Rufford and Holmeswood Flood Study

A review of flooding and flood prevention strategies, including Sustainable Drainage Systems (SuDS), in the Rufford and Holmeswood area of West Lancashire

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EXECUTIVE SUMMARY

The Rufford and Holmeswood area has a history of flooding, with the latest major flooding events in 2012 and 2015. The area is served by a network of drainage ditches, pumping stations and sluices. The River Douglas is located immediately to the east of Rufford and Holmeswood Parish, where it is bounded by levees which provide flood protection to the adjacent low-lying agricultural land. There is a concern that development locally and upstream may increase flood risk.

Conditions in the Douglas catchment have changed over the past two decades, with more run-off to the River Douglas, irrespective of the size of rainfall event. Furthermore, significant development is planned in the River Douglas catchment upstream of Rufford. It is noted that no development is currently planned within the Rufford and Holmeswood Parish boundary.

In order to manage downstream flood risk, Sustainable Drainage Systems (SuDS), are a statutory requirement on all major developments (unless deemed to be inappropriate). The SuDS approach involves slowing down and reducing the quantity of surface water runoff from a developed area through considered design of rainwater harvesting, pervious surfacing, infiltration, conveyance and storage systems. Whilst SuDS can achieve good hydraulic performance, physical factors in the Rufford area (including a shallow groundwater table, extensive local drainage and pumped drainage systems, low lying land, and flood defences) will render some forms of SuDS ineffective, and a high level of scrutiny of SuDS is therefore required.

Research on SuDS delivery, both nationally and locally, demonstrates a need for locally specific design standards and clear and robust local policies for SuDS, including maintenance and adoption arrangements. The policy requirements and design principles for SuDS in West Lancashire are in some respects inadequate and not sufficiently robust. Moreover, Lancashire County Council, as the Lead Local Flood Authority for Lancashire and those ultimately responsible for assessing and approving all surface water drainage systems for all major developments, has not yet published its policies and standards for SuDS.

Modelling (ReFH) of peak flow and runoff volumes for the River Douglas to Rufford showed that new development that does not incorporate SuDS (or has SuDS that are defunct), could lead to significant increases in peak flows and runoff volumes, and an effective reduction in the Standards of Protection afforded by flood defences. Conversely, new development with SuDS that are effective and well maintained could provide significant flood risk betterment.

Additionally, import of water to new developments in the Douglas catchment, via domestic supply and then discharge to sewers, may increase water in the River Douglas to Rufford in the catchment by up 1.4 %, which may in turn increase flood risk.

Whilst SuDS has the technical potential to achieve good protection against flooding on-site and downstream, under the current circumstances, poor SuDS performance may increase flood risk and reduce the Standards of Protection of existing flood defences.

In conclusion, it is recommended that regulators and stakeholders take urgent consideration of the following five issues:

1. The lack of clear policies on SuDS design, adoption, management and maintenance
2. Options for effectively measuring the impacts of SuDS on flood risk
3. The possible cumulative impacts of minor developments that do not have SuDS
4. The cross-catchment impacts of flooding from the Douglas on Standards of Protection in the Crossens catchment
5. The role of import of water from adjacent catchments to new developments

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GLOSSARY

APE	Annual probability event
BFI	Baseflow index
BGS	British Geological Survey
CEH	Centre for Ecology Hydrology
CFMP	Catchment flood management plan
CIRIA	Construction Industry Research and Information Agency
CSO	Combined sewer overflow
Defra	Department for Environment, Food and Rural Affairs
EA	Environment Agency
FEH	Flood Estimation Handbook
FRA	Flood risk assessment
HFCL	H Fraser Consulting Ltd
HOST	Hydrology of soil types
IDB	Internal Drainage Board
IF	Imperviousness factor
IRF	Impervious runoff factor
LASOO	Local Authority SuDS Officer Organisation
LCC	Lancashire County Council
LLFA	Lead Local Flood authority
LPA	Local Planning Authority
LPR	Local plan review
m^3/s	Cubic metres per second
m aOD	Metres above Ordnance Datum
NERC	Natural Environment Research Council
NGR	National grid reference
NPPF	National planning policy framework
NPPG	National planning practice guidance
NRFA	National River Flow Archive
NSTS	Non-statutory technical standards
PROPWET	Proportion of time soils are wet
ReFH	Revitalised flood hydrograph
RHP	Rufford and Holmeswood Parish
RHPC	Rufford and Holmeswood Parish Council

SAAR	Standard average annual rainfall
SFRA	Strategic flood risk assessment
SoP	Standard of protection
SPD	Supplementary planning document
SPR	Standard percentage runoff
STW	Sewage treatment works
SuDS	Sustainable drainage systems
UU	United Utilites
URBTEXT2000	FEH catchment descriptor defining urban extent
WLBC	West Lancashire Borough Council
WLMB	Water Level Management Board

1 INTRODUCTION

Rufford and Holmeswood Parish Council (RHPC) has commissioned H Fraser Consulting (HFCL) to undertake a review of Sustainable Drainage Systems (SuDS) and flooding in its area.

The parish has been subject to several flooding events in recent years, and much of the parish is in an area of pumped drainage. There is concern that development within the catchment may exacerbate flooding and lead to more frequent or more severe floods.

Development of land has the potential to increase flooding by increasing both the rate and volume of run-off over hard surfaces compared with greenfield land. Modern developments are designed with SuDS, which regulate the run-off from the developed area to reduce the risk of flooding. Not all types of SuDS will operate effectively in a pumped drainage area, and there is also growing scrutiny over the general performance of SuDS and their role in reducing flood risk associated with new development.

RHPC has therefore commissioned this report to assess whether current local and regional policies and practices with regard to flood prevention, development and SuDS are sufficiently protective.

1.1 Objective

The objective of this report is to develop an understanding of flooding and flood prevention strategies in the area, to assess how development and SuDS are likely to impact on flooding and to highlight areas of concern that should be taken forward for discussion with other stakeholders.

1.2 Report structure

The report is structured as follows:

- Context: provides a brief summary of setting, flooding history, drainage history, current responsibility for flooding, planning policy with respect to flooding, and plans for development.
- Desk study and hydrological assessment: summarises topography, geology, hydrology (including river flows, hydrographs), hydrogeology (groundwater levels), and water balance, including the role of sewage treatment works (STWs). Includes catchment descriptors, Environment Agency (EA) pump capacities, the Standard of Protection (SoP) of flood defences, flood modelling software used by third parties, and the type of flooding mechanisms relevant to local and regional scale.
- Sustainable drainage systems (SuDS): introduces the principle of SuDS, and its limitations, especially in areas where there is a high water table. Discusses greenfield run-off rates, examines return periods with up-to-date rainfall events, investigates whether the standard calculations for SuDS are appropriate in the Rufford setting. This includes information pertaining to the Local Authority's local plan for runoff and SuDS requirements for developments and importantly exceptions to those requirements. Also includes comments from recent studies on the general performance of SuDS around the UK.
- Potential impacts of development on flooding in the Rufford area: considers local development and flooding and regional development further up the catchment. Investigates historical response of hydrographs/pumping rates to urbanisation (as far as data is available). Extrapolates (qualitatively) into the future with and without functional

SuDS. Includes consideration of potential regional cumulative effects on flood mechanism and defences posed by development and potential failures of EA pumping stations.

- Conclusions and recommendations: provides conclusions and recommendations regarding the capacity of flood defences, the implications of development in the catchment and the changes in policies and practices that are needed to mitigate effects.

1.3 Acknowledgements

HFCL is pleased to have worked with technical partners to deliver this report. Interpretation of hydrological data has been provided by Dr Phil Marren of CREST@UCS[1]. Hydrological assessment, technical review of SuDS and hydrological modelling has been provided by Envireau Water.[2]

Dr Phil Marren is a physical geographer with a wide range of research interests and expertise but with a particular emphasis on fluvial geomorphology, sedimentology and hydrology. Since completing his PhD in 1999, he has undertaken Postdoctoral research at the University of the Witwatersrand and the University of British Columbia, and worked as a Lecturer in Physical Geography at the University of Melbourne. Over this time he has investigated rivers in Australia, New Zealand, southern Africa, Canada, Iceland and the UK. His research includes work on the role of flooding in forming and modifying river channels and floodplains; the impacts of glacier retreat and catastrophic flooding on rivers in glaciated landscapes; and Quaternary environmental change. Dr Marren is currently a senior lecturer at the University of Chester.

[1] http://crestatucs.com/
[2] https://www.envireauwater.co.uk/

2 CONTEXT

2.1 Setting

Rufford and Holmeswood Parish (RHP) is a ward within West Lancashire Borough. The Rufford area is rural in nature and is served by a network of drainage ditches, pumping stations and sluices. An intricate system of upper and lower level sluices, together with the Rufford and Holmeswood Pumping Stations, are used to move water westwards to the coast at Crossens, where it is pumped into the Irish sea.

The Rufford Branch of the Leeds and Liverpool Canal passes immediately east of Rufford and links Burscough to Tarleton.

Rufford and Holmeswood Parish is bounded to the east by the former course of the River Douglas, with levees providing flood defence to the adjacent low-lying agricultural land. Although most of the parish is not drained by the River Douglas, the river is of key importance to the Rufford area because of the flood risk it poses. The on-going development in the River Douglas catchment upstream, and in the vicinity of Rufford, may pose an increase in flood risk.

2.2 Drainage history

Historically, much of central West Lancashire Borough comprised wetlands, open water, marshland and moss land.

In the Middle Ages, much of the parish was under the waters of Martin Mere, which was a large area of open water which drained to the River Douglas. Martin Mere was reportedly the largest lake in England, measuring four miles by two miles[3]. In 1695 local landowners agreed to drain the mere in order to create farmland from the good quality peat soils, although for centuries the land remained prone to flooding.

The area was eventually reliably drained in 1961 with the opening of the new pumping station on the coast at Crossens, whereby water is pumped into the Irish Sea, without the use of tidal flaps. In 2014 Crossens Pumping Station was upgraded, improving the resilience from mains power failure.

The River Douglas between Rufford and Tarleton was rerouted and straightened in 1805 and the profile was improved in the 1960s. The main channel was dredged and the embankments were raised and widened. This stretch of river was again dredged in the 1980s. In 2016 the Environment Agency found a build-up of silt on the channel sides and aimed to dredge the sides in 2018-2019.

2.3 Flooding history

A summary of the flood history in the vicinity of Rufford is presented in Table 2-1.

[3] Copley, J., October 2018. Landscape Character Assessment for Rufford Parish Council

Table 2-1 Summary of flood history in the vicinity of Rufford

Date	Description of flooding
1950s	Extensive flooding in West Lancashire in the Crossens catchment
October 2000	Flooding of Croston village, affecting around 200 properties[4]. The flow was recorded and estimated to be the equivalent of a 0.5% APE or 1-in-200-year event. The Yarrow broke out of its banks upstream and the defences stopped the water returning to the river.
2008	Flooding of properties in Croston (River Yarrow)
2012	• New Reed Brook burst its bank, forming a large lake (4.4 km long, 400 m wide) • Flooding of properties in Croston, from the River Yarrow • Over-topping of Catchwater Drain which submerged the Holmeswood pumps
2015	• Eller Brook burst its bank, knocking out Rufford Pumping Station when water engulfed the electricity supply cabinet • Fettlers Marina was flooded and businesses put at risk • The River Douglas also breached on the east bank opposite Rufford, flooding Mawdesley Moss, Croston Moss and affecting drainage in the Bretherton area

A map of flooding in December 2015 is shown in Figure 2-1.

[4] Environment Agency, December 2009. River Douglas Catchment Flood Management Plan

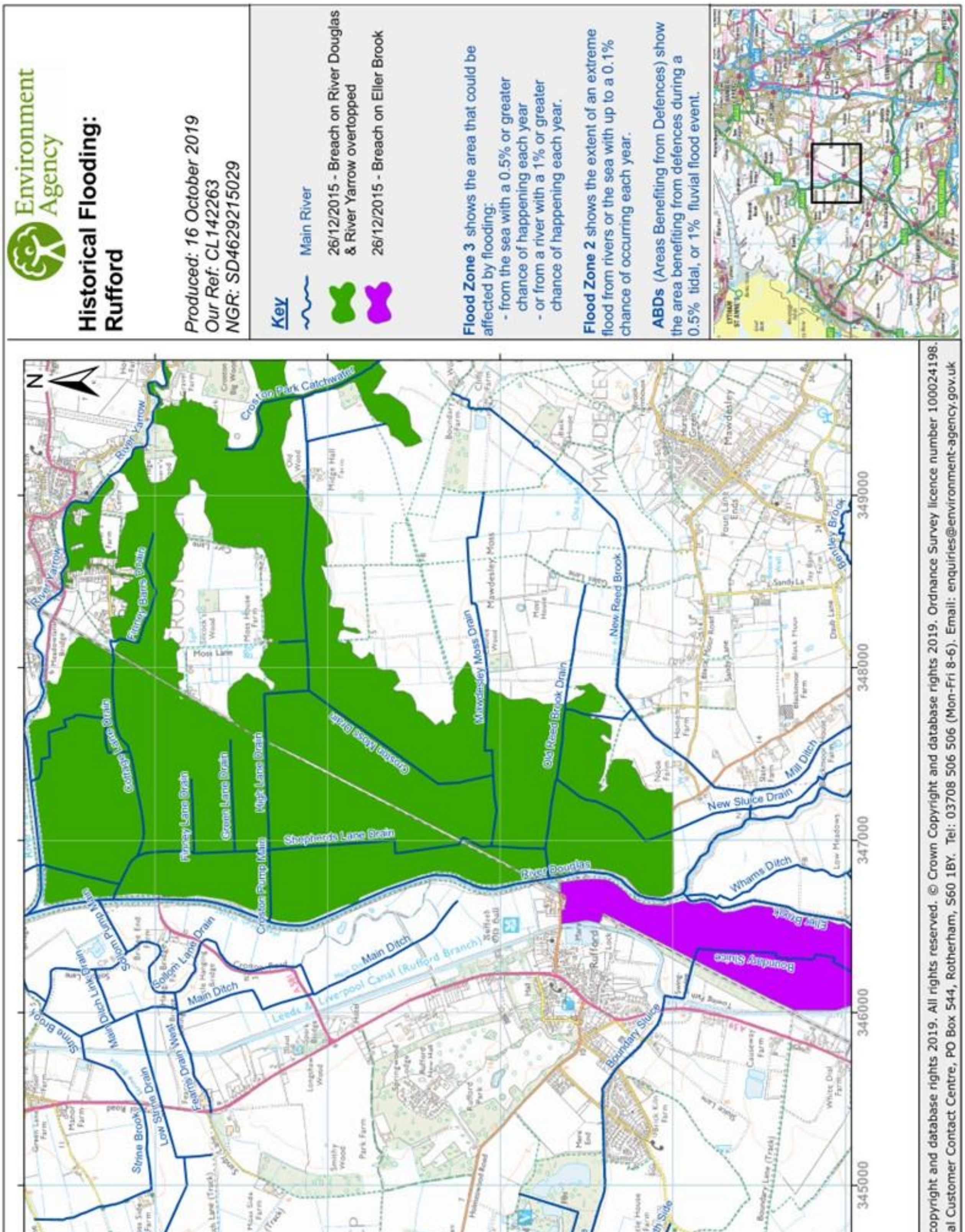

Figure 2-1 Map of flooding during December 2015

2.4 Current responsibility for flooding

The Flood and Water Management Act (2010) introduced a number of new roles and responsibilities. Lead Local Flood Authorities (LLFAs) are encouraged to bring together relevant bodies and stakeholders to manage local flood risk, which may include District/Borough Councils, Internal Drainage Boards, Highways Authorities, water companies and the Environment Agency.

The organisations responsible for managing flood risk within the Borough of West Lancashire are shown in Table 2-2.

Table 2-2 Organisations responsible for managing flood risk within the Borough of West Lancashire

Body	Role
Lancashire County Council	As the Lead Local Flood Authority (LLFA), Lancashire County Council (LCC) is responsible for developing, maintaining and applying a strategy for local flood risk management in their area and for maintaining a register of flood risk assets. LCC has lead responsibility for managing the risk of flooding from surface water, groundwater and ordinary watercourses. LCC is also responsible for recording and investigating local flood incidents, preparing and publishing a Preliminary Flood Risk Assessment and approving works to ordinary watercourses through the issuing of Land Drainage Consent. The LLFA is a statutory consultee for all major development proposals with surface-water implications. LCC is also the Highway Authority responsible for providing and managing highway drainage and roadside ditches, and must ensure that road projects do not increase flood risk.
West Lancashire Borough Council	West Lancashire Borough Council, the Local Planning Authority, is a key partner in planning local flood risk management and can carry out flood risk management works on minor watercourses, working with Lead Local Flood Authorities and others, including through taking decisions on development in their area which ensure that risks are effectively managed. The Council is responsible for completing a strategic flood risk assessment (SFRA) and following the sequential approach to decision making in relation to identifying sites for development. There is also a role of contingency planning for flood events.
Environment Agency	The Environment Agency (EA) is responsible for taking a strategic overview of the management of all sources of flooding and coastal erosion. This includes, for example, setting the direction for managing the risks through strategic plans; providing evidence and advice to inform government policy and support others; working collaboratively to support the development of risk management skills and capacity; and providing a

	framework to support local delivery. The Agency also has operational responsibility for managing the risk of flooding from main rivers, reservoirs, estuaries and the sea, as well as being a coastal erosion risk management authority. The Environment Agency is responsible for delivering sustainable flood management solutions and for preparing strategic plans for measures to reduce flood risk. The Agency produces Catchment Flood Management Plans (CFMPs), Shoreline Management Plans and Flood Risk and Hazard maps.
Internal Drainage Board/ Water Level Management Board	Internal Drainage Boards (IDBs) are independent public bodies responsible for water level management in low-lying areas. They cover approximately 10% of England at present, working in partnership with other authorities to actively manage and reduce the risk of flooding. The Environment Agency currently operates the pumping stations that manage water levels in the Alt Crossens catchment. The EA has previously notified landowners and occupiers that it is stopping activity that it considers does not deliver sufficient flood risk benefit to people and property. The EA had given notification of their intent to turn off the pumps at Rufford Causeway (plus 4 others) by the end of 2018, with a new Water Level Management Board (formerly known as IDBs) to be set up by then. It is understood that this has not happened, and it is not known what the current plans for ongoing pumping in the Alt Crossens catchment are.
United Utilities	United Utilities (UU) are a Water and Sewerage Company and are responsible for water supply and for any public sewers in the North West adopted under the Water Industry Act 1991. They investigate flooding from sewers and carry out improvements as well as managing the risks of flooding from water and foul or combined sewer systems providing drainage from buildings and yards. UU prepare Asset Management Plans which include future investment programmes.

In addition to the above, landowners and developers are responsible for managing the flood risk issues associated with their land and managing the drainage of their land such that it does not adversely impact on adjoining properties.

2.5 Planning policy with respect to flooding

The National Planning Policy Framework (NPPF), published in March 2012, indicates the approach to be taken when dealing with flood risk. Local Plans must be supported by a Strategic Flood Risk Assessment (SFRA) and develop policies to manage flood risk from all sources, taking account of advice from the Environment Agency and other relevant flood risk management bodies.

National Planning Practice Guidance (NPPG) provides further advice on how the NPPF's polices should be implemented. It explains that SFRAs should assess the risk to an area from flooding from all sources, now and in the future, taking account of the impacts of climate change, and should also assess the impact that land use changes and development in the area will have on flood risk.

In order to avoid inappropriate development, a sequential approach is advocated by the NPPF and NPPG towards planning and management of the risk and consequences of flooding, as follows:

1. Assess flood risk: For sites that are found to be in areas at risk of flooding, or sites with an area of 1 ha or greater, a specific Flood Risk Assessment (FRA) must be undertaken to accompany planning applications or prior approval/other permitted development mechanisms.
2. Avoid flood risk: This entails applying a sequential approach to site selection to ensure that development is located where the risk of flooding from all sources is the lowest possible, whilst taking into account climate change and the vulnerability of future/existing uses. Less vulnerable development types should be substituted for those that are incompatible with the degree of flood risk.
3. Manage and mitigate flood risk: When alternative sites in areas at a lower risk of flooding are unavailable, development may need to be located in areas at risk of flooding. In order to ensure that a site is appropriately flood resilient and resistant, safe for its users and not increasing flood risk overall, flood risk management opportunities should be sought to reduce the cause and impacts of flooding[5].

The FRA should demonstrate to the decision-maker how flood risk from all forms of flooding will be managed now and over the development's lifetime, taking climate change into account, and with regard to the vulnerability of its users. The FRA should identify opportunities to reduce the probability and consequence of flooding, including the design of surface water management systems including Sustainable Drainage Systems (SuDS), and address the requirement for safe access to and from the development in areas at risk of flooding.

2.6 Plans for development

2.6.1 Rufford

The West Lancashire Local Plan Review (LPR): Preferred Options, published August 2018 states that between 2012 to 2050 there will be a need for 15,992 new dwellings (net) as a minimum and a need for 190 ha of land to be newly developed for employment uses. It is noted that the Local Plan was withdrawn in the spring of 2019 due to opposition from the public and is due to be re-issued. The 2018 LPR has nonetheless been used to guide this report in the absence of revised information. Policy SP1: Delivering Sustainable Development states that new development will be promoted in accordance with the following settlement hierarchy (Table 2-3). Settlements higher up the hierarchy will generally take more development than those lower down, with new development being of a type and use that is appropriate to the scale and character of settlements at each level of the hierarchy.

Table 2-3 Hierarchy of development in West Lancashire

Hierarchy	Settlements

[5] West Lancashire Borough Council, February 2017. Strategic Flood Risk Assessment Level 1

Regional Town	Skelmersdale and Up Holland
Key Service Centres	Ormskirk and Aughton; Burscough
Key Sustainable Villages	Tarleton and Hesketh Bank; Parbold; Banks
Rural Sustainable Villages	Southport / Birkdale / Ainsdale boundary; Halsall; Haskayne; Scarisbrick; Rufford; Newburgh; Appley Bridge; Tontine
Small Rural Villages	Crawford; Hilldale; Mere Brow; Shirdley Hill; Stanley Gate; Westhead; Wrightington (Hunger Hill, Mossy Lea, Wrightington Bar)

The distribution of required housing and employment land is presented in Table 2-4.

Table 2-4 Distribution of required housing and employment land in West Lancashire

Location	Housing	Employment land
Skelmersdale and south-eastern parishes	8,572 dwellings	150 Ha
Ormskirk and Aughton	3,003 dwellings	10 Ha
Burscough and central parishes	1,495 dwellings	25 Ha
Northern parishes	1,435 dwellings	5 Ha
Western parishes	923 dwellings	
Eastern parishes	564 dwellings	

Skelmersdale and Up Holland; Ormskirk and Aughton; and Burscough will take the vast majority of new development. However, it is envisaged that 1,495 of these dwellings and 25 ha employment land will be located within Burscough and central parishes, within which Rufford and Holmeswood Parish is located. Four sites were considered around Rufford for housing development, as shown in Figure 2-2. However, these sites were ruled out on sustainability considerations. Of the four sites BACO26 and BACO27, which are located in Flood Zone 2, were ruled out due to a combination of flood risk issues and sustainability considerations. No development is therefore planned within the Rufford and Holmeswood Parish boundary.

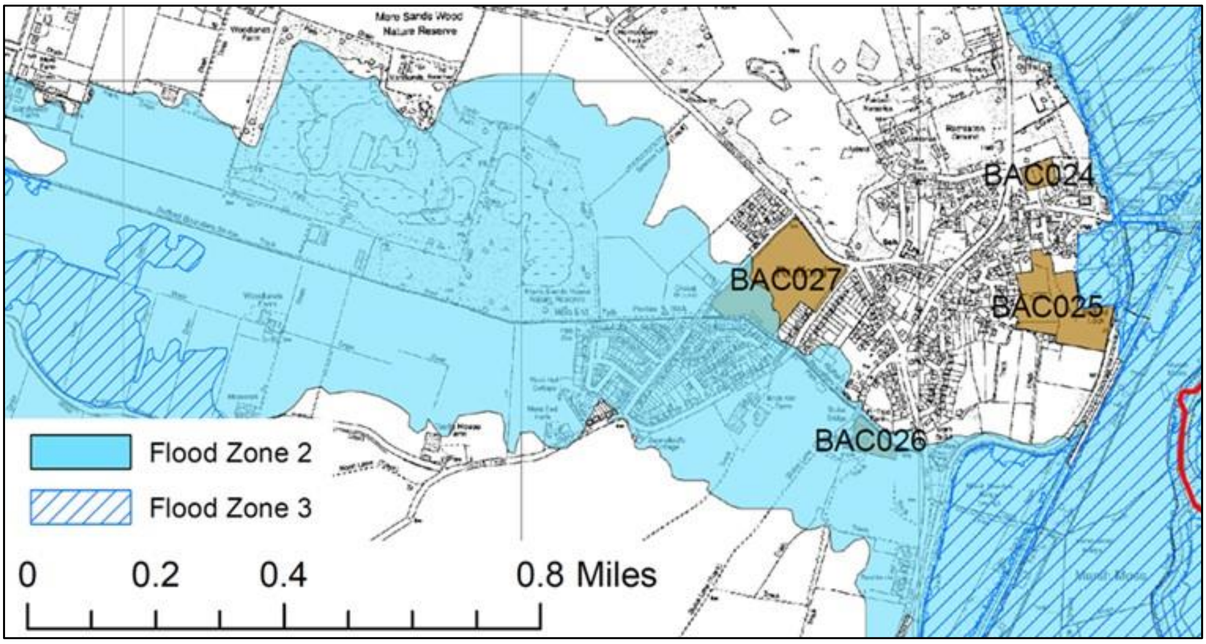

Figure 2-2 Map of development considered in Rufford

Source: West Lancashire Borough Council, October 2018. Strategic Flood Risk Assessment Level 2

23 sites in Burscough were considered for development in the WLBC Strategic Flood Risk Assessment Level 2. Two of the sites, BAC01 and BAC023, are situated within the catchment of Holmeswood Pumping Station.

2.6.2 Douglas catchment

In order to assess the potential risk of flooding in the vicinity of Rufford associated with increased development in the Douglas catchment, the development plans of four upstream and adjacent districts must be considered, namely:

- Wigan District
- West Lancashire Borough
- Chorley District
- South Ribble District

An overview of administrative boundaries and rivers is shown in Figure 2-3. The River Douglas rises in the Wigan District, then flows through West Lancashire Borough (within which Rufford is located). The confluence of the River Yarrow with the River Douglas is located 2 miles north of Rufford. Since this area is prone to flooding, with potential backing-up of water to the Rufford area, development at the River Yarrow and its tributaries is also considered. The River Yarrow is in Chorley District and the River Lostock, a tributary of the Yarrow, is in South Ribble District.

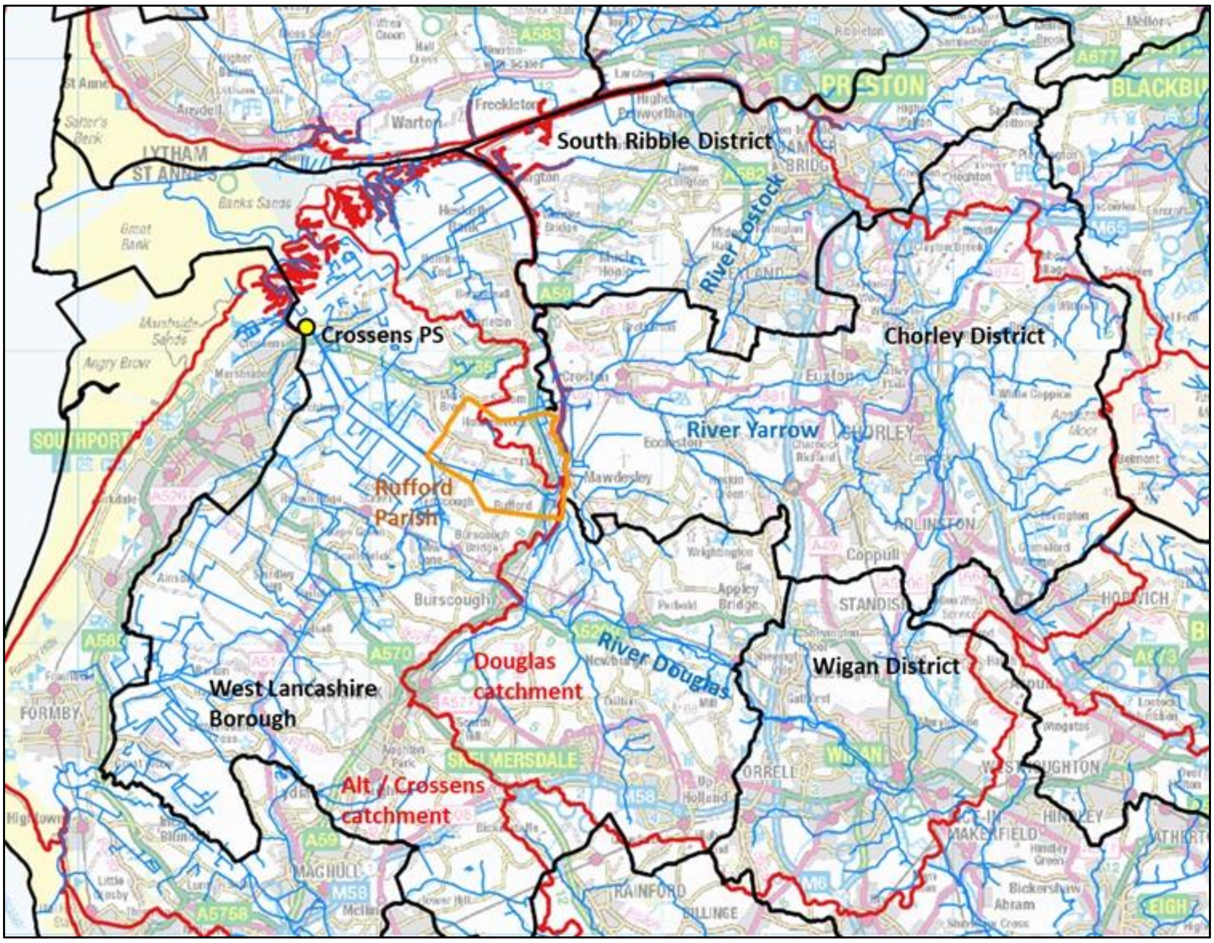

Figure 2-3 Overview of regional drainage and administrative boundaries

The Wigan Local Plan Core Strategy, September 2013, states that development will be directed primarily towards the east-west core of the borough, which is located in the Mersey Estuary, rather than the Douglas River catchment. However, potential housing supply between 2011 and 2026 (indicative) within the River Douglas catchment (in Wigan, Ashton, Standish, Shevington, Orrell and Billinge) includes a total of 6,693 houses. Provision is made for approximately 200 hectares (gross) of employment land between 2011 and 2026 in the Borough. Within the Douglas catchment, this equates to c. 106 Ha of employment land in Wigan, Ashton and Standish.

Within the West Lancashire Borough, the regions located in the Douglas River catchment upstream of Rufford comprise Skelmersdale and south-eastern parishes; Burscough and central parishes; and eastern parishes. It is therefore estimated that in West Lancashire, within the Douglas catchment, 10,631 dwellings will be constructed and 175 ha will become employment land by 2050.

The Chorley Local Plan, July 2015, states that there is a minimum requirement of 5,755 dwellings and 112 ha of employment land by 2026.

Within the South Ribble District, only the southern section, containing Leyland and the south of Bamber Bridge are part of the Lostock catchment. It is estimated that of the 6,576 new dwellings planned, 3,651 are in the Lostock catchment. A total of 100 ha of employment land has been allocated within the Lostock catchment (65 ha for Cuerden strategic site and 35 ha for new employment land).

The required housing and employment land in the River Douglas catchment upstream and in the River Lostock/Yarrow catchment is summarised in Table 2-5. The total required housing and employment land in the Douglas catchment upstream of Rufford (parts of Wigan District and West Lancashire Borough) is 17,234 dwellings and 281 hectares of employment land. The total required housing and employment land in the River Lostock/Yarrow catchment (Chorley District and parts of the South Ribble District) is 9,406 dwellings and 212 hectares of employment land. In total it is estimated that at least 26,730 dwellings and 493 hectares of employment land will be required on land that might affect flooding in the Rufford area.

Table 2-5 Required housing and employment land in the River Douglas catchment upstream or in the vicinity of Rufford

District	Housing	Employment land
Wigan[1]	6,693 dwellings	106 ha
West Lancashire[2]	10,631 dwellings	175 ha
Total: Douglas catchment to Rufford	*17,324 dwellings*	*281 ha*
Chorley[3]	5,755 dwellings	112 ha
South Ribble[3]	3,651 dwellings	100 ha
Total: Yarrow and Lostock	*9,406 dwellings*	*212 ha*
Total	**26,730 dwellings**	**493 ha**

[1]Development planned 2011-2026
[2]Development required by 2050
[3]Development required by 2026

3 DESK STUDY

3.1 Location

Rufford and Holmeswood Parish (RHP), a ward within West Lancashire Borough, has a population of approximately 2,048[6]. The village of Rufford is approximately 12 miles north-west of Wigan and 12 miles south-east of Preston. The town is accessed via the A59 between Liverpool and Preston. Rufford and Holmeswood Parish is located along the eastern edge of the Borough of West Lancashire, with the former course of the River Douglas forming the eastern border. The location of RHP is shown in Figure 3-1 and a map of Rufford is shown in Figure 3-2.

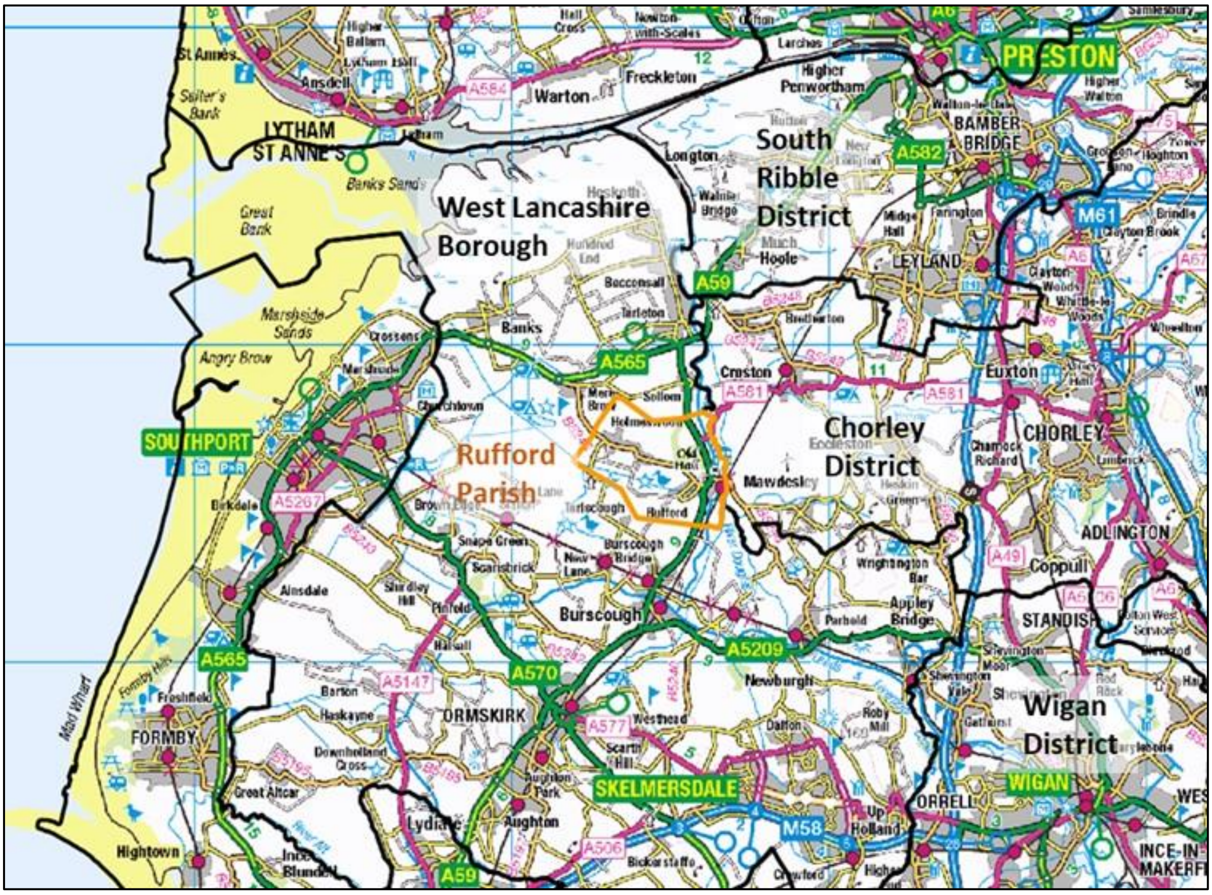

Figure 3-1 Location map

[6] Wikipedia. Civil parishes in Lancashire

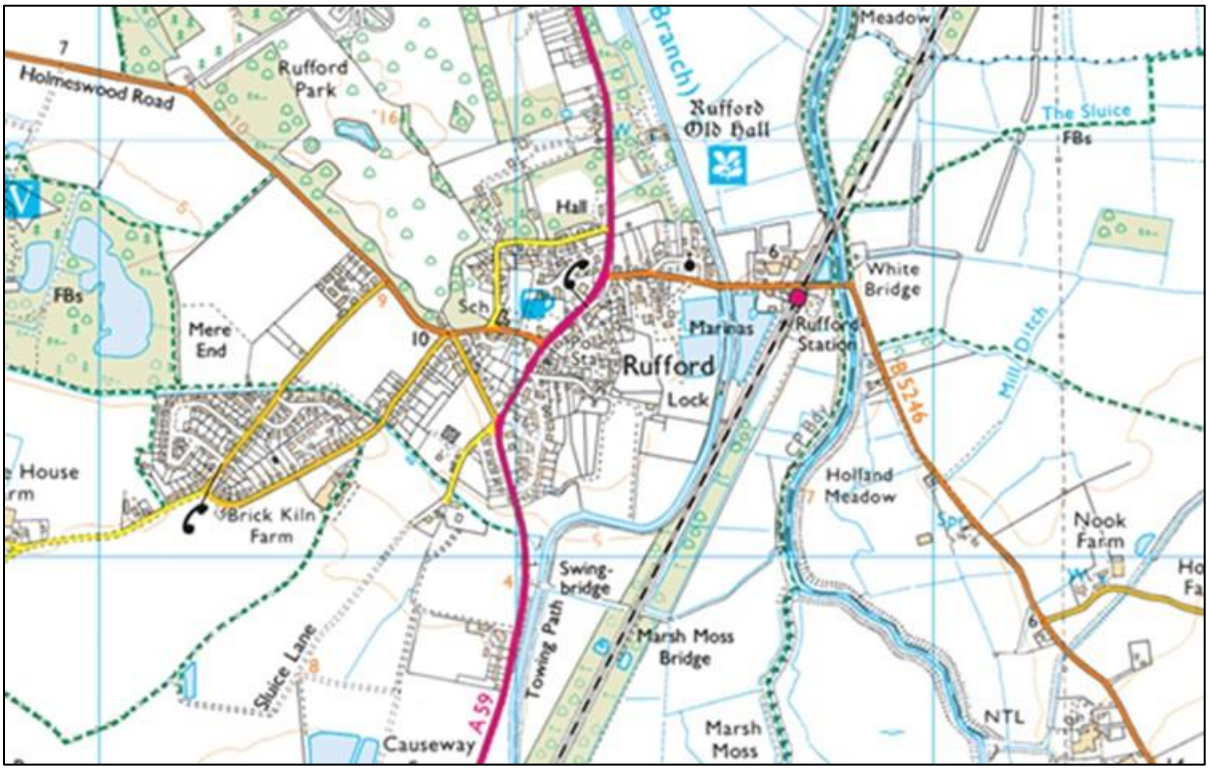

Figure 3-2 Map of Rufford

3.2 Topography and land use

The central areas of Rufford and Holmeswood Parish comprise mostly flat and low-lying land at an elevation of approximately 2 m aOD. Land rises to the north of the parish at Holmeswood and to the south around Tarlscough, where topographical high points of 16 m aOD and 13 m aOD, respectively, are attained.

Much of the land is used for arable farming or pasture. The soils are freely draining very acid sandy and loamy and are predominantly classed by Natural England as grade 1 or grade 2 agricultural land (where grade 1 is best quality and grade 5 is poorest quality).

3.3 Geology

Regionally, the bedrock geology comprises undifferentiated mudstone, siltstone, sandstone and conglomerate of Triassic age which dip in a generally north-westerly direction towards the coast. The entire region is overlain by superficial deposits, with bedrock only outcropping at the coast.

Within Rufford and Holmeswood Parish the superficial geology comprises a patchwork of peat, wind-blown sands, boulder clay and tidal flat deposits in approximately equal proportions, with minor alluvium. The local superficial geology is presented in Figure 3-3. Peat occurs in the north and the south of the parish. Till (boulder clay) outcrops in the north-east and north-west. Tidal Flat Deposits, comprising silt, sand and clay, are found in the east of the parish, in the vicinity of the River Douglas. A band of Shirdley Hill Sand Formation, comprising wind-blown sands, runs across the middle of the parish from south-east to north-west.

The geological map also indicates the course of buried channels within the parish, which are filled with superficial deposits. The buried channels are located approximately east-west in the north of the parish, north-west to south-east in the south-west of the parish and within Rufford itself.

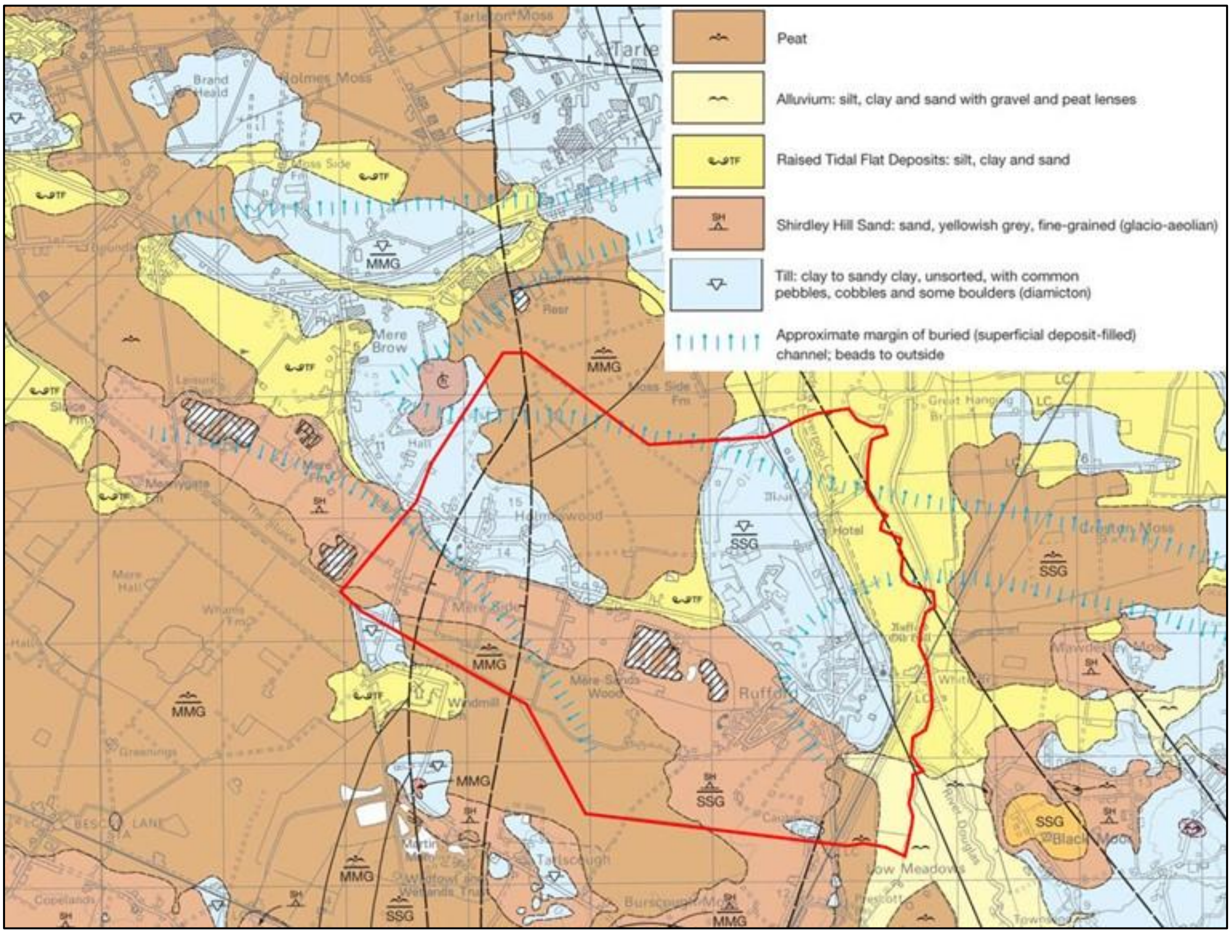

Figure 3-3 Geology map

Investigation of borehole logs held by the British Geological Survey suggests that the superficial geology is underlain throughout the parish by a substantial thickness of Till (boulder clay). The top of the boulder clay occurs at a depth of 0 m and 13 m and the base sits on Triassic age bedrock at between c.35 m and 55 m depth.

3.4 Hydrology

3.4.1 Rufford

3.4.1.1 Overview

As stated in section 2.1 above, the Rufford area is rural and served by a network of drainage ditches, pumping stations and sluices. The majority of Rufford and Holmeswood Parish sits within the Crossens river catchment, except for the north-eastern part and a narrow band on the eastern boundary. An intricate system of upper and lower level sluices, together with the Rufford and Holmeswood Pumping Stations, are used to move water westwards to the coast at Crossens, where it is pumped into the Irish Sea by Crossens Pumping Station. The River Douglas is located immediately to the east of Rufford and Holmeswood Parish and is bounded by levees providing flood protection to the adjacent low-lying agricultural land. The north-east corner of the parish is drained into the River Douglas by Solom Pumping Station. An overview of drainage in the vicinity of Rufford is shown in Figure 3-4.

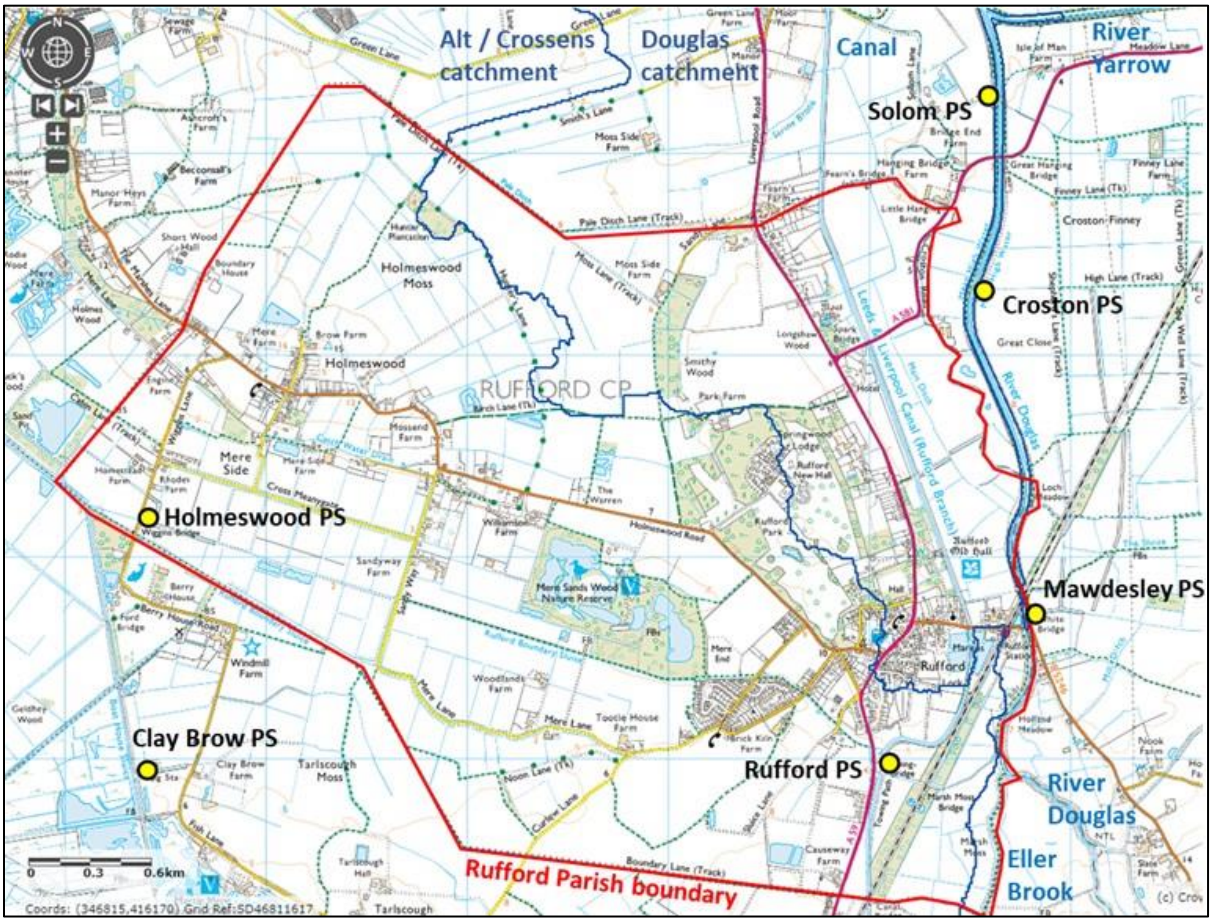

Figure 3-4 Overview of drainage within Rufford and Holmeswood Parish
PS = Pumping station

3.4.1.2 Pumped drainage

The pumped drainage network for the southern part of Rufford and Holmeswood Parish is shown in Figure 3-5. The low-level Rufford Boundary Sluice, which drains land between the canal and the Eller Brook, is pumped into the high-level Rufford Boundary Sluice at Rufford Pumping Station. Between the villages of Rufford and Holmeswood, low-level Mere Sands Drain and Tootle Brook flow westwards to Pump Ditch. Pump Ditch is pumped into Rufford Boundary Sluice (high-level) at Holmeswood Pumping Station (Figure 3-6). Within the network of high- and low-level drains, there is one place, along Sandy Way, where a high-level drain (Rufford Boundary Sluice) crosses over a low-level drain (Tootle Brook), as shown in Figure 3-7. Pump Ditch is shown in Figure 3-8.

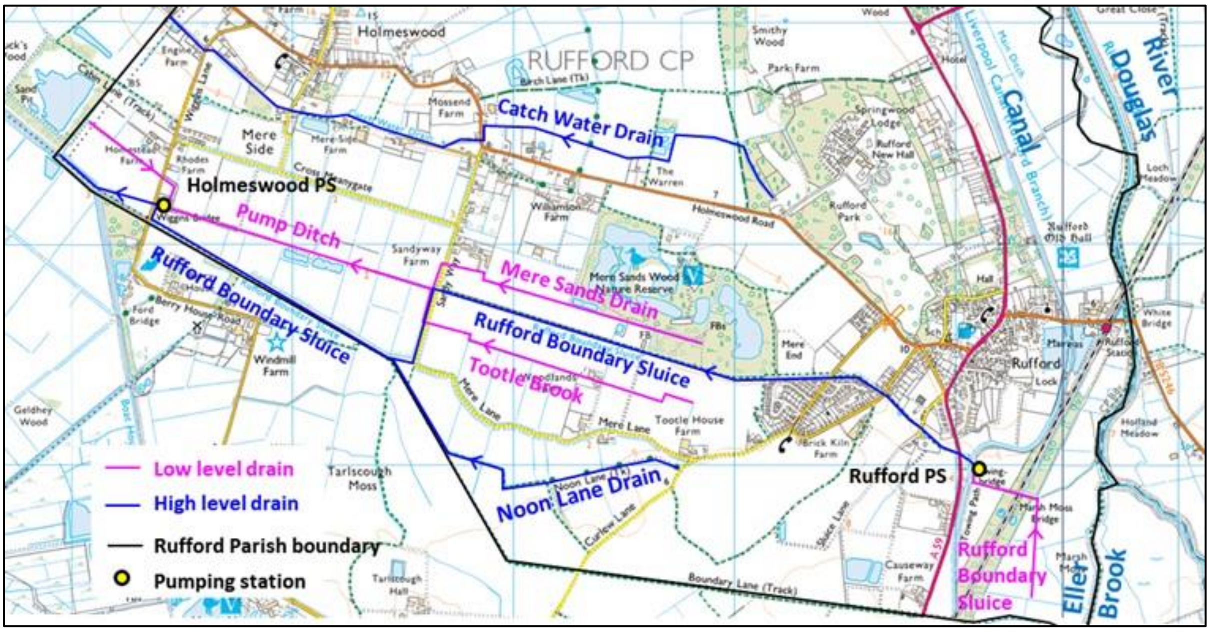

Figure 3-5 Pumped drainage in Rufford and Holmeswood Parish (Alt Crossens catchment)

Figure 3-6 Holmeswood Pumping Station

Figure 3-7 Drainage network at Sandy Way

Figure 3-8 Pump Ditch (low-level), looking west

3.4.1.3 Catchment description

The hydrological catchment draining to Holmeswood Pumping Station is largely rural, with the exception of the village of Rufford, and covers approximately 10 km^2 from the headwaters in Burscough. Ground elevations range from approximately 16 m aOD to 2 m aOD. An overview of the catchment is shown in Figure 3-9.

The relevant Flood Estimation Handbook (FEH) catchment descriptors are provided in Table 3-1. FEH descriptors provide a general overview of the physical and hydrological characteristics of catchments. The Base Flow Index (BFI), a measure of the long-term average proportion of flow that comes from baseflow, is 0.685 which is high, indicating that the watercourses and land drainage networks within the catchment have a high groundwater component within their discharge. The Standard Percentage Runoff (SPR) or the proportion of rainfall that is converted to runoff is 18.8%, which is relatively low and reflects the nature of the local and regional soils and superficial geology. The PROPWET value of 0.51 indicates that saturated soil conditions are likely to prevail, particularly during winter months, which can contribute to flood formation.

Table 3-1 Flood Estimation Handbook catchment descriptors for Holmeswood Pumping Station

Catchment Descriptors	Abbreviation	Catchment to Holmeswood PS
Catchment Area	AREA	10 km^2
Mean Catchment Altitude	ALTBAR	9 m
Base Flow Index (BFI) derived by using the UK Hydrology of Soil Types (HOST) classification (0:1)	BFIHOST	0.685
Standard Percentage Runoff (SPR) derived by using the UK Hydrology of Soil Types (HOST) classification (10-53%)	SPRHOST	18.8%
Catchment Wetness Index (PROPortion of time soils are WET). Values range from over 80% in the wettest catchments to less than 20% in the driest parts of the country.	PROPWET	0.510
Standard Average Annual Rainfall (SAAR) (1961 – 1990)	SAAR	893 mm/yr
Extent of urban and suburban land cover within catchment (2000). Moderately urbanised = 0.060 to 0.150.	$URBEXT_{2000}$	0.0384

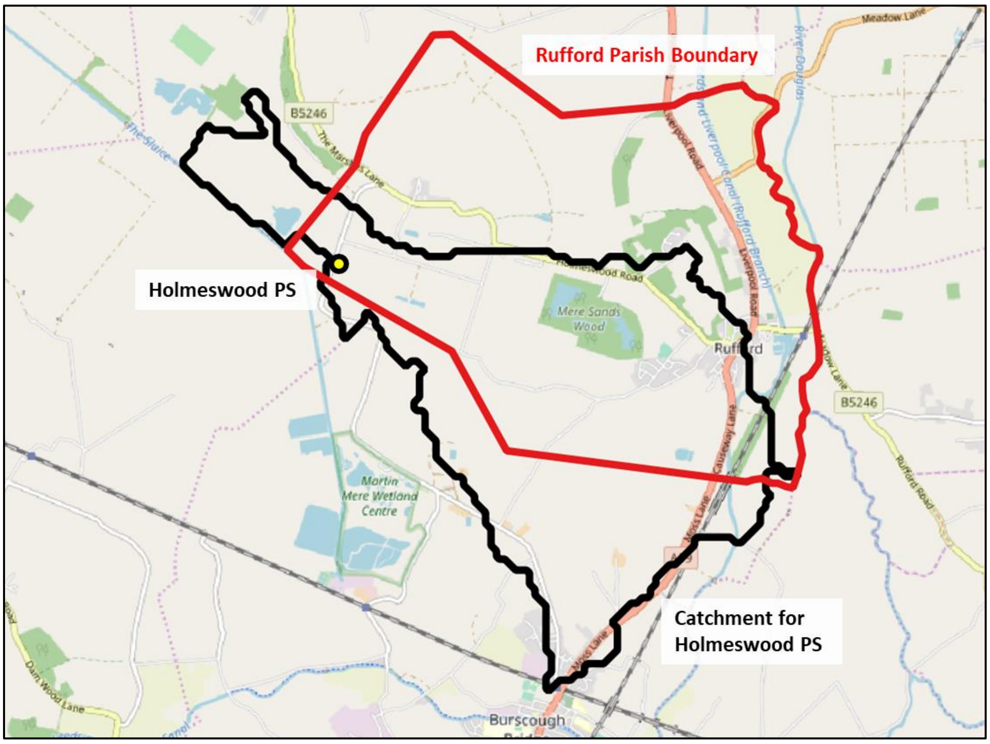

Figure 3-9 Overview of Rufford's drainage catchment

3.4.2 River Douglas

3.4.2.1 Overview

The River Douglas rises on Rivington Moor in the Pennines, but soon enters more urban and industrial environments further downstream, with the river and its tributaries passing through the towns of Wigan, Chorley, Leyland and Skelmersdale. The lower section of the Douglas catchment comprises flat fertile agricultural land, including the area around Rufford. The two major tributaries of the Douglas, the River Yarrow and River Lostock, enter the River Douglas at Croston, c. 2 miles north of Rufford. The Douglas flows into the Ribble Estuary approximately 6 miles to the south-west of Preston. An overview of the River Douglas catchment to Rufford and the River Yarrow and River Lostock catchment to the River Douglas is shown in Figure 3-10.[7]

[7] The catchment of a river at a given point along the river refers to the area upstream of a given point. For example the River Douglas catchment to Rufford is smaller than the River Douglas catchment at the mouth of the river

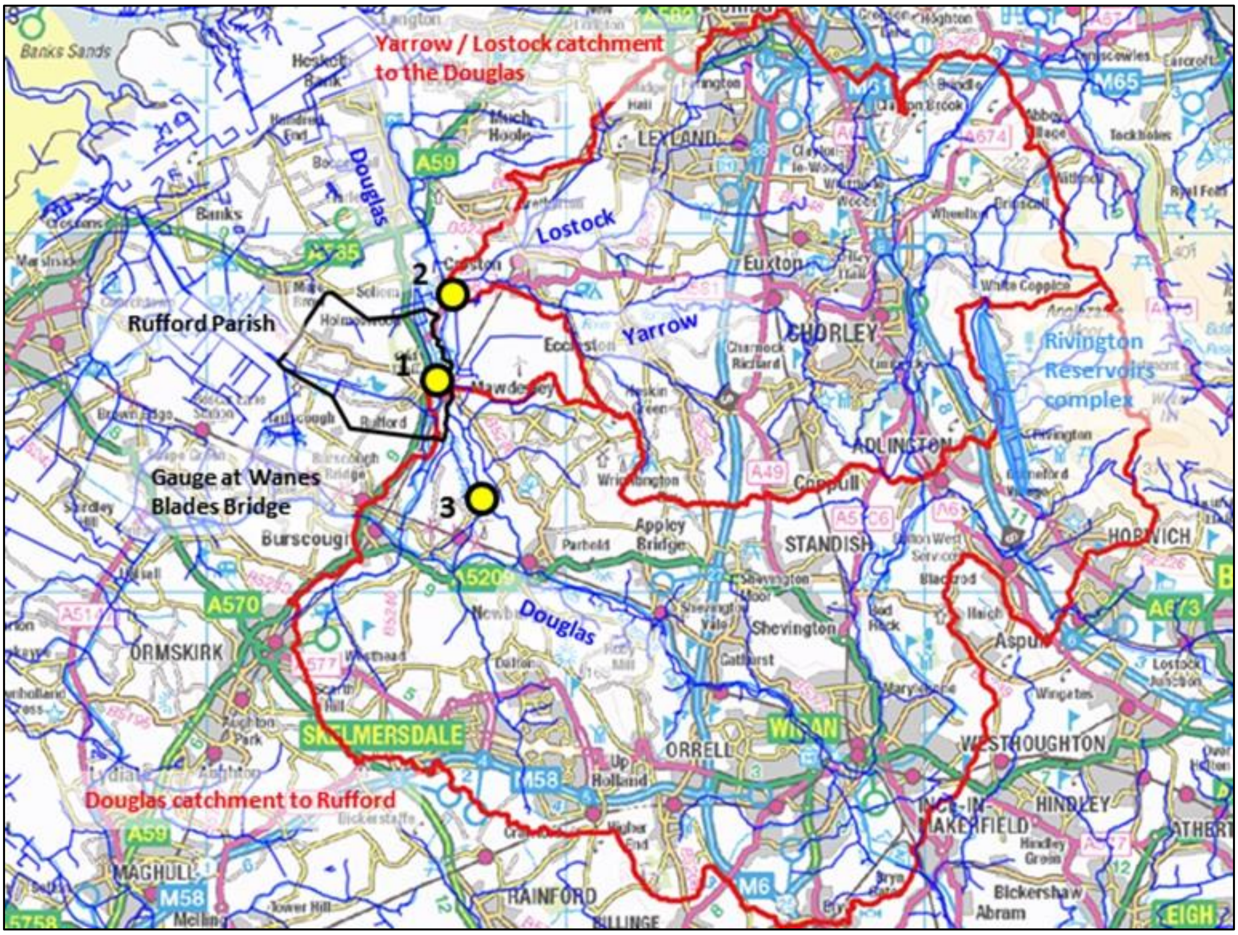

Figure 3-10 Overview of the River Douglas catchment

1 River Douglas to Rufford
2 River Yarrow/Lostock to River Douglas
3 River Douglas to gauge at Wanes Blades Bridge

3.4.2.2 Human modification of the catchment

Land drainage within the Douglas catchment has been significantly changed over time to allow intensively managed agricultural land and urban areas to be created. Development has taken place in the floodplain, leading to the risk of flooding in developed areas such as Wigan, Croston and Appley Bridge. In many reaches the rivers have been heavily modified. Raised defences have been introduced and used widely (Figure 3-11), reducing flood risk by moving water rapidly along the channel and culverts. They prevent overtopping of the banks up to their designed standard of protection. Heavily modified watercourses, such as culverts can increase flood risk by restricting flow and forcing water to back up behind them and possibly flow out of the banks or channel. The floodplain of the lower Douglas and Yarrow consists of high grade agricultural land where drainage is modified by pumping within a complex network of artificial channels (Figure 3-12). The lower reaches of the Douglas are influenced by the tide, which controls discharge from a number of river tributaries of the lower Douglas, that have pumped or flap outfalls.

Figure 3-11 River Douglas from Meadow Lane, looking southwards

Figure 3-12 Mawdesley Pumping Station

The upper catchment of the Douglas is characterised by the Rivington Reservoir complex. This significantly alters the natural drainage patterns of the Douglas and Yarrow. These reservoirs are used for public water supply and play a strategic role in water supply across North West England. Natural flows in the River Douglas are modified by the series of eight reservoirs at Rivington, located where the river drains from the West Pennine Moors. The reservoirs were constructed between the 1850s and 1875. The scheme diverts water from the River Yarrow (which would otherwise enter the River Douglas downstream of Rufford) into the upstream Douglas, so that it can be used for water supply purposes (in Wigan). The reservoirs alter the flow regime downstream of Rivington via controlled releases, providing a compensation flow to ensure a persistent baseflow in the river. They also provide a degree of flood control as they can store floodwaters draining off the West Pennine Moors.

Water from the River Douglas is also abstracted (removed) to supply the Leeds and Liverpool Canal and locally, for agricultural use. Flows are also altered by the Wigan Flood Control Scheme, completed in 2011. Phase 1 of the scheme, completed in 2008, provided local protection via flood walls along the River Douglas in Wigan. These would locally increase water velocities and thus slightly increase flood peaks downstream. However, in Phase 2 of the scheme an earthen dam wall was built across the River Douglas floodplain in the Swinley area of Wigan. Capable of providing temporary storage for up to 400,000 m^3 of water, this dam is intended to attenuate flows downstream, thus reducing flood peak magnitude (whilst increasing flood duration). The overall effect of this scheme on water levels will decrease further downstream as water being added by tributaries where the flow has not been regulated (in particular, the River Tawd) will "renormalize" the flows in the river.[8]

3.4.2.3 Catchment description

Flood Estimation Handbook (FEH) catchment descriptors for the River Douglas to Rufford and catchment of the River Yarrow and Lostock to their confluence with the Douglas are presented in Table 3-2. The catchments are shown to be similar in terms of their physical and hydrological characteristics. The Base Flow Index (BFI) values for the catchments are moderate which indicates that the Douglas and Yarrow have a moderate groundwater component within their discharge. The Standard Percentage Runoff (SPR) values indicate that runoff in the catchment is moderate, again reflecting the nature of the regional soils and geology. As with the Rufford area, the PROPWET value of 0.51 indicates that saturated soil conditions are likely to prevail, contributing to flood formation.

[8] Environment Agency 2009. River Douglas Catchment Flood Management Plan

Table 3-2 Flood Estimation Handbook catchment descriptors for the River Douglas

Catchment Descriptors	**Abbreviation**	**Average Catchment Values**	
		River Douglas to Rufford	**River Yarrow/ Lostock to River Douglas**
Catchment Area	AREA	229 km^2	150 km^2
Mean Catchment Altitude	ALTBAR	86 m	77 m
Base Flow Index (BFI) derived by using the UK Hydrology of Soil Types (HOST) classification (0:1)	BFIHOST	0.471	0.464
Standard Percentage Runoff (SPR) derived by using the UK Hydrology of Soil Types (HOST) classification (10-53%)	SPRHOST	32.9%	38.2%
Catchment Wetness Index (PROPortion of time soils are WET). Values range from over 80% in the wettest catchments to less than 20% in the driest parts of the country.	PROPWET	0.510	0.510
Standard Average Annual Rainfall (SAAR) (1961 – 1990)	SAAR	1,009 mm/yr	1,029 mm/yr
Extent of urban and suburban land cover within catchment (2000). Moderately urbanised = 0.060 to 0.150.	$URBEXT_{2000}$	0.116	0.111

3.4.2.4 River flows

Gauge description

Flow gauge data from Wanes Blades Bridge (NGR SD476125) on the River Douglas, c. 2 miles upstream (south) of Rufford, has been analysed in order to describe river flow behaviour and how this has changed over time. It is noted that the Eller Brook joins the River Douglas in the reach between the gauging station and Rufford, and flows added by this waterbody are therefore not measured by the gauge.

The gauge is a shallow-V weir constructed in 1969 and flow data is available from 1973 onward. However, the weir is drowned out at high tides, introducing scatter in the data. A new weir was constructed in 1984, providing more reliable data for low flows, but accurate peak flow readings only became available from 1996 onwards, when an ultrasonic depth gauge was installed. As a result of this, it is difficult to examine long-term patterns in flooding using the gauge data.

Catchment description at Wanes Blades Bridge

The catchment area at the gauging station is 198 km2. Based on data provided by the National River Flow Archive (NRFA), 25.93% of the catchment is urbanized, particularly in the middle reaches where the towns of Wigan and Skelmersdale are located. The upper part of the catchment drains from the upland areas of the West Pennine Moors (Winter Hill, elevation 456m, is the highest point in the catchment). The river loses altitude quickly and the majority of the catchment is at relatively low altitude. The 50th percentile (i.e. the average elevation of the catchment) is 80 m. Three percent (3%) of the catchment is mountain heath or bog, and a further

8.97% is woodland. The majority of the catchment is used for agricultural purposes (18.97% arable/horticultural; 41.72% grassland).

Rainfall across the catchment ranges from an annual average of approximately 850 mm per year in the west to over 1,600 mm per year on the West Pennine Moors in the east of the catchment. For the catchment as a whole, annual average rainfall was 1,028 mm for the period 1971-1990 (and 1,023 mm per year for the period 1941-1970). Rainfall averages for more recent decades (the date ranges were selected to make them comparable to the available river gauge data) are presented in Table 3-3.

Table 3-3 Rainfall and runoff data for the River Douglas catchment

	10-year Average Rainfall (mm)	10-year Average Runoff (mm)	% Runoff
1996-2005	1,060	665	63
2006-2015	1,069	696	65

Also shown in Table 3-3 is runoff data, averaged per decade for the two decades where peak flow data was collected9. The data shows that on average, 64% of rain ends up in the river (the rest is lost, mainly to the atmosphere as evapotranspiration).

The available data shows a slight tendency for more rainfall to be converted into runoff in more recent years. The results indicate an increase in the percentage of runoff from 63% between 1996 and 2005 to 65% between 2006 and 2015. Given the average rainfall for each decade is very similar, this may reflect land use changes across the catchment.

Flow duration curves

Flow duration curves plot all the flow data and show the percentage of time a given flow is exceeded (i.e. a large, rare flow is exceeded 1% of the time, lower flows, which happen frequently are exceeded 80% of the time). Flow duration curves for the River Douglas are shown in Figure 3-13. The blue line includes all the data and shows the larger, rarer flows (occurring 30% of the time or less) to be smaller than those recorded by the more recent data (shown in the brown and grey curves). This reflects the absence of peak flow record in the older data. The curves for 1996 to 2005 and 2007 to 2017 are more useful (there is no data available for the year 2006). The top line (the curve for the most recent period, since 2007) is higher for all exceedance periods, which shows that the river is carrying more water not just in rare, peak flows, but also in times of intermediate discharge.

This reinforces the observation made above: irrespective of the size of rainfall event, more of the water is entering the river. As discussed, this may be due to land use changes, although other

[9] Runoff is the proportion of rainfall that ends up in the river. It is calculated from the average daily flow (in m^3/s) by multiplying it through to show the total amount of flow per year (×60×60×24×365), dividing it by 1,000 (to convert metres to mm) and dividing it by the catchment area to give a runoff figure per square kilometre of catchment land. The number is a depth of water in mm produced by each km^2 of land (on average) and is directly comparable to the rainfall data. Runoff is affected by a number of factors. In very wet years, more rain becomes runoff because there is less opportunity for water to evaporate and transpire. Another major control on runoff is land use. As land is converted from woodland to farmland, or from farmland to urban, the amount of vegetation decreases (reducing transpiration) and the amount of water soaking into the soil decreases (which means it is more likely to flow over the surface, directly into the river, or via storm sewers into the river).

factors, such as more frequent medium-sized releases from the Rivington reservoirs could create similar patterns. Changes such as this do not just indicate that floods are getting bigger (although the largest floods have all occurred in this period, the lines converge for moderately rare flows, exceeded only 10% of the time), but indicate that overall, conditions in the catchment have changed over the past two decades.

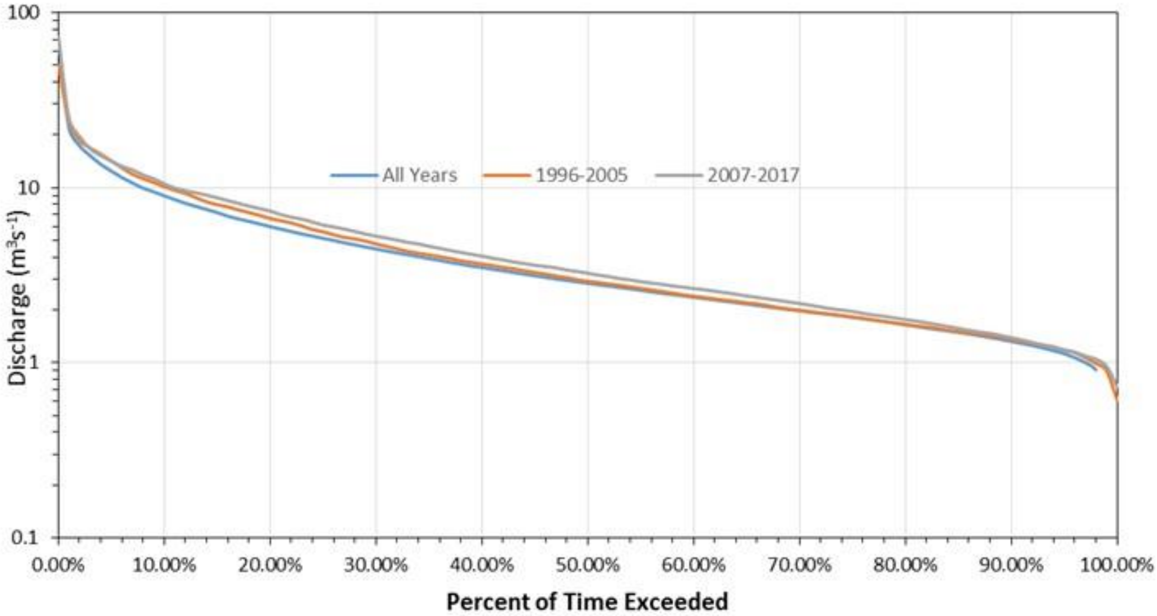

Figure 3-13 Flow duration curves for the River Douglas at Wanes Blades Bridge

Annual maximum flow

The annual maximum series (the largest flood from each year) is presented in Figure 3-14. As described above, the data for the years before 1996 is unreliable. Peak flows were not measured consistently, and are not included in the data set. Low flows were measured inconsistently prior to 1984. The more reliable data, from 1996 onwards, contains all the biggest floods on record, and the smallest flood in each year is never smaller than 20 m^3/s. There is no data available for 2003 and 2006.

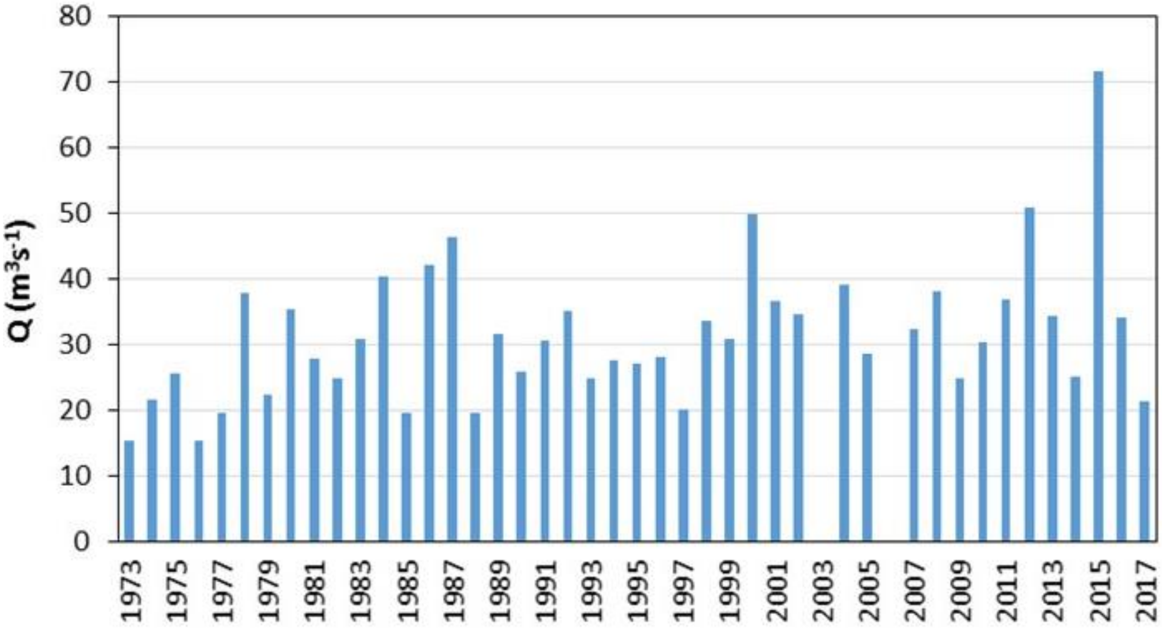

Figure 3-14 Annual maximum series for the Douglas River at Wanes Blades Bridge

Flood frequency analysis

It is usual to use all the available data for a flood frequency analysis, as this greatly increases the statistical reliability. However, as the pre-1996 data is of questionable quality, an analysis has be done both with and without the pre-1996 data.

Based on the full data set (Figure 3-15), the largest flood on record has a recurrence interval of 44 years, and a 1 in 10 year flood will have a discharge of approximately 45 m^3/s. Dividing the data in two (Figure 3-16) shows how the 1973 to 1995 data has consistently smaller floods for a given recurrence interval (mostly reflecting the fact the largest floods were not recorded). The recurrence intervals of the largest floods are somewhat meaningless when using such a short data set (1 in 22 years), but for shorter recurrence intervals, using the more recent data increases confidence in the data as a whole, since 1 in 5 year floods have a similar magnitude (c. 40 m^3/s) irrespective of which data set is used.

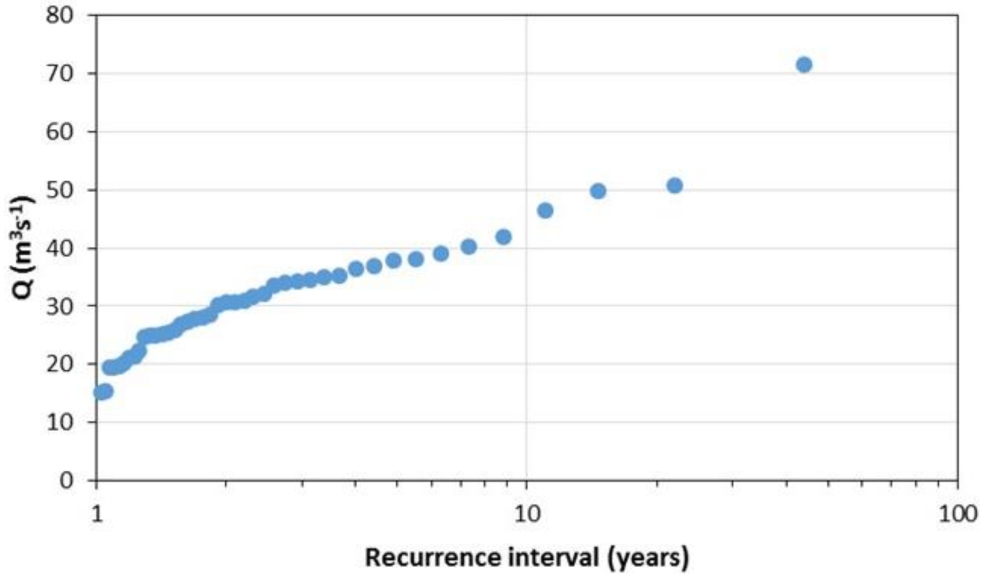

Figure 3-15 Flood magnitude and frequency using all data

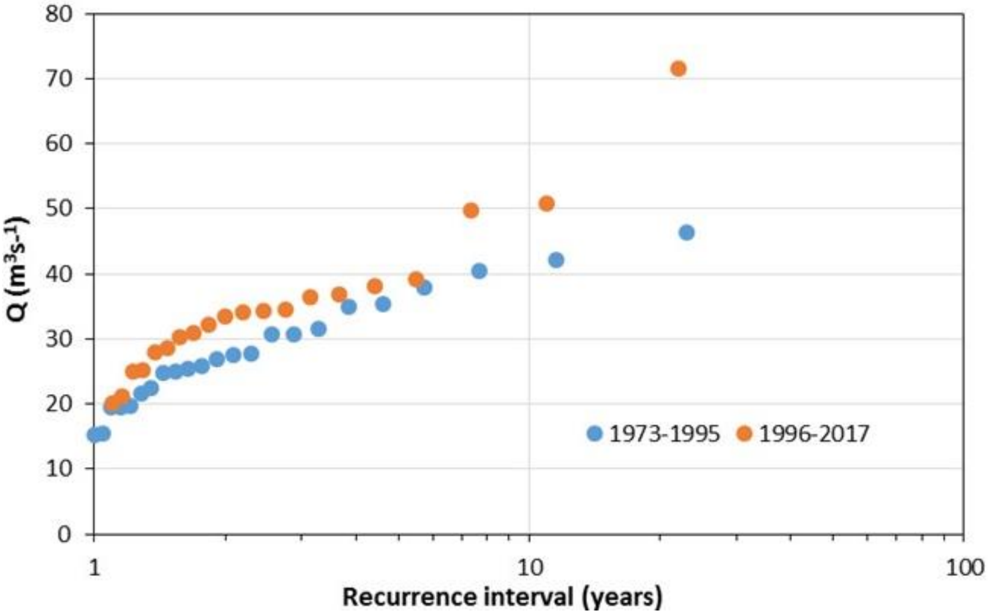

Figure 3-16 Flood magnitude and frequency with the data split pre- and post- 1996

Summary

Flow gauge data from Wanes Blades Bridge on the River Douglas, c. 2 miles upstream (south) of Rufford, has been analysed in order to describe river flow behaviour and how this has changed over time. On average, 64% of rain ends up in the river (the rest is lost, mainly to the atmosphere as evapotranspiration). The available data shows a slight tendency for more rainfall to be converted into runoff in more recent years, irrespective of the size of rainfall event. This may be due to land use changes, although other factors, such as more frequent medium sized releases from the Rivington reservoirs could create similar patterns. The flow data indicates that floods are getting bigger and that overall, conditions in the catchment have changed over the past two decades.

3.5 Hydrogeology

British Geological Survey records of deep boreholes (>30 m in depth) were used to assess the groundwater level within the parish. The borehole drilling records are summarised in Table 3-4 and indicate that groundwater within the bedrock is artesian[10] within the central and eastern regions of the parish.

Table 3-4 Groundwater levels within Rufford and Holmeswood Parish

Borehole ID	Location	NGR	Date	Rest water level
SD41NE5	Croston Lodge	SD459168	1970	Artesian
SD41NE54	Rufford	SD462164	1927	Artesian
SD41NE17	Mere End	SD451153	1972	Artesian
SD41NW4/A	Moss End Farm	SD444167	1978	Artesian
SD41SW63	Helm Wood	SD442148	1988	4.5 m below datum
SD41NW/3	Mere End Farm (west of parish)	SD429181	1977	6.4 m below datum

Groundwater level has been measured at Yew Tree Farm, Burscough (NGR SD344412), approximately 3 miles south-west of Rufford, since 1973. Results are shown in Figure 3-17.

[10] An artesian aquifer is a confined aquifer containing groundwater under positive pressure. An artesian aquifer comprises trapped water, surrounded by layers of impermeable rock or clay which apply positive pressure to the water contained within the aquifer. If a well were to be sunk into an artesian aquifer, water in the well-pipe would rise to a height above ground, corresponding to the point where hydrostatic equilibrium is reached.

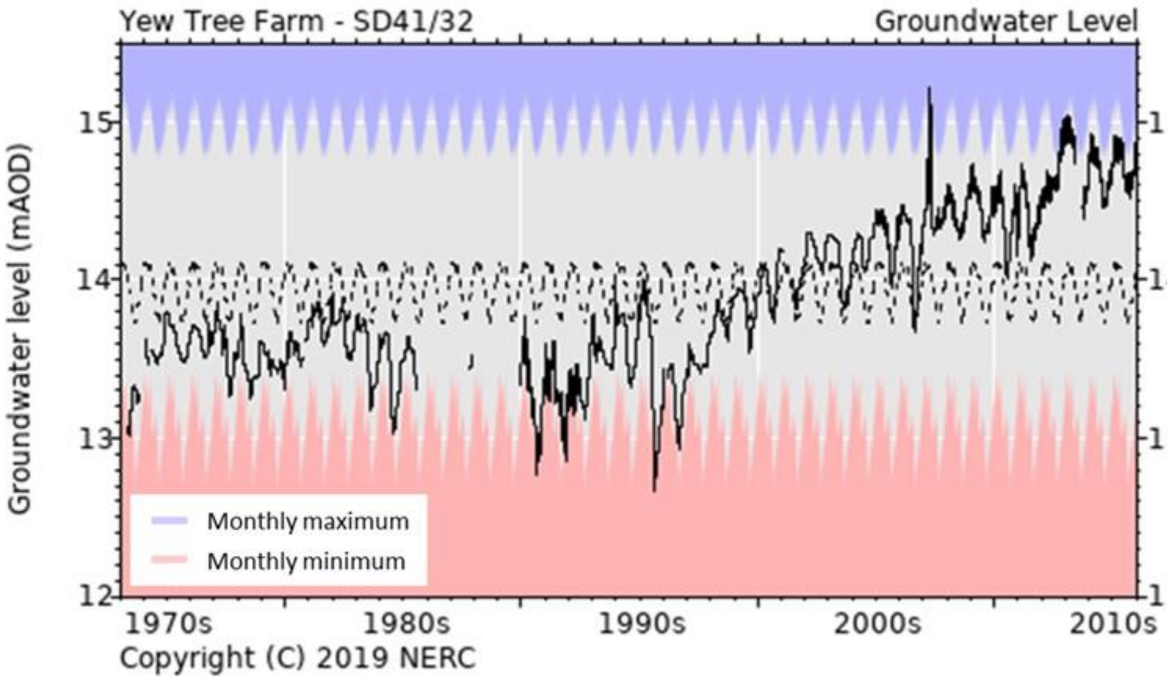

Figure 3-17 Regional groundwater level

The Yew Tree Farm borehole (SD41/32) is used to monitor groundwater levels in the Permo-Triassic Sandstones of Lancashire. The borehole penetrates the Ormskirk Sandstone Formation, overlain by 18 metres of Till (Boulder Clay), which is impermeable and acts as a confining layer. The datum elevation is 23.69 m aOD meaning that a groundwater level of c.14 m aOD is at a depth of c. 9 metres, mid-way into the Till. The hydrograph has an annual sinusoidal (repeating) pattern, with short term responses to annual recharge events. In addition, since the early 1990s a rising trend is detected; prior to this, levels were stable. Annual fluctuations are generally less than 0.5 metres, although occasional variations of a metre have been observed.

Groundwater also occurs within the superficial deposits overlying the Till and a shallow water table is expected. The peat, in particular, holds a large quantity of groundwater.

3.6 Flood risk

3.6.1 Catchment flood management plans

The Alt/Crossens Catchment Flood Management Plan

The Crossens catchment is considered to have some flood risk in its current condition. There is a risk to 1,500 hectares of high-grade agricultural land around Martin Mere and Mere Sands Wood, the Southport to Wigan and Preston to Liverpool railway lines, as well as some risk from surface water and coastal flooding to localised areas of Southport. Although these areas are at risk of flooding, this risk is limited to larger flood events, with the majority of smaller risks being placed at a 1% Annual Probability Event (APE). The main potential flood risks within Crossens catchment are predominately associated with the failure of existing assets including:

- Inoperability of pumping stations, particularly Crossens Pumping Station in Banks
- Failure of existing coastal and tidal defences resulting in direct tidal flooding and indirect tidal flooding as a result of ingress to the river systems and land drainage networks
- Failure of the embankment between Crossens Sluice and Banks Marsh Drain

The Alt/Crossens Flood Management Plan concludes that the Crossens flood defence integrity is reliant upon the existing management approach adopted and has the potential for large scale flooding should any of the three assets (pumping stations, sea defences, embankment) fail[11].

Douglas Catchment Flood Management Plan

The Douglas catchment FMP identifies the primary sources of flooding within the Douglas catchment as river, tidal, local flooding related to urban drainage and canal flooding where the Leeds-Liverpool Canal is above the level of surrounding properties. The River Douglas joins the Ribble in an estuarine area and therefore storm surges, waves and tides are a potential source of flooding. The tidal limit (upper limit to the area influenced by the sea) of the River Douglas is at Rufford. The only settlements to be identified as being directly at risk from tidal flooding are areas of Hesketh Bank and Tarleton.

Raised river defences have been constructed across much of the Douglas's reach to prevent flooding and the area now has a legacy of dependency on such defences, particularly within urbanised areas in Wigan. The Douglas catchment contains 54 flood defence structures with a combined length of c. 31 miles. 55% of the total length is maintained by the EA with the remainder the responsibility of private landowners. Most of the length of privately owned defences (80%) is along the tidal reaches of the Douglas. In relation to such defences, the EA have permissive powers to maintain the existing flood embankments as necessary.

Most of the man-made, purpose-built structures are located on the tidally influenced areas of the Douglas and Tawd (also on the Lostock and Yarrow outside West Lancashire) and within known flood risk areas. Concentrations of flood defences can be seen surrounding Hesketh Bank. These defences within the tidal reaches of the Douglas protect significant areas of agricultural land against both river and tidal flooding and are supplemented by a network of pumping stations (similar to those within the Alt/Crossens CFMP) to drain the low-lying agricultural land. The standard of protection ranges along the catchment, from a 1 in 25 year event for Appley Bridge (i.e. relatively small defences) to a 1 in 150 years event (i.e. much more substantial) in Hesketh Bank.

Flood risk is forecast to increase in the future, with additional flooding of rural property and high-grade agricultural land mostly in the Abbey/Eller Brooks and River Tawd catchments. In the built-up areas there will also be an increase in flood risk in the future associated with urban runoff and channel restrictions which may not be able to cope with the intense rainfall events which are expected to become more frequent. Flood defences in the lower part of the sub-area protect agricultural land and rural property. There is some flood risk associated with rapid releases from Rivington Reservoirs, to allow maintenance work, which may increase flood risk, particularly if they occur during a wet period. The Environment Agency is working with United Utilities to ensure any such releases do not unduly increase flood risk.[12]

3.6.2 Flood zones in the vicinity of Rufford

The Environment Agency's flood map for planning shows the likelihood of flooding from rivers and sea, categorising England and Wales into three zones: zone 1 (low probability); zone 2 (medium probability) and zone 3 (high probability).

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11 West Lancashire Borough Council, February 2017. Strategic Flood Risk Assessment Level 1

12 Environment Agency, December 2009. River Douglas Catchment Flood Management Plan

Flood zones in the Rufford area are shown in Figure 3-18. The majority of Rufford and Holmeswood Parish is located within flood zone 1, although there are three main areas with a higher probability of flooding:

- A band of land between Rufford Pumping Station and Holmeswood Pumping Station lies within flood zone 2
- The area immediately south-east of Rufford lies within flood zone 3
- The east of the parish adjacent to the River Douglas is in zone 3, but benefits from flood defences. The raised embankments of the River Douglas provide flood protection north of Mawdesley Pumping Station, with a 1 in 150 year Standard of Protection (SoP), as discussed in Section 3.6.4. However, the area immediately west of the River Douglas, pumped by Solom Pumping Station, has a 1 in 5 year SoP. As mentioned elsewhere, the tidal limit of the River Douglas is at Rufford, meaning that the area is at risk of both river flooding and tidal surge.

It is noted that the map does not consider other sources of flooding or future impacts of climate change.

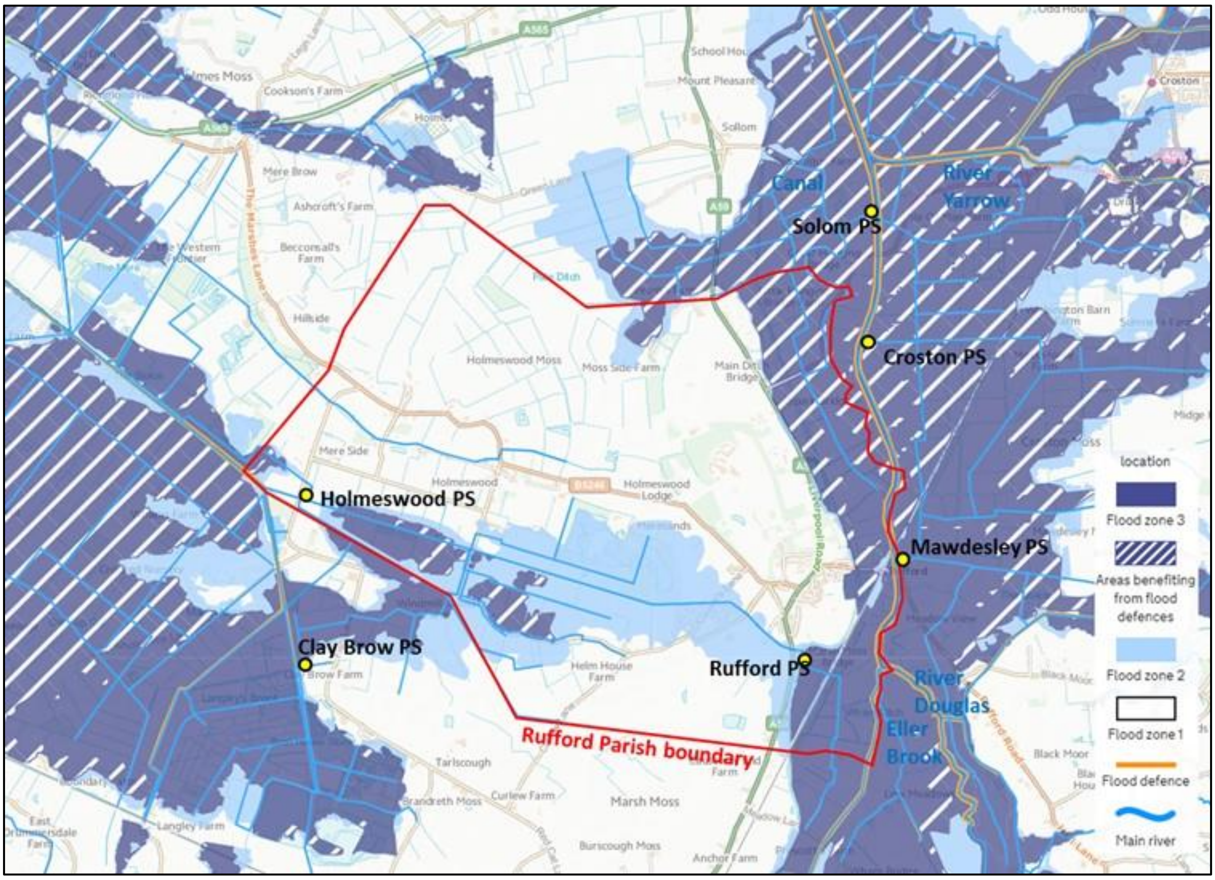

Figure 3-18 Flood zones in the Rufford area

Groundwater flooding occurs when heavy or prolonged rainfall makes the level of water underground rise above the natural surface. Groundwater flooding can have a significant influence on surface water flooding because in areas where there is a susceptibility to groundwater flooding there is also a lower likelihood of the soil being able to absorb much rainfall before becoming saturated. The risk of groundwater flooding can also be increased by factors such as a reduction in water abstraction by industry. A map showing the broad areas that may be at risk of flooding from groundwater in West Lancashire is shown in Figure 3-19. It is possible that the locations experiencing such flooding are more localised within the grid squares shown. The plan indicates that the majority of West Lancashire is at low risk from groundwater flooding. However, within the Rufford and Holmeswood Parish, Holmeswood is at higher risk from groundwater flooding[13].

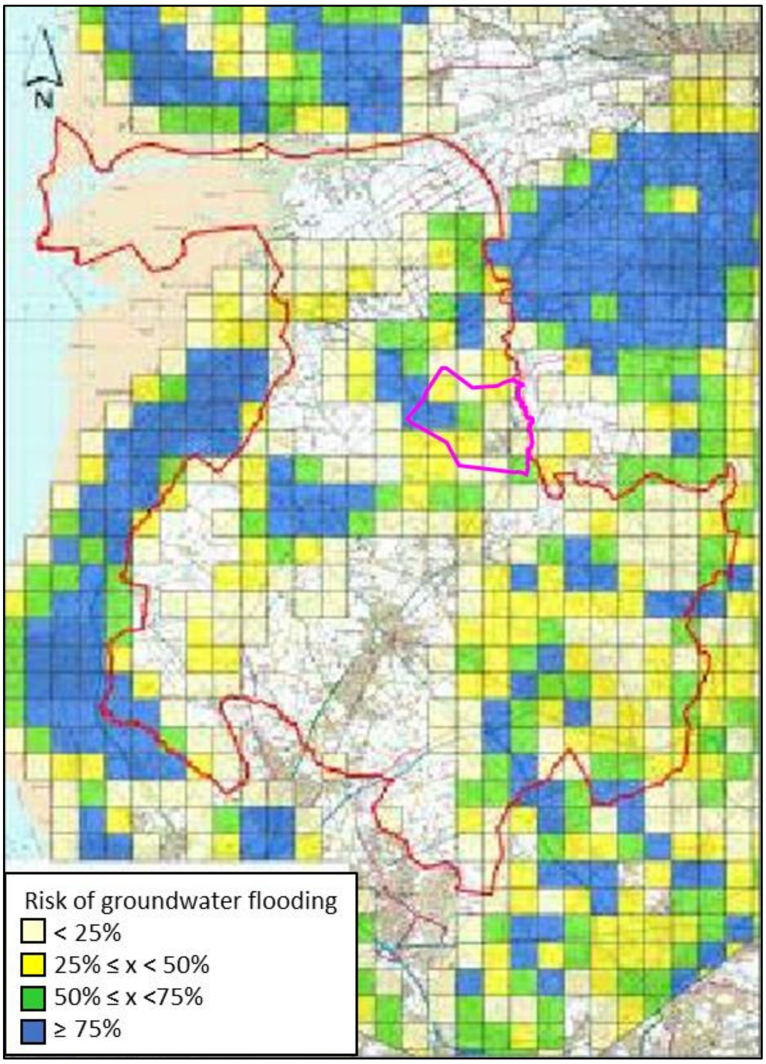

Figure 3-19 Map of susceptibility to groundwater flooding
Source: based on West Lancashire Local Plan Review, Strategic Flood Risk Assessment Level 1, 2017

3.6.3 Flooding mechanisms in the Rufford area

The area of Rufford is susceptible to a complex set of flooding mechanisms which can interact and combine to produce significant flood risk.

The risk of flooding in the areas of Rufford relating to the Douglas hydrological catchment can be attributed to following key mechanisms:

- Fluvial flooding as a result of overtopping and/or failure of the flood defence embankments along the River Douglas.
- High water level within the Ribble Estuary may cause tide locking (i.e. the river flow out to sea becomes restricted due to a high tide or storm surge) thereby a) reducing the

[13] West Lancashire Borough Council, February 2017. Strategic Flood Risk Assessment Level 1

capacity of flapped outfalls and/or b) causing flows in the River Douglas to back up upstream, raising water levels in the Douglas at Rufford.

- Incapacity and/or inoperability of the pumping stations to pump out waters from the land drainage network due to flood inundation and/or mechanical failure.
- Localised surface water flooding, particularly in urbanised areas, in and around the urban centre, such as in residential areas and along road networks. Surface water flooding may exacerbate fluvial or other types of flooding in certain areas.
- Flooding as a result of overtopping and/or failure of the Leeds and Liverpool Canal situated to the east of Rufford.

The risk of flooding in the areas of Rufford relating to the Holmeswood Pumping Station and Crossens hydrological catchment can be attributed to following key mechanisms:

- Fluvial flooding as a result of overtopping and/or failure of the embankments along the main sluices.
- High water levels in the Irish Sea may prevent Crossens Pumping Station, the outlet of the drainage system serving Rufford and surrounding areas, pumping flood waters to the sea, causing water levels to increase.
- Incapacity and/or inoperability of the pumping stations, particularly the Holmeswood Pumping Station and Crossens Pumping Station.
- Incapacity of the land drainage network to accommodate rainfall-runoff and groundwater.
- Groundwater flooding at low elevations may occur locally during prolonged wet periods when the groundwater table is near to the surface.
- Tidal flooding as a result of overtopping and/or failure of the flood defences along the coastline affecting flood mitigation and water management infrastructure.
- Flooding as a result of overtopping and/or failure of the Leeds and Liverpool Canal situated to the east of Rufford.

3.6.4 Flood management systems

There are a number of flood risk management systems covering West Lancashire. The parish of Rufford falls within the Rufford and Mawdesley system and the Martin Mere System, as shown in Figure 3-20.

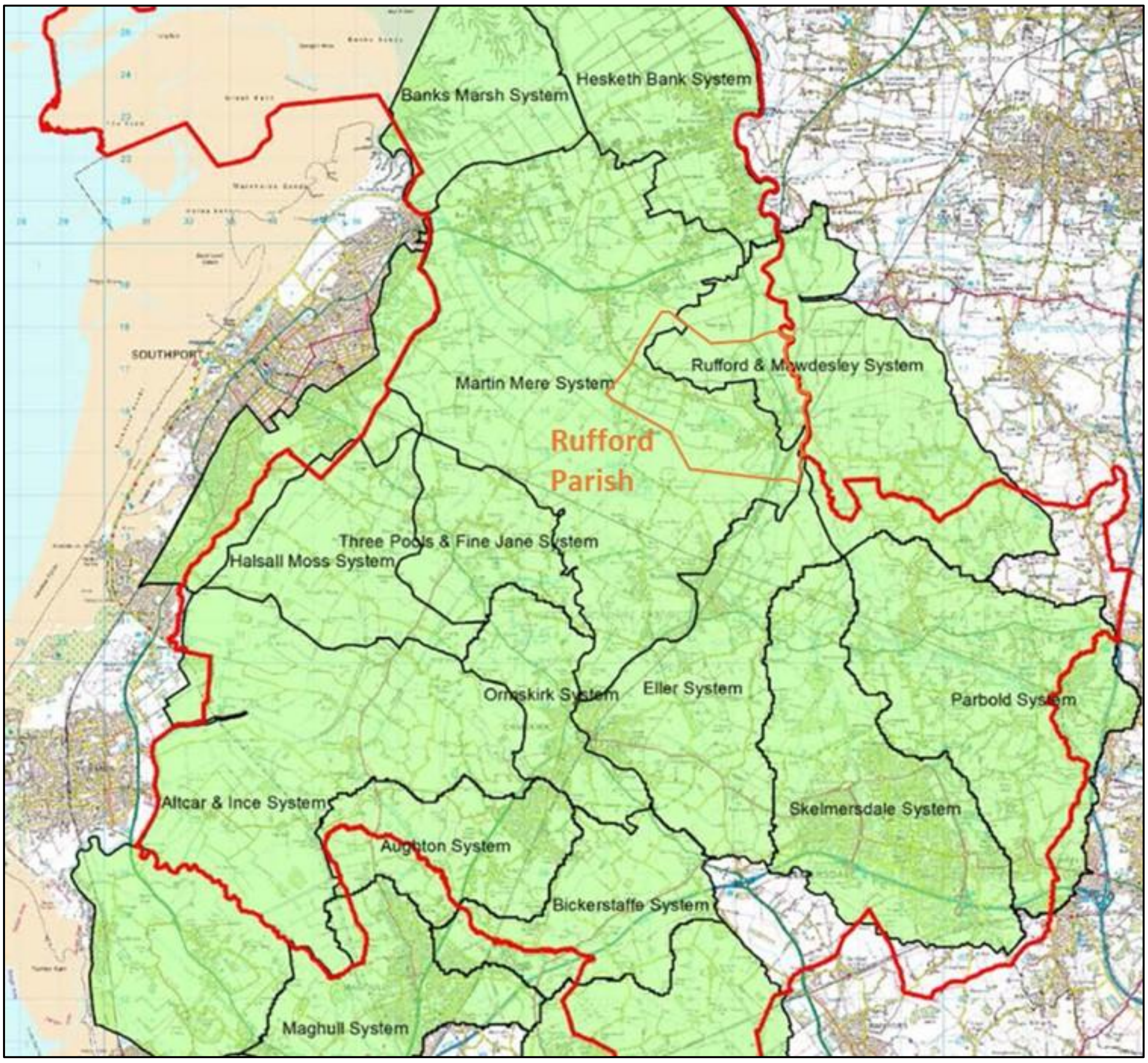

Figure 3-20 Flood risk management map

The Martin Mere system is a high flood risk system with a total of 2,250 properties identified by the Environment Agency as being at risk. This system includes the majority of the watercourse within the Crossens catchment, draining all of the low-lying wetland area and also includes a number of satellite pumping stations. In relation to the flood defences, the standard in this system is for a 1 in 50 year event. Routine and recurring maintenance is carried out with medium to low inspection frequencies in this area. However it is unclear (but unlikely) whether floodwater entering the Martin Mere system from the River Douglas or its tributaries is taken into account when calculating the SoPs.

The Rufford and Mawdesley system is a high flood risk system with a total of 652 properties identified by the Environment Agency as being at risk. This system contains most of the low-level flood plain for the River Douglas. In relation to the flood defences the standard in this system is for a 1 in 50 year event, however this varies considerably in the Rufford area as shown in Figure 3-21. The SoP in the main channel of the River Douglas varies from 1 in 25 year events to 1 in 100 year events. The Eller Brook's SoP are for 1 in 40 year to 1 in 50 year events and the areas of pumped drainage adjacent to the River Douglas have SoP for 1 in 5 year events. In this area routine and recurring maintenance is carried out.[14]

[14] West Lancashire Borough Council, February 2017. Strategic Flood Risk Assessment Level 1

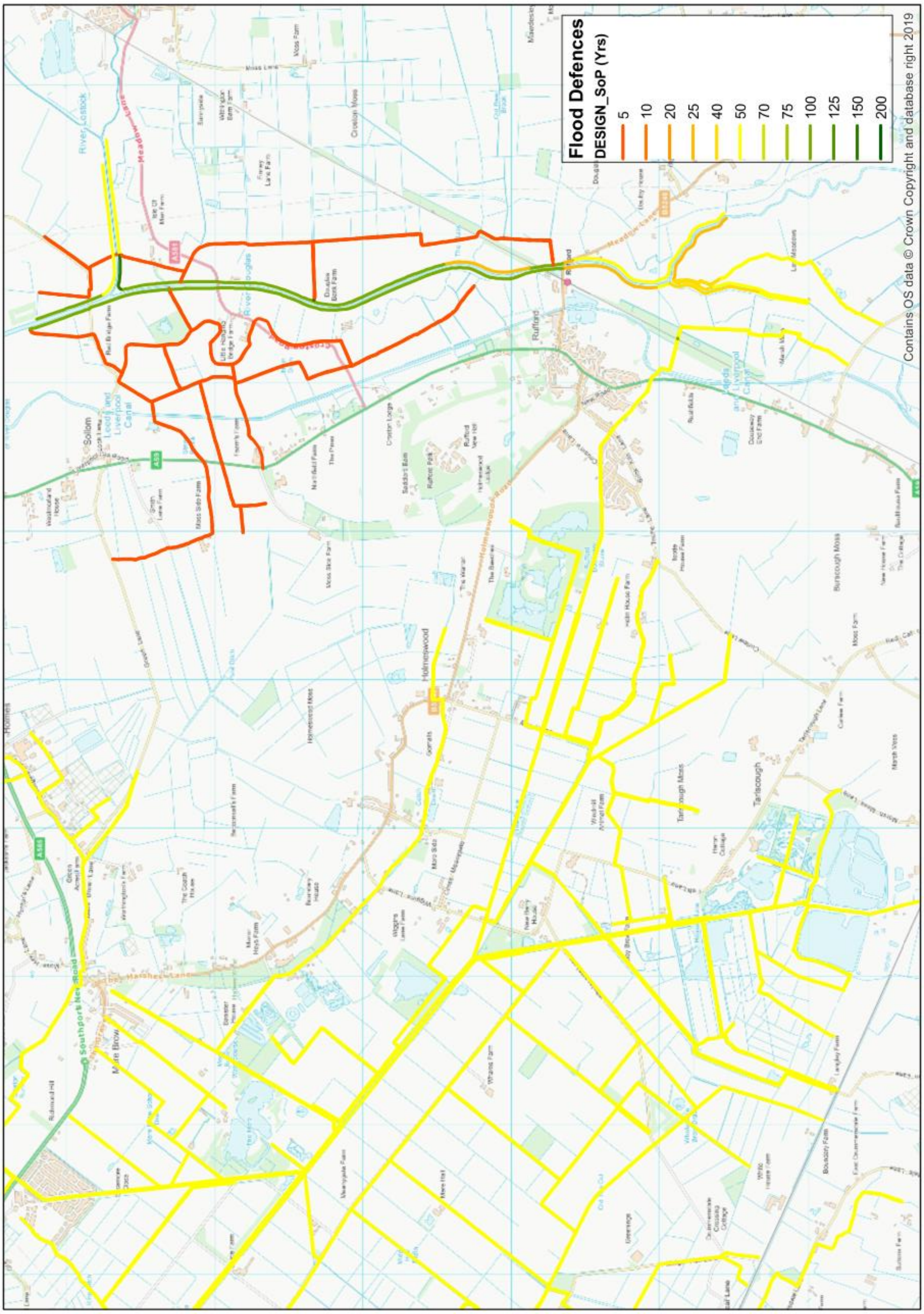

Figure 3-21 Flood defence Standards of Protection (SoP)
From Environment Agency data request

The flood models provided by the EA were built in ISIS (now known as Flood Modeller) and TUFLOW hydraulic modelling software packages.

Pumping capacity from the pumping stations in the vicinity of Rufford are shown in Table 3-5. The pumps automatically turn on and off as controlled by the levels that are set at each site. They can also be operated manually if needed.

Table 3-5 Pumping station capacities

Site/pump	Pump capacity (m^3/s)	Total capacity (m^3/s)
Causeway (Rufford)		0.21
Pump 1	0.105	
Pump 2	0.105	
Holmeswood		0.5
Pump 1	0.25	
Pump 2	0.25	
Croston		0.86
Pump 1	0.43	
Pump 2	0.43	
Mawdesley		1.36
Pump 1	0.68	
Pump 2	0.68	
Sollom		1.56
Pump 1 (External)	0.38	
Pump 2 (External)	0.38	
Pump 3 (Internal)	0.4	
Pump 4 (Internal)	0.4	

4 SUSTAINABLE DRAINAGE SYSTEMS (SuDS)

4.1 Introduction and legislative background to SuDS

Urbanisation alters the natural landscape and affects catchment hydrological processes due to the removal of vegetation and the introduction of impervious surfaces. This reduces the permeability of a catchment and increases surface water runoff. The traditional method of draining runoff from built-up areas involves the use of underground drainage systems such as pipes and sewers, which aim to capture and convey runoff directly to watercourses or treatment works. This results in quicker run-off than for natural systems, giving higher peak river flows in response to rainfall and exacerbating flooding.

In recent years, there has been a focus towards the adoption of more natural drainage solutions to the management of surface water runoff, commonly termed sustainable drainage systems (SuDS). SuDS are a collection of water management practices that seek to manage rainfall and minimise the negative impacts on the quantity and quality of runoff whilst maximising the benefits of amenity and biodiversity for people and the environment.

SuDS are a statutory requirement on all *major* developments (unless deemed to be inappropriate) under The Town and Country Planning (Development Management Procedure) (England) Order 2010[15]. Planning authorities can also request for SuDS on other types of development, including smaller developments and regeneration projects in areas of increased flood risk, if deemed necessary. "Major development" means development involving any one or more of the following:

a) the winning and working of minerals or the use of land for mineral-working deposits;

b) waste development;

c) the provision of dwellinghouses where:

   (i) the number of dwellinghouses to be provided is 10 or more; or

   (ii) the development is to be carried out on a site having an area of 0.5 hectares or more and it is not known whether the development falls within sub-paragraph (c)(i);

d) the provision of a building or buildings where the floor space to be created by the development is 1,000 square metres or more; or

e) development carried out on a site having an area of 1 hectare or more.

The Flood and Water Management Act 2010 assigned the responsibility for managing local sources of flooding from surface water, groundwater and small ("ordinary") watercourses to Lead Local Flood Authorities (LLFA) in upper tier authorities (county and unitary councils). For the Lancashire area, Lancashire County Council (LCC) undertakes the role of the LLFA. LCC are responsible for assessing and approving all surface water drainage systems for all *major* developments in line with planning policy, planning guidance and national SuDS standards set out by government and the specific local standards.

[15] The National Archives. (2019). The Town and Country Planning (Development Management Procedure) (England) Order 2010.

LCC are required to provide consultation responses on surface water drainage provisions for new *major* developments to the Local Planning Authority (LPA). The LPA for West Lancashire is West Lancashire Borough Council (WLBC). LCC will technically assess applications and provide comments and conditions if required and will ensure, through the use of planning conditions, that there are clear arrangements in place for ongoing maintenance of the SuDS over the lifetime of the development. WLBC will take LLFA comments into consideration, determine planning applications and apply planning conditions on adoption and maintenance. The responsibility for ensuring that SuDS are built in accordance with the approved plans lies with the LPA and the developer will be responsible for ensuring that a maintenance plan is in place and for setting out who will be responsible for the maintenance.

Legislation affecting surface water drainage and SuDS is complex. There are numerous pieces of legislation, including the National Planning Policy Framework (NPPF), the Water Industry Act 1991, and Building Regulations, amongst others, that affect surface water drainage and how SuDS on developments are governed. SuDS were not widely delivered in England when much of the legislation was passed, so are not dealt with explicitly, although various legislation has been updated since to account for SuDS. Future legislation is expected to focus more heavily on the use of SuDS at new developments.

4.2 The philosophy and principles of SuDS

4.2.1 Background

The philosophy of SuDS is centred around treating surface water as a resource and managing it effectively in the built environment to maximise the benefits and minimise the negative impacts of surface water runoff from developed areas. SuDS present an opportunity for developers to add value to their development scheme, whilst at the same time meeting local planning requirements around increasing sustainability and managing flood risk.

The SuDS approach involves slowing down and reducing the quantity of surface water runoff from a developed area to manage downstream flood risk and reducing the risk of runoff causing pollution to the water environment. SuDS achieve this by mimicking natural hydrological processes and managing rainfall close to where it falls. SuDS can be designed to transport (convey) surface water, slow down (attenuate) runoff before it enters watercourses, and to provide areas to store and treat water. They can be used to allow water to soak (infiltrate) into the ground or evaporate from surface water and be lost or transpired from vegetation (known as evapotranspiration).

4.2.2 General design principles

SuDS can deliver effective surface water management and provide a multitude of benefits to the water environment and communities. For the success of SuDS, it is important for the design to satisfy the "four pillars of SuDS design" (Figure 4-1), taking account of water quantity (flood risk), water quality (pollution), amenity and biodiversity (wildlife and plants), as outlined in the Construction Industry Research and Information Association (CIRIA) SuDS Manual C753[16]. Each of these pillars has a design objective, as presented in Figure 4-1. For the purposes of this report, discussion will be limited to how SuDS manage water quantity and reduce flood risk.

[16] CIRIA, 2015. The SuDS Manual C753

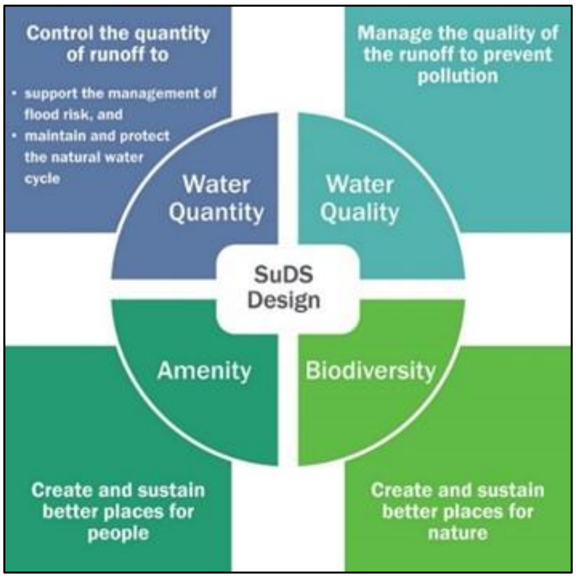

Figure 4-1 The four pillars and design objectives of SuDS
Source: The SuDS Manual, CIRIA 2015

4.2.3 SuDS Management Train

A central design concept for SuDS is the 'SuDS Management Train' (CIRIA, 2015). This describes the use of a sequence of components that collectively provide the necessary processes to control the frequency of runoff, the flow rates and the volumes of runoff, and to reduce concentrations of contaminants to acceptable levels. These are not independent, and one component may provide two or more functions. There are six common functions provided by SuDS components:

1. **Rainwater harvesting systems** – components that capture rainwater and facilitate its use within the building or local environment.
2. **Pervious surfacing systems** – structural surfaces, for example, green roofs and permeable pavements that allow water to infiltrate into the ground, thus reducing the quantity of runoff that is conveyed to the drainage system. These systems can include some subsurface storage and treatment.
3. **Infiltration systems** – components that facilitate the infiltration of water into the ground, reducing runoff volumes and providing treatment of the runoff water. These systems can include soakaways, infiltration basins and swales.
4. **Conveyance systems** – components that transport runoff to downstream storage or infiltration systems. Where possible, these systems also provide flow and volume control and treatment e.g. swales.
5. **Storage systems** – components such as ponds, detention basins, ponds and wetlands that control flows and, where possible, volumes of runoff being discharged from the site, by temporarily storing water and releasing it slowly (attenuation). These systems may also provide treatment of the runoff.
6. **Treatment systems** – components such as swales and infiltration basins that remove or facilitate the degradation of contaminants in runoff.

Examples of a number of different SuDS systems and components listed above are presented in Figure 4-2.

Figure 4-2 Examples of SuDS components
Attenuation/infiltration basin (top left), swale (top right), attenuation pond with swale (bottom left), and pervious pavement (bottom right). Source: Susdrain, 2019

4.2.4 Water quantity

In order to ensure that runoff from a developed site or area does not have a detrimental impact on people, property and the environment, it is important to control:

- How fast the runoff is discharged from the site (i.e. the peak runoff rate); and
- How much runoff is discharged from the site (i.e. the runoff volume).

SuDS that are designed to manage water quantity in this way reduce the likelihood of flooding caused by the development. They can help protect natural water cycles by promoting the recharge of soil moisture levels (and subsequent evapotranspiration processes), by maintaining stream and river baseflows, and by replenishing groundwater. They can also help reduce the risk of erosion of the banks and river bed, caused as a result of the receiving watercourse experiencing more frequent bankfull or near bankfull conditions.

Peak runoff rates

Peak rates of surface water runoff discharged from a developed (i.e. relatively impermeable) site, if left uncontrolled, are normally significantly greater than in its pre-development (greenfield) state. This is because the runoff drains the surfaces of the developed site much quicker than the greenfield site and there is more runoff, as less water is able to infiltrate to ground or be intercepted by grassed surfaces and vegetation.

Figure 4-3 shows the pre-development or greenfield discharge rate (green line) compared to the uncontrolled post-development discharge rate (blue line). The post-development peak rate of discharge is much higher and arrives much earlier than the pre-development peak.

The purpose of controlling peak runoff rates is therefore to limit the rate of runoff after development to the rate that would have occurred before development. This can be achieved by the process of attenuation: slowing and temporarily storing runoff on-site and then discharging it at specified maximum rate to the receiving watercourse. SuDS components such as basins and swales, coupled with the use of flow controls, can be used to attenuate runoff and reduce peak rates from the development.

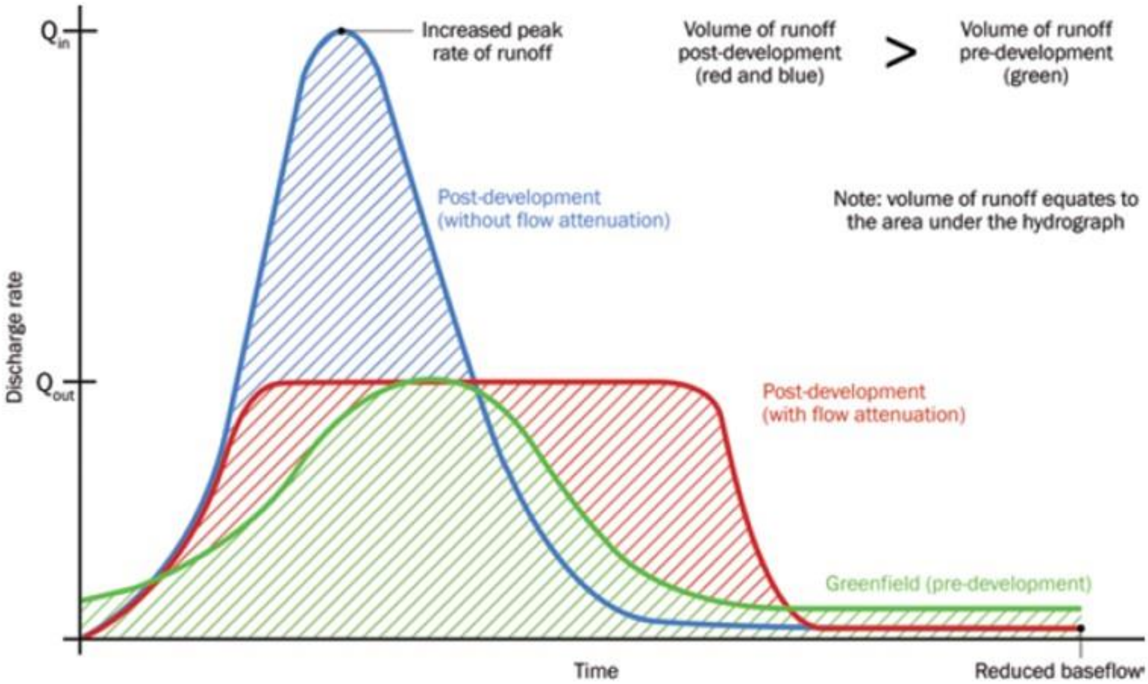

Figure 4-3 Runoff hydrograph showing comparison of pre-development (greenfield) and post-development peak runoff rates and volumes
Source: CIRIA, 2015

Runoff volumes

Attenuation controls the peak runoff rate by extending the hydrograph (Figure 4-3 – red hatched area). The volume of runoff is the area under the graph. While the peak rate of runoff may not increase, the duration over which this peak rate occurs will be significantly longer than before development as a result of the additional runoff volume. This can also increase the likelihood of flooding in the receiving watercourse.

Where sites discharge to sewer systems, changes in volumes are particularly important, due to the risk of sewer flooding and Combined Sewer Overflows (CSOs) spills. Similarly, changes (increases) in runoff volumes to land drainage systems such as that in operation within the Rufford area can increase the risk of fluvial flooding by removing flood volume storage.

The use of infiltration and rainwater harvesting are important mechanisms for delivering volume control: the greater the volume of runoff that is infiltrated or used on site, the lower the volume of runoff that is discharged. It is important to note that, for sites with clay soils, greenfield runoff volumes will tend be to be high because of the underlying low permeability of the soils. Therefore, the increase in volume for the developed site will be small. Where developments take place on more permeable soils, the difference will be much greater, but infiltration or rainwater harvesting options can assist in managing these larger volumes.

It is noted that in areas with high water tables, such as the Rufford area, infiltration may be limited.

4.3 National SuDS design guidance

4.3.1 Non-statutory technical standards

The current design, operation and maintenance of SuDS in England should follow the Department for Environment, Food & Rural Affairs (Defra) Non-Statutory Technical Standards (NSTS) March 2015[17]. There are currently no statutory standards for SuDS in England.

The Defra NSTS apply to systems that drain surface water from housing, non-residential or mixed-use developments for the lifetime of the developments. NSTS allow for the setting of Local Standards by the LLFA and LPA. This enables specific design criteria for SuDS to be set which are deemed necessary for the district in order to effectively reduce flood risk.

The NSTS are to be used in conjunction with the National Planning Policy Framework (NPPF), and National Planning Practice Guidance on Flood Risk & Coastal Change (NPPG). For planning purposes, the 'Local Authority SuDS Officer Organisation (LASOO) Non-Statutory Technical Standards for Sustainable Drainage'[18] is often preferred, as the document offers simplified practice guidance that provides an interpretation of the NSTS for SuDS.

The standards for SuDS contained within the Defra NSTS pertaining to the management of water quantity and flood risk within and from developments are provided below for reference. Further details and explanations of the standards are provided in Defra, 2015 and LASOO, 2016.

Runoff destinations

In accordance with Building Regulations Part H – Drainage and Waste Disposal of the Building Regulations[19], SuDS should discharge surface water runoff as high up the following hierarchy of drainage options as reasonably practicable:

1. Into the ground (infiltration);
2. To a surface water body including a watercourse; or
3. To a surface water sewer, highway drain or another drainage system; or
4. To a combined sewer.

Peak rate of runoff control

For greenfield developments, the peak runoff rate from the development to any surface water body, sewer or highway drain for the 1 in 1 year rainfall event and the 1 in 100 year rainfall event should not exceed the peak greenfield runoff rate for the same event.

For brownfield developments, the peak rate of runoff from the development to any surface water body, sewer or highway drain for the 1 in 1 year rainfall event and the 1 in 100 year rainfall event should be as close as reasonably practicable to the greenfield runoff rate from the development

[17] Defra, 2015. Non-Statutory Technical Standards for Sustainable Drainage Systems

[18] LASOO, 2016. Non-Statutory Technical Standards for Sustainable Drainage Systems – Practice Guidance

[19] HM Government, 2010. Building Regulations Part H – Drainage and Waste Disposal

for the same rainfall event, and should never exceed rates of discharge for the same events prior to redevelopment.

Runoff volume control

Where reasonably practicable, for greenfield development, the runoff volume from the development to any highway drain, sewer or surface water body in the 1 in 100 year, 6-hour rainfall event should never exceed the greenfield runoff volume for the same event.

Where reasonably practicable, for developments which have been previously developed, the runoff volume from the development to any highway drain, sewer or surface water body in the 1 in 100 year, 6-hour rainfall event must be constrained to a value as close as is reasonably practicable to the greenfield runoff volume for the same event, but should never exceed the runoff volume from the development site prior to redevelopment for that event.

Where it is not reasonably practicable to constrain the volume of runoff to any drain, sewer or surface water body in accordance with the above, the runoff volume must be discharged at a rate that does not adversely affect flood risk.

Flood risk within the development

The drainage system must be designed so that, unless an area is designated to hold and/or convey water as part of the design, flooding does not occur on any part of the site for a 1 in 30 year rainfall event.

The drainage system must be designed so that, unless an area is designated to hold and/or convey water as part of the design, flooding does not occur during a 1 in 100 year rainfall event in any part of: a building (including a basement); or in any utility plant susceptible to water (e.g. pumping station or electricity substation) within the development.

The design of the site must ensure that, so far as is reasonably practicable, flows resulting from rainfall in excess of a 1 in 100 year rainfall event are managed in exceedance routes that minimise the risks to people and property.

Flood risk outside the development

Where the drainage system discharges to a surface water body that can accommodate uncontrolled surface water discharges without any impact on flood risk from that surface water body (e.g. the sea or a large estuary) the peak rate of runoff control standards and volume control standards need not apply.

4.3.2 Industry guidance

Industry design guidance for SuDS providing recommendations on the planning, design, construction and maintenance of surface water management systems for new developments and redevelopment sites is often used by developers and designers alongside the NSTS and other guidance.

CIRIA's SuDS Manual (C753) is recognised as the primary SuDS technical guidance document available in the UK. The Code of Practice for Surface Water Management for Development Sites[20] also gives advice for minimising and/or mitigating flooding and other environmental risks arising from site surface water runoff.

[20] British Standard BS 8582:2013. Code of Practice for Surface Water Management for Development Sites

4.4 Local SuDS design guidance

4.4.1 Local planning policy

Future development in Rufford and within the wider Borough of West Lancashire over the next 15 years will be guided by the policies within the Council's West Lancashire Local Plan 2012-2027[21]. The Local Plan sets out the local policy requirements for managing flood risk and drainage at new developments in the district. Policy GN3: Criteria for Sustainable Development - 3. Reducing Flood Risk is shown in Figure 4 below.

3. Reducing Flood Risk

The Council will ensure development does not result in unacceptable flood risk or drainage problems by requiring development to:

i. Take account of the Council's Strategic Flood Risk Assessment (Level 1 and 2) along with advice and guidance from the Lead Local Flood Authority (Lancashire County Council), the Environment Agency and the National Planning Policy Framework;

ii. Be located away from Flood Zones 2 and 3 wherever possible, with the exception of water compatible uses and key infrastructure;

iii. Satisfy the sequential and, if necessary, the exceptions test as set out within National Guidance, for proposals within Flood Zones 2 and 3 on sites that have not been allocated within the Local Plan;

iv. Be supported by a Flood Risk Assessment for all proposals within Flood Zones 2 and 3 that satisfy both the sequential and exceptions tests and for proposals within Critical Drainage Areas[10] within Flood Zone 1 or on sites larger than 1 hectare within Flood Zone 1;

v. Demonstrate that sustainable drainage systems have been explored alongside opportunities to remove surface water from existing sewers. Robust justification will be required for any development seeking to connect surface water to the public sewer network. In addition, any surface water connection must be at an agreed attenuated rate; and

vi. Achieve a reduction in surface water run-off of at least 30% on previously developed land, rising to a minimum of 50% in Critical Drainage Areas unless this is demonstrated to be unfeasible or unviable.

Figure 4-4 West Lancashire Local Plan Policy GN3 – Reducing Flood Risk

* *Critical Drainage Areas are areas within Environment Agency Flood Zone 1 which have critical drainage problems. These areas are established in consultation with the Environment Agency and the LLFA, Lancashire County Council, in this instance. It is noted that there are currently no Critical Drainage Areas in West Lancashire*

4.4.2 Local SuDS design guidance

Lead Local Flood Authorities (LLFAs) and Local Planning Authorities (LPAs) in England can set local design standards to complement national requirements, industry guidance and to prioritise local needs.

Lead Local Flood Authority

Lancashire County Council (LCC), as the LLFA, sets out its proposed policies and design standards for SuDS in Lancashire within the Consultation Document 'Sustainable Drainage Systems – Local Specifications, Standards and Policies' dated May 2015[22]. The Consultation

[21] West Lancashire Borough Council, 2013. The Local Plan 2012-2027

[22] Lancashire County Council, 2015. Consultation Document – Sustainable Drainage Systems – Local Specifications, Standards and Policies

Document lists several SuDS Policies and design principles, including LCC's requirements for maintenance and adoption and a comprehensive section on the design and construction standards for specific SuDS elements such as ponds and infiltration basins. Much of the policies and standards appear to be in line with national guidance i.e. NPPF/NPPG, Defra Non-Statutory Technical Standards and industry guidance e.g. the CIRIA SuDS Manual.

The document provides guidance on LCC's preferred method of calculating greenfield runoff rates. LCC's preferred method for calculating greenfield runoff rates is the Institute of Hydrology (IH124) methodology which is referred to in the document as the 'ICP SUDS' method.

A climate change allowance factor in the calculation of runoff storage requirements at new developments is typically required by planning authorities in England. LCC state that a +30% allowance for climate change should be applied to determine to the maximum storage volume for SuDS drainage design.

The Consultation Document states that LCC proposes to publish local policies and standards for SuDS in Lancashire. However, the outcome of the consultation is not known.[23]

Local Planning Authority

West Lancashire Borough Council (WLBC), as the LPA, sets out the principles and design standards for SuDS in West Lancashire within the published document 'Planning Applications – Drainage, Flood Risk and Sustainability' [24]. The LASOO Non-Statutory Technical Standards for Sustainable Drainage[25] are stated within the WLBC SuDS document to form the basis for the WLBC guidance and expectations relating to SuDS. The NSTS as outlined in Section 4.3.1 of this report are therefore expected to be followed.

Local Plan Policy GN3 – 'Criteria for Sustainable Development', including the CIRIA SuDS Manual and Building Regulations are also stated to be consulted to determine the approaches and standards for the control of runoff at greenfield and brownfield sites in West Lancashire.

The WLBC SuDS guidance document gives the preferred method of calculating greenfield runoff rates as the Institute of Hydrology (IH124) 1994 methodology. The IH124 method is one of two standard methods for calculating greenfield rates, the other being the Flood Estimation Handbook (FEH) 2013 statistical method. Both of these techniques are the typical approved methods with LLFAs and Planning authorities in England.

A climate change allowance factor in the calculation of runoff storage requirements at new developments is typically required by planning authorities in England. WLBC state that a minimum allowance of 30% is acceptable, but that 40% is preferred.

Various other guidance is provided within the WLBC SuDS guidance document, including the maintenance and adoption of SuDS, ground investigation, drainage strategies and individual SuDS components.

[23] Based on a search of the LCC website, the LCC local policies and standards SuDS document for Lancashire has not yet been published online. The LCC Flood risk management team confirmed via email in November 2019 that the only SuDS guidance document currently available is the CIRIA C753 SuDS Manual 2015.

[24] West Lancashire Borough Council, 2017. Planning Applications – Drainage, Flood Risk and Sustainability

[25] LASOO. (2016). Non-Statutory Technical Standards for Sustainable Drainage Systems – Practice Guidance

4.5 Comparison of local and national SuDS policy and design guidance

4.5.1 Policy

The West Lancashire Local Plan 2012-2027 Policy GN3 is vague and lacking in detail in relation to SuDS. Several key design principles are absent or considered inadequate as discussed below.

There is no mention of SuDS being a statutory requirement for all major developments in the policy. However, it is implied that SuDS are a requirement for major developments (unless demonstrated to be inappropriate) and that they should be designed in accordance with the NSTS and industry guidance.

There are no details provided in Policy GN3 in relation to the control of runoff rates and volumes from greenfield developments, only brownfield developments. However, again it is implied that the SuDS should be designed in accordance with the requirements for greenfield developments in the NSTS.

The requirement in Policy Point 6 for *'a reduction in surface water runoff of at least 30% on previously developed land'* is considered inadequate on the basis that it does not meet the NSTS for brownfield developments. It is also unclear whether the reduction relates to runoff rates and/or runoff volumes. The NSTS states that the runoff (discharge) rate from a brownfield site *'should be as close as reasonably practicable to the greenfield runoff rate from the development for the same rainfall event'*. Therefore, the stated 30% reduction in runoff should be considered a secondary requirement, in the event that the greenfield rate cannot be achieved. This is important, as a 30% reduction in existing runoff rate may result in a higher runoff rate than the greenfield runoff rate. While this does provide some betterment over the existing scenario, it may not be sufficient in reducing flood risk both at the development and downstream. Moreover, the stated minimum percentage reduction factor of 30% is lower than other LLFA/LPA guidance in England, which generally state a reduction of 40% or 50%. With the aim of reducing flood risk from brownfield developments in Rufford, it is considered that either of the latter are more robust.

Policy Point 6 also requires runoff rates from brownfield sites to be *'…a minimum of 50% in Critical Drainage Areas'*. However, there are currently no Critical Drainage Areas in West Lancashire (including Rufford). Consequently, this would mean that runoff rates from brownfield sites in Rufford would only need to be reduced by at least 30% under the requirements of Local Policy GN3. This may not provide a sufficient level of flood risk mitigation or betterment to either the development or the receptors downstream.

4.5.2 Design Guidance

The WLBC SuDS guidance document does not state any specific local requirements for the control of runoff rates for developments on greenfield land other than referring to the NSTS.

The WLBC SuDS guidance document states that the Local Plan Policy GN3 should be consulted to determine the minimum requirement for the reduction in runoff on previously developed land. However, as discussed in Section 4.5.1, Point 6 of Policy GN3 is considered inadequate and may not be sufficient in reducing flood risk from developments on brownfield land in West Lancashire and Rufford.

The IH124 method is the WLBC's preferred method for calculating greenfield runoff rates. Latest research does conclude that the FEH methods are slightly more accurate than IH124 methods. Whether this applies to Rufford however, is unclear and detailed numerical analysis of the methods in the context of Rufford would be required to determine the differences. In terms of formulae behind the methods, both the IH124 and FEH methods do not account for the gradient (slope) of the land and are therefore suited to the topographical characteristics of the Rufford area. Both methods are recommended in the CIRIA SuDS Manual (C753).

The WLBC accepted climate change allowance factors used in the calculation of runoff rates and storage control requirements at developments of 30% and preferred value of 40% are considered robust and in line with other LLFA/LPA guidance in England, the CIRIA SuDS Manual (C753) and the LCC SUDS Consultation Document.

4.6 The adoption and maintenance of SuDS

Like all drainage systems, SuDS need to be inspected and maintained to ensure efficient operation and prevent failures. Adoption is when an organisation agrees to take responsibility for the long-term future management and maintenance of the SuDS component(s). WLBC as the LPA requires arrangements for the adoption of SuDS in West Lancashire, as laid out in the WLBC SuDS guidance document.

Local authorities, water companies (e.g. United Utilities), Internal Drainage Boards (IDBs) and private management companies can adopt SuDS. Adoption is typically undertaken on a case-by-case basis and where the SuDS meet the local design standards. Unless the SuDS have been adopted, the landowner is the party responsible for ensuring that SuDS within their land are maintained over the lifetime of the development even if those SuDS serve other properties.

The present challenge is that institutional arrangements for the ongoing maintenance of piped conventional drainage are clear, but remain less so for non-traditional SuDS components such as ponds, swales and wetlands. An article on SuDS adoption by Environment Analyst[26] reported that *'the lack of a national structure for formal adoption or long-term maintenance of SuDS, means Local Authorities have no guarantee that SuDS will continue to function as designed. There are no mechanisms to inspect SuDS post-construction or for the developer to retain any long-term liability for the system. Local Authorities place conditions on requiring details and proof of maintenance arrangements; however, these are not enforced or monitored'*.

4.7 The performance of SuDS in England

Research on the effectiveness of SuDS in terms of hydraulic performance, water quality and amenity in England is limited. The most recent, national-scale review of the performance of SuDS was undertaken by CIRIA in 2009, as presented in the report 'Overview of SuDS Performance'.[27]

The CIRIA report sets out several key findings from the current evidence base. It should be noted that these findings are from 2009, which was before SuDS were made a statutory requirement for new major developments. Consequently, there was little uptake in SuDS by developers nationally at this time and thus the evidence for SuDS performance was limited.

The key findings of the CIRIA report in relation to the hydraulic performance of SuDS are as follows:

- SuDS have particular value in areas of flat topography as the hydraulic gradient can be created within the SuDS unit and self-cleansing is not an issue.
- SuDS schemes are less effective in steep environments; the need for embankments and the risk of erosion due to high flow rates and the reduction in effective storage can reduce

[26] Environment Analyst, 2017

[27] CIRIA, 2009. Overview of SuDS Performance

the overall effectiveness of the system. However, well designed systems can help reduce the velocity of flows.

- Rainwater harvesting has traditionally been regarded as being of little value for stormwater management. This is largely true for the standard sizing of storage systems and also where yield (from the roof) is significantly greater than demand. However, for most of England where the standard average annual rainfall (SAAR) < 1,000mm, rainwater harvesting based on tank sizes of 750 to 1,000 l/person results in major flood protection and reduction of flood flows from properties.
- The primary SuDS components of importance (basins, ponds, permeable pavements) are relatively well understood with respect to their hydraulic performance, in terms of their robustness against both deterioration and failure. Their variability in performance is largely related to the assumptions made in the design process e.g. soil characteristics and permeabilities, topography and shape in comparison to the on-site ground conditions.
- The SuDS components where greatest uncertainty arises with regards to their performance for extreme rainfall events are green roofs (both in terms of hydraulic behaviour and potential for damage).
- The major SuDS components (ponds, detention basins and permeable pavements) are fundamental to the success of a SuDS based system, particularly within urbanised areas where densities are high, as they provide the best facility to manage extreme rainfall events.
- The effectiveness of infiltration-based methods is limited in areas which contain low permeability soils and underlying geology, and where the groundwater table is high (i.e. close to the ground surface) such as in low-lying areas. The infiltration rate must be considered in conjunction with the groundwater table elevation which for most schemes should be at least 1 m below the base of the SuDS component. This unsaturated thickness is necessary to ensure that there is space for a local rise in groundwater that may result from stormwater infiltration.

4.8 The delivery of SuDS in England

While there is some evidence for good hydraulic performance of SuDS in England, in practice, the design and delivery of SuDS is often a different story. In recent years, there has been much debate regarding the delivery of SuDS through the planning system. Not only the extent to which SuDS are being included within development proposals, but also the way in which they are then delivered: their integration within a design; the quality and nature of the proposals; and whether they are used to deliver benefits beyond the management of water quantity.

Research on SuDS delivery through the planning system was published in the document 'Achieving sustainable drainage - a review of delivery by Lead Local Flood Authorities'.[28] The research evaluated the effectiveness of SuDS delivery through the planning system in England, the successes and failures of the current system, and how those failures could be remedied. The key findings of the research are as follows:

[28] CIC and Landscape Institute, 2019. Achieving Sustainable Drainage; a review of delivery by Lead Local Flood Authorities

- **Design principles**. The best practice principles of multifunctional SuDS described in CIRIA SuDS Manual are rarely used as the basis for schemes submitted to planning. 96% of authorities reported that the quality of submissions was either 'inadequate' or 'mixed'. The 'easy' option of over-sized pipes, tanks, and crates is common, with a 'token gesture' swale or pond.
- **Local Policy**. There is a wide variability in SuDS policy across England, from the comprehensive to the almost non-existent. 34% of authorities rely on Design Guides rather than policy or supplementary planning documents (SPDs), while 25% have no formal policy and no plans to implement one.
- **Adoption and maintenance of SuDS.** Almost no residential SuDS schemes have been adopted by local authorities since April 2015, with many ongoing management and maintenance issues still unresolved.
- **Scope of LLFA remit.** LLFAs feel constrained in their ability to require SuDS submissions to include multi-functional benefits (improvements to water quality, biodiversity and public amenity), as the Non-Statutory Technical Standards do not require them.
- **Consultation.** Involvement of the LLFA at the pre-application stage is crucial to encourage development that embraces a multi-functional approach. Almost half of authorities (49%) offer pre-application advice 'only when requested'.
- **Quality of submissions.** Only 3% of authorities reported receiving adequate information to assess a planning application. Clear submission requirements for major and minor schemes would help, with separate checklists on the Planning Portal for outline, detailed, and reserve matters applications.
- **Delivery.** The planning process from outline to detailed consent tends to erode the delivery of potentially high-quality SuDS. Provisional concepts are not followed through, exacerbated by piecemeal/phased applications, or negotiations by the developer.

4.9 What might this mean for Rufford?

The main principles of SuDS are to ensure that developments do not lead to an increase in flooding or flood risk. SuDS should also seek to provide betterment to flood risk wherever possible. In theory, SuDS designed to an appropriate level will ensure that this happens. However, in planning and practice, this may not be the case, with SuDS schemes either not being designed appropriately; not being constructed in a manner that provides the performance of the theoretical design or not being maintained in a manner that allows the SuDS to perform to their design.

The research on the performance of SuDS and delivery in England demonstrates the need for clear and robust local policies and locally specific design standards for SuDS. A review of the West Lancashire Local Plan and the WLBC local SuDS design guidance in this report found that the policy requirements and design principles for SuDS in West Lancashire are in some respects considered inadequate and not sufficiently robust. Moreover, LCC as the LLFA for Lancashire and the body ultimately responsible for assessing and approving all surface water drainage systems for all *major* developments, have not yet published their policies and standards for SuDS.

Maintenance and adoption arrangements are important for ensuring that SuDS are functional and effective at all times. Non-functional SuDS arising from a lack of maintenance or adoption could potentially result in a greater risk of flooding to both the development and elsewhere. A long-term maintenance and adoption plan for the SuDS at new developments, alongside robust design and implementation, will be critical in ensuring that there is no increase in flood risk. However, how this can be enforced is currently not clear as there are no mechanisms for local authorities to inspect SuDS post-construction or for the developer to retain any long-term liability for the system.

There are a number of key physical factors that affect the implementation of SuDS schemes, including local ground conditions, shallow groundwater conditions, local drainage conditions and whether local drainage systems require pumping or are located on low-lying land or benefiting from flood defences. Where these factors are present, as at Rufford, a high level of scrutiny is required to ensure that the SuDS will perform to ensure there is no increase in flood risk posed by a development.

Should development in Rufford be planned, SuDS are designed to control the rate of discharge to the greenfield rate and more critically, manage the volume of runoff (particularly during extreme storm events), are considered key in reducing future flood risk due to the presence of the pumped land drainage system in the area. The land drainage system is the principal point of discharge for both existing and new developments along with the local sewer networks in Rufford. As a result, increases in the rate and volume of runoff entering the land drainage system due to development with SuDS that have not been designed appropriately, may increase the risk of flooding by reducing flood storage volume and increasing loading on the pumping stations. SuDS which focus on volume control e.g. infiltration and storage elements will be important in this regard and should be prioritised at developments in Rufford wherever possible.

Whilst any potential development in the Rufford area deserves close scrutiny regarding its SuDS, development in the Douglas catchment upstream of Rufford is considered more concerning. This is due to the sheer scale of planned development and the impact of flooding when the Douglas (and its tributaries) breach their banks. The magnitude of the potential impact of upstream development, with and without functioning SuDS, is estimated in chapter 5.

5 POTENTIAL IMPACTS OF DEVELOPMENT ON FLOODING IN THE RUFFORD AREA

5.1 Implications of development and SuDS on flooding in Rufford

Development such as housing and dysfunctional or defunct SuDS schemes in the River Douglas and Holmeswood catchments could increase the risk of flooding in Rufford and Holmeswood Parish by increasing flows and runoff volumes to rivers and the pumped land drainage systems.

Quantifying the effects of these impacts in detail is a difficult task given that development and associated SuDS are spatially variable, vary in size and design, and may or may not be maintained over the long-term. However, a basic quantitative assessment of the magnitude of changes in peak flow and runoff volumes that might be expected in the catchment due to future development and SuDS can be made by applying a simple catchment hydrological modelling approach.

5.1.1 Methodology

To assess the potential impacts of future development and SuDS on flood risk in Rufford, estimates of peak flow and runoff volumes for the catchments River Douglas to Rufford and Holmeswood Pumping Station were derived from the Wallingford HydroSolutions Revitalised Flood Hydrograph (ReFH) Model v. 2.3.

ReFH is the industry-standard model for estimating design and observed flood hydrographs for rural and urbanised ungauged catchments across the UK. ReFH is designed and calibrated to long-term, gauged UK rainfall data with national coverage, thereby providing realistic estimates of peak flows and runoff volumes for different storm event magnitudes. The modelling covers a range of rainfall return periods using the latest Flood Estimation Handbook (FEH) 2013 depth-duration-frequency (DDF) design rainfall data which is derived from statistical analysis of gauged rainfall data.

As a means of modelling the changes in peak flows and runoff volumes in the catchments due to development, the urbanisation parameters in the ReFH model were adjusted. Urbanisation in the ReFH model is defined by three parameters: Urban Area (km^2), Imperviousness Factor (IF) and Impervious Runoff Factor (IRF).

Urban Area is defined by default within the ReFH model using the FEH catchment descriptor defining urban extent (*URBEXT2000*). The land cover data used in the derivation of *URBEXT2000* is based on the Centre for Ecology Hydrology (CEH) Land Cover Map of Great Britain produced in the year 2000. This is the latest catchment urban extent data set available for use within ReFH and provides an estimate of the 'existing' extent of urbanisation in each of the three catchments. It is understood that an update to the *URBEXT2000* descriptor is due in 2020/2021. While it is noted that there has likely been an increase in urban extent within the catchments since 2000, for the purposes of this assessment the emphasis is on looking at the relative change in flows and volumes and therefore use of *URBEXT2000* is considered appropriate. Given that development since 2000 to present is not included in the model, both peak flow and runoff volume values are underestimates.

The IF parameter defines the proportion of the catchment which is impervious (e.g. covered by roofs or paving). The default value for IF in the model is 0.4 (i.e. 40% of the Urban Area is assumed to be impervious). The IRF parameter represents the proportion of rainfall that results in runoff for the defined Urban Area. The default value for IRF in the model is 0.7 (i.e. 70% of the rainfall incident on the impervious surface area runs off). For consistency and comparability across the catchments, the default values for both parameters were used.

The extent of expected future urbanisation in the Douglas catchment upstream of Rufford, as a result of required development, was derived from Table 2-5.[29] No significant development is planned in the catchment of the Holmeswood Pumping Station, therefore the catchment is solely modelled based on the existing urban area. Table 5-1 provides a summary of the existing Urban Area derived from *URBEXT2000* and the future Urban Area defined by required development and employment land in the relevant Local Plans (see Section 2.6). It is assumed that all new development is on greenfield land. Table 5-1 highlights that the River Douglas catchment to Rufford is expected to experience an increase in urbanised area of +4.13 km^2, or 10%.

Table 5-1 Summary of existing and future catchment urban areas

Catchment	Catchment Area (km^2)	(A) Existing Urban Area[1] (km^2)	(B) Required Dwellings and Equivalent Land Area[2]	(C) Required Employment Land (km^2)	(A+B+C) Future Urban Area (km^2)	Change in Urban Area (km^2)
River Douglas to Rufford	229.11	41.46	17,324 (1.32km^2)	2.81	45.59	+4.13 (10%)
Holmeswood Pumping Station	10.25	0.61	-	-	-	-

[1] Based on Flood Estimation Handbook (FEH) urban extent descriptor (URBEXT) for the year 2000
[2] Dwelling area calculated assuming average floor space for new houses in the UK of 76m^2 [30]

Using the Urban Area data contained in Table 5-1, three scenarios were configured within the ReFH model to enable a comparison of the magnitude of change in peak flows and runoff volumes between the existing catchment scenario and that due to future development and SuDS. The three modelling scenarios are as follows:

1. Existing extent of urbanisation in the catchment based on the FEH descriptor for urban extent (*URBEXT2000)*.
2. Required development by the year 2050, assuming developments do not have SuDS or that the SuDS are defunct either by poor design or through lack of or no maintenance.
3. Required development by the year 2050, assuming that SuDS are employed and maintained, and are attenuating runoff back to the 1 in 1 year greenfield runoff rate, therefore providing betterment to flood risk.

For each modelling scenario, the model was run for six storm event severities, ranging from a small, common event (1 year return period), to a large, rare storm event (100 year return period), including a 40% allowance factor for climate change in line with Environment Agency guidance. With the exception of the 1 year return period event, the remaining return periods selected relate to the main Standards of Protection (SoP) currently provided by the Environment Agency flood defences within and around Rufford and Holmeswood Parish.

[29] The River Yarrow is prone to flooding, therefore has the potential to cause backing-up of water in River Douglas at Rufford area. Development in the Yarrow / Lostock catchment and the backing-up of water have not been included in the modelling but it is noted that these factors may cause additional flood risk

[30] The National Archives. (2019). The Town and Country Planning (Development Management Procedure) (England) Order 2010.

A Summer storm seasonality was selected for all model runs as this produced the highest peak flow and runoff volumes, therefore providing what would be 'worst case' scenarios.

5.1.2 Results and discussion

River Douglas Catchment to Rufford

The peak flow and runoff volume outputs from the modelling scenarios for the River Douglas catchment to Rufford are presented in Table 5-2 and Table 5-3 respectively. The values in red represent an increase, while the values in green represent a decrease in either peak flow or runoff volume relative to the existing scenario (Scenario 1).

Table 5-2 River Douglas to Rufford - peak flows

Storm return period	Existing peak flow	Future peak flow - no or defunct SuDS		Future peak flow - with SuDS and maintained	
years	m^3/s	m^3/s	% change	m^3/s	% change
1 in 1	43.2	44.6 (+1.4)	3.2	43.2	0.0
1 in 5	60.6	62.5 (+1.9)	3.0	60.3 (-0.3)	-0.5
1 in 25	87.4	90.1 (+2.7)	3.1	86.6 (-0.8)	-0.9
1 in 50	102.7	105.9 (+3.2)	3.1	101.6 (-1.1)	-1.1
1 in 100	121.1	124.8 (+3.7)	3.1	119.7 (-1.4)	-1.2
1 in 100 + 40% CC	182.9	188.4 (+5.5)	3.0	180.4 (-2.5)	-1.4

Table 5-3 River Douglas to Rufford - runoff volumes

Storm return period	Existing peak flow	Future peak flow - no or defunct SuDS		Future peak flow - with SuDS and maintained	
years	m^3	m^3	% change	m^3	% change
1 in 1	1,550,980	1,602,490 (+51,510)	3.3	1,550,980	0.0
1 in 5	2,266,672	2,340,032 (+73,360)	3.2	2,229,822 (-36,850)	-1.6
1 in 25	3,387,478	3,493,488 (+106,010)	3.1	3,330,948 (-56,530)	-1.7
1 in 50	4,033,101	4,157,231 (+124,130)	3.1	3,965,031 (-68,070)	-1.7
1 in 100	4,817,945	4,963,565 (+145,620)	3.0	4,735,685 (-82,260)	-1.7
1 in 100 + 40% CC	7,493,261	7,708,781 (+215,520)	2.9	7,361,631 (-131,630)	-1.8

Table 5-2 shows that peak flows in the River Douglas at Rufford due to new development and no/defunct SuDS in the catchment, could be increased by between 1.4 m^3/s for a 1 year storm, to 5.5 m^3/s for a large 100 year storm event (taking into account climate change), equivalent to a c. 3 % increase in peak flow. Similarly, Table 5-3 shows that runoff volumes could increase by between 52,000 and 216,000 m^3, equivalent to a c. 3 % increase in runoff volumes. In both cases, climate change coupled with new development without SuDS or defunct SuDS could lead to even greater increases in peak flows and runoff volumes.

The increase in peak flows and runoff volumes is greater as the storm event return period (severity) increases, meaning the risk of flooding during more severe storms would be much higher. Given that the Douglas is tidally influenced at Rufford, increases in peak flow (and water level) would be exacerbated further by high tides, increasing the risk of flooding to Rufford. In the event of the River Douglas breeching its western bank near Rufford, floodwater would increase loading on Rufford Pumping Station which could increase the risk of flooding to the A59 road, along with nearby properties and the surrounding local area.

Higher peak flows in the River Douglas will reduce the SoP provided by the flood defences around Rufford as water levels in the Douglas would be higher, which could lead to overtopping or failure of the defences. The SoP of the defences along the Douglas past Rufford range from 1 in 25 to 1 in 100 years. For these events, significant increases in peak flow of between 2.7 to 3.7 m^3/s are predicted. It is estimated based on the modelling results, that development with no or defunct SuDS could reduce the SoP of the defences to 1 in 22.5 and 1 in 89.5 years.

While a basic estimate of the relative change in SoP of the flood defences can be made using the model outputs, determining the absolute change in SoPs, in response to future development and SuDS, would require a detailed hydraulic modelling approach. This could be undertaken if it were deemed necessary in order to provide a much better understanding of the potential changes in the current level of protection provided by the defences.

Assuming that all new development in the catchment has SuDS that are maintained and which attenuate runoff to the 1 in 1 runoff rate, peak flows and runoff volumes would be reduced to lower than the existing catchment scenario. This would therefore provide betterment to flood risk in Rufford and Holmeswood Parish. For the 100 year return period (accounting for climate change), peak flow and runoff volume could be reduced by 2.5 m^3/s and 131,600 m^3, respectively, compared to existing conditions, if all new development employ maintained SuDS. This betterment is equivalent to a reduction in peak flow of up to 1.4 % and reduction in runoff volume of up to 1.8 % compared to the existing situation.

Catchment to Holmeswood Pumping Station

The peak flow and runoff volume outputs for the catchment to the Holmeswood Pumping Station are presented in Table 5-4.

Table 5-4 Holmeswood Pumping Station – peak flows

Storm return period (years)	Existing peak flow (m^3/s)	Existing runoff (m^3)
1 in 1	1.4	37,140
1 in 5	2.1	58,853
1 in 25	3.3	95,730
1 in 50	4.0	117,561

1 in 100	4.9	143,843
1 in 100 + 40% CC	7.8	231,529

The peak flow data highlight that the maximum pump capacity of Holmeswood Pumping Station (0.5 m^3/s; Table 3-5) alone would be exceeded during a small return period storm event. However, it is important to note that the excess flood water is stored in the expansive land drainage systems of drains and sluices within the catchments. Any potential increase in runoff volumes in this low-lying, pumped catchment is therefore critical as it would reduce the capacity in the drainage system to accommodate flood waters, thereby increasing loading on the pumping stations and increasing the risk of flooding. The maximum pump capacity is lower than the predicted 1 in 1 year peak flow, and therefore surplus volume that cannot be pumped to the high-level carrier drain will need to be stored in the low-level carrier drains. A basic estimate based on the modelling outputs for the flood volume capacity provided in the low-level carrier drains and Mere Sands Nature Reserve is approximately 100,000 m^3. This equates to the system being able to retain a 1 in 29 year storm event under the existing scenario.

As is the case in the River Douglas catchment, new development without SuDS or defunct SuDS, coupled with climate change, could lead to even greater increases in peak flows and runoff volumes.

Summary

New development in the River Douglas and Holmeswood catchments that does not incorporate SuDS or has SuDS that are defunct, could lead to significant increases in peak flows and runoff volumes and thus increased flood risk in Rufford and Holmeswood Parish. The changes in flows and runoff could be greater during more severe storm events. In addition, the results highlight that climate change could also exacerbate the impacts of new development which does not incorporate or maintain SuDS.

In all modelled scenarios, it is predicted that new development with SuDS that are maintained and attenuate runoff to the 1 year greenfield runoff rate could provide significant flood risk betterment by reducing peak flows and runoff volumes. The results show therefore that SuDS which are appropriately designed, implemented and maintained will be important in reducing the risk of flooding increasing in Rufford and Holmeswood Parish in the future.

5.2 Import of water due to development

When considering discharge of water associated with development, the discharge of domestic supply (via sewers) must be taken into account as well as drainage of rainfall runoff.

An annual additional use of 2.2 million cubic metres of water in the Douglas catchment upstream of Rufford is calculated assuming a daily domestic water usage of 349 litres per household[31] for the planned 17,324 houses. A significant proportion of the public water supply in the Douglas catchment upstream of Rufford is sourced from outside the catchment.[32] The majority of this

[31] https://energysavingtrust.org.uk/sites/default/files/reports/AtHomewithWater%287%29.pdf

[32] Wigan's public water supply is sourced from the Rivington Reservoir complex, much of which is diverted water from the River Yarrow (which would otherwise enter the River Douglas downstream of Rufford) into the upstream Douglas. Skelmersdale's public water supply is sourced from the River Dee (https://www.unitedutilities.com/help-and-support/your-water-supply/drinking-water-quality)

water is thought to be discharged to Waste Water Treatment Works (WWTWs), e.g. Wigan (Hoscar) WWTW and Skelmersdale WWTW, and ultimately, the River Douglas.

The annual average river flow of the River Douglas at Rufford is c.155 million cubic metres.[33] It is therefore calculated that planned development in the River Douglas catchment to Rufford may increase the volume of water in the catchment by up 1.4 %, which may in turn increase flood risk.

5.3 Mitigating the impacts of development and SuDS on flooding in Rufford

Comprehensive and robust local policy in West Lancashire will be important in setting out the core requirements for surface water drainage and SuDS at new developments in order to reduce flood risk in the district.

Locally specific and robust SuDS design standards and principles for West Lancashire and areas within that have physical and hydrological factors which make them sensitive to flooding, such as Rufford will be critical in ensuring that SuDS are designed to a standard which would sufficiently prevent flood risk from being increased. There are a number of key physical factors that could affect the implementation of SuDS schemes which need to be considered in Rufford, including local ground conditions, shallow groundwater conditions, local drainage conditions and whether local drainage systems require pumping or are located on low-lying land or benefiting from flood defences.

SuDS at new developments that are designed to manage and reduce the rate of runoff to the greenfield (pre-development) runoff rate, via the use of attenuation systems (e.g. attenuation basins, swales), will be vital for reducing the risk of flooding downstream. This is particularly important to fluvial systems (i.e. the River Douglas) which are strongly influenced by flows (discharges) from land and development in the catchment. In the future, new development and general urbanisation would increase the rate of runoff to rivers and streams, unless SuDS measures are in place that are acting to attenuate flows to the greenfield rate.

Managing the volume of runoff (and also runoff rates to a lesser extent) from any new development in areas of Rufford and Holmeswood Parish which lie within the Holmeswood catchment will also be a key aspect of flood risk mitigation in the future. Emphasis on storing surface water or discharging it via infiltration-based methods at new developments will be important in reducing the volume of runoff entering the land drainage systems. Such measures would help maintain flood water capacity in the system and reduce loadings on the pumping stations, thereby reducing the risk of flooding.

The statutory requirement for SuDS on *major* developments within the planning process may mean that small and minor scale developments, e.g. for developments of less than 10 dwellings, are constructed without SuDS. Developers would not be required to include SuDS as part of the development scheme. Cumulatively over the catchment, these minor developments without SuDS would increase flows and runoff volumes and increase the risk of flooding.

Long-term adoption and maintenance arrangements will be important for ensuring that SuDS at new developments are managed and remain functional and effective at all times. The modelling results for all three catchments relevant to Rufford emphasise how development without SuDS or with defunct SuDS (due to lack of or no maintenance) could potentially lead to significant increases in peak flows and runoff volumes, thereby increasing flood risk in Rufford and

[33] Using catchment area of 229 km2, standard average annual rainfall of 1,009 mm/yr and (100 minus) the standard percentage runoff of 32.9 % from Table 3-2.

Holmeswood Parish. Therefore, adoption and maintenance plans for SuDS at new developments, alongside robust design and construction, will be critical in ensuring that there is no increase in flood risk. How WLBC as the LPA for West Lancashire can enforce this, however, is not currently clear.

Verification that SuDS at new developments (particularly major developments) have been constructed as per the agreed scheme will be critical in ensuring what is approved by the planning permission process is actually followed through on the ground and to the required standard. A verification report would typically be carried out by a qualified drainage engineer and must be submitted to and approved by the LPA as part of planning conditions. Each LPA may have different policies with regards to surface water drainage and SuDS verification. WLBC's position and policy on drainage verification at new developments is not currently known.

6 CONCLUSIONS AND RECOMMENDATIONS

The Rufford area has a history of flooding, with the latest major flooding events in 2012 and 2015.

The area is served by a network of drainage ditches, pumping stations and sluices. The River Douglas is located immediately to the east of Rufford and Holmeswood Parish, where it is bounded by levees which provide flood protection to the adjacent low-lying agricultural land. There is a concern that development locally and upstream may increase the flood risk.

The Rufford area is susceptible to a complex set of flooding mechanisms which can interact and combine to produce significant flood risk. The risk of flooding in the areas of Rufford relating to the Douglas catchment can be attributed to following key mechanisms:

- Fluvial flooding, as a result of overtopping and/or failure of the flood defence embankments along both the River Douglas and main sluices in the Crossens catchment
- Tidal factors:
  - High water level within the Ribble Estuary may cause tide locking (this is when the level of the incoming high tide stops the river water flowing out to sea)
  - High water levels in the Irish Sea may prevent Crossens Pumping Station, the outlet of the drainage system serving Rufford and surrounding areas, pumping flood waters to the sea, causing water levels to increase
  - Tidal flooding affecting flood mitigation and water management infrastructure
- Localised surface water flooding in residential areas and along road networks
- Incapacity of the land drainage network to accommodate rainfall-runoff and groundwater
- Groundwater flooding
- Incapacity and/or inoperability of the pumping stations, particularly the Holmeswood Pumping Station and Crossens Pumping Station
- Overtopping and/or failure of the Leeds and Liverpool Canal situated to the east of Rufford

Flood management systems are in place to reduce flood risk. The south-western half of Rufford and Holmeswood Parish lies within the Martin Mere system where the Standard of Protection (SoP) is for a 1 in 50 year event. However it is unclear (but unlikely) whether floodwater entering the Martin Mere system from the River Douglas or its tributaries is taken into account when calculating the SoPs. The north-eastern half of Rufford and Holmeswood Parish lies within the Rufford and Mawdesley system which has variable levels of protection. The SoP in the main channel of the River Douglas vary from 1 in 25 year events to 1 in 100 year events. The Eller Brook's SoP are for 1 in 40 year to 1 in 50 year events and the areas of pumped drainage adjacent to the River Douglas have SoP for 1 in 5 year events.

Analysis of flow gauge data from the River Douglas near Rufford indicate that the percentage of runoff has increased (from 63% between 1996-2005 to 65% between 2006-2015) and that irrespective of the size of rainfall event, more of the water is entering the river. These results indicate that indicate that conditions in the catchment have changed over the past two decades.

Furthermore, significant development is planned in the River Douglas catchment upstream of Rufford (parts of Wigan District and West Lancashire Borough Council), comprising c.17,234 dwellings and 281 Ha of employment land (by 2026 in Wigan District and 2050 in WLBC). This represents a 10% increase in the urban area of the catchment. It is noted that no development is currently planned within the Rufford and Holmeswood Parish boundary.

In order to manage downstream flood risk, Sustainable Drainage Systems (SuDS), are a statutory requirement on all major developments (unless deemed to be inappropriate). The SuDS approach involves slowing down and reducing the quantity of surface water runoff from a developed area through considered design of rainwater harvesting, pervious surfacing, infiltration, conveyance and storage systems. Research on the performance of SuDS demonstrates that SuDS can achieve good hydraulic performance. However, there are a number of key physical factors that affect the implementation of SuDS schemes, including local ground conditions, shallow groundwater conditions, local drainage conditions and whether local drainage systems require pumping or are located on low-lying land or benefiting from flood defences. Where these last factors are present, as at Rufford, a high level of scrutiny is required to ensure that the SuDS will perform to ensure there is no increase in flood risk posed by a development.

Research on SuDS delivery both nationally and locally, demonstrates a need for locally specific design standards and clear and robust local policies for SuDS, including maintenance and adoption arrangements. Within the Rufford area, Lancashire County Council (as Lead Local Flood Authority), are required to provide consultation responses on surface water drainage provisions for new major developments to West Lancashire Borough Council (as Local Planning Authority). The policy requirements and design principles for SuDS in West Lancashire are in some respects inadequate and not sufficiently robust. Moreover, LCC, as the LLFA for Lancashire and those ultimately responsible for assessing and approving all surface water drainage systems for all major developments, have not yet published their policies and standards for SuDS.

Whilst any potential development in the Rufford area deserves close scrutiny regarding its SuDS, development in the Douglas catchment upstream of Rufford is considered more concerning. This is due to the sheer scale of planned development and the impact of flooding when the Douglas (and its tributaries) breach their banks.

Modelling (ReFH) results showed that new development that does not incorporate SuDS (or has SuDS that are defunct), could lead to significant increases in peak flows and runoff volumes and thus increased flood risk in Rufford and Holmeswood Parish. However, modelling indicates that new development with SuDS that are maintained and attenuate runoff to the 1 year greenfield runoff rate could provide significant flood risk betterment by reducing peak flows and runoff volumes. Modelling results indicate that SuDS which are appropriately designed, implemented and maintained will be important in reducing the risk of increased flooding in Rufford and Holmeswood Parish in the future.

Additionally, import of water to new developments into the Douglas catchment, via domestic supply and then discharge to sewers, may increase the volume of water in the River Douglas to Rufford in the catchment by up 1.4 %, which may in turn increase flood risk.

SuDS has the technical potential to achieve good protection against flooding on-site and downstream, but the current regulatory regime is considered unlikely to deliver the high standards of design, implementation, verification and maintenance of SuDS that is required if SuDS is to deliver benefit. Under current circumstances, there is every possibility that poor SuDS performance will increase flood risk and reduce the Standards of Protection of existing flood defences.

In conclusion, it is recommended that regulators and stakeholders take urgent consideration of the following five issues:

1. The lack of clear policies on SuDS design, adoption, management and maintenance
2. Options for effectively measuring the impacts of SuDS on flood risk
3. The possible cumulative impacts of minor developments that do not have SuDS

4. The cross-catchment impacts of flooding from the Douglas on Standards of Protection in the Crossens catchment
5. The role of import of water from adjacent catchments to new developments

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