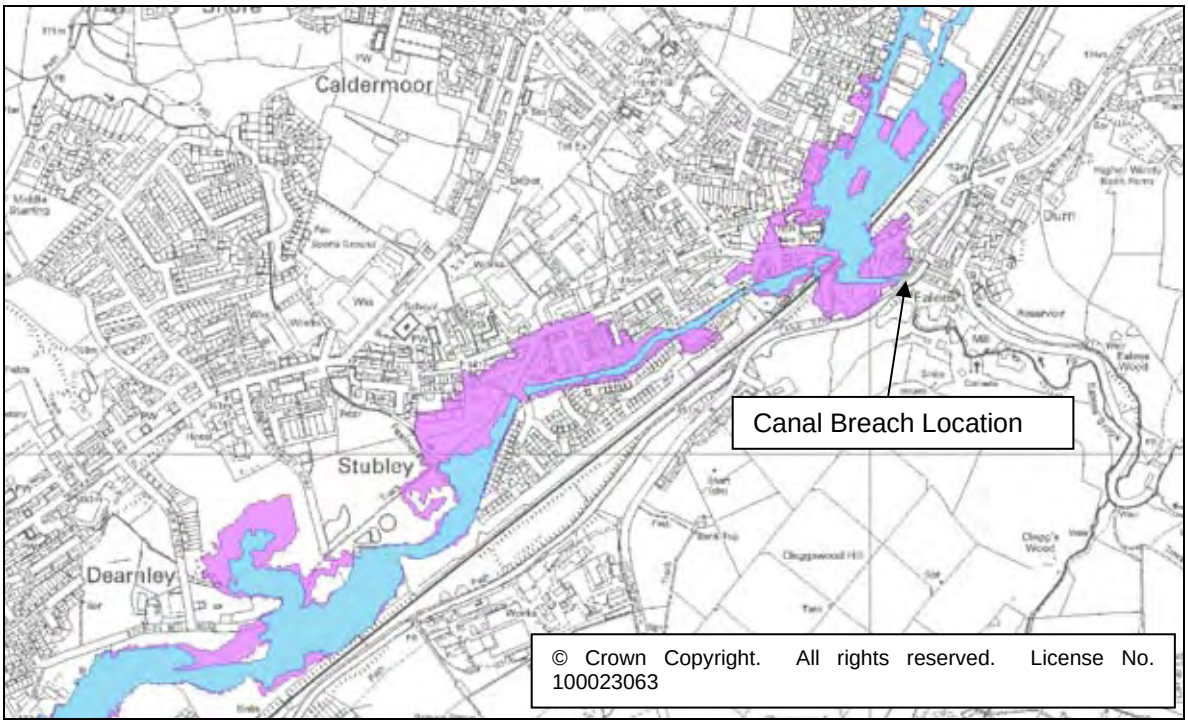
Eight scenarios were tested for the maximum flow and volume through the breach. The worst of these cases was selected and included in the final ISIS-TUFLOW Roch model produced for the investigation into fluvial risk discussed in Section 3. The worst case scenario (40m wide breach

developing over 5 minutes) was tested at breach locations at Littleborough (Figure 4-1) and Smithy Bridge (Figure 4-2).

The assessment showed that for this scenario, peak flow was 83.5 m³/s with a total volume of 143,070 m³ passing through the breach. The resulting hydrograph was then included in the 1 in 100 year event along the Roch using the ISIS-TUFLOW model as above. This was used to investigate the immediate impact of a breach on the surrounding area and the potential increases in water levels downstream. The breach scenarios were run separately and their immediate impact on flood extents is shown in Figure 4-1 and Figure 4-2. The impact of a breach on water levels in the River Roch at a number of key locations is shown in Table 4-1.

Figure 4-1: Impact of canal breach on 1 in 100 year flood extent in Littleborough

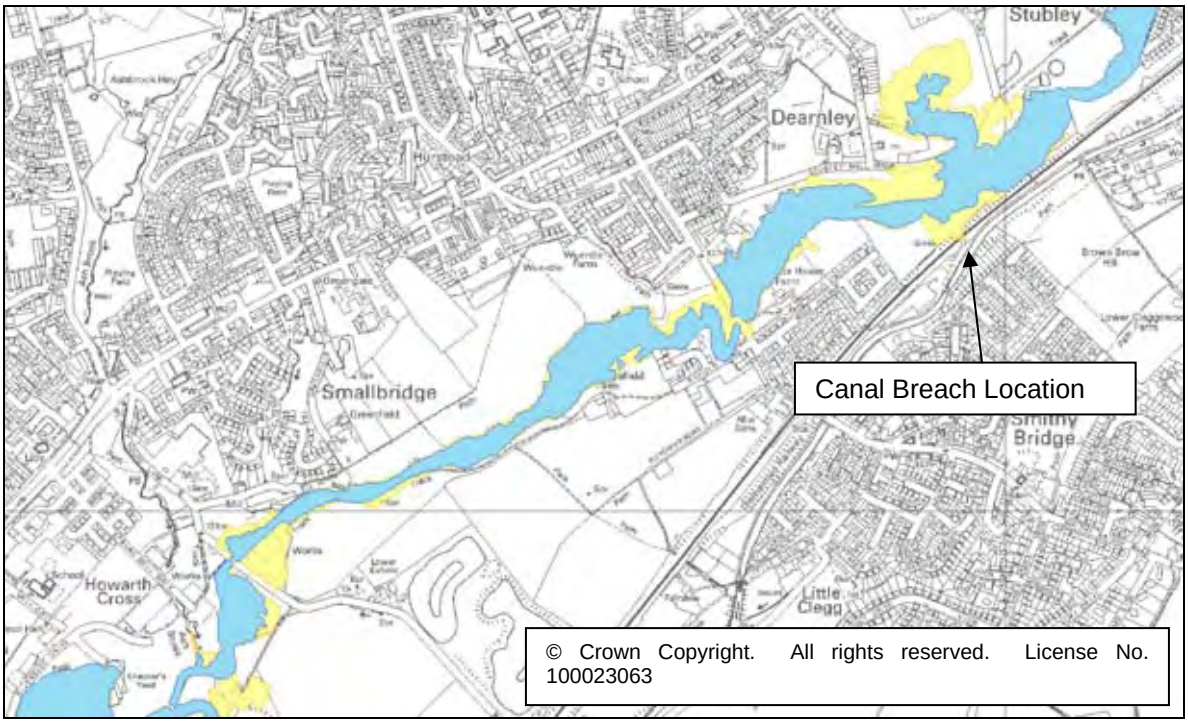
(A larger inundation map is provided at the back of this report)



The impact of a canal breach in Littleborough is evident along the Roch (pink outline) when compared to the 1 in 100 year modelled outline (blue outline). The worst affected areas are directly adjacent to the breach due to the sudden inundation of canal water on the Ealees Brook system and the Roch. Due to the velocity and volume of the flood water and the lack of capacity in the Roch through Littleborough, raised defences along the right hand bank are exceeded, flooding areas around Church Street, Victoria Street and Howard Street. Further downstream the impacts are still present as the increase in volume again exceeds raised defences on the right bank, flooding properties off Church Street and William Street around Stubley. The impact on flood extents is seen as far down the Roch as Dye House Road Bridge in Howarth Cross. The impact on water levels is shown in Table 4-1.

Figure 4-2: Impact of canal breach on 1 in 100 year flood extent in Dearnley

(A larger inundation map is provided at the back of this report)



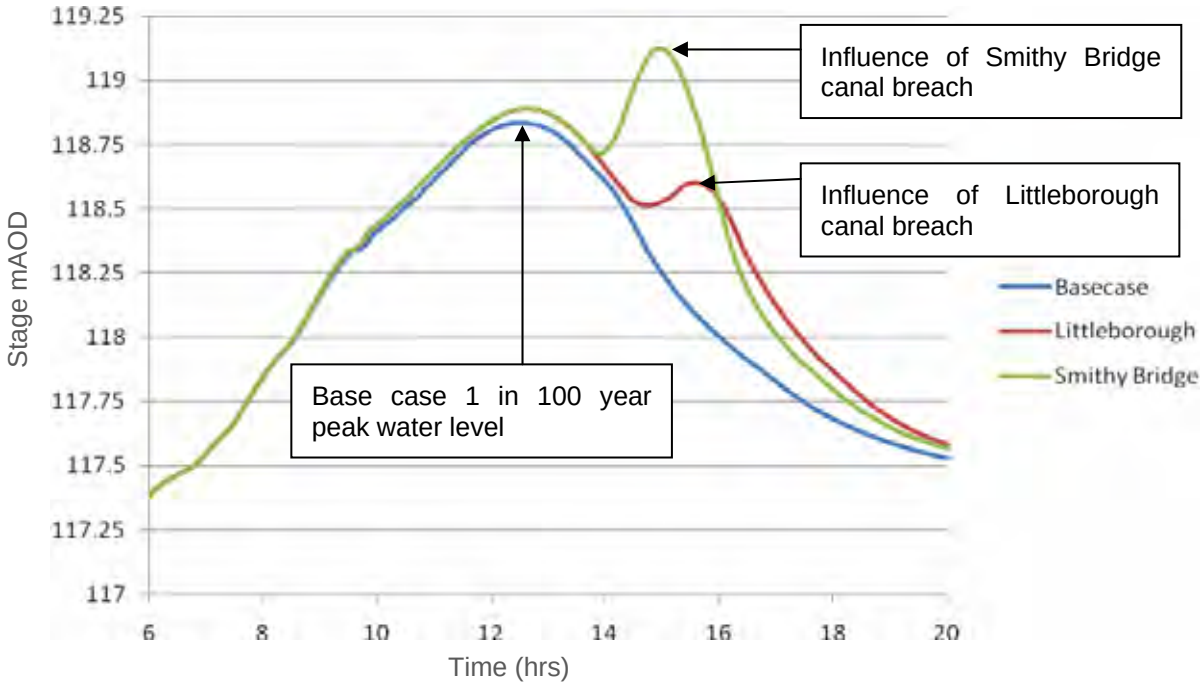
The impact of a canal breach upstream of Smithy Bridge is evident along the Roch (yellow outline) when compared to the 1 in 100 year modelled outline (blue outline). The worst affected areas are directly adjacent to the breach, however this is constrained to rural land and no extra properties are flooded. The impact of the extra volume of canal water entering the Roch system is not as evident as that in Littleborough, due to the capacity of the Roch through this section. However, flood extents increase around Stanney Road and Mitchell Hey. The impact on water levels is shown in Table 4-1.

Table 4-1: Impact of canal breach during 1 in 100 year event on water levels

Location	Model Cross Section	Base Case mAOD	Plus canal breach at Littleborough mAOD	Plus canal breach at Smithy Bridge mAOD
Newall Street	ROCH05_9757	144.43	144.91	-
Railway Street	ROCH05_9385	143.07	144.44	-
Box Street	ROCH05_9060	140.97	141.49	-
Featherstall Brook	ROCH05_8655	138.94	139.34	-
Stubley Mill Road	ROCH05_8205	136.45	136.76	137.00
Smithy Bridge	ROCH05_7505	134.65	135.08	135.24
Dye House Lane	ROCH05_6145	127.73	128.29	128.89
Stanney Road	ROCH04_4560	123.65	123.74	124.00
Allotment Gardens	ROCH04_3826	122.68	122.71	122.87
Esplanade Culvert	ROCH04_2504	118.84	118.89	119.12
Mitchell Hey	ROCH04_1610	117.59	117.62	117.70

Whilst the extent of the flooding does not significantly increase through Rochdale, water levels rise as shown in Table 4-1. The modelling undertaken assumes a breach in the canal does not occur at the same time as peak flows in Rochdale, however if the events were to occur at the same time, peak water levels through Rochdale could be greater than predicted and defences could be overtopped.

Figure 4-3: Water level hydrograph at Esplanade Culvert



5 CRITICAL DRAINAGE AREAS

5.1 Introduction

Future Water (Defra, 2008) sets out the role that SFRAs can have in identifying Critical Drainage Areas (CDAs) for which more detailed Surface Water Management Plans (SWMPs) can be developed. The recent Defra Surface Water Management Plan Guidance (2009) supports the use of SFRAs in providing the evidence base for where SWMPs are required.

The SFRA has identified CDAs based on natural catchments and known flooding problems. United Utilities flood risk and network data was not available for use in this SFRA. The sewer network can have a significant impact on the location of surface water and sewer flooding for more frequent events. It can also affect the distribution of water throughout urban catchments during flood events, passing excess flows from the combined network into watercourses through combined sewer overflows.

The CDAs identified here should therefore only be taken as a starting point in the identification of areas for which a SWMP would be beneficial. Where sewer systems are interconnected across the boundaries of natural catchments, the additional catchments of the sewers (and in particular combined sewer overflow sub-catchments) should be taken into account when finalising SWMP boundaries in areas where there is a high risk of sewer flooding, known historic flooding incidents or the sewer network is at capacity. The catchments of sewers often encompass more than one local authority.

Screening for Critical Drainage Areas within the Bury, Rochdale and Oldham (Beal catchment) Council areas was undertaken for the BRO Level 1 SFRA (see Volume 2, Section 6), using data from the following sources:

- Local authority incident records
- Discussions with Local Authority Drainage Engineers
- The national Areas Susceptible to Surface Water Flooding map

Littleborough, Heywood, Ramsbottom, Radcliffe, Sholver and Derker were put forward as CDAs for more detailed analysis as part of the Level 2 SFRA, including detailed surface water modelling to further define the risk of surface water flooding.

The 2D modelling software JFLOW was used to route rainfall over an elevation map and is the same base tool used for the national Areas Susceptible to Surface Water Flooding map. However, in this instance:

- The elevation model was modified to include roads and buildings to help define flow paths,
- The resistance of the surface of the model was varied depending on whether an area was developed or green space,
- The rainfall inputs were modified to make them specific to the catchments in Bury, Rochdale and Oldham, and
- An extreme 1 in 200 year rainfall event was chosen, as used for the National Surface Water Map.

Under such extreme conditions it was assumed that the sewer network would be at capacity, blocked or have failed and so this was not taken into account. This is a conservative approach that gives an indication of what might happen in such an extreme event and clearly picks out surface water flow paths and areas of ponding. A current and a future scenario were considered. The future scenario takes into account the increased intensity of extreme rainfall predicted by climate change models and increased runoff from new developments on green space. Hence the future scenario provides a conservative and worst case scenario which is considered appropriate for a strategic study.

Most new sewers are designed to a 1:30 year design standard. Sewer flooding problems will often be associated with more frequent storm events when a sewer become blocked or fails. In the larger events that are less frequent but have a higher consequence, surface water will exceed the sewer system and flow across the surface of the land. The surface water modelling and mapping, which is based on an extreme scenario, picks up overland flow paths that would be expected should the

sewers surcharge (back up) in most locations. This is also the case for the more frequent storms when sewers could become blocked and flood at manholes, although flooding would be less extensive depending on the point in the sewer network where the blockage or failure has occurred.

Considering both sewer and surface water flooding together is considered to be appropriate when taking a strategic view of flood risk in an extreme event from both these sources. More detailed consideration of the mechanisms and locations of sewer flooding is beyond the scope of the SFRA. The Greater Manchester Water Cycle Strategy (yet to be commissioned) should consider the provision of water infrastructure to new developments and this will include consideration of sewer capacity. Surface Water Management Plans and Drainage Strategies that are recommended as part of the Level 2 SFRA should be undertaken in partnership with United Utilities and the Environment Agency and will provide the opportunity to undertake detailed sewer modelling to help assess options to reduce surface water flood risk to new and existing development. The councils, as the lead for local flood risk management, should co-ordinate future surface water management work.

5.2 Surface Water Flood Risk

The highest risk of surface water flooding is in Littleborough (Rochdale) and in Ramsbottom (Bury). Both Littleborough and Ramsbottom are surrounded by steep hillsides that will encourage water to runoff quickly into the settlements. The problem is further exacerbated by the presence of river flood defences that do not allow excess surface water into the river system. In this case ponding would occur behind the defences and/or water would continue to flow downstream parallel to the defences.

There is also a significant risk of surface water flooding in Heywood and Radcliffe. In both cases there are known capacity problems in the sewer network, which may cause sewers to surcharge more frequently and increase the incidence of surface water and sewer flooding. The disused Manchester, Bury and Bolton Canal in Radcliffe acts as a conduit for surface water flows and helps to reduce flood risk as it conveys surface water away from more built up areas. In Heywood surface water flooding is associated with the valley of the Millers Brook and Pilsworth Road.

The analysis shows that surface water flood risk will increase significantly in the future in Littleborough, Heywood, Ramsbottom and Radcliffe.

There is not a significant risk of surface water flooding in Sholver or Derker but the detailed surface water mapping undertaken here can be used to help master plan future development.

5.3 Recommendations for Surface Water Management

Local authorities and the Environment Agency should work closely with United Utilities, using the outputs from the SFRA as a starting point, to identify the potential locations of and priorities for SWMPs. Surface water management needs to take a holistic approach, taking into account all the sources of local flood risk, including sewers, overland flow, culverted and open watercourses and groundwater. A suite of options are available for surface water management including source control, such as the implementation of SuDs, increasing the capacity of sewers or watercourses, storing excess water and managing exceedance flows through urban design and Green Infrastructure. Options to reduce flood risk in one location should not increase risk upstream or downstream. SWMP areas may cross one or more local authority area(s) and different local authorities, the Environment Agency and United Utilities can be brought together in a SWMP partnership to develop sustainable options to manage surface water flood risk.

Based on the above analysis, the following recommendations are made for future surface water management. These are referred to again in Table 11-1: Recommendations for future work.

Table 5-1: Recommendations for future Surface Water Management

CDA	LPA	Recommendation
Littleborough	Rochdale	A SWMP should be undertaken that will look in detail at drainage assets and local flood risk and assess feasible options for reducing risk. This may include a drainage strategy for the collection of development sites to identify areas suitable for SUDS and where surface water flow paths could be opened up in new development.
Heywood	Rochdale	A SWMP should be undertaken that will look in detail at drainage assets and local flood risk and assess feasible options for reducing risk. This may include a drainage strategy for the collection of development sites to identify areas suitable for SUDS and where

CDA	LPA	Recommendation
		surface water flow paths could be opened up in new development.
Ramsbottom	Bury	A SWMP should be undertaken that will look in detail at drainage assets and local flood risk and assess feasible options for reducing risk. This may include a drainage strategy for the collection of development sites to identify areas suitable for SUDS and where surface water flow paths could be opened up in new development.
Radcliffe	Bury	A SWMP should be undertaken that will look in detail at drainage assets and local flood risk and assess feasible options for reducing risk. This may include a drainage strategy for the collection of development sites to identify areas suitable for SUDS and where surface water flow paths could be opened up in new development.
Derker	Oldham	A Drainage Strategy should be undertaken for the neighbourhood to identify areas suitable for SUDS, allowable discharges from sites and where surface water flow paths could be opened up in new development. It is important that future development does not increase surface water discharges into the River Beal.
Sholver	Oldham	A Drainage Strategy should be undertaken for the neighbourhood to identify areas suitable for SUDS, allowable discharges from sites and where surface water flow paths could be opened up in new development. It is important that future development does not increase surface water discharges into the River Beal.

Other large strategic sites that would benefit from a drainage strategy include:

- Kingsway Business Park, Rochdale
- Stakehill Industrial Estate, Middleton
- Chamberhall, Bury
- New development between Bury and Radcliffe (could be covered by a SWMP for Radcliffe).

On the 19th August 2008, Defra announced that they were awarding £9.7m to 77 local authorities at the highest risk of surface water flooding to undertake surface water management. Other local authorities will be able to bid for a share of £5m to deal with known local surface water flooding issues. Through this process Rochdale MBC have been awarded £75,000 to undertake surface water management.

There is a high risk from surface water flooding throughout Greater Manchester and AGMA have identified that a Greater Manchester wide Surface Water Management Plan would be preferable. Water (including United Utilities drainage infrastructure) does not respect administrative boundaries. Cross boundary and site specific issues already exist and future development in Bury, Rochdale and Oldham has the potential to increase or decrease flood risk elsewhere and needs to be carefully managed. A Greater Manchester wide and strategic SWMP would benefit from joint working and cost efficiencies and is consistent with emerging legislative requirements (draft Flood and Water Management bill, (2009)). Such a SWMP would build on the assessment undertaken for the AGMA Level 2 SFRAs, undertaking a Greater Manchester wide assessment of current and future surface water flood risk and identifying the most cost effective solutions (per property at risk) to enable the maximum reduction in surface water and overall risk for minimum cost.

6 MULTIPLE SOURCES OF FLOODING

6.1 Multiple Sources of Flooding

Collating available information on multiple sources of flood risk can provide a quick overview of where there may be development sites at risk from more than one source of flooding. Maps were produced showing areas with one or more sources of risk using the following data:

- Fluvial: Environment Agency Flood Zone 3
- Surface water: national Areas Susceptible to Surface Water Flooding map
- Canals: Canal Hazard Zone

The mapping is shown in Maps 6.1 to 6.3. Areas at risk of one sources are coloured yellow, two sources are coloured orange and all three sources are coloured red.

7 DOWNSTREAM IMPACTS OF DEVELOPMENT

7.1 Introduction

There is significant development planned for Bury, Rochdale and Oldham which will take place on both previously developed and Greenfield sites. The Regional Spatial Strategy sets out new housing provision and alongside this there will be land developed for commercial, industrial, public services and recreation use. The Regional Spatial Strategy is discussed in more detail in the SFRA User Guide Volume I Appendix C.

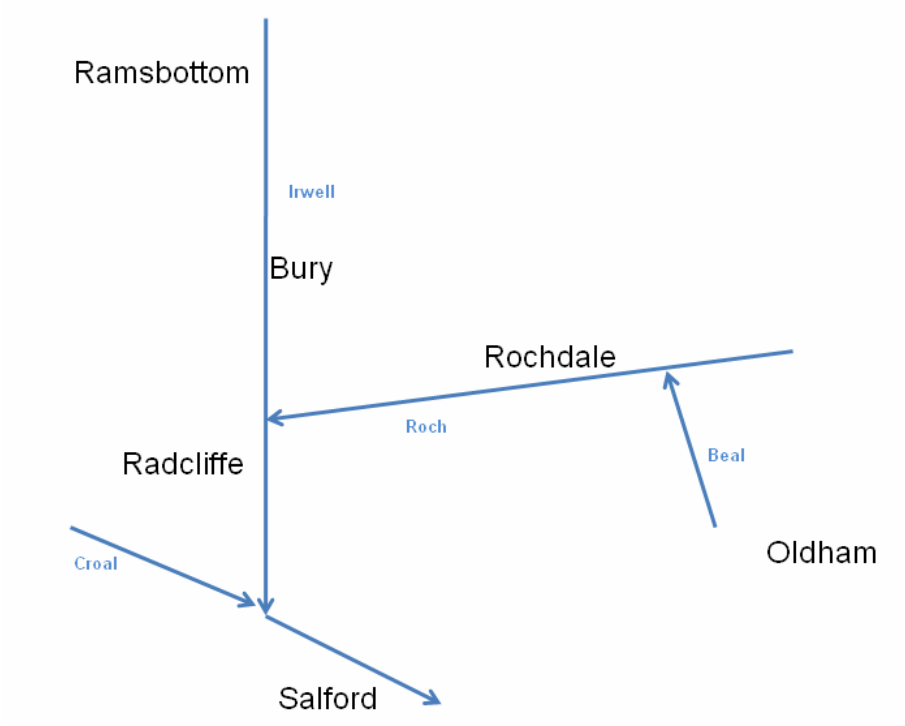
The Greater Manchester Sub Regional SFRA identified hydrological links between the different local authorities within AGMA. The table below summarises where development could have an impact downstream. There are particular concerns about the impact of development in the Beal catchment in Oldham, and especially the two large Housing Market Renewal areas at Sholver and Derker that fall within or partly within the catchment.

Table 7-1: Hydrological links

LPA	Potentially affected LPAs	Pathway
Oldham (Beal catchment)	Rochdale, Bury, Salford, Manchester, Trafford	Beal – Roch – Irwell – Grey Irwell – Manchester Ship Canal
Rochdale	Bury, Salford, Manchester, Trafford	Roch – Irwell – Grey Irwell – Manchester Ship Canal
Bury	Salford, Manchester, Trafford	Irwell – Grey Irwell – Manchester Ship Canal

Figure 7-1 shows how the river system is connected within the Bury, Rochdale and Oldham (Beal catchment) local authority areas, with the downstream link to Salford.

Figure 7-1: River network



If the flood risks to new development are reduced by inappropriate mitigation measures such as land raising or defences without providing compensatory flood storage, then the capacity of the floodplain at that location to store water will reduce and more water will be passed downstream.

New development can also increase the amount of impermeable areas, such as roofs and roads, where water is unable to infiltrate into the ground. This causes an increase in surface water runoff rates and volumes and a potential increase in flood risk downstream due to overloading of sewers, watercourses and other drainage infrastructure.

Historically, developments were designed to drain water away as quickly as possible to the nearest watercourse or sewer. This has caused water levels in drainage systems to rise rapidly following rainfall and can cause flash flooding, such as that seen in Shaw in 1964. In recent years there has been a move towards controlling water at source to reduce flood risk elsewhere, with water being stored in sustainable drainage systems that mimic the natural water cycle.

It is a policy aim of PPS25 to reduce flood risk both to and from new development through the use of Sustainable Drainage Systems, which are discussed in more detail in the SFRA User Guide Volume 1 Section 4.6 and Appendix F.

Hence redevelopment on previously developed sites can actually reduce flood risk elsewhere by reducing the amount of surface water runoff from the site. Development on greenfield sites should ensure that there is no increase in surface water from the undeveloped situation.

As part of the SFRA the following development scenarios were tested:

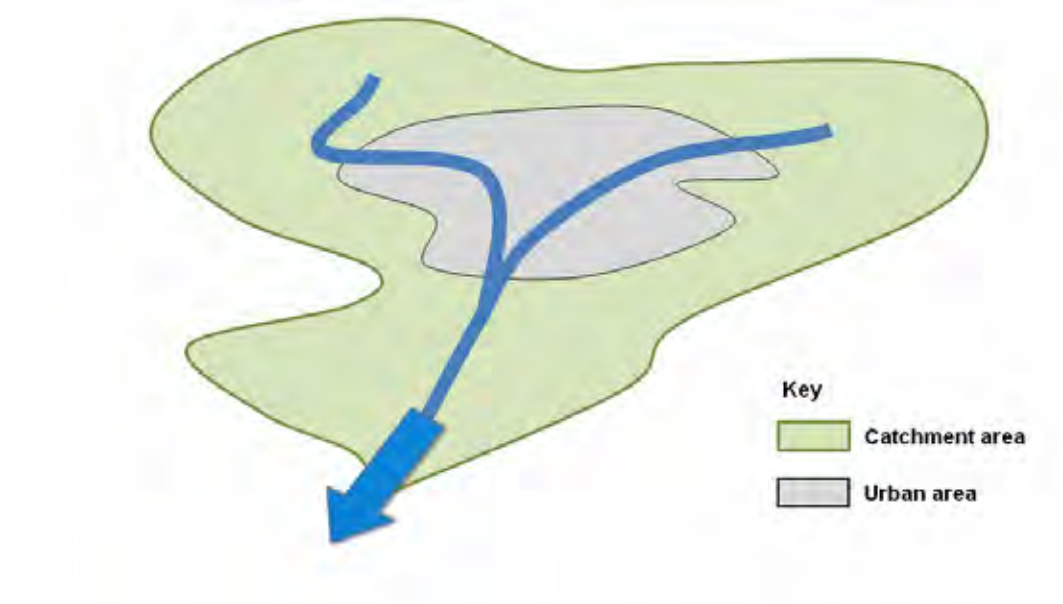
1. **Worst case scenario**, which is highly unlikely in the current legislative and policy environment, where there would be no storage of surface water on development sites and consequently more water reaching sewers and watercourses at a faster rate, and
2. **Best case scenario**, which is most likely in the current legislative and policy environment, where surface water would be stored on development sites in sustainable drainage systems, reducing the amount of water reaching sewers and watercourses.

7.2 Methodology

The impact of the development sites to flood risk downstream was assessed from the current pre-development baseline to the future post-development situation. The methodology used builds on the approach used in the River Irwell CFMP to assess future flood risk and is based on the impact on flood risk during a 1 in 100 year flood event. The impact of climate change has not been taken into account to show the actual effect of development itself on flood risk. The impact of climate change on flood risk is explored in detail in sections 3 and 5 of this Volume.

This assessment has used the River Irwell routing model developed for the River Irwell CFMP. The routing model is a simplified catchment model that includes all the main watercourses and hence is valuable in understanding catchment processes. Flood Estimation Handbook (FEH) methods were used to calculate flood hydrographs and flows in river system. The FEH method takes into account the amount of urban area in a river catchment, as shown in Figure 7-2.

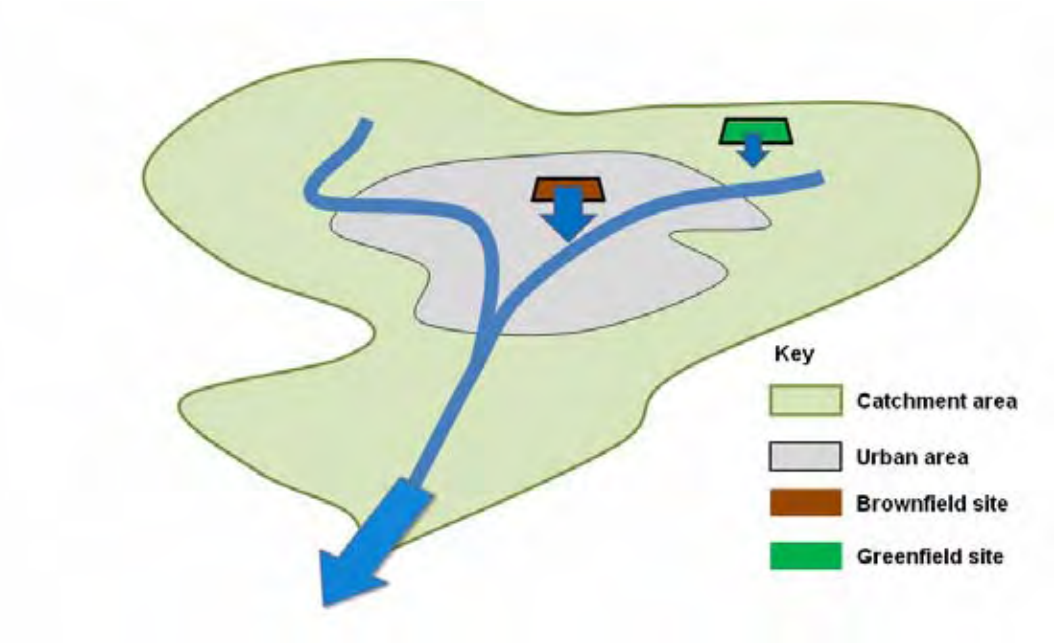
Figure 7-2: Calculated 1 in 100 year flood from the FEH allowing for urban cover



7.2.1 Current Baseline Case

Development sites inside urban areas were assumed to be previously developed and those outside of urban areas were assumed to be greenfield. The surface water runoff contribution from the brownfield and greenfield development sites was assumed to be included in FEH calculations for the River Irwell routing model; hence there is a larger amount of runoff from previously developed sites in urban areas than from greenfield sites. This is shown in Figure 7-3.

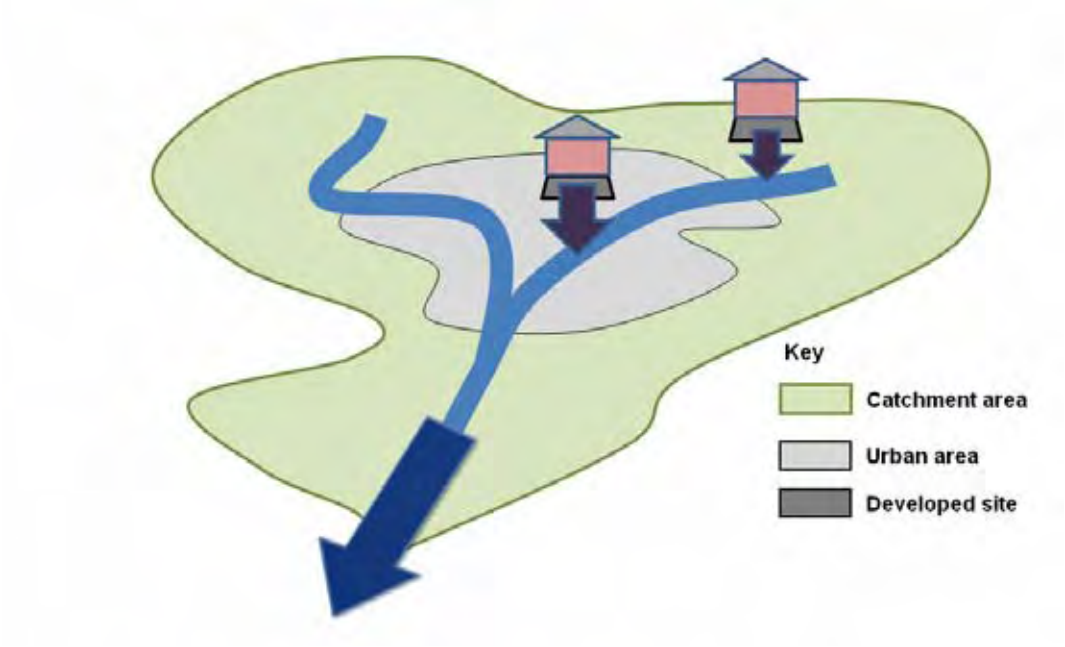
Figure 7-3: Contribution of the proposed development sites to the current 1 in 100 year flood



7.2.2 Worst Case

All developed sites would have a large impermeable area and hence there would an increase in surface water runoff from these sites. In a storm event this would increase flood levels downstream, as shown in Figure 7-4.

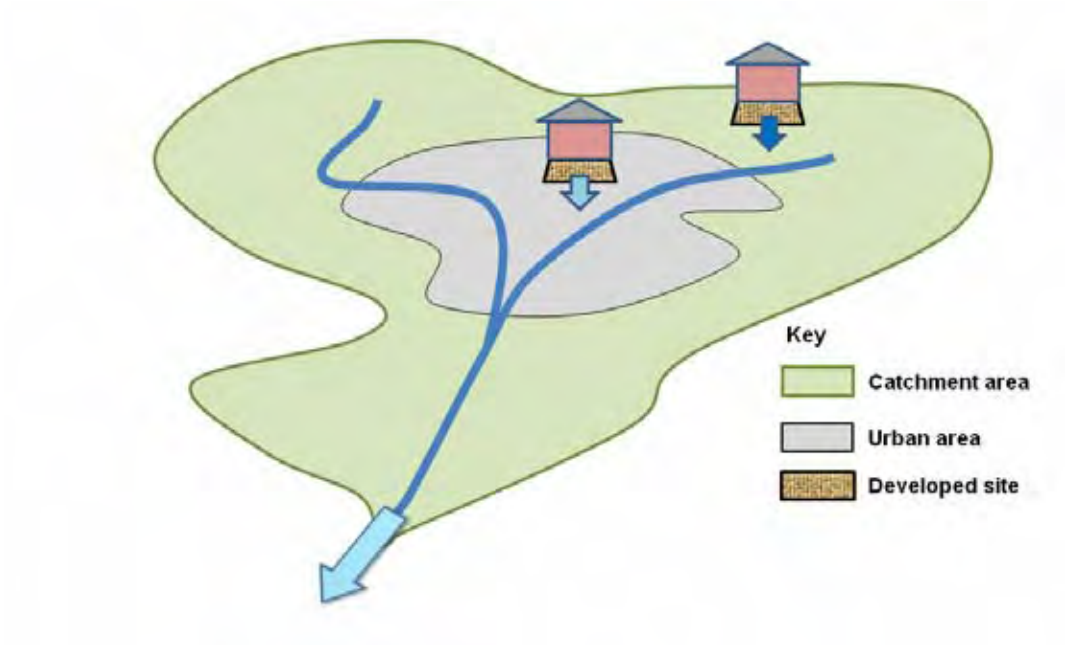
Figure 7-4: Worst case assuming proposed sites are developed without SUDS



7.2.3 Best Case

The drainage from development sites would be reduced through the use of Sustainable Drainage Systems to mimic natural site drainage (this assumes greenfield rates). There would be less surface water runoff and this may help to reduce flood levels, as shown on Figure 7-5.

Figure 7-5: Best case assuming proposed sites are developed with SUDS



7.3 Results

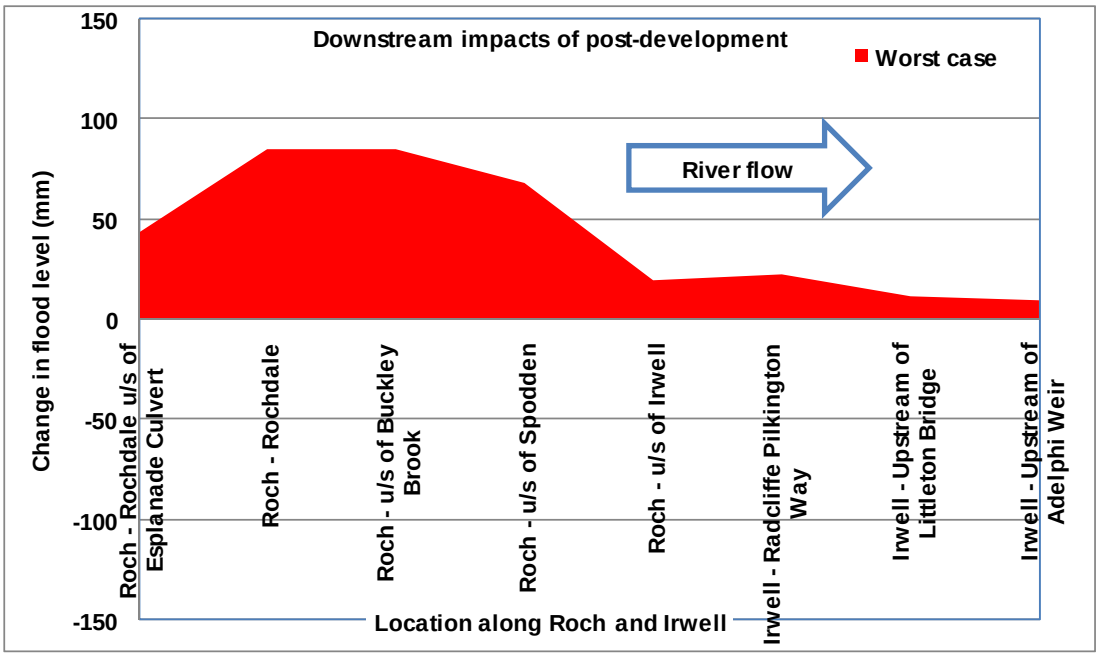
7.3.1 Worst Case

Development in the River Beal Catchment

The change in river levels at various locations downstream of Oldham is shown in

Figure 7-6. The largest increase is water level is approximately 85mm in Rochdale. Downstream of the River Roch and River Irwell confluence the impact diminishes, with a minimal impact in Salford (Adelphi Weir).

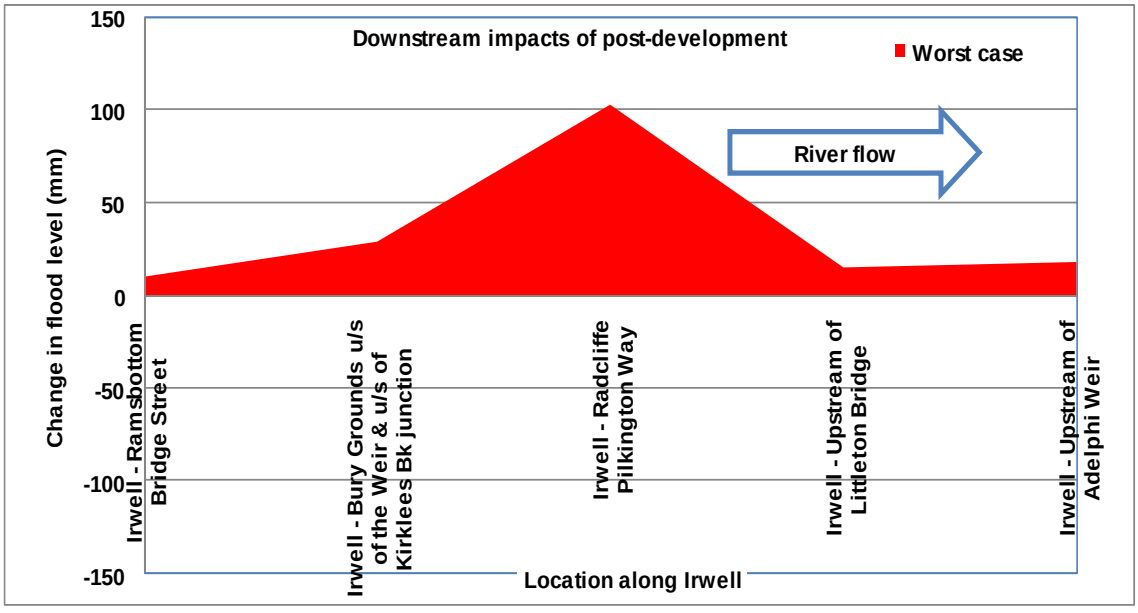
Figure 7-6: Worst case changes in 1 in 100 year flood levels caused by development in Oldham



Development in Bury, Rochdale and Oldham

The change in river levels at various locations on the River Irwell, downstream of development sites, is shown in Figure 7-7. The largest increase is water level is approximately 105mm in Radcliffe.

Figure 7-7: Worst case changes in 1 in 100 year flood levels caused by development in Bury, Rochdale and Oldham

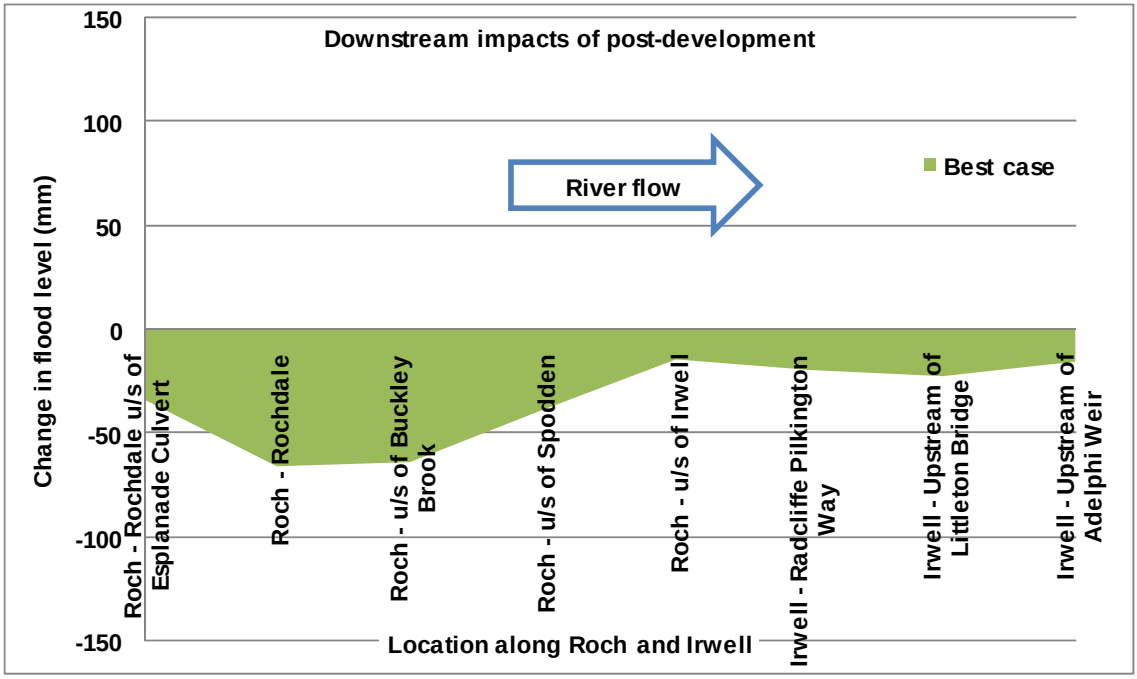


7.3.2 Best Case

Development in the River Beal Catchment

The change in river levels at various locations downstream of Oldham is shown inFigure 7-8. The largest reduction is water level is approximately 65 mm in Rochdale. Downstream of the River Roch and River Irwell confluence the benefits diminish.

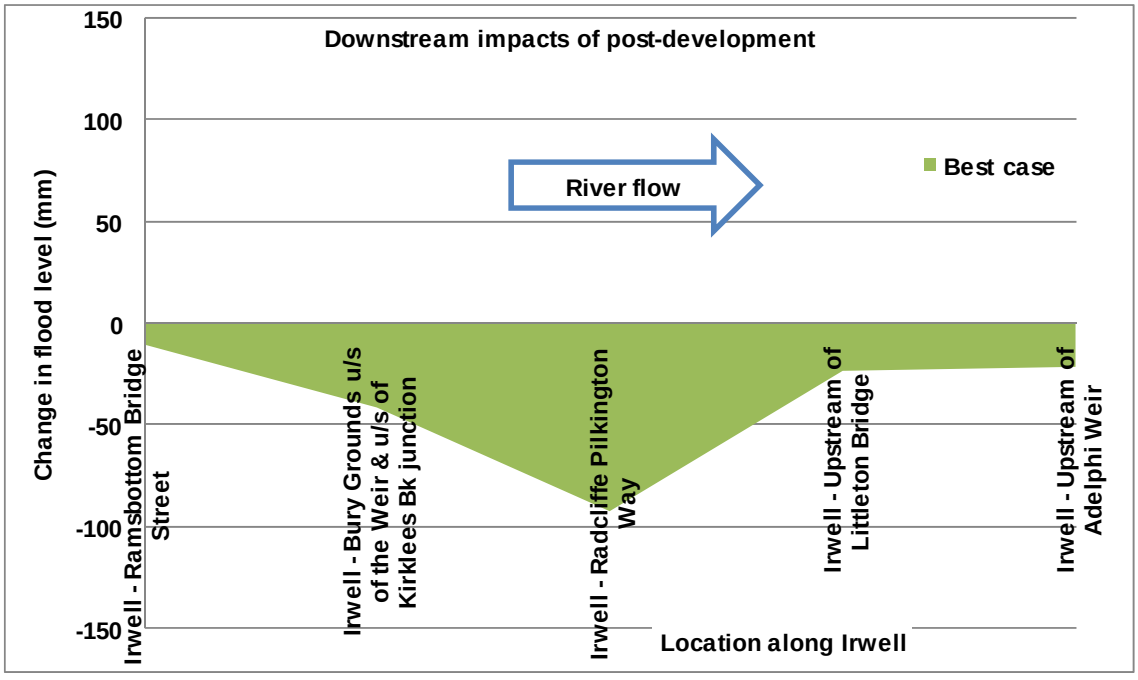
Figure 7-8: Best case changes in 1 in 100 year flood levels caused by development in Oldham



Development in Bury, Rochdale and Oldham

The change in river levels at various locations on the River Irwell, downstream of development sites, is shown in Figure 7-9. The largest reduction is water level is approximately 95 mm in Radcliffe. The benefit of the development to flood risk diminishes downstream of Littleton Bridge.

Figure 7-9: Best case changes in 1 in 100 year flood levels caused by development in Bury, Rochdale and Oldham



7.4 Discussion

Mitigation measures are discussed in the SFRA User Guide Volume I Section 5. Following the principles laid down in PPS25, these should not increase flood risk elsewhere and so there should be no downstream impact.

The SFRA User Guide discusses appropriate surface water discharges from development sites depending on site characteristics and the location of Critical Drainage Areas (Volume I Section 4.6). A policy aim of PPS25 is to reduce flood risk both to and from new development and Sustainable Drainage Systems should be used to reduce current site discharges from previously developed sites and maintain natural drainage on greenfield sites.

Hence the likely outcome on flood risk downstream from development in Bury, Rochdale and Oldham is likely to be closer to the best case scenario where there would be a beneficial effect on flood risk downstream.

8 COMMUNITY AND DEVELOPMENT RISK REVIEW

8.1 Introduction

In the first instance the Sequential Test should be applied to all proposed development to confirm that there are no reasonable alternatives on land with a lower probability of flooding. The results from the Level 2 SFRA have identified that there are significant areas of developed land in Bury, Rochdale and Oldham where existing development has a high probability of flooding. If, following the application of the Sequential Test, it is identified that there is a requirement to place additional development in areas with a high or medium probability of flooding then the following issues must be considered:

- The level of "actual" flood risk to the existing communities should be evaluated,
- The implications of climate change on the level of "actual" risk should be understood,
- The implications of the residual risk, as a consequence of over topping of defences should be determined, and
- The consequences of failure of defences should be identified.

Having followed this procedure it is then possible to consider the appropriate responses that will be required to protect not only the existing community, but also as a consequence of the need to protect planned development. It will be necessary to consider the full range of responses according to the type of risk being addressed and if new development is being proposed then this must be done in accordance with the guidance given in PPS25 and the associated Practice Guide.

To assist with this assessment, this chapter contains an outline review of flood risk in the following communities:

- Ramsbottom
- Chamberhall and Western Waterside
- Bury (South) and Radcliffe
- Littleborough
- Rochdale
- Shaw

The review is based on a procedure developed to provide a greater appreciation of the actual, residual and breach risks. The Flood Risk Management (FRM) policy and strategy with respect to the protection of these communities is identified in the River Irwell CFMP and the River Irwell Strategy and discussed in more detail in the next chapter of this report. Evaluation of the implications of new development in the high and medium risk zones demands the responses to the level of protection and the commitment to "mitigation" within the relevant FRM documents to be considered alongside specific measures associated with the proposed new development. Accordingly the analysis performed in this chapter addresses these issues.

The underlying objective is to identify whether there is a need for consideration to be given to a commitment to Strategic Flood Risk Mitigation measures or whether it is possible for new development to be permitted and provisions made on a piecemeal basis (it should be noted that this is not the preferred approach according to PPS25). If it is identified that there is a requirement to make a commitment to provide strategic infrastructure then the requirements of PPS12 should also be addressed.

8.2 Review of Flood Risk

The risk to the identified communities has been summarised by addressing the following range of relevant issues:

1. Is the community at significant risk during a 1 in 100 year event (depth/hazard/extent coverage)?
2. Is there a consistent asset standard of protection?
3. Is there a consistent asset condition?

4. Is there a significant possibility of assets breaching?
5. Could assets overtop during climate change or extreme events?
6. Is overall residual risk significant in the area?
7. Is surface water flooding an issue?
8. Is flood risk a significant environmental issue/constraint?
9. Does development need to be considered strategically?
10. If a strategic approach is not necessary, can development proceed in a piecemeal basis without considering adjacent areas in the floodplain?
11. Does development need to be integrated into a flood risk management strategy?
12. Will there be off site effects?
13. Will flood risk be an urban design issue?
14. Can residual risk be successfully managed?
15. Could development reduce risk?

Preparing responses to these questions for each of the identified communities will generate a profile of:

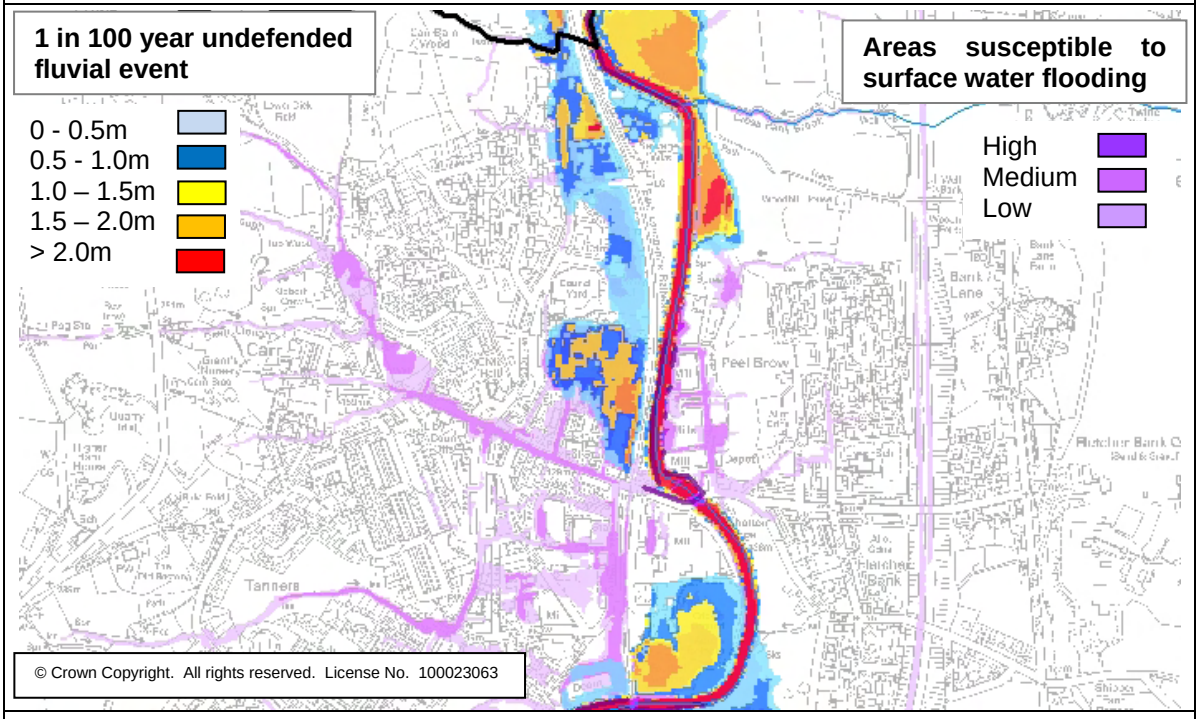
- The implications of seeking to manage the actual risks to acceptable levels,
- The effects of climate change on existing defences and the residual risk due to overtopping, and
- The consequences of the residual risk in the event that defences fail.

The results of this analysis are described in Table 8-1 to Table 8-6.

Table 8-1: Risk of flooding in Ramsbottom

Community	Ramsbottom, Bury			
Catchment	Irwell			
Main Source of Flood Risk	River Irwell			
Secondary Sources of Flood Risk	Surface Water			
	Number of Sites	**Total area**	**Sites in Flood Zone 3a**	**Area in Flood Zone 3a**
Housing Sites	24	6.84ha	6	1.21ha
Employment Sites	8	4.22ha	3	0.24ha

Map Illustrating General Community Area

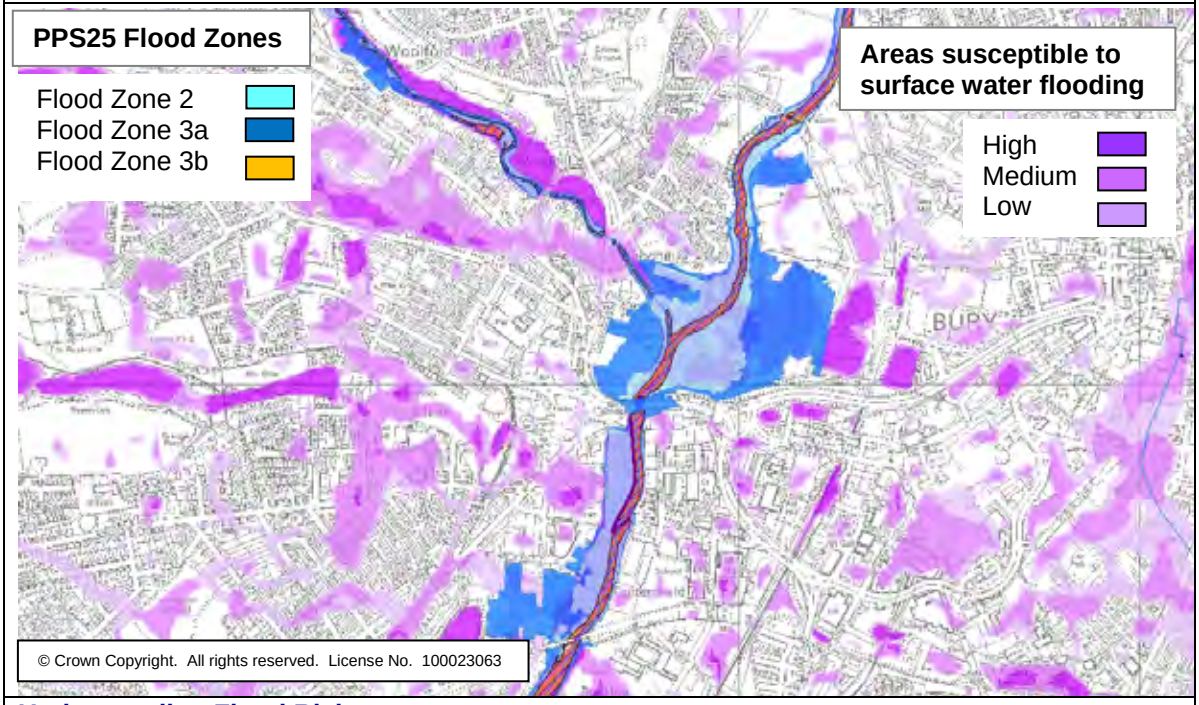


Understanding Flood Risk		
Significant Risk during 1 in 100 year Event?	Yes	No
Consistent Asset Standard of Protection?	Yes	No
Consistent Asset Condition Standard?	Yes	No
Significant Risk of Assets Breaching?	Yes	No
Could Assets Overtop with Climate Change?	Yes	No
Could Assets Overtop in an Extreme Event?	Yes	No
Significant Residual Risk?	Yes	No
Is Residual Risk a Significant Proportion of Flood Zones?	Yes	No
Issues of Surface Water Flooding?	Yes	No
Is Flood Risk an Environmental Constraint?	Yes	No
Managing Flood Risk		
Does Development Need to be Considered Strategically?	Yes	No
Can Development Proceed in a Piecemeal Basis?	Yes	No
Flood Risk Management Strategy Required?	Yes	No
Likelihood of Passing Exception Test		
Will there be off Site Effects?	Yes	No
Will Flood Risk be an Urban Design Issue?	Yes	No
Can Residual Risk be Successfully Managed?	Yes	No
Could Development Reduce Risk?	Yes	No

Table 8-2: Risk of flooding in Bury

Community	Chamberhall and Western Waterside			
Catchment	Irwell			
Main Source of Flood Risk	River Irwell and Kirklees Brook			
Secondary Sources of Flood Risk	Surface Water			
	Number of Sites	Total area	Sites in Flood Zone 3a	Area in Flood Zone 3a
Housing Sites	102	66.35ha	3	3.06ha
Employment Sites	50	65.05ha	4	6.03ha

Map Illustrating General Community Area

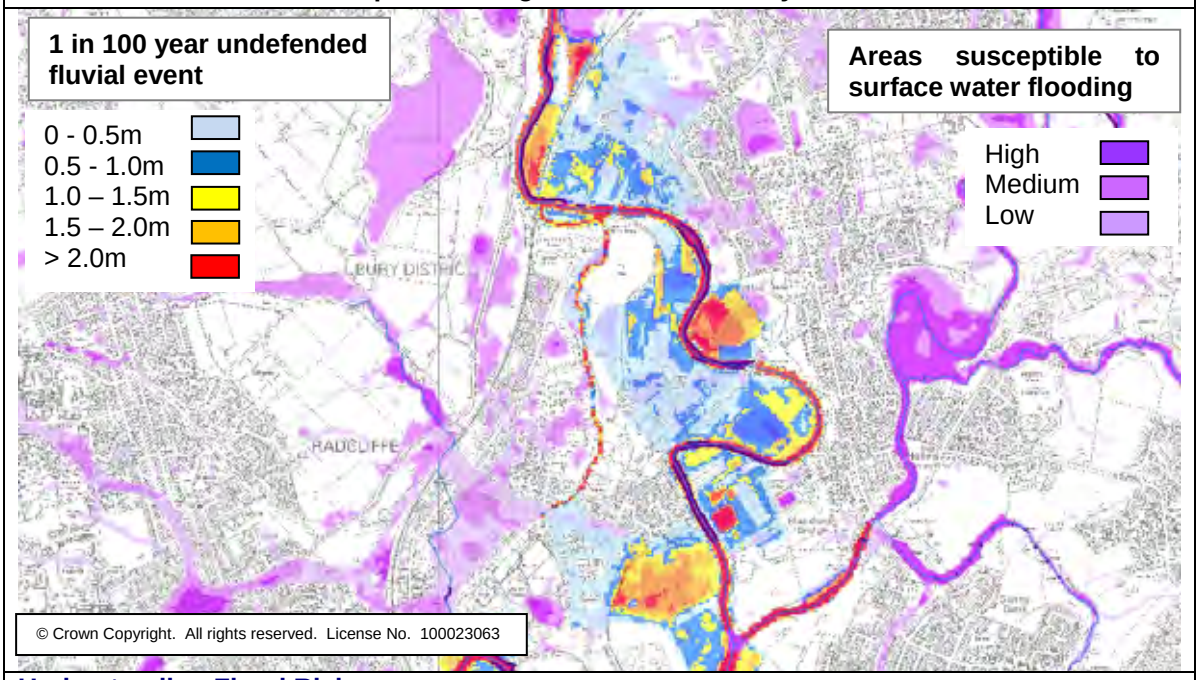


Understanding Flood Risk		
Significant Risk during 1 in 100 year Event?	Yes	No
Consistent Standard of Protection?	Yes	No
Consistent Condition Standard?	Yes	No
Significant Risk of Assets Breaching?	Yes	No
Could Assets Overtop with Climate Change?	Yes	No
Could Assets Overtop in an Extreme Event?	Yes	No
Significant Residual Risk?	Yes	No
Is Residual Risk a Significant Proportion of Flood Zones?	Yes	No
Issues of Surface Water Flooding?	Yes	No
Is Flood Risk an Environmental Constraint?	Yes	No
Managing Flood Risk		
Does Development Need to be Considered Strategically?	Yes	No
Can Development Proceed in a Piecemeal Basis?	Yes	No
Flood Risk Management Strategy Required?	Yes	No
Likelihood of Passing Exception Test		
Will there be off Site Effects?	Yes	No
Will Flood Risk be an Urban Design Issue?	Yes	No
Can Residual Risk be Successfully Managed?	Yes	No
Could Development Reduce Risk?	Yes	No

Table 8-3: Risk of flooding in South Bury and Radcliffe

Community	Bury (South) and Radcliffe			
Catchment	Irwell			
Main Source of Flood Risk	River Irwell and River Roach			
Secondary Sources of Flood Risk	Surface Water, Elton Reservoir, Hutchinson's Goit and Manchester, Bury and Bolton Canal			
	Number of Sites	**Total area**	**Sites in Flood Zone 3a**	**Area in Flood Zone 3a**
Housing Sites	65	53.14ha	6	4.67ha
Employment Sites	22	62.46ha	10	20.27ha

Map Illustrating General Community Area

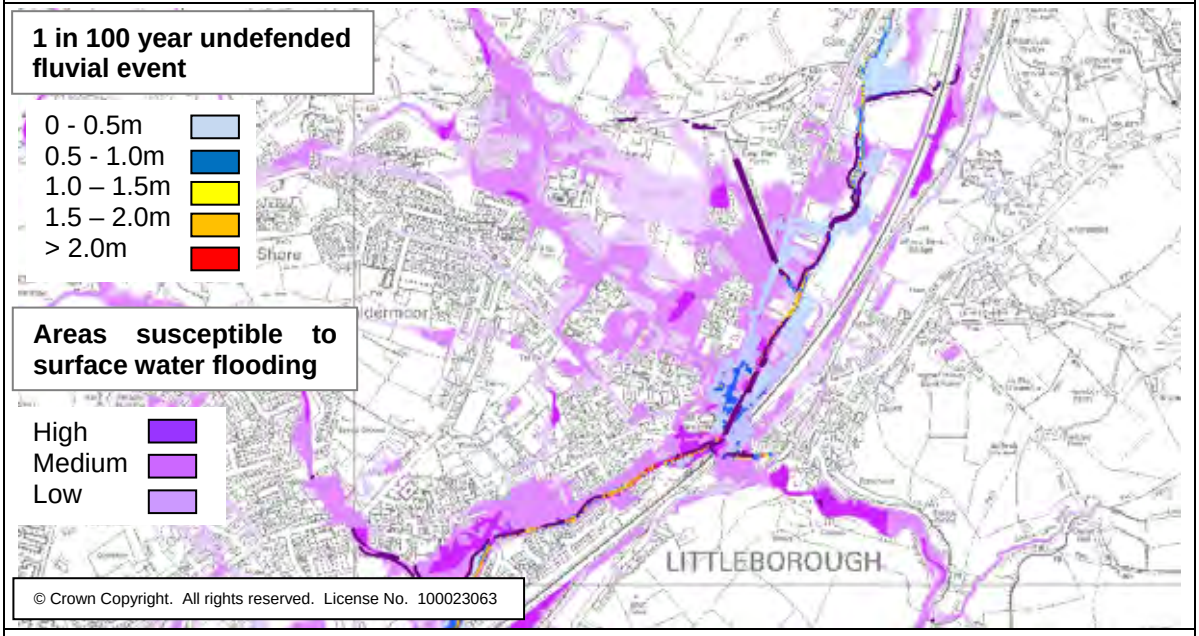


Understanding Flood Risk		
Significant Risk during 1 in 100 year Event?	Yes	No
Consistent Standard of Protection?	Yes	No
Consistent Condition Standard?	Yes	No
Significant Risk of Assets Breaching?	Yes	No
Could Assets Overtop with Climate Change?	Yes	No
Could Assets Overtop in an Extreme Event?	Yes	No
Significant Residual Risk?	Yes	No
Is Residual Risk a Significant Proportion of Flood Zones?	Yes	No
Issues of Surface Water Flooding?	Yes	No
Is Flood Risk an Environmental Constraint?	Yes	No
Managing Flood Risk		
Does Development Need to be Considered Strategically?	Yes	No
Can Development Proceed in a Piecemeal Basis?	Yes	No
Flood Risk Management Strategy Required?	Yes	No
Likelihood of Passing Exception Test		
Will there be off Site Effects?	Yes	No
Will Flood Risk be an Urban Design Issue?	Yes	No
Can Residual Risk be Successfully Managed?	Yes	No
Could Development Reduce Risk?	Yes	No

Table 8-4: Risk of flooding in Littleborough

Community	Littleborough, Rochdale			
Catchment	Roch			
Main Source of Flood Risk	River Roch, Ealees Brook and Farm House Brook			
Secondary Sources of Flood Risk	Surface Water and Rochdale Canal			
	Number of Sites	**Total area**	**Sites in Flood Zone 3a**	**Area in Flood Zone 3a**
Housing Sites	58	15.13ha	5	0.54ha
Employment Sites	1	0.49ha	0	0.00ha

Map Illustrating General Community Area

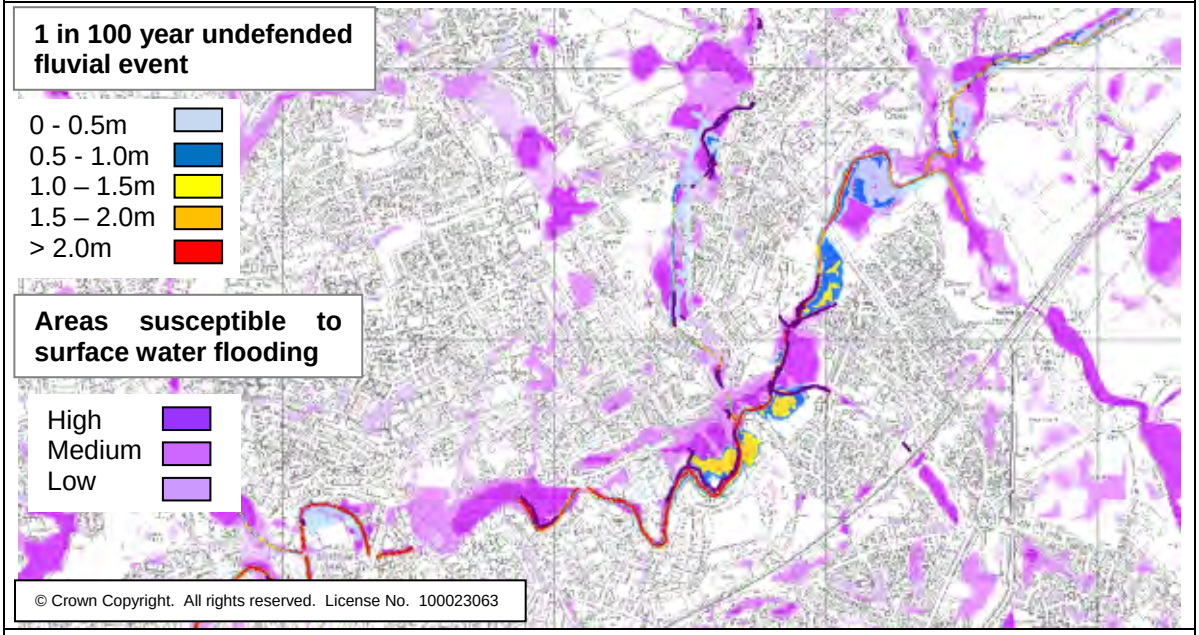


Understanding Flood Risk		
Significant Risk during 1 in 100 year Event?	Yes	No
Consistent Standard of Protection?	Yes	No
Consistent Condition Standard?	Yes	No
Significant Risk of Assets Breaching?	Yes	No
Could Assets Overtop with Climate Change?	Yes	No
Could Assets Overtop in an Extreme Event?	Yes	No
Significant Residual Risk?	Yes	No
Is Residual Risk a Significant Proportion of Flood Zones?	Yes	No
Issues of Surface Water Flooding?	Yes	No
Is Flood Risk an Environmental Constraint?	Yes	No
Managing Flood Risk		
Does Development Need to be Considered Strategically?	Yes	No
Can Development Proceed in a Piecemeal Basis?	Yes	No
Flood Risk Management Strategy Required?	Yes	No
Likelihood of Passing Exception Test		
Will there be off Site Effects?	Yes	No
Will Flood Risk be an Urban Design Issue?	Yes	No
Can Residual Risk be Successfully Managed?	Yes	No
Could Development Reduce Risk?	Yes	No

Table 8-5: Risk of flooding in Rochdale

Community	Rochdale			
Catchment	Roch			
Main Source of Flood Risk	River Roch, Buckley Brook and River Beal			
Secondary Sources of Flood Risk	Surface Water and Rochdale Canal			
	Number of Sites	**Total area**	**Sites in Flood Zone 3a**	**Area in Flood Zone 3a**
Housing Sites	233	573.14	6	3.62 ha
Employment Sites	28	325.36	10	13.00 ha
RDA Sites	8	27.25	8	10.84

Map Illustrating General Community Area

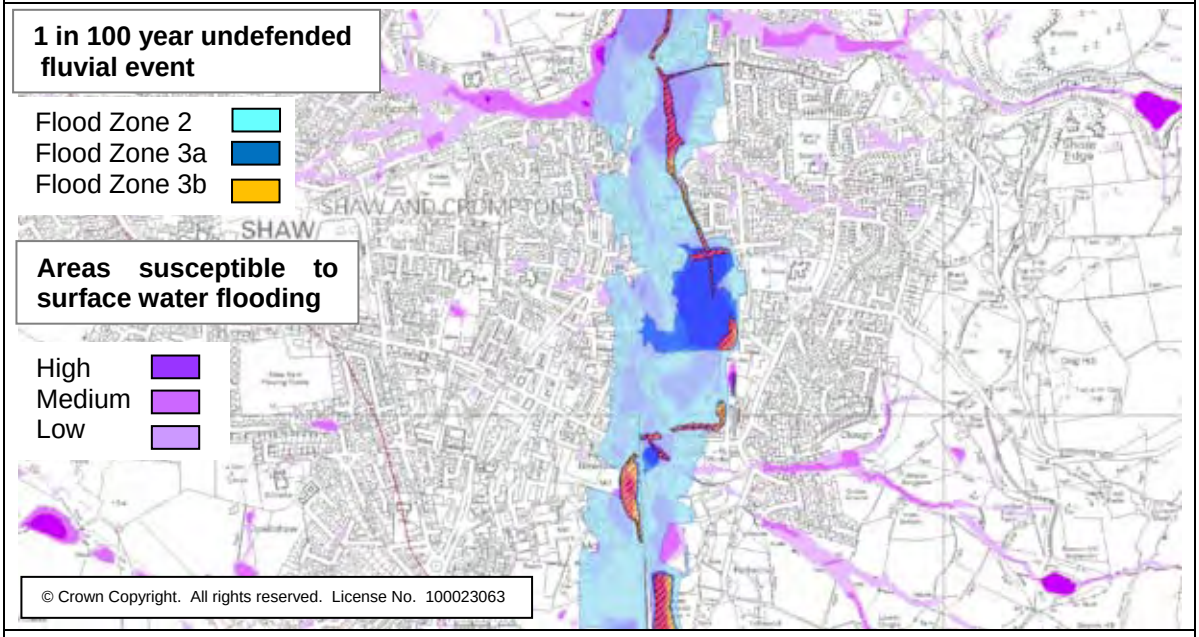


Understanding Flood Risk		
Significant Risk during 1 in 100 year Event?	Yes	No
Consistent Standard of Protection?	Yes	No
Consistent Condition Standard?	Yes	No
Significant Risk of Assets Breaching?	Yes	No
Could Assets Overtop with Climate Change?	Yes	No
Could Assets Overtop in an Extreme Event?	Yes	No
Significant Residual Risk?	Yes	No
Is Residual Risk a Significant Proportion of Flood Zones?	Yes	No
Issues of Surface Water Flooding?	Yes	No
Is Flood Risk an Environmental Constraint?	Yes	No
Managing Flood Risk		
Does Development Need to be Considered Strategically?	Yes	No
Can Development Proceed in a Piecemeal Basis?	Yes	No
Flood Risk Management Strategy Required?	Yes	No
Likelihood of Passing Exception Test		
Will there be off Site Effects?	Yes	No
Will Flood Risk be an Urban Design Issue?	Yes	No
Can Residual Risk be Successfully Managed?	Yes	No
Could Development Reduce Risk?	Yes	No

Table 8-6: Risk of flooding in Shaw

Community	Shaw			
Catchment	Beal			
Main Source of Flood Risk	River Beal			
Secondary Sources of Flood Risk	Surface Water			
	Number of Sites	**Total area**	**Sites in Flood Zone 3a**	**Area in Flood Zone 3a**
Housing Sites	27	10.59 ha	3	0.02 ha
Employment Sites	2	31.54 ha	1	5.58 ha

Map Illustrating General Community Area



Understanding Flood Risk		
Significant Risk during 1 in 100 year Event?	Yes	No
Consistent Standard of Protection?	Yes	No
Consistent Condition Standard?	Yes	No
Significant Risk of Assets Breaching?	Yes	No
Could Assets Overtop with Climate Change?	Yes	No
Could Assets Overtop in an Extreme Event?	Yes	No
Significant Residual Risk?	Yes	No
Is Residual Risk a Significant Proportion of Flood Zones?	Yes	No
Issues of Surface Water Flooding?	Yes	No
Is Flood Risk an Environmental Constraint?	Yes	No
Managing Flood Risk		
Can Development Proceed in a Piecemeal Basis?	Yes	No
Does Development Need to be Considered Strategically?	Yes	No
Flood Risk Management Strategy Required?	Yes	No
Likelihood of Passing Exception Test		
Will there be off Site Effects?	Yes	No
Will Flood Risk be an Urban Design Issue?	Yes	No
Can Residual Risk be Successfully Managed?	Yes	No
Could Development Reduce Risk?	Yes	No

8.3 Summary

The community and development review tables provide an overview of flood risks associated with Ramsbottom, Chamberhall and Western Waterside, Radcliffe and Bury (South), Littleborough, Rochdale, and Shaw. By providing yes/no answers to key questions they have highlighted the links between flood risk information provided in the early section of this Level 2 SFRA and recommended mitigation strategies discussed in the next chapters.

The likelihood of those sites within each community passing the Exception Test depends highly on the implementation of a flood risk management strategy. Whilst the Exception Test is not dependent on one being produced, development within Radcliffe and Rochdale especially, will find it difficult to continue without an overall strategy and vision for appropriate land use and mitigation measures. In Radcliffe this is more evident due to the inconsistency of current asset conditions, whilst residual risk in Rochdale could be reduced if assets are improved along Buckley Brook.

A FRM strategy is not recommended in Ramsbottom. However, development will find it difficult to continue on a piecemeal basis as there is the potential risk of off site impacts through inappropriate mitigation methods. Sites, especially east of the railway line, cannot be developed individually as risk is associated with the flow path originating in Rossendale, which will need to be mitigated. However, an actual FRM Strategy is not required as risk is understood and mitigation measures needed to reduce risk are clear. Currently the majority of development is at risk from flow paths arising outside of Bury Council, which if mitigated could reduce the risk of fluvial flooding to a large number of current properties and future development sites.

Development in Littleborough will be relatively straightforward and will be an urban design issue (i.e. increased floor levels and strategically placed buildings within the development footprint). Due to lack of proposed development sites at flood risk in Shaw, the consequence of flooding could be reduced through the application of the Sequential Test rather than producing detailed flood risk management strategies.

LPA Development Management officers should use the summary of the communities above to assess whether windfall development is appropriate in these areas, and if so, the likelihood of the developments passing the Sequential and Exception Test. Where risks are too great, sites should be sequentially less preferable in these communities. The Exception Test would be less likely to be passed in Bury-Radcliffe compared to Ramsbottom and Littleborough. The community summaries should also provide an indication of the detail required within a site-specific FRA and highlight the possible need for large mitigation measures, which may make the site unviable when compared to potential yield size.

Flood risk matrices for Littleborough and Ramsbottom have been provided in Appendix A. These Matrix tables facilitate the Exception Test and identify those proposed development sites which Bury and Rochdale Council should try and avoid where possible or where lower vulnerability land use is more appropriate.

The matrix tables were not possible to create for Rochdale and Bury-Radcliffe as these areas have been identified as requiring flood risk management strategies and future development is dependent on the outcome of the strategies rather than the sequential placement of the development.

9 OUTLINE FLOOD RISK MITIGATION STRATEGY

9.1 Introduction

The assessment described in this chapter focuses on the implications of the risks associated with the construction of new development in Flood Zones 2 and 3. It is a requirement of PPS25 that consideration is also given to the consequences of defences being overtopped or failing, for instance by breach or blockage. Accordingly when more detailed Flood Risk Management strategies are developed these will need to allow for the response during flood emergencies. There are a wide range of resistance, resilience and adaptation strategies that can be deployed and it is likely that a "one size fits all approach" will be economic.

The Outline Flood Risk Mitigation Strategies identified in this chapter have been developed to demonstrate the feasibility and commitment required to deliver development that will be safe for its intended life span. It will be necessary to commission a series of more detailed studies to properly test the full range of options and demonstrate their feasibility. It is possible more details on the Flood Risk Mitigation Strategy are required to demonstrate that the proposed infrastructure requirements satisfy policies in PPS12, which includes a "Soundness" test based on a robust and credible evidence base. The evidence in this SFRA should be tested to confirm whether or not it satisfies the criteria and supplementary assessments prepared as necessary.

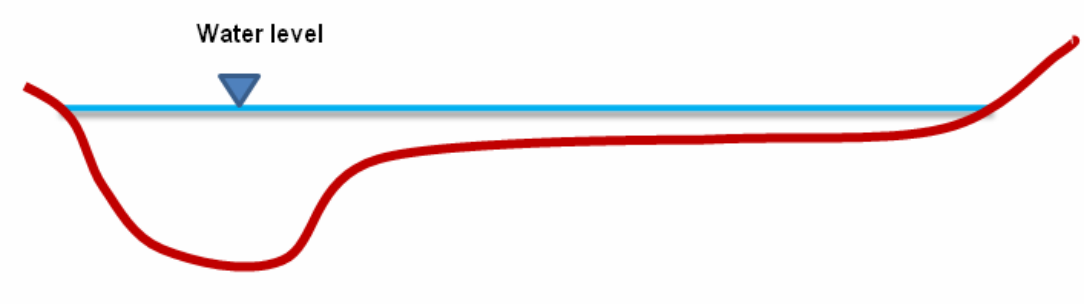
9.1.1 Flood Mitigation

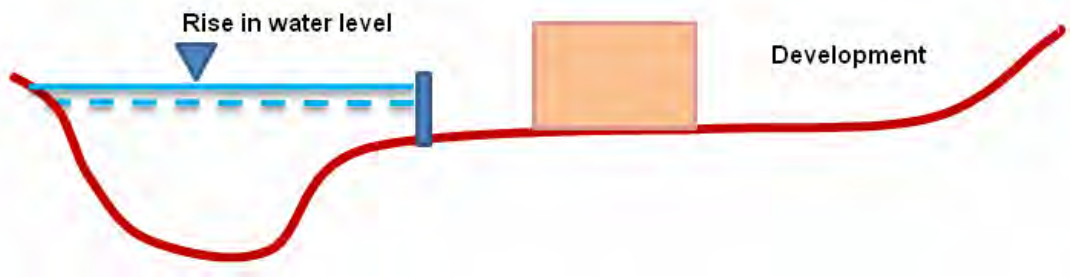
Where a site requires mitigation against flood risk, the principles of PPS25 should be applied in that flood risk should be reduced both to and from the development. Mitigation measures should be considered on a strategic basis that avoids a piecemeal approach and advocates partnership between the council and the Environment Agency and integration with wider Environment Agency flood risk management works and strategies (e.g. River Irwell CFMP, Irwell Strategy). An Outline Mitigation Strategy has been undertaken for Bury at Chamberhall and Western Waterside and the River Irwell from the railway bridge at Warth Mills to the railway crossing downstream of the East Lancs Paper Mill and Rochdale where the River Roch flows through the East Central Rochdale and Town Centre East regeneration areas. These consider the wider and cumulative impacts of mitigation and involve master-planning an area from a flood risk perspective.

Implementing mitigation measures on a piecemeal basis could potentially increase the flood risk to the site itself or to other locations upstream or downstream of the particular watercourses on which the sites lie. The general mechanism is shown in Figure 9-1.

If, for example, development on each of the sites is maximised by using flood defences or land raising, floodwater will be displaced and this will be forced elsewhere. This may cause a rise in water level upstream of the development site and an increase in upstream risk. Alternatively, it may mean that more flow is passed on downstream and the risk is increased downstream. The increase in risk will require mitigation if the development goes ahead. The degree of impact depends on how the sites are developed. Fully defending all sites is a worst case scenario.

Figure 9-1: Potential impact of development on flood risk





9.1.2 Flood Risk Policy: PPS25

PPS25 advocates that flood risk should be taken into account at all stages in the planning process to avoid inappropriate development in areas at risk of flooding and direct development away from areas at highest risk. Land should be safeguarded from development that could have a future flood management use such as conveyance and storage of floodwater or for flood defences, which may include recreating functional floodplain. Flood risk to and from new development should be reduced by development location, layout and design and through the use of sustainable drainage systems.

9.1.3 Flood Risk Policy: River Irwell CFMP

The River Irwell Catchment Flood Management Plan (CFMP) is an Environment Agency document which sets the direction of flood management policy in the River Irwell catchment as discussed within Volume I of the BRO SFRA. The CFMP Policy that applies to a policy unit (geographic area with similar flood risk characteristics) will influence future flood risk management in that area. Sites that are available for new development could in some instances provide a valuable flood risk management function and this should be considered within the planning process.

9.2 Outline Strategic Flood Risk Management Proposals for Rochdale

9.2.1 Summary of Flood Risk

The River Roch capital flood alleviation scheme was completed in 2005, which was designed to provide a 1 in 100 year standard of flood risk protection to Rochdale and Littleborough. A review[5] of the River Roch Flood Alleviation Scheme was carried out in 2008 following the flooding of property in the Roch catchment in January 2008. The report identified that some sections of the flood defences in Littleborough and at Mitchell Hey in Rochdale are below the design standard of protection.

Hydrological studies undertaken for the 2008 Roch review, with more recent flood estimation methods, estimate that peak flood flows in the centre of Rochdale and for locations downstream are significantly lower than were previously predicted. The consequence of these results is that some defences along the Roch may have a higher standard of protection than was previously thought. Also, some defences are able to maintain their design defence standard considering the effect of predicted climate change. The Roch review included a summary of the current standard of protection of defences along the River Roch.

Actual flood risk within Rochdale is described in Section 3 using modelling carried out for this Level 2 SFRA.

Flood risk in Rochdale can be summarised as:

- From the River Roch there is generally very little displaced floodwater for the 1 in 100 year flood across the proposed development sites,
- There are generally small differences in overtopping of defences from the 1 in 100 year flood to the 1 in 100 year flood with climate change allowances,
- Some of the most severe flooding in the 1 in 100 year with climate change event is caused by water overtopping Buckley Brook, flowing down roads and ponding behind flood defences on the River Roch,
- The Esplanade Culvert is a critical point where flood water would spill into the centre of Rochdale,

[5] Environment Agency (2009) Review River Roch FAS (Hydrology and Hydraulics)

- At Mitchell Hey in Rochdale electrical substation infrastructure is at risk of flooding,
- There is a localised risk of surface water flooding, including behind flood defences where surface water could pond when water levels in the river are high, and
- There is the potential for flooding caused by canal or reservoir failure on higher ground. If this occurred at the same time as river flooding, the flood defences could be overtopped.

9.2.2 Flood Risk Policy: the River Irwell CFMP

Rochdale, Littleborough and Whitworth on the River Spodden lie within policy unit 18 of the CFMP. The CFMP recommends policy 4 for Rochdale which is to take further action to sustain the current level of flood risk into the future.

The CFMP recommends a long term strategy for the Roch and Spodden catchments by the Environment Agency. The Shaw to Rochdale Strategy has recently been commissioned by the Environment Agency. Mitigation measures that are implemented for new developments should work with the long term flood risk management policies in the CFMP. CFMP actions include:

- The need to investigate a range of issues including gravel management and the potential for storage basins together with localised improvements,
- The need to guide inappropriate development away from flood risk areas,
- The need to mitigate the risk where development is taking place in flood risk areas,
- Use of new development to achieve a reduction in flood risk, and
- The need to set a target standard of protection for critical infrastructure.

9.2.3 Potential Adverse Flood Consequences of New Development

Initially, the development sites were assessed for their potential impact on flood risk in the worst case scenario by assessing the potential volumes displaced. This is as if each site were to be completely defended and developed to its maximum potential. The sites that lie at least partially within the 1 in 100 year plus climate change floodplain through Rochdale are listed in Table 9-1. All the sites lie within Flood Zone 2 and all sites, except 2, lie within Flood Zone 3b. The volumes listed in Table 9-1 shows the maximum volumes potentially displaced, excluding areas in the functional floodplain (3b).

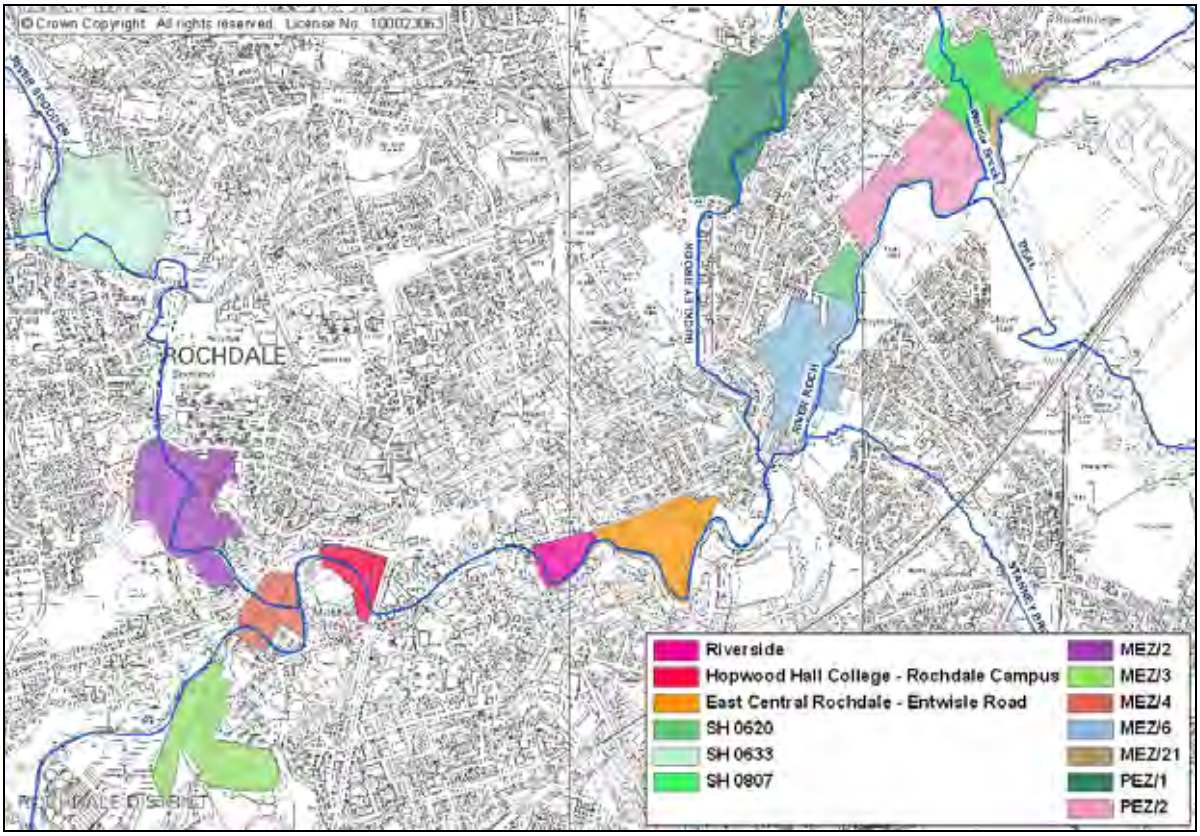
Table 9-1: Maximum estimated floodwater displacement for defended development sites at flood risk

Site reference[1]	Site name	Watercourse[2]	Modelled 1% AEP + CC	
			Potential development impact on flood risk in worst case	Estimated max flood volume displaced (m^3)
Roch				
MEZ/21, SH 0807	Dyehouse Lane	Roch (Ash Brook)	Floodplain displaced east side of site.	400
PEZ/2	Smallbridge Industrial Estate.	Roch, Ash Brook	Small volume of floodplain displaced east side of site. Reduction in conveyance.	350
SH 0620	-	Roch	Floodplain displaced east side of site.	-
MEZ/6	Belfield Road. East Central Rochdale, Gowers Street.	Roch, Hey Brook or Buckley Brook	Floodplain displaced south side of site. Reduction in conveyance.	700
-	Riverside	Roch	Floodplain displaced south east of site.	150
-	Hopwood Hall College, Rochdale	Roch	Floodplain displaced. Reduction in conveyance.	1250

Site reference[1]	Site name	Watercourse[2]	Modelled 1% AEP + CC	
			Potential development impact on flood risk in worst case	Estimated max flood volume displaced (m^3)
	Campus			
(SH 1108)	East Central Rochdale, Entwisle Road.	Roch	Floodplain displaced east side of site.	1900
MEZ/3	-	Roch	Minimal	100
			Total volume displaced	**4,900**
Buckley Brook				
PEZ/1	Buckley Road.	Buckley Brook	Buckley Brook spill prevented. Floodplain displaced.	750
			Total volume displaced	**750**
Spodden				
SH 0633	Rooley Moor Road, Rochdale	Spodden	Floodplain displaced.	500
MEZ/2	Spotland Bridge	Spodden	Minimal	-
MEZ/4	-	Roch, Spodden	Small volume of floodplain displaced west side of site.	350
			Total volume displaced	**850**

Table-Notes
1 Reference in bracket is subdivision of a larger site without a reference number.
2 Primary flood source with secondary lower risk flood source in brackets.

Figure 9-2: Development Sites Identified in Table 10-1



9.2.4 Mitigation for Site Development

This section considers options for flood risk mitigation that will be required for development of the sites listed in Table 9-1. Development on Buckley Brook has a significant potential to reduce flood risk to current developments in Rochdale and contribute to the wider policy aim in Rochdale to take climate change into account and hence is considered here.

Different mitigation options have been considered including providing flood defences or land raising, constructing flood storage and land use planning, such as applying the sequential approach to development layout.

It is considered that the total risks along each main watercourse and tributary should be considered separately to some extent, so that any increase in flood risk caused by site development is effectively mitigated, as far as possible, within the length of the watercourse. This will ensure that other places along that particular watercourse do not suffer any increase in risk. Therefore, Buckley Brook, the Spodden and the Roch are considered separately.

9.2.5 Flood Mitigation for Buckley Brook for Development and Climate Change

Development here has a significant potential to reduce flood risk downstream in Rochdale and hence both defences and flood storage were considered.

Defended Scenario

Flood risk from Buckley Brook is discussed in Section 3.5 and any future development of sites along Buckley Brook would increase this risk. In the 1 in 100 year flood event water would overtop the Buckley Brook, flow down roads and pond behind flood defences on the River Roch. The consequences of flooding in the 1 in 100 year event with climate change are noticeably worse.

The Rochdale model was rerun, blocking off four overtopping locations to show the effect of increasing the heights of defences at these four locations. These are:

- An upstream spill on the right bank at Site PE Z/1,
- A spill from the left bank at Site PE Z/1 into Red Lane,
- A downstream spill from an access ramp into Buckley Brook at Entwisle Road, and
- A spill at Selby Street from the right bank.

The results of this model run showed that water levels increase by up to 170mm upstream of the blockage locations. Water spills from the brook at other locations and there is still a flood risk to Rochdale caused by overland flow. The outcome of the modelling shows that increasing defence lengths and standards along Buckley Brook will not offer a long term reduction in flood risk in Rochdale.

This shows that development site PE Z/1 can only be fully defended and developed if the existing flood problems and the post-development flood impacts could be offset along the length of the brook, considering climate change.

Storage Scenario

Investigations of potential flood storage areas suggest that there are limited opportunities along the steep sided valley of Buckley Brook in existing open spaces to store the large volume of flood water that would be required. Limited possibilities for providing storage have been identified as:

- Providing additional storage at Watergrove Reservoir. The additional depth of storage required in the reservoir would be approximately 0.02m for 750m³ lost by development,
- Providing a small additional volume at Rydings Dam (grid reference 390620 4162452), or
- Provision of some storage at Buckley in the valley bottom.

It may be possible to explore some of these possibilities but one or more of these solutions are only likely to offer short term mitigation measures and would be unlikely to provide a solution for climate change. These storage solutions would also have to be designed to become active at the right time in the storm event to reduce risks.

The Preliminary Mitigation Review in the SFRA Volume IV has explored flood storage locations further on the Buckley Brook. A zone of search is possible, with one option being to use at least part of development site PE Z/1 for flood storage. Two storage areas, denoted as S13 and S14, have been looked at at the time of developing this volume of the SFRA. The estimated available volume using both sides of Buckley Road would be of the order of 28,000 m³. Development of this available volume would reduce the risk to Rochdale in the near future and offset the impacts of climate change

in the long term. Storage volumes are shown in Table 9-2. **These are indicative volumes that would need detailed investigations before any flood storage areas were constructed.**

Table 9-2: Potential flood storage along Buckley Brook.

Site ref	Site location	Estimated flood storage (m3)
S13	Buckley Road	11,000
S14	Buckley Road	17,000
	Total	**28,000**

9.2.6 Flood Mitigation for Development Sites on the River Spodden

Table 9-1 shows the total estimated volume of displaced flood water for development of the SH 0633 and ME Z/4 sites along the Spodden is approximately 850m³.

There is limited potential for flood storage along the Spodden valley owing to the steep topography. Therefore there will need to be local mitigation at the development sites.

Since the displaced volume is small the simplest approach for these sites would be to apply the sequential approach to the layout of the development, leaving areas at flood risk as open space. The alternative approach would be to allow for compensation volumes and mitigation within the development site.

9.2.7 Flood Mitigation for Development Sites on the River Roch

A good proportion of the flood risk to Rochdale can be mitigated by actions on Buckley Brook as stated in Section 9.2.5. Flood mitigation for two development sites ME Z/6 and SH 1108 along the Roch in this section assumes that the measures have been carried out on Buckley Brook. **If actions on Buckley Brook cannot be carried out subject to more detailed investigation then the area of these sites (that form part of the East Central Rochdale Housing Market Renewal area) that can be delivered will be reduced**, as a sequential approach to development layout will need to be considered. Delivering mitigation options in a piecemeal way to reduce the risk of flooding from the Buckley Brook on these HMR sites could potentially divert this water into current developments.

Table 9-3 shows proposed mitigation measures. For most of the sites the extent of flooding is small and application of the sequential approach to development layout will permit appropriate development within the site.

Mitigation for other sources of flooding should be applied as outlined in the SFRA User Guide.

Table 9-3: Mitigation options in Rochdale

Site ref	Site name	Watercourse	Mitigation
MEZ/21, SH 0807	Dyehouse Lane	Roch (Ash Brook)	Apply sequential approach to development layout
PE Z/2	Smallbridge Industrial Estate.	Roch, Ash Brook	Apply sequential approach to development layout
SH 0620	-	Roch	Apply sequential approach to development layout
ME Z/6	Belfield Road. East Central Rochdale, Gowers Street.	Roch, Hey Brook or Buckley Brook	Apply sequential approach to development layout (partly mitigated by Buckley Brook actions)
-	Riverside	Roch	Improve defences on the right bank between John Street and Smith Street
-	New Bus Station	Roch	Apply sequential approach to development layout
-	Hopwood Hall College, Rochdale	Roch	Apply sequential approach to development layout

Site ref	Site name	Watercourse	Mitigation
	Campus		
(SH 1108)	East Central Rochdale, Entwisle Road.	Roch	None (mitigated by Buckley Brook actions)
ME Z/3	-	Roch	Apply sequential approach to development layout

9.2.8 Delivering CFMP Policy in Rochdale

The Shaw to Rochdale Strategy will look at how a CFMP policy P4 should be delivered in Rochdale. The potential for development sites to deliver flood storage was considered within the SFRA and can feed into this analysis.

The Irwell CFMP highlighted the preference for storage options to deal with climate change in the long term. Areas along the River Roch were investigated for global flood storage possibilities. There are topographical limitations for the provision of storage on the River Roch owing to the V-shaped valley upstream of Littleborough. The situation is generally similar on the tributaries upstream of Rochdale. Along the urban corridor of the Roch there are a few locations where storage is possible.

There may be a need to balance the use of the re-development sites along the Roch Valley for part flood storage and for part development. This should be explored between the council and the Environment Agency as part of the developing Shaw to Rochdale Strategy.

The potential for development on the Buckley Brook to reduce flood risk in Rochdale is significant and should be considered as an urgent location for more detailed investigations of the amount of flood storage that would be required. The council are advised to take this into account when considering planning permissions that may come forward for the site on Buckley Road.

9.3 Outline Strategic Flood Risk Management Proposals for Bury

9.3.1 Summary of Flood Risk

The Environment Agency Flood Zones show that there is a risk of fluvial flooding in Bury to developments alongside the River Irwell. However, the risk is much lower in Bury than in Radcliffe. There is a localised risk of surface water flooding and potential reservoir failure upstream could augment river flows. There is also a risk of flooding from minor reservoirs and local watercourses.

9.3.2 Flood Risk Policy: the River Irwell CFMP

The CFMP policy for Bury is policy 4 which is to sustain the current level of flood risk into the future. This may involve providing flood storage in rural areas, although there is the potential for works within Bury itself.

9.3.3 Mitigation in Bury

Both Chamberhall and Western Waterside are key regeneration sites that would need to pass the Exception Test in order to develop in flood risk areas (dependent on the vulnerability of proposed development). Mitigation should be designed to account for climate change and the wider implementation of a CFMP policy 4 within Bury.

Chamberhall

Many of the sites here have been the subject of recent FRAs that have identified appropriate mitigation measures that would not increase flood risk elsewhere and meet the policy aims of PPS25.

Western Waterside

A large area (around 60% of the site) is shown to be in Flood Zone 3. Hence after applying the Sequential Test, the Exception Test would need to be passed to permit residential development in this part of the site. If the site was defended, a large area of compensatory storage would be required. There are also potential flood risk issues from a minor watercourse and a mill lodge on the site that would need to be explored as part of a FRA.

9.4 Managing flood risk in Radcliffe

9.4.1 Summary of Flood Risk

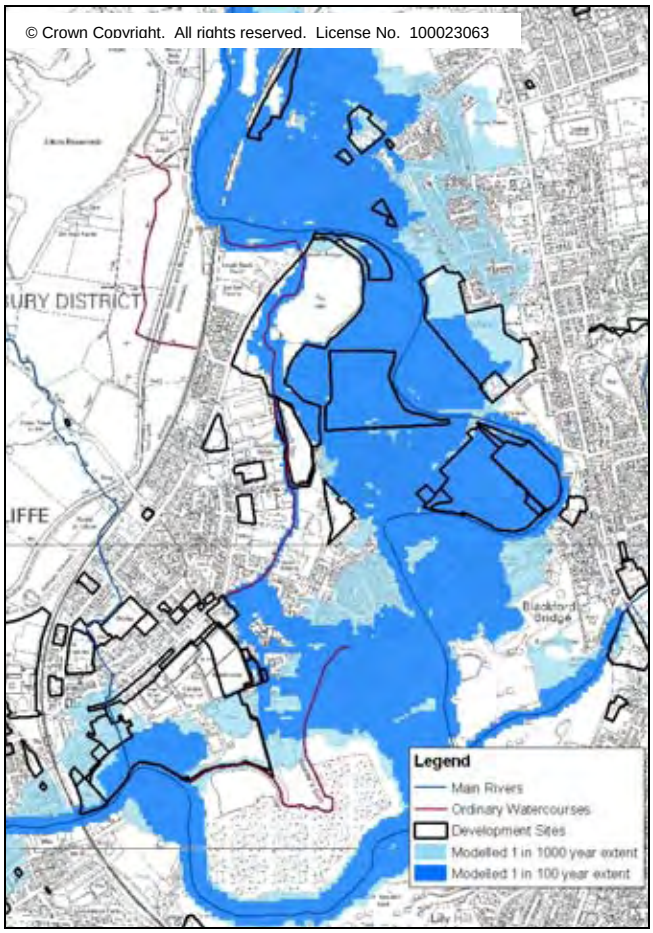
Large areas of Radcliffe are at high risk of flooding, with up to 650 existing properties flooded in a 1 in 100 year event, caused by insufficient channel capacity and development alongside both the River Irwell and Roch (source River Irwell CFMP). The high risk arises for a number of reasons:

- Flood defences in this area are piecemeal and offer little protection against flooding,
- The extent and depth of flooding is particularly sensitive to climate change,
- There are large meanders in the River Irwell across low-lying land which means that the river tends to take a direct flow path during flood conditions,
- The Metrolink bridge causes a restriction to flood flows and increases flood risk upstream,
- There is a high level of interaction between the River Irwell and Hutchinson's Goit upstream of Warth Bridge. The amount of water that flows down the goit is limited by a culvert on Warth Bridge. The goit could overtop with water escaping east to the River Irwell at Swan Lodge and just upstream of the East Lancs Paper Mill site,
- There is a localised risk of surface water flooding, especially when surface water cannot discharge to the river when water levels are high, and
- There is a risk of flooding from reservoirs on higher ground, including Elton Reservoir and the Manchester, Bury and Bolton Canal. Failure of these could cause direct flooding and also augment flows in the River Irwell.

There is also the potential risk of a major pollution incident in the area if the sewage works at Radcliffe near to Blackford Bridge were to flood. The current modelling analysis shows that this would be at risk in as low as a 1 in 25 year flood event.

Level 2 SFRA fluvial flood extents in Radcliffe are shown in Figure 9-3 and discussed in more detail in section 3.3.

Figure 9-3: Flood risk in Radcliffe



9.4.2 Flood Risk Policy: the River Irwell CFMP

A CFMP policy 5 applies to Radcliffe, whereby the Environment Agency and their partners will seek to take action to reduce flood risk. It should be noted that this is for current developments only. Sites that have come up for redevelopment and that are no longer occupied would be unlikely to qualify for flood defence under current cost: benefit rules and the principles of PPS25 should be applied whereby development is avoided if possible in high flood risk areas.

The CFMP advocates that in Radcliffe high priority actions under a policy 5 include:

- Develop a FRM strategy for the Upper Irwell to assess the most viable methods of reducing flood risk in the Radcliffe area, including clarifying the standard of protection by flood mapping and assessing the flood risk posed by culverts.
- Ensure that inappropriate development is guided away from flood risk areas and that where development is taking place, risks are adequately mitigated. This should include provision for predicted climate change. Where development, exceptionally, must take place in areas at risk of flooding, floor levels should be raised above the predicted flood levels, flood resilience measures should be incorporated into building designs and safe access and evacuation routes must be maintained. These are all recommended in PPS25.

The Upper Irwell Strategy will develop the options for flood risk management in Radcliffe. There is a possibility that rural areas upstream of Radcliffe in the Rural Rossendale policy unit (where a policy 6 applies which is to take action to increase the frequency of flooding to deliver benefits locally or elsewhere) could be used to provide flood storage that could help reduce flood risk in Bury and Radcliffe.

Whilst the shape of future works to reduce flood risk in Radcliffe are unknown at this time, there is the potential that now derelict development sites could be used to reduce flood risk to existing properties by providing flood storage or as a means to increase channel conveyance.

9.4.3 Potential Adverse Flood Consequences of New Development

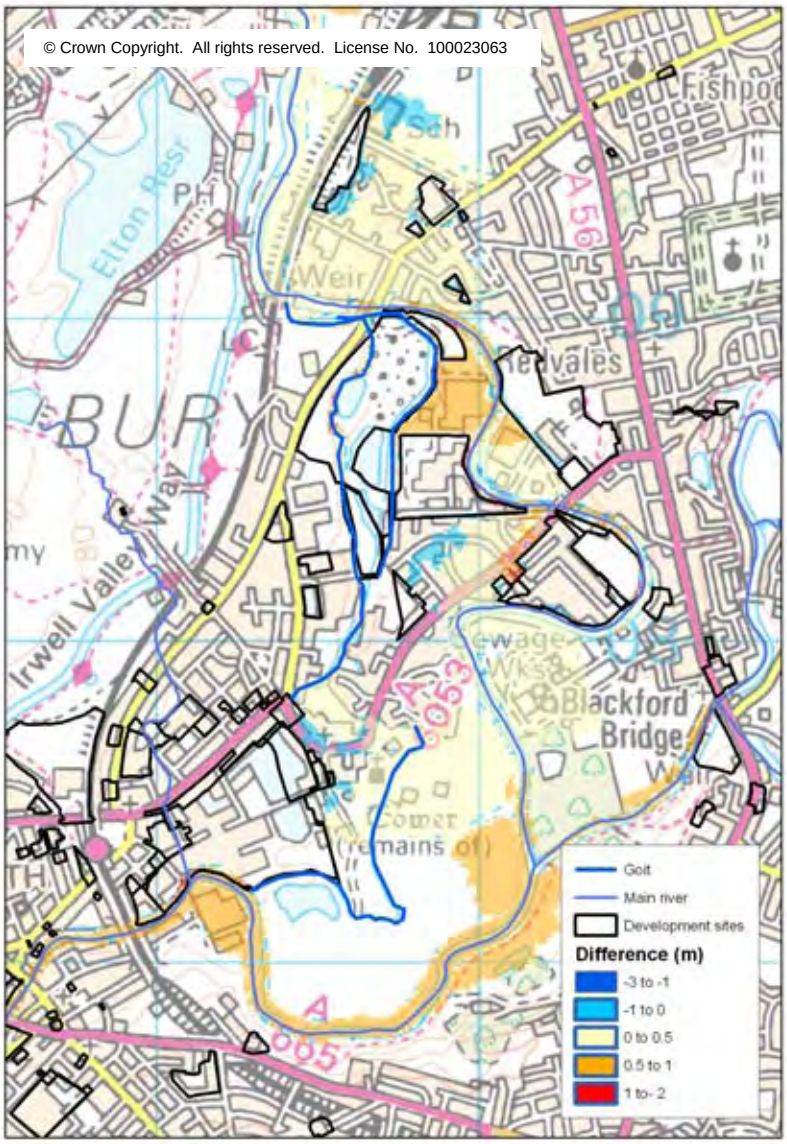
The impact of defending all the development sites in Radcliffe, taking into account climate change, in a 1 in 100 year flood event was modelled, as shown on Figure 9-4. This shows that this would have a significant effect on flood risk elsewhere in Radcliffe and block major flow paths across the floodplain. Flood risk would increase both upstream and downstream, including to the Blackford Bridge WwTW. There are some localised areas where flood risk would decrease, which is most likely to be caused by changes in flow paths caused the developments.

9.4.4 Applying the Principles of PPS25 within Radcliffe

1. Applying the Sequential Test under PPS25, development should firstly be avoided in flood risk areas looking within the wider community for other suitable development sites. Lower risk areas may be available within Radcliffe that are outside of high flood risk areas and the council should in the first instance apply the Sequential Test to such development.
2. After this developments should be substituted, with lower vulnerability developments being placed in higher risk zones. Residential is classed as highly vulnerable and is sequentially not preferred (and would require Exception Testing) in Flood Zone 3a High Probability (1 in 100 year). Commercial is classed as less vulnerable and is suitable in Flood Zone 3a.

   However it should be noted that many sites lie within the 1 in 25 year extent. In non urban areas this is generally classed as Functional Floodplain 3b. In this critical flood risk area of the River Irwell, there may be a strong case for allowing previously developed sites to return to Functional Floodplain in urban areas where they can act to convey and store flood water and reduce risk to current development. Only water compatible uses and critical infrastructure should be permitted in Functional Floodplain.
3. If development is needed in flood risk areas the Exception Test needs to be applied, unless the vulnerability of the land use passes the Sequential Test as above. To pass this test the site needs to provide wider sustainability benefits, be on previously developed land and made safe from flooding, without increasing flood risk elsewhere. Even if the Exception Test is not required, a site specific FRA must prove that the development can be made safe from flooding, without increasing flood risk elsewhere.

Figure 9-4: Changes in water levels with development in a 1 in 100 year flood event, considering climate change



9.4.5 Mitigation Options within Radcliffe

If the Exception Test is required or the Sequential Test has been passed, mitigation will be needed to ensure that a development is made safe from flooding whilst not increasing flood risk elsewhere.

A recent FRA has been undertaken for one site which demonstrates that a mitigation solution that involves raising levels on one part of the site and providing flood storage alongside the River Irwell will reduce risk to the development site and have a negligible impact elsewhere. However, the cumulative effects of applying a piecemeal approach on each development site are unknown.

The interactions between different sources of flood risk in Radcliffe is complex, including the River Irwell and River Roch and their tributaries, alongside Hutchinson's and Bealey's Goit plus additional sources of risk, such as the Manchester, Bury and Bolton Canal, Elton Reservoir and surface water.

The River Irwell overtops its banks during flood events and takes the shortest path downstream across the floodplain. **Developing sites in a piecemeal way and not considering a wider and strategic option in these areas would be likely to affect flow paths, altering the pattern of flooding and making flooding worse for some of the existing communities.**

An integrated and engineered solution for the whole area would be the most sustainable and help to deliver reductions in flood risk to both new and current developments. This could include:

- Providing flood storage upstream at playing fields at Buckley Wells on the River Irwell. There is low lying land here that may have the potential for flood storage. An embankment would be needed to stop water flowing under the railway line. However, there is unlikely to be a large enough amount of land to store enough water to reduce flood risk significantly downstream.
- Providing flood storage at playing fields at Goshen on the River Roch. There is potential for flood storage here although the River Roch makes a much smaller contribution to flood risk in Radcliffe than the River Irwell (contributing less than half the flows of the River Irwell) since it has a smaller catchment. However, there is unlikely to be a large enough amount of land to store enough water to reduce flood risk significantly downstream and any effect would only be felt downstream of major development sites at York Street and Dumers Lane.
- Providing flood storage at Close Park on the River Irwell. There is low lying land here that may have the potential for flood storage. However, there is unlikely to be a large enough amount of land to store enough water to reduce flood risk significantly downstream and any effect would only be felt downstream of major development sites at York Street and Dumers Lane.
- Lowering land adjacent to the River Irwell on both banks to allow for land raising for development to the western edge of the floodplain. There is a major problem with this option of land availability since not all the land is proposed for development.
- Increasing conveyance through the Dumers Road Bridge and using the downstream development site for flood mitigation will reduce flood levels upstream of the road bridge and reduce flood risk to the existing community between York Street and Dumers Lane.

Many of the above would be major engineering undertakings that are likely to be very costly, potentially affecting the economic feasibility of developing sites, especially as the land area available for development would be reduced.

Even if a piecemeal approach to mitigation is taken forward as the preferred option, the residual risk to developments could be significant and difficult to manage. There is potentially a major public safety issue with access and egress issues on sites that could effectively become islands during flood events or that are not currently accessible by roads outside of flood risk areas.

It should be noted that an integrated and engineered solution for the whole area could deliver reductions in flood risk to both new and existing developments and there is a significant opportunity for the council to work with the Environment Agency to reduce flood risk in Radcliffe, which would be delivered through the Upper Irwell Strategy. However, there must be an acceptance of overall loss of developable area within individual development sites.

9.4.6 Recommendations for Flood Risk Management in Radcliffe

The Level 2 SFRA recommends that:

1. The council should apply the Sequential Test and seek to move development out of such a high flood risk area. They should explore the possibility of using derelict sites for future flood risk management works to reduce flood risk to the existing community with the Environment Agency as part of the Upper Irwell Strategy.
2. If this is not possible, the council should substitute developments with the lowest possible vulnerable land uses. Residential areas are not acceptable under PPS25 in Flood Zone 3a, without passing the Exception Test. They should look to reinstate Functional Floodplain where this could reduce flood risk to current development as outlined in the Flood Zone 3a policy aims.
3. If development in this area is essential for wider sustainability reasons then all 3 parts of the Exception Test need to be met where applicable or a FRA needs to prove that the development can be made safe from flooding, without increasing flood risk elsewhere. For the reasons outlined above, an integrated strategy, which has the potential to work in partnership with the Environment Agency's aspirations to reduce flood risk, must be adopted as sustainable development cannot be achieved through a piecemeal approach. A piecemeal approach may have a cumulative effect on flood risk elsewhere in current developments. There would also be a potential issue with public safety during flood events if this was taken forward.

4. Mitigation for other sources of flooding should be applied as outlined in the SFRA User Guide.

9.5 Outline Strategic Flood Risk Management Proposals for Ramsbottom

9.5.1 Summary of Flood Risk

The Environment Agency flood defences provide a 1 in 100 year SOP and protect areas through central Ramsbottom up to a 1 in 100 years plus climate change event when they are overtopped.

The main flooding in Ramsbottom in a 1 in 100 year event is caused by the River Irwell overtopping its banks at Stubbins in Rossendale Council area. Flood waters then flow underneath the East Lancashire Railway and southwards along Stubbins Lane. Flood waters collect around Drill Hall as they are constrained by high road levels along Bridge Street causing flood depths of up to 2m.

In a 1 in 1000 year event there is significant and deep flooding in Ramsbottom with deep water flowing under the railway, along Stubbins Lane and collecting at Peel Brow before overtopping Bridge Street and flooding areas downstream. Deep water would pond behind the flood defences, which would act as a barrier to letting floodwaters escape back into the River Irwell. The flood hazard would be 'Dangerous for All' in most parts of Ramsbottom that are affected in this event.

There is also a high risk of surface water flooding in Ramsbottom, which may pond behind flood defences when river levels are high. Failure of upstream reservoirs that could augment river levels.

9.5.2 Flood Risk Policy: the River Irwell CFMP

The River Irwell CFMP recommends a policy 4 for Ramsbottom which is to take further action to sustain the current level of flood risk into the future. This may involve providing flood storage in rural areas upstream, although there is the potential for works within Ramsbottom itself. The Upper Irwell Strategy should identify the shape of flood risk management actions undertaken by the Environment Agency and its partners in the future.

9.5.3 Potential Adverse Flood Consequences of New Development

Ramsbottom has been identified as having potential for future development in the river corridor where opportunities may arise through land use change, alongside sites that are identified in the Bury Core Strategy. Developing these sites to a worst case scenario with defences or land raising would have the potential to alter flow paths, remove flood storage from the floodplain and make flooding worse on other development sites and to the wider community.

9.5.4 Mitigation Options within Ramsbottom

1. The Sequential Test should be applied to avoid developing in areas at high risk of river and surface water flooding in Ramsbottom in the first instance. Where this is not possible and lower vulnerability land use can be substituted or the Exception Test needs to be applied, mitigation options should be considered on a strategic basis. Bury MBC should work closely with the Environment Agency and Rossendale Borough Council through the Upper Irwell Strategy and further flood risk assessment work to develop options to cut off the flow path into Ramsbottom caused by overtopping of the River Irwell at Stubbins.
2. If this source of risk could be removed during a 1 in 100 year flood event, considering climate change then it would reduce the extent of actual risk to the current community and future development sites. However, residual risk from river flooding would remain, which would need to be considered alongside the risk of surface water flooding. There is significant flood risk during a 1 in 1000 year event and this would need to be carefully considered when developing mitigation measures such as urban design, and in particular, flood awareness, flood warning and evacuation. A sequential approach to development must also be considered to avoid high risk areas and blocking important flow paths.
3. Mitigation for other sources of flooding should be applied as outlined in the SFRA User Guide.

10 MAINTENANCE

10.1 Introduction and General Recommendations

Main rivers within the catchments of the River Roch and River Irwell are maintained by the Environment Agency (EA). This covers most of the watercourses in the Bury, Rochdale and Oldham Council areas. The Environment Agency Flood Risk Management Operations Team has procedures for asset inspection, annual and reactive maintenance. Maintenance may involve routine cutting of bank vegetation, weed removal, gravel removal and removal of debris from the watercourse. The Environment Agency take a risk based approach to maintenance of main rivers, targeting more resources at known problem areas.

The River Irwell CFMP identified that flood risk is likely to increase in the future to a combination of climate and land use changes in the catchment. Hence the maintenance routine will need to change in the future to take account of this.

As discussed in section 2 of this Volume, site walkovers were undertaken in Rochdale, Ramsbottom and Bury-Radcliffe by a Chartered Engineer. Some problems with existing key infrastructure (both private and Environment Agency) were identified and these are recorded below. Many of the private defences recorded in the SFRA asset database are very local and are not critical to flood risk management.

In addition to tackling problems with river assets, Councils, the Highways Agency and United Utilities must continue to maintain road gullies and surface water sewer systems. This will ensure that the full system design capacity is available in storm conditions.

Existing reservoirs and associated infrastructure were mentioned in the BRO Level 1 SFRA (Volume II). Existing legislation covers regular inspection and maintenance of these structures. Detailed reservoir information was not available for this report.

The canal embankments are currently owned, inspected and maintained by British Waterways (BW). Principal embankments above Rochdale are inspected more rigorously in accordance with BW schedules.

10.2 Rochdale

10.2.1 River Irwell CFMP

The CFMP made reference to a number of possible responses under a policy 4 for the maintenance of watercourses and river assets in the Rochdale area (Policy Unit 18). These include:

- Undertaking a review of the condition and capacity of the culverts within the unit to identify any potential flooding issues (by the Environment Agency),
- Assessment and possible remedial work to the flood defences assessed to be in poor condition (by the Environment Agency),
- Investigating sewer and drainage flooding problems (by United Utilities and Local Authorities), and
- Undertaking a fluvial audit to develop an understanding of the sediment processes in the watercourses, followed by a review of gravel management operations (by the Environment Agency).

10.2.2 River Roch

Weirs

There are a number of small private weir structures upstream of Howarth Cross. The weirs are generally small and the impounded volumes are low. Failure of the weirs is unlikely to cause a significant flood incident. No particular maintenance issues have been identified.

There is a small weir at Bridgefield St (NGR 388789 413072). The impoundment behind this weir is small.

Defences

Privately owned defences that are important for flood risk management along the River Roch are shown in Table 10-1.

Table 10-1 mentions the embankment at the allotment gardens. This is currently in poor condition and it offers a minimal flood defence benefit. It would be preferable to remove the earth embankment (Ref: SFRA_ROCH_50) to allow more frequent flooding and flood water storage at the allotment gardens.

10.2.3 Buckley Brook

Defences

Privately owned defences with current maintenance issues that provide a flood risk management function along Buckley Brook are shown in Table 10-1.

10.2.4 River Spodden

Culverts

The CFMP reported that culverts have caused historic flooding problems. Ongoing culvert maintenance and debris clearance is important. The historic problems suggest that the hydraulic efficiency of some culverts should be improved.

10.3 Bury

10.3.1 River Irwell CFMP

The CFMP made reference to a number of possible responses under a policy 4 for the maintenance of watercourses and river assets in the Bury area (Policy Unit 6). These include:

- Undertaking a risk based review of the condition and capacity of the culverts within the unit to identify any potential flooding issues (by the Environment Agency),
- Continuing to investigate the condition of defences and improvements if necessary (by the Environment Agency),
- Investigation into partnership opportunities concerning the renovation of canals in the area (by the Environment Agency and British Waterways), and
- Upstream sediment source management and making improvements to conveyance.

10.3.2 River Irwell

Weirs

There are weirs at Tentersfield and Buckley Wells that are not currently included in the NFCDD database. The impoundment behind this weir is likely to be small.

Defences

There are very few defences in Bury along the River Irwell. There is a private defence on the right bank of the River Irwell south of Bury Bridge.

The defence shown in NFCDD at Warth Mills (NGR 379339 409313) seems to be ineffective as a flood defence structure. Floodwater can potentially flow past the north end of the structure. To protect the existing Warth Mills estate and defend the proposed sites in this location, a new defence would be required to prevent water flowing through the openings in the railway embankment.

Privately owned infrastructure that is important for flood risk management along the River Irwell are shown in Table 10-1.

10.4 Radcliffe

10.4.1 River Irwell CFMP

The CFMP made reference to a number of possible responses under a policy 5 for the maintenance of watercourses and river assets in the Radcliffe area (Policy Unit 5). These include:

- Developing a sustainable approach to gravel management across the catchment (by the Environment Agency),

- Determining the condition of the existing defences and culverts and continuing to develop a risk based approach to asset management (by the Environment Agency), and
- Improving conveyance by the removal of redundant weirs.

10.4.2 River Irwell

Defences

Most of the private defences in Radcliffe provide very local protection to individual sites. Long term maintenance for most of these defences is not critical for flood risk management in the wider area in the more extreme flood events. A number of the defences noted in NFCDD are ineffective since they are raised earth mounds that do not seem to have been properly constructed as a flood defence structure. The main private defences and structures of wider importance are included in Table 10-1.

Hutchinson's Goit

The current operating regime of Hutchinson's Goit provides some small flood relief to the main River Irwell channel during peak flood conditions. This may currently be seen as a partial benefit. However, if flows in the goit are high enough to exceed channel capacity the flood risk to Radcliffe is increased when the goit embankments are overtopped. The use of the goit in providing some flood relief from the River Irwell in Radcliffe needs to be reviewed as part of the Upper Irwell Strategy.

Table 10-1: River Roch and Irwell (Bury) defence infrastructure

Ref	Asset	NGR	Benefit	Owner	Short term actions	Long term actions
River Roch						
SFRA_ROCH_59	Embankment at Belfield Rd	390910 414142	Prevents local flooding of site ME Z/6	Private	-	Inspections and ongoing maintenance
SFRA_ROCH_47	Ramp to car park	390837 414080	Prevents local flooding of the site ME Z/6	Private	-	Inspections and maintenance
SFRA_ROCH_50	Embankment to allotment gardens	390624 413498	Some small benefit from flood storage currently. Poor defence condition	Private	Remove embankment to allow more flood storage volume in allotment gardens area	
SFRA_ROCH_7	Raised ground created by spoil			Private	Construct formal defence	Inspections and maintenance
SFRA_ROCH_37	Raised ground created by spoil			Private	Requires repairs to wall	Inspections and maintenance
Buckley Brook						
SFRA_ROCH_62	Ramp at Red Lane	390584 414652	Prevents floodwater spilling into Red Lane	Private (not in NFCDD)	-	Inspections and maintenance
SFRA_ROCH_61	Wall at school	390469 414088	Prevents floodwater spilling into Yorkshire St	Private	-	Inspections and maintenance
SFRA_ROCH_21	Wall at Norman Road	389054 413069	Prevents floodwater spill into Norman Rd	Private	-	Inspections and maintenance
River Irwell						
SFRA_BURY_46	Weir at Tentersfield	379708 410655		Unknown (not in NFCDD)	-	Inspections and ongoing maintenance
SFRA_ROCH_47	Raised boundary wall	379736 410766	Full benefit unknown. May prevent local flooding of development site	Private	Unknown requirements – requires inspection.	Inspections and maintenance
SFRA_BURY_48	Weir at Buckley Wells	379422 410000		Unknown (not in NFCDD)	-	Inspections and ongoing maintenance
SFRA_BURY_13	Raised defence embankment		Minimal benefit	Private	Review construction of formal defences as part of Upper Irwell Strategy	Inspections and maintenance if required

11 RECOMMENDATIONS FOR FUTURE WORK

11.1 Recommendations Summary

Table 11-1 provides recommendations for further work to be carried out by each council. This should be read in conjunction with the SFRA User Guide, which provides guidance on how to apply the Sequential and Exception Test within Bury, Rochdale and Oldham for LPA officers.

Table 11-1: Recommendations for future work

LPA	SFRA Section	Recommendation	Other stakeholders
Rochdale	5.3 Recommendations for Surface Water Management	Undertake a SWMP for Littleborough	United Utilities, Environment Agency
Rochdale	5.3 Recommendations for Surface Water Management	Undertake a SWMP for Heywood	United Utilities, Environment Agency
Rochdale	5.3 Recommendations for Surface Water Management	Undertake a Drainage Strategy for Kingsway Business Park	United Utilities, Environment Agency
Rochdale	5.3 Recommendations for Surface Water Management	Undertake a Drainage Strategy for Stakehill Industrial Estate	United Utilities, Environment Agency
Rochdale	9.2.7 Flood Mitigation for Development Sites on the River Roch	Consider mitigation options for delivering regeneration in East Central Rochdale and Town Centre East in more detail, including scheduling and costing	Provided as Volume IV for the SFRA
Rochdale	9.2.8 Delivering CFMP Policy in Rochdale	Work with the Environment Agency on the Shaw to Rochdale Strategy and further flood risk assessment work to deliver mitigation that works with the long term policy in Rochdale to reduce flood risk into the future	Environment Agency
Bury	4 Canal Flood Risk	Minimise canal flood risk during canal restoration	British Waterways
Bury	5.3 Recommendations for Surface Water Management	Undertake a SWMP for Ramsbottom	United Utilities, Environment Agency
Bury	5.3 Recommendations for Surface Water Management	Undertake a SWMP for Radcliffe	United Utilities, Environment Agency
Bury	5.3 Recommendations for Surface Water Management	Undertake a Drainage Strategy for Chamberhall	United Utilities, Environment Agency
Bury	5.3 Recommendations for Surface Water	Undertake a Drainage Strategy for Bury-	United Utilities, Environment Agency

LPA	SFRA Section	Recommendation	Other stakeholders
	Management	Radcliffe	
Bury	9.4.6 Recommendations for Flood Risk Management in Radcliffe	After first applying the Sequential Test, work with the Environment Agency on the Upper Irwell Strategy and further flood risk assessment work to develop mitigation options for new and existing development	Environment Agency
Bury	9.5.4 Mitigation Options within Ramsbottom	After first applying the Sequential Test, work with the Environment Agency and Rossendale Borough Council on the Upper Irwell Strategy and further flood risk assessment work to develop mitigation options for new and existing development	Environment Agency, Rossendale Borough Council
Oldham	5.3 Recommendations for Surface Water Management	Undertake a Drainage Strategy for Sholver	United Utilities, Environment Agency
Oldham	5.3 Recommendations for Surface Water Management	Undertake a Drainage Strategy for Derker	United Utilities, Environment Agency

APPENDICES

Appendix A: - Flood Risk Matrices

A.1.1 Littleborough Flood Risk Matrix

		Flood risk indicators adopted as measure of Acceptability *(-ve indicates flood risk will be required to be managed or maybe considered unacceptable when viewed with all the other flood risk indicators)*							
		A	B	C	D	E	F	G	Recommendation
Policy area	**Proposed land use**	Is the development within existing flood-risk area?	What are the scale and nature of flood risks?	What scale of residual risk measures will be required?	How will egress and access be assured? What will the emergency planning impact?	Will there be a change in number of people at risk?	Will there be a change in number of properties at risk?	Will there be an impact of the mitigation measures elsewhere?	**Counter** to strategic approach, flood risk unacceptable. Exception Test would be difficult to pass. Not recommended **Sequentially not preferred, where limited land uses maybe possible** **Sequentially not preferred** but a range of land uses could be put forward after careful consideration and FRA **Acceptable with some detailed consideration of flood risk issues** **Acceptable** subject to FRA
Todmorden Road MEZ/12	Employment	-	-	- -	-	=	=	+	
Todmorden Road SH0919	Housing	-	+ +	+ +	+	=	=	=	
Phoenix Mill SH0600	Housing	-	+ +	+ +	+	=	=	=	
Ealees Area of Opp. SH0594	Housing	-	-	=	-	-	-	-	
Peel Street SH0856	Housing	-	+ +	+ +	=	=	=	=	
Charles Street SH1020	Housing	-	-	-	=	=	=	-	

Stubley Mill Road SH1021	Housing	-	-	-	=	=	=	-	
Church Street SH0956	Housing	-	-	-	=	=	=	-	
Featherstall Road SH0928	Housing	-	+	+ +	+	=	=	-	
Whitelees Road PEZ/3	Employment	-	+ +	+ +	+	=	=	+	

A.1.2 Ramsbottom Flood Risk Matrix

		Flood risk indicators adopted as measure of Acceptability *(-ve indicates flood risk will be required to be managed or maybe considered unacceptable when viewed with all the other flood risk indicators)*							
		A	B	C	D	E	F	G	Recommendation
Policy area	**Proposed land use**	Is the development within existing flood-risk area?	What are the scale and nature of flood risks?	What scale of residual risk measures will be required?	How will egress and access be assured? What will the emergency planning impact?	Will there be a change in number of people at risk?	Will there be a change in number of properties at risk?	Will there be an impact of the mitigation measures elsewhere?	**Counter** to strategic approach, flood risk unacceptable. Exception Test would be difficult to pass. Not recommended **Sequentially not preferred, where limited land uses maybe possible** **Sequentially not preferred** but a range of land uses could be put forward after careful consideration and FRA **Acceptable with some detailed consideration of flood risk issues** **Acceptable** subject to FRA
Croft End Mill	Industrial	=	+	=	++	=	=	=	
146 Stubbins Lane	Housing	-	- -	- -	-	-	-	+	
Auto Rescue Stubbins Lane	Housing	-	- -	- -	- -	-	-	-	
Stubbins Water Pumping Station	Housing	-	-	- -	- -	-	-	+	
95 Stubbins Lane	Housing	-	-	+	-	-	=	+	
Millfield House	Housing	-	-	- -	- -	-	-	+	
Kays Ramsbottom Ltd	Industrial	-	- -	- -	-	=	=	=	
Irwell St Metal Co.	Industrial	-	-	=	-	=	=	=	

A.1.3 Scoring Sheet

Indicator						
A	**B**	**C**	**D**	**E**	**F**	**G**
+ No risk **-** Risk area within resilient communities **- -** Vulnerable community, which would struggle to recover	**+ +** Benign, and understood **- -** Difficult to warn, unpredictable, may result in operational failure of defences, from multiple sources	**++** None required **+** Measures could reduce risk to existing development **-** Standard, no major alteration to layout and form **- -** Flood resistance is dominant in design	**+** No special provisions, safe **-** Needs to be managed, should be safe, must be proven in FRA **- -** Special provision, natural response will not be obvious. Safety not guaranteed, and may not convince LPA/EA when examined in detail	**+** Reduction **-** Increase	**+** Reduction (preferable outcome in PPS25) **-** Increase	**+** Reduction **=** Neutral impact **-** Increase in flood risk elsewhere (Exception test requires no impact)

Appendix B: - Maps