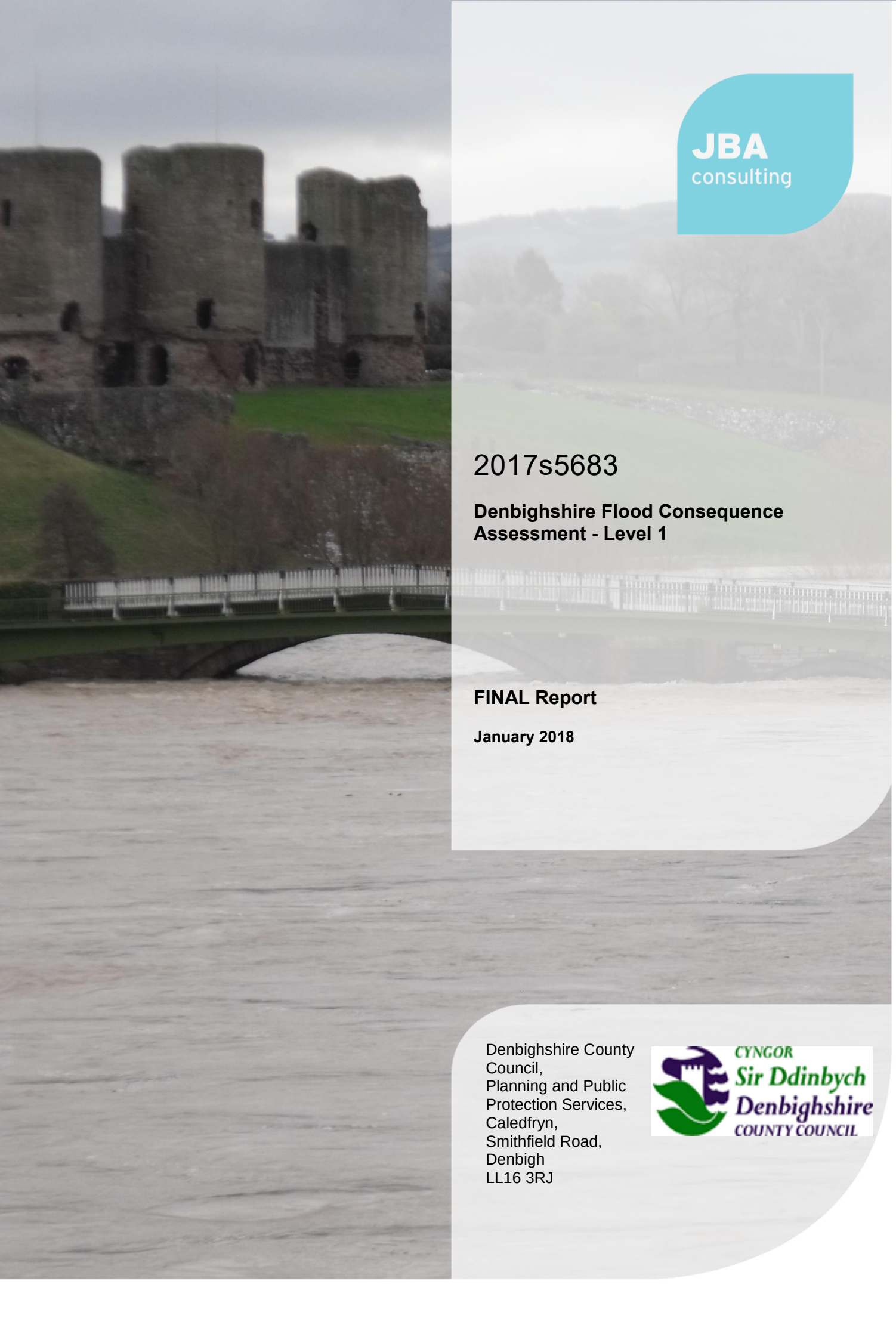


2017s5683

Denbighshire Flood Consequence Assessment - Level 1

FINAL Report

January 2018

Denbighshire County Council,
Planning and Public Protection Services,
Caledfryn,
Smithfield Road,
Denbigh
LL16 3RJ

JBA Project Manager

Mike Williamson
JBA Consulting
Bank Quay House
Sankey Street
WARRINGTON
WA1 1NN

Revision History

Revision Ref / Date Issued	Amendments	Issued to
v0.1 Draft SFCA Report		Howard Keeble
v.02 Draft SFCA Report		Claire Macfarlane
v.03 Draft SFCA Report	Additional community of Llangollen added to SFCA	Claire MacFarlane
V0.4 Draft SFCA Report	Focus report and maps on key settlements	Claire MacFarlane, Wayne Hope
v.0.5 Draft SFCA Report	Clarifications/minor edits	Claire MacFarlane, Wayne Hope (Denbighshire County Council and Ryan Knowles and Emyr Gareth Natural Resources Wales)

Contract

This report describes work commissioned by Denbighshire County Council. Denbighshire County Councils' representative for the contract were Claire MacFarlane of (Planning Policy). Andrew Fielding, Ellen Broad, Michael Williamson, Charlotte Lloyd Randall, Charlotte Beattie and Howard Keeble of JBA Consulting carried out this work.

Prepared by ..... Charlotte Lloyd-Randall (BSc)
Technical Assistant

Charlotte Beattie BA MTPL MRTPI
Chartered Town Planner

Reviewed by ..... Howard Keeble MPhil BEng BSc CEng CEnv CSci CWEM MICE MCIWEM MCMI
Technical Director

Purpose

This document has been prepared as a Draft Report for Denbighshire County Council. JBA Consulting accepts no responsibility or liability for any use that is made of this document other than by the Client for the purposes for which it was originally commissioned and prepared.

JBA Consulting has no liability regarding the use of this report except to Denbighshire County Council.

Acknowledgements

JBA would like to thank Denbighshire County Council, Natural Resources Wales and Welsh Water staff for their time and commitment to providing data and discussing the issues identified during = this study, to ensure it is fit for purpose.

Carbon Footprint

A printed copy of the main text in this document will result in a carbon footprint of 511g if 100% post-consumer recycled paper is used and 651g if primary-source paper is used. These figures assume the report is printed in black and white on A4 paper and in duplex.

JBA is aiming to reduce its per capita carbon emissions.

Executive Summary

Denbighshire County Council (DCC) has commissioned a Strategic Flood Consequence Assessment (SFCA) update to be carried out in accordance with TAN 15: Development and Flood Risk[1]. It takes on board the guidelines of TAN 15 which advises a precautionary framework and action required through development plans, specifically the consideration of flooding issues during the preparation of Local Development Plans, whilst acknowledging the current review of TAN 15 is underway.

This Strategic Flood Consequence Assessment for Denbighshire provides a new level 1 assessment. It considers new or updated flood risk information on fluvial, coastal and surface water flooding issues within the county whilst assessing flood risk to existing development site allocations and the surrounding communities. The consideration of flood risk at this stage should help to inform the spatial strategy and new Local Development Plan, help to avoid inappropriate development in high flood risk areas process and facilitate a risk based approach to decision making by the Local Planning Authority.

This SFCA at the request of Denbighshire County Council has focussed the consideration of fluvial, tidal and surface water flood risk and the implications for key settlement areas and has assessed flood risk in the following communities;

- **Rhyl**
- **Prestatyn**
- **Ruthin**
- **Rhuddlan**
- **Bodelwyddan**
- **St Asaph**
- **Corwen**
- **Denbigh**
- **Clocaenog**
- **Dyserth**
- **Meliden**
- **Llanfair Dyffryn Clwyd**
- **Llangollen (New)**

This SFCA demonstrates the risk of flooding from fluvial, surface water and tidal risks within the settlements of Denbighshire from flood risk mapping data and updated breach modelling assessments which have been re-run to include climate change allowances. The climate change outputs from the breach assessments were based on the Welsh Government Climate Change allowances (2016). The settlement based maps in section five help to illustrate the risk of surface water, TAN15 and DAM fluvial zones and ground water flooding and should be read in combination with the NRW Flood Zone maps 2 provided in Appendix C and Appendix A.

Appendix A provides detailed interactive mapping across Denbighshire and key settlements in terms of all available mapping data and areas benefiting from defences, flood storage and flood warning areas and historical flooding data. This is a strategic Level 1 SFCA and does not consider detailed flood risk impacts, or detailed information behind the areas benefiting from significant defences database or capacity of DCWW sewerage or surface water drainage, or ongoing tidal strategies or shoreline management plan 2 policies. This SFCA does include:

- Detailed interactive GeoPDF maps showing all available flood risk information together with the settlement areas - Appendix A;
- Development Site Assessment spreadsheet detailing the risk to each site with strategic recommendations on development - Appendix B;
- Mapping of each settlement area illustrating the risk of flooding using NRW Flood Zone Maps - Appendix C;

1 Welsh Assembly Government (2004) Technical Advice Note 15 Development and Flood Risk

Contents

List of Figures

List of Tables

Abbreviations

AIMS ..... Asset Information Management System
AStSWF ..... Areas Susceptible to Surface Water Flooding
AStGWF..... Areas Susceptible to Ground Water Flooding
CDA ..... Critical Drainage Area
CFMP..... Catchment Flood Management Plan
DAM ..... Development Advice Map
DCC ..... Denbighshire County Council
DCLG ..... Department of Communities and Local Government
DCWW ..... Dwr Cymru Welsh Water
EA.……Environment Agency
FCA..... Flood Consequence Assessment
FMfSW ..... Flood Map for Surface Water
FWMA..... Flood and Water Management Act
LDP ..... Local Development Plan
LFRMS..... Local Flood Risk Management Strategy
LLFA ..... Lead Local Flood Authority
LPA ..... Local Planning Authority
NFCDD ..... National Flood and Coastal Defence Database
NRW ..... Natural Resources Wales
PFRA ..... Preliminary Flood Risk Assessment
PPM ..... Planned Preventative Maintenance
PPW..... Planning Policy Wales
RBMP..... River Basin Management Plan
RFRA ..... Regional Flood Risk Appraisal
RMA..... Risk Management Authority
SAB..... SuDS Approving Body
SFCA ..... Strategic Flood Consequence Assessment
SIRS..... Sewerage Incident Register System
TAN 15..... Technical Advice Note 15: Development and Flood Risk
SWMP..... Surface Water Management Plan
uFMfSW ..... updated Flood Map for Surface Water
WFD..... Water Framework Directive
WG..... Welsh Government
WIRS..... Wastewater Incident Register System Insert Abbreviations

1 Introduction

1.1 Commission

Denbighshire County Council (DCC) commissioned JBA Consulting in February 2017 to review the updated Strategic Flood Consequence Assessment (SFCA) commissioned in November 2013 which updated the study carried out in 2007. The update is required due to changes in flood risk information, flood forecasting and flood defences since 2007. This update is carried out in accordance with the Welsh Government's development planning guidance, Planning Policy Wales[2] (PPW), Technical Advice Note 15: Development and Flood Risk[3] (TAN 15) and Welsh Government Chief Planning Officers letters, published 9th January 2014, and Welsh Government (2016): FCA Climate Change allowances which, in part, discussed the necessity to take account of climate change for a 0.1% AEP fluvial or tidal flood event. This is discussed in Section 6.

The SFCA will be used in informing development in Denbighshire County, including any future review of the Denbighshire Local Development Plan (LDP).

1.2 Purpose of the SFCA

The purpose of this SFCA update is to identify the strategic flood risks to key communities in Denbighshire to support the preparation of the Local Development Plan:

- Identify potential sources of flooding within the identified C1 flood zones, resultant impacts, variations in actual flood risk, and, the effect of any flood management programme of works within key communities.
- Indicate the potential broad and strategic effects of any increased surface water runoff and groundwater flooding in relation to key communities in consultation with, Natural Resources Wales (NRW), and Welsh Water (DCWW)
- Identify any significant changes to flood risk since previous two studies and allocated Local Development Plan sites.

As a Lead Local Flood Authority (LLFA) and a Local Planning Authority (LPA), Denbighshire County Council is required to produce a SFCA. This SFCA update will be used to inform the development of the new Denbighshire Local Development Plan.

The aims and objectives of the SFCA are:

- To inform development regarding the management of flood risk within the County Council's Local Development Plan.
- To understand flood risk from all sources and to investigate and identify the extent and severity of flood risk throughout the County. This assessment will enable the County Council to steer development away from those areas where flood risk is considered greatest, ensuring that areas allocated for development can be developed in a safe, cost effective and sustainable manner.
- To pay attention to surface water flood risk, using Natural Resources Wales' third generation Risk of Flooding from Surface Water (RoFSW).
- To enable the County Council to meet its obligations under Planning Policy Wales (PPW) and Technical Advice Note 15: Development and Flood Risk (TAN 15).
- To enable the County Council to take extreme events, including consideration of climate change into consideration (in accordance with the recent instruction from The Welsh Government to Chief Planning Officers on 9th January 2014 and Welsh Government (2016): FCA Climate Change allowances.
- To supplement current policy guidelines and to provide a straightforward risk based approach to development management in the area. This is aimed at Councillors, the public and developers.

2 Planning Policy Wales, Edition 9, November 2016

3 Technical Advice Note 15: Development and Flood Risk, July 2004

- To provide a reference document to which all parties involved in development planning and flood risk can reliably turn to for initial advice and guidance.
- To develop a report that forms the basis of an informed development management process that also provides guidance on the potential risk of flooding associated with future planning applications and the basis for site specific Flood Consequence Assessments (FCAs) where necessary.
- To assist the County Council in identifying specific areas where further and more detailed flood risk data and assessment work may be required.
- To provide an update to previous 2007 and 2013 SFCA's using new and updated flood risk information to summarise flood risks to existing allocated sites in the Local Development Plan.

It is important to highlight that this SFCA is strategic in nature and makes use of the most current available information. This SFCA should be used as a starting point for planners, developers and the public to initially consider development and flood risk and whether more detailed, site specific assessments of flood risk, such a Flood Consequence Assessment, are required. It is also worth noting that the presence of flood zones in an area, be it fluvial, tidal or surface water, does not mean that development simply cannot happen. Sites located within areas of lower risk should be considered in preference to areas at higher risk as part of the development planning process and a more detailed assessment of flood risk may be required to ensure that risks can be effectively managed.

1.3 Report Format

This report provides background information to planning policy and flood risk, a summary of known flood risk from all sources in Denbighshire, a spatial assessment of risk to key sites from all sources. This report is supported by SFCA maps in the form of interactive GeoPDFs focussed on key settlements and updated site flood risk screening spreadsheets for existing allocated sites.

1.4 SFCA Future Proofing

This SFCA was developed using the most up-to-date data and information available at the time of commission. The SFCA has been future proofed as far as possible though the reader should always confirm with the source organisation (Denbighshire County Council) that the latest information is being used when decisions concerning development and flood risk are being made. Welsh Government policy documents Planning Policy Wales and Technical Advice Note 15: Development and Flood Risk are referred to throughout this SFCA as these are the current documents available at the time of the finalisation of this SFCA. Also, be aware this is a live document and can be updated by the Council as and when new information becomes available.

2 SFCA Study Area

The SFCA study area (see Figure 2-1) consists of the Denbighshire County Council administrative area in North Wales covering an area of approximately 846 km². Denbighshire is bounded by Conwy and Gwynedd unitary authorities to the West, Powys to the South, Wrexham to the South and East and Flintshire to the East.

The main places of interest, or key areas identified by DCC, for this SFCA have not changes since the last study in 2013 and comprise of:

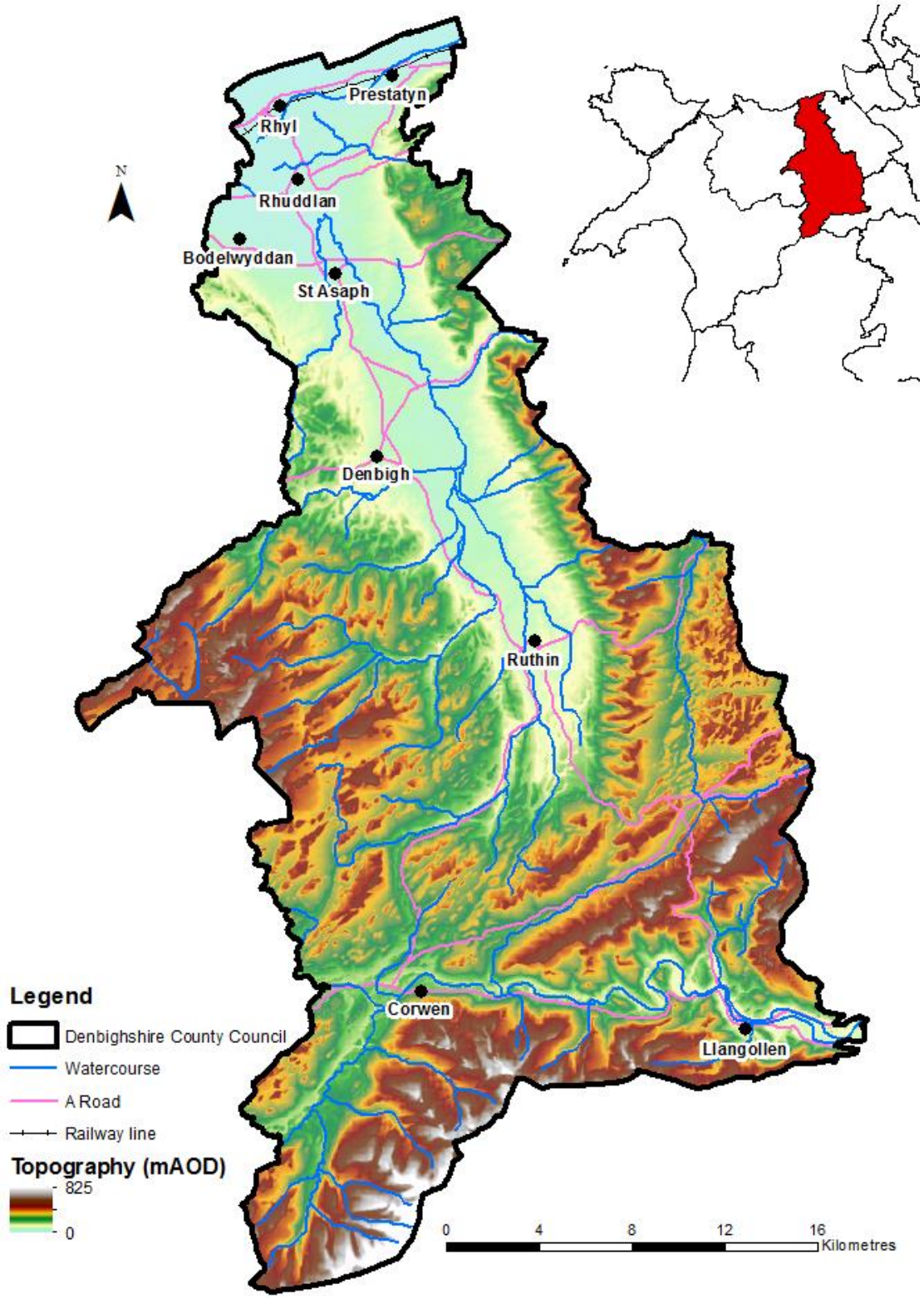
- Rhyl
- Prestatyn
- Ruthin
- Rhuddlan
- Bodelwyddan
- St Asaph
- Corwen

Other key areas, where DCC's key site allocations are located, have also been reviewed. These areas include:

- Denbigh
- Dyserth
- Meliden
- Clocaenog
- Llanfair Dyffryn Clwyd
- Llangollen

There are a number of Main Rivers flowing through Denbighshire, fed by a number of tributaries. The two largest Main Rivers include the River Clwyd and the River Dee. The River Clwyd rises in the Clocaenog Forest Southwest of Ruthin, and runs primarily Northwest through Ruthin, St Asaph and Rhuddlan before discharging into the Irish Sea at Rhyl. The River Dee runs through the South of Denbighshire, through the communities of Corwen and Llangollen.

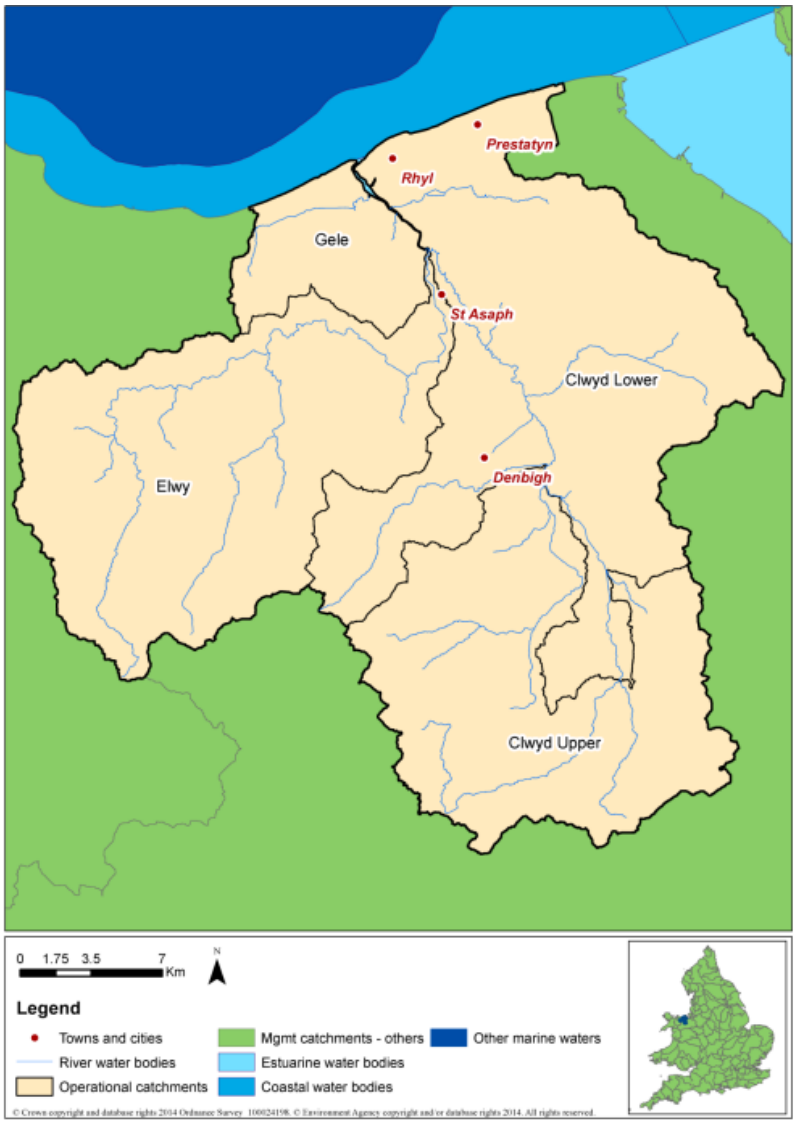
Figure 2-1: Denbighshire SFCA Study Area



River Clwyd

The Clwyd catchment can be split into two sub-catchments, the Clwyd and the Elwy. The Clwyd drains from the Clocaenog Forest and is slow moving and meandering for part of its length. The Elwy, which has its source to the West of the Denbigh Moors above Gwytherin, is an extremely flashy river having high run-off during times of heavy rain and suffers extreme low flows during dry periods[4]. Part of the lower Clwyd catchment is a nitrate vulnerable zone for both surface and groundwater. The lower part of the Clwyd was canalised in medieval times from Rhuddlan to the sea. Modified natural lakes provide public water supplies, and the main river Clwyd is supported by ground water augmentation when flows are naturally low[5].

Figure 2-2 River Clwyd Catchment



River Dee

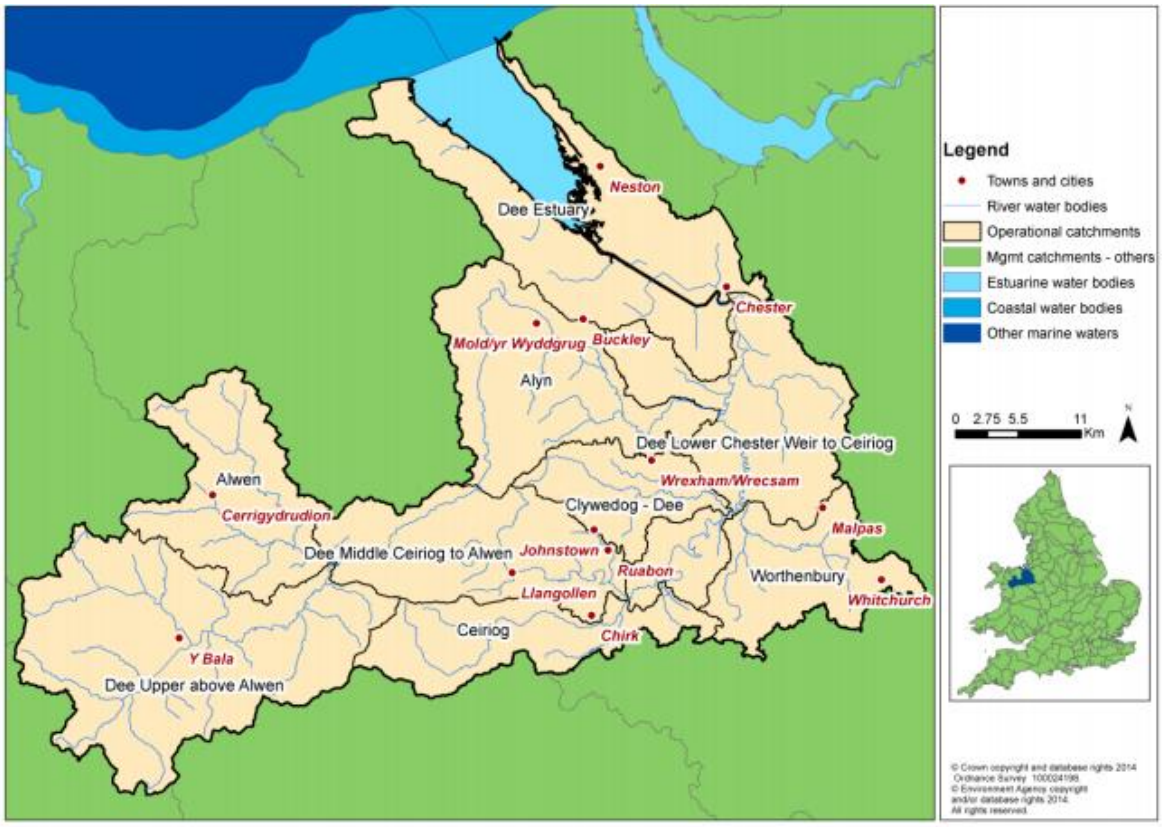
The Dee management catchment covers an area of 2,251 square kilometres, mainly in Wales but in the lower reaches the Dee often runs along the border with England. Its source is in the mountains and lakes of the Snowdonia National Park and it runs to the internationally significant intertidal and wading bird habitat of the Dee Estuary Reservoirs in the upper part of the catchment store water and regulate flow in the Dee. They sustain abstractions for public and industrial water supply and modify flood response in the river, reducing the frequency of flooding in the Dee between Bala and Chester. Parts of the Dee catchment are underlain by a Permo-Triassic

4 https://naturalresources.wales/media/680071/2015-river-clwyd.pdf
5 https://naturalresources.wales/media/3206/clwyd-management-catchment.pdf

Sandstone aquifer. This aquifer is used to support agricultural, industrial and water supply abstractions and contributes to baseflows in the lower Dee and some of the tributaries. The river is an important source of drinking water for nearly three million people, in Wales and North-West England. Risks from pollution have led to it becoming one of the most protected rivers in Europe. In 1999, the lower part of the Dee was designated as the UK's first, and to date only, Water Protection Zone.

The Dee and its estuary has a high conservation value, it is designated as two Special Areas of Conservation (SAC), and notified as three separate Sites of Special Scientific Interest (SSSIs)6.

Figure 2-3: River Dee Catchment



6 https://naturalresources.wales/media/3225/dee-management-catchment.pdf

3 The Planning Framework and Flood Risk Policy

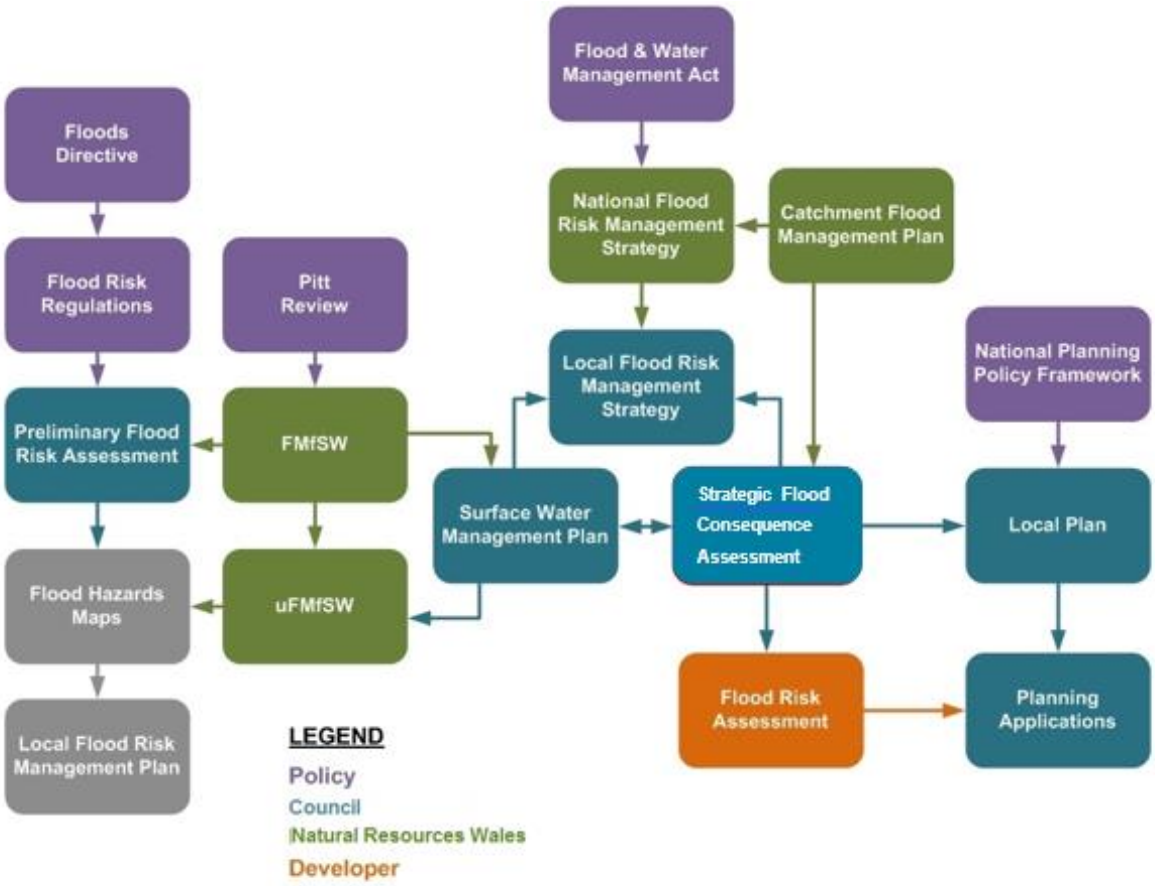
3.1 Introduction

The main purpose of this section of the SFCA is to provide an overview of the key planning and flood risk policy documents that have shaped the current planning framework. This section also provides an overview and context of the County Council's responsibilities and duties in respect to managing local flood risk including but not exclusive to the delivery of the requirements of the Flood Risk Regulations (FRR) 2009 and the Flood and Water Management Act (FWMA) 2010.

Figure 3-1 illustrates the links between legislation, national policy, statutory documents and Flood Consequence Assessments. The figure shows that whilst the key pieces of legislation and policy are separate, they are closely related and their implementation should aim to provide a comprehensive and planned approach to asset record keeping and improving flood risk management within communities.

It is intended that the non-statutory SWMPs and SFCAs can provide much of the base data required to support the delivery of statutory flood risk management tasks as well supporting Local Authorities in developing capacity, effective working arrangements and informing Local Flood Risk Management Strategies (LFRMS) and Local Development Plans, which in turn help deliver flood risk management infrastructure and new development at a local level.

Figure 3-1: Key Documents and Strategic Planning Links – Flood Risk



3.2 Legislation

3.2.1 EU Floods Directive & the Flood Risk Regulations

European Flood Directive (2007) sets out the EU's approach to managing flood risk and aims to improve the management of the risk that floods pose to human health, the environment, cultural heritage and economic activity.

The Directive was translated into Welsh law by the Flood Risk Regulations (FRR) 2009 and outlines the requirement for Natural Resources Wales and Lead Local Flood Authorities (LLFA) to create Preliminary Flood Risk Assessments (PFRAs), with the aim of identifying significant Flood Risk Areas.

Figure 3-2: PFRA Process

PFRAs should cover the entire area for local flood risk (focusing on ordinary watercourses, surface water and groundwater flooding). Where significant Flood Risk Areas are identified using a national approach (and locally reviewed), the LLFA are then required to undertake flood risk hazard mapping and Flood Risk Management Plans (FRMPs) as illustrated in Figure 3-2.

The FRMP will need to consider objectives for flood risk management (reducing the likelihood and consequences of flooding) and measures to achieve those objectives.

Natural Resources Wales (NRW) has implemented one of the exceptions for creating PFRAs, etc for main rivers and coastal flooding, as they already have mapping (i.e. Risk of Flooding from Rivers and Sea Map) and plans (i.e. CFMPs) in place to deal with this. NRW has therefore focused their efforts on assisting LLFAs through this process.

3.2.2 Denbighshire Preliminary Flood Risk Assessment

The PFRA for Denbighshire was published in 2011 as required under the FRR. Based on NRW's national Flood Map for surface water (FMfSW), approximately 1,600 properties were estimated to be at risk from flooding to a depth of 0.3 m during a rainfall event with a 1 in 200 annual chance of occurring. In terms of Flood Risk Area identification, NRW did not identify any indicative Flood Risk Areas for Denbighshire. DCC reviewed the maps produced by Welsh Government (WG) and NRW showing Flood Risk Areas in Wales and agrees that there are no Flood Risk Areas in Denbighshire.

3.2.3 Hazard Mapping and Flood Risk Management Plan

Hazard maps for all of Wales and England were published by Natural Resources Wales and Environment Agency, and whilst the legislation only requires the significant flood risk areas to publish flood risk management plans. There is a commitment in Wales from all LLFA to publish a plan and Natural Resources Wales have published flood risk management plans in 2016 at the river basin scale.

1. Denbighshire County Council's Core Flood Risk Management Objectives:
2. Reducing the consequences for individuals, communities, businesses and the environment from flooding and coastal erosion;
3. Raising awareness of and engaging people in the response to flood and coastal erosion risk; Providing an effective and sustained response to flood and coastal erosion events;
4. Prioritising investment in the most at risk communities.

From the main objectives, there are a further 8 objectives:

1. To improve the understanding of local flood risk.

2. Ensure that local communities understand their responsibilities in relation to local flood risk management.
3. Work in partnership with other Risk Management Authorities and stakeholders.
4. Actively manage flood risk associated with new development proposals.
5. Encourage proactive, responsible maintenance of privately-owned flood defence and drainage assets.
6. Investigate opportunities to reduce surface water run-off from the upper catchments and for flood storage in flood plain areas.
7. Identify affordable, sustainable flood risk management projects.
8. Ensure local FRM knowledge is aligned with the Councils emergency planning procedures.

3.2.4 Flood & Water Management Act

The Flood and Water Management Act (FWMA) was passed in April 2010. It aims to improve both flood risk management and the way we manage our water resources.

The FWMA creates clearer roles and responsibilities and instils a more risk-based approach. This includes a new lead role for Local Authorities in managing local flood risk (from surface water, ground water and ordinary watercourses) and a strategic overview role of all flood risk for Natural Resources Wales.

The content and implications of the FWMA provide considerable opportunities for improved and integrated land use planning and flood risk management by Local Authorities and other key partners. The integration and synergy of strategies and plans at national, regional and local scales, is increasingly important to protect vulnerable communities and deliver sustainable re-generation and growth. Table 3-1 provides an overview of the key LLFA responsibilities under the FWMA.

Table 3-1: Key LLFA Duties under the FWMA

Responsibility	Description	Implementation Date
Local Strategy for Flood Risk Management	A LLFA is required to develop, maintain, apply and monitor a local strategy for flood risk management in its area. The local strategies will build on information such as national risk assessments and will use consistent risk based approaches across different Local Authority areas and catchments. The local strategy will not be secondary to the national strategy; rather it will have distinct objectives to manage local flood risks important to local communities. DCC produced its Consultation Strategy Document in January 2014.	March 2013
Investigating Flood Incidents	A LLFA has a duty to investigate and record details of significant flood events within their area. This duty includes identifying risk management authorities and their functions and how they intend to exercise those functions in response to a flood. The responding risk management authority must publish the results of its investigation and notify any other relevant risk management authorities. DCC has begun this process.	April 2011
Asset Register	A LLFA has a duty to maintain a register of structures or features, which are considered to have an effect on flood risk, including details on ownership and condition as a minimum. The register must be available for inspection and the Secretary of State will be able to make regulations about the content of the register and records.	April 2011
Works Powers	The Act provides a LLFA with powers to do works to manage flood risk from surface runoff, groundwater and on ordinary watercourses, consistent with the local flood risk management strategy for the area.	December 2011
Designation Powers	The Act provides a LLFA with powers to designate structures and features that affect flooding or coastal erosion. The powers are intended to overcome the risk of a person damaging or removing a structure or feature that is on private land and which is relied on for flood or coastal erosion risk management. Once a feature is designated, the owner must seek consent to alter, remove, or replace it.	August 2012
SuDS Approving Body	The Act establishes each LLFA as a SuDS Approving Body (the "SAB"). The SAB would have responsibility for the approval of proposed drainage systems in new developments and redevelopments, subject to exemptions and thresholds. Approval must be given before the developer can commence construction. The SAB would also be responsible for adopting and maintaining SuDS, which serve more than one property, where they have been approved. Highways authorities will be responsible for maintaining SuDS in public roads, to National Standards.	On hold (Awaiting outcome of current WG Consultation 2017)
A full progress report on the implementation of the FWMA in Wales can be found on the Welsh Government and Defra website.[7]		

7 http://www.defra.gov.uk/publications/2012/12/14/pb13844-fmwa-progress/

3.2.5 Water Framework Directive & Water Environment Regulations

The purpose of the Water Framework Directive (WFD) is to deliver improvements across Europe in the management of water quality and water resources. The first cycle of River Basin Management Plans (RBMP) and WFD required all inland and coastal waters to reach "good ecological status" by 2015 through a catchment-based system. Incorporating a programme of measures to improve the status of all natural water bodies. There is an exception for "heavily modified water bodies", that are required to achieve "good ecological potential". The Water Environment Regulations (2003) transposed the WFD into law in England and Wales. Natural Resources Wales is leading on the delivery of the WFD in Wales.

The Western Wales River Basin District covers the whole county borough of Denbighshire. This first RBMP for this basin was published by Environment Agency Wales in 2009 The main responsibility for DCC is to work with Natural Resources Wales to develop links between river basin management planning and the development of Local Authority plans, policies and assessments. In particular, the programme of actions (measures) within the RBMP highlights the need for:

- Water Cycle Studies to promote water efficiency in new development through regional strategies and local development frameworks,
- Surface Water Management Plan implementation,
- Considering the WFD objectives (achieving good status or potential as appropriate) in the spatial planning process, including LDDs and Sustainable Community Strategies, and
- Promoting the wide scale use of Sustainable Drainage Systems (SuDS) in new development.

Since the first RBMP in 2009 there has been a second cycle plan for Western Wales which was published in 2016 by Natural Resources. This document is the first update to that plan and will subsequently be reviewed in 2021 when a further update will be published. River basin management is a continuous cycle of planning and delivery. The purpose of this management plan is to protect and improve the water environment for the wider benefits to people and wildlife.

The current status of the RBD in 2015 allows us to review progress made during the last six years and set out the foundation for this next cycle of river basin planning. Current status is assessed on the standards, methodologies and waterbody network introduced for the second cycle of River Basin Management Planning. In 2015, 225 waterbodies which is equivalent to 40% are in good or better overall status. 425 water bodies which is equivalent to 74% have an objective of good status or better to be achieved by 2021 however, there is a large degree of uncertainty that such a significant increase in achieving good status or better will be observed by 2021.

3.3 Planning Policy

3.3.1 Planning Policy Wales

The Planning Policy Wales (PPW) Edition 9 was published in November 2016 sets out the land use planning policies of the Welsh Government and the planning system in Wales. This is supported by Technical Advice Notes (TANs), including TAN 15: Development and Flood Risk and TAN 14: Coastal Planning, Chief Planning Officer Letters and Circulars.

The Wales Spatial Plan: People, Places, Futures (2008) Update, sets a strategic framework to guide future development and policy interventions. It integrates the spatial aspects of national strategies for social inclusion and economic development, health, transport and environment, translating the Welsh Government's sustainable development duty into practice.

Together Planning Policy Wales and the Wales Spatial Plan should be considered in the preparation of local development plans. These may be considered material to decisions on individual planning applications and considered by the Welsh Ministers and Planning Inspectors in the determination of called-in planning applications and appeals.

PPW forms a framework to Local Planning Authorities for preparation of Local Development Plans (LDPs) and development management decisions. Detailed advice on the preparation of LDPs is contained in PPW and Local Development Plan Manual Edition 2, 2018.

8 Welsh Government (2015) Local Development Plan Manual Edition 2 http://gov.wales/topics/planning/policy/policy-and-guidance-

3.3.2 Technical Advice Note 15: Development and Flood Risk

TAN 15 forms the technical guidance to Planning Policy Wales (PPW) on development and flood risk. It sets out a long-term approach to the role of development and flood risk and its contribution towards sustainability principles (Section 4.3 of PPW), with regards to flood risks arising from both river and coastal flooding, and from additional runoff from development.

The overarching aim of TAN 15 is to take a precautionary approach and direct development away from areas at high risk of flooding where possible. It clearly states where development must be considered in high risk areas those developments must be considered against the justification and acceptability tests set out in the TAN.

In TAN 15, the whole of Wales is divided into three flood zones (flood risk from Zone A at little or no risk to Zone C at high risk or extreme event). Zone C is further subdivided into C1 and C2 indicating whether the area is defended or not. These flood zones are described fully in Table 3-2.

Table 3-2: Flood Zones as Defined by TAN 15

Description of Zone	Zone	Use within the Precautionary Framework
Considered to be at little or no risk of fluvial or coastal / tidal flooding	A	Used to indicate that justification test is not applicable and no need to consider flood risk further
Areas known to have been flooded in the past evidenced by sedimentary deposits	B	Used as part of a precautionary approach to indicate where site levels should be checked against the extreme (0.1%) flood level. If site levels are greater than the flood levels used to define adjacent extreme flood outline there is no need to consider flood risk further
Based on NRW extreme flood outline, equal to or greater than 0.1% (river, tidal or coastal)	C	Used to indicate that flooding issues should be considered as an integral part of decision making by the application of the justification test including assessment of consequences. In accordance with The Welsh Government letter to Chief Planning Officers of 9 January 2014, DCC will need to now also consider the impaction of climate change into account in terms of development planning.
Areas of the floodplain which are developed and served by significant infrastructure, including flood defences	C1	Used to indicate that development can take place subject to application of justification test, including acceptability of consequences
Areas of the floodplain without significant flood defence infrastructure	C2	Used to indicate that only less vulnerable development should be considered subject to application of a justification test, including acceptability of consequences. Emergency services and highly vulnerable development should not be considered

As well as the risk of flooding, the type of development proposed is important when assessing flood risk. These zones are shown on the settlement maps in section 5 of the report and Appendix A and C. The three categories of development used in TAN 15 are given in

Table 3-3: Development Categories from TAN 15

Development Category	Types
Emergency services	Hospitals, ambulance stations, fire stations, police stations, coastguard stations, command centres, emergency depots and buildings used to provide emergency shelter in time of flood
Highly vulnerable development	All residential premises (including hotels and caravan parks), public buildings (e.g. schools, libraries, leisure centres), especially vulnerable industrial development (e.g. power stations, chemical plants, incinerators), and waste disposal sites
Less vulnerable development	General industrial, employment, commercial and retail development, transport and utilities infrastructure, car parks, mineral extraction sites and associated processing facilities, excluding waste disposal sites

Following the precautionary approach, the central policy aim of TAN 15 for development reads that: *"New development should be directed away from zone C and towards land in zone A, otherwise to zone B, where river or coastal flooding will be less of an issue. In zone C the tests outlined in sections 6 and 7 will be applied, recognising, however, that Highly Vulnerable development and Emergency Services in zone C2 should not be permitted. All other new development should only be permitted within zones C1 and C2 if determined by the planning authority to be justified and acceptable in that location."*

The tests in Section 6 relate to the development supporting local authority planning objectives and in Section 7 the tests relate to the consequences of flooding. Those relating to local authority planning objectives (Section 6) are not considered further in this document but would need applying to any proposed development in Zone C. The distinction between C1 and C2 is critical. Within C2 allowable development is restricted to Less Vulnerable Development but in C1 this restriction does not apply. Any development type in either C1 or C2 must pass further tests to justify the development in terms of flood risk (TAN 15 Section 7).

3.3.2.1 Assessing Flood Consequences

Where development in Zone C can be justified (and acceptable) under Section 6, assessment must be made to establish whether suitable mitigation measures can be incorporated to ensure that the development is as safe as possible and there is:

- Minimal risk to life
- Minimal disruption to people living and working in the area
- Minimal potential damage to property
- Minimal impact of the proposed development on flood risk generally; and,
- Minimal disruption to the natural environment.

TAN 15 goes on to specify more detail on these points. A flooding frequency threshold for different development types (Table 3-4) should be met to ensure developments are flood free up to the appropriate threshold frequency. This may include mitigation measures where appropriate which may reduce the frequency of flooding from that which may occur naturally. However, there are limitations of data and estimations, with issues of uncertainty and these have been superseded by WG guidance on climate change allowances referred to section 3.4.6

Table 3-4: Flooding frequency thresholds of development types (TAN 15 Table A1.14)

Type of Development	Threshold Frequency (Years)	
	Fluvial	Tidal
Residential	1%	0.5%
Commercial / retail	1%	0.5%
Industrial	1%	0.5%
Emergency Services	0.1%	0.1%
General infrastructure	1%	0.5%

Beyond the threshold frequency, proposed developments would be expected to flood under extreme conditions. To protect people and property at these locations TAN 15 lays down tolerable criteria for the anticipated flooding during an extreme event. Again, this can be assessed to include appropriate mitigation measures.

Table 3-5 shows the tolerable criteria for different development types.

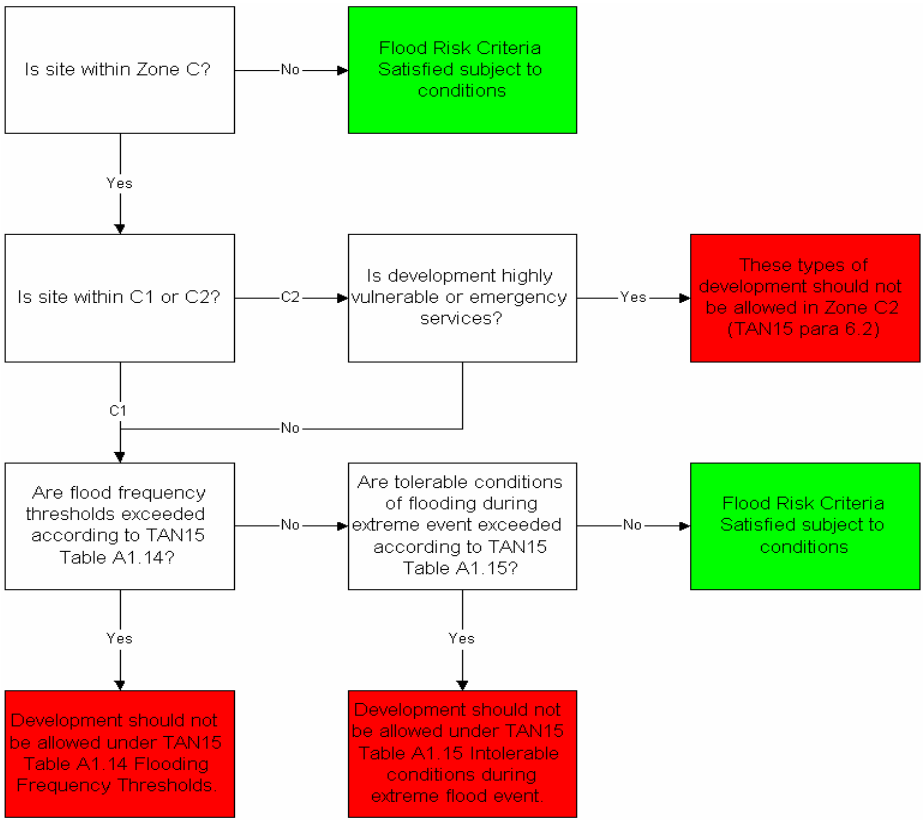
Table 3-5: Indicative Guidance on Tolerable Conditions in an Extreme Flood (TAN 15 Table A1.15)

Type of development	Maximum depth of flooding (mm)	Maximum rate of rise of floodwaters (m/hr)	Maximum speed of inundation of flood risk area (hrs)	Maximum velocity of floodwaters (m/s)
	Property access			Property access
Residential (habitable rooms)	600 600	0.1	4	0.15 0.3
Commercial & Retail	600 600	0.3	2	0.15 0.3
Industrial	1000 1000	0.3	2	0.3 0.45
Emergency	450 600	0.1	4	0.15 0.3
Services	600 600	0.3	2	0.3 0.3

TAN 15 is therefore fairly prescriptive and presents a series of tests that a development must satisfy before being deemed acceptable. Figure 3-3 shows a flow chart of the TAN 15 procedure for assessing suitability of areas for development. These considerations can be used during site specific FCAs and during this SFCA.

The presence of flood defences complicates understanding of risk as the actual risk may be reduced. However, where residual risk exists, if defences are breached or overtopped for example, then areas may be considered to be extremely vulnerable due to the speed of flooding. In such cases TAN 15 suggests that NRW advises the LPA on the likely flooding consequences and the LPA must make a decision on acceptability of proposed development. Taking into account climate change and extreme flood risks as a result of climate change. Where development is allowed, measures to manage the risk must be put in place which may include developers taking responsibility for the ongoing maintenance of flood defences (TAN 15 paragraph 7.5). Detailed assessment of the flood risks and function of defences should be carried out by in site specific FCAs to inform decision making.

Figure 3-3: Flow Chart of the TAN 15 Procedure for Assessing Acceptability of Developments in Relation to Flood Risk



3.3.2.2 Applying TAN 15 for a SFCA

Application of TAN 15 should in the first instance advocate moving development out of areas of high risk to areas of lower risk. Following this approach, any development within Zone C (the 0.1% AEP flood extent) should be avoided. To limit the occurrence of flooding issues in planning decisions, land within Zone C (in particular Zone C2) should not be allocated for development where possible. The SFCA Maps, in Appendix A, show the 0.1% flood extent and can, therefore, be used to assess the boundaries of Zone C and form the precautionary barrier to areas of development.

It is, however, accepted that there may be times where development within Zone C (in particular Zone C1) may be required, justifying the conditions in Section 6 of TAN 15. The development must also pass the flooding frequency and tolerable condition criteria. Consideration of detailed and specific mitigation measures cannot be made during an SFCA as these are site specific and can be complex. However, consideration of the unmitigated flooding criteria will give a good indication of whether mitigation is likely to be effective. For example, it is less likely that a site, which is at frequent risk from deep and fast flowing water can be successfully mitigated, achieving the tolerable criteria and limiting wider impacts are likely to be difficult to achieve.

Table 3-6: Data Provision and use within the SFCA

Data type	Use
Map of flood depth during 0.1% extreme event	Defines the Zone C outline which should ideally be avoided for development. Also provides water depth and velocity for extreme event which is one of the tolerable criteria tests
Map of flood extent during the 1% fluvial and 0.5% tidal events	Provides additional information on the frequency of natural flooding in an area and whether mitigation to achieve flood frequency thresholds will be required. Also provides water depth and velocity for extreme event which is one of the tolerable criteria tests
Map of 5% fluvial event	Shows areas at risk from frequent fluvial flooding
Table of flooding tolerable criteria at known development sites	These are colour coded to show whether they achieve (green) or exceed (red) the TAN 15 figures. For those in red, mitigation would be required to achieve the targets. If the figures substantially exceed the criteria it may be that mitigation will not be effective
Updated Flood Map for Surface Water	Provides information on surface water flood risk to sites, including extreme 1 in 1000 year event outlines and more frequent 1 in 30 year event outlines
DG5 register	Provides records of previous sewer related flood incidents

Clearly the SFCA does not remove the need for site specific FCAs for individual developments as more detailed assessments would be required to produce a greater understanding of flood risk at any particular site. This would include detailed proposals for mitigating flood risk and achieving the flood risk tolerable criteria.

The information provided in this SFCA allows the LPA to have a good understanding of flood risk across the key areas of the County. This information should inform spatial planning decisions, ideally to avoid Zone C areas or, where it is necessary, to look at development in Zone C with a better understanding of achievable mitigation.

3.3.3 Risk of Flooding from Rivers and Sea

Tan 15 and the DAM food zones are both included within the interactive maps of Appendix A. In addition to these the NRW Risk of Flooding from Rivers and Seas data is also included within Appendix A. The dataset shows the chance of flooding from rivers and/or the sea, based on cells of 50m. Each cell is allocated one of four flood risk categories, taking into account flood defences and their condition.

The four risk categories are listed in Table 3-7 and are how they appear within the interactive map of Appendix A.

Table 3-7: Categories of Risk of Flooding from Rivers and Seas

Category	Definition
High	High means that each year, this area has a chance of flooding of greater than 1 in 30 (3.3%). This takes into account the effect of any flood defences that may be in this area. Flood defences reduce, but do not completely stop the chance of flooding as they can be overtopped or fail.
Medium	Medium means that each year, this area has a chance of flooding of between 1 in 100 (1%) and 1 in 30 (3.3%). This takes into account the effect of any flood defences that may be in this area. Flood defences reduce, but do not completely stop the chance of flooding and they can be overtopped or fail.
Low	Low means that each year, this area has a chance of flooding of between 1 in 1000 (0.1%) and 1 in 100 (1%). This takes into account the effect of any flood defences that may be in this area. Flood defences reduce, but do not completely stop the chance of flooding as they can be overtopped or fail.
Very Low	Very low means that each year, this area has a chance of flooding of less than 1 in 1000 (0.1%). This takes into account the effect of any flood defences that may be in this area. Flood defences reduce, but do not completely stop the chance of flooding as they can be overtopped or fail.

3.3.4 Local Development Plan

Local Development Plans (LDPs) provide guidelines as to what can be built and where over a 15 year period. Each LPA in Wales is required to produce a LDP for its area. The LDP determines where new development will take place, taking into account the need for employment land, housing, leisure facilities and safeguarding of the local environment.

Once the LPA has prepared the LDP, there is an examination by an independent Planning Inspector to consider the 'soundness' of the plan, with hearings held in public. Once adopted, LPAs must prepare an Annual Monitoring Report (AMR) demonstrating how the Plan is delivering against its objectives. They must complete a full review every four years to ensure the plans stay up-to-date. Community engagement is vital to the plan making process. LPAs publish a Delivery Agreement at the start of the process setting out the key stages and when stakeholders and members of the public can get involved.

The process stages involved in the preparation of LDPs are set out in Local Development Plans Edition 2 (2015) and Planning Policy Wales Edition 9 (2016).

3.3.5 Denbighshire Local Development Plan

Denbighshire County Council formally adopted the LDP at a meeting of the County Council on 4th June 2013. This replaced the Denbighshire Unitary Development Plan (UDP).

A key objective of the LDP is to provide employment opportunities within the County in order to reduce the need to commute long distances to improve sustainability. Around 50 ha of employment land has been allocated in the LDP.

The LDP also contained a spatial strategy which is designed to focus development into a small number of large sites in the North of the County, with smaller scale new development being supported in other County settlements. The main justification for this spatial approach is based on issues and objectives which can be viewed in the Denbighshire CC LDP document[9].

The Annual Monitoring Report provides feedback on the extent to which the LDP Strategy and policies are being delivered and achieved the document reviews the relevance and success of the LDP, and looks at the extent to which the LDP Strategy and local policies are being delivered and achieved. It also identifies subject areas and local policies that have been recognised as not performing as expected or where legal changes outweigh previously defined indicators and trigger

9 Denbighshire County Council, Local Development Plan: 2006 – 2021, Adopted 4th June 2013

levels. These elements will be considered when the Council is carrying out the statutorily required LDP Review.

This LDP Review is currently underway and the Council are considered the evidence for a new Local Development Plan.

3.3.6 Economic & Community Ambition Strategy (2013-2023)

The Strategy, looks both at what can be done within Denbighshire to stimulate economic growth and the creation of jobs, and also how to connect Denbighshire residents and businesses to opportunities outside the county.

The strategy aims to make Denbighshire a better place by having the following:

- The right Infrastructure for Growth
- Businesses that are Supported and Connected
- Maximised Economic Strengths/Opportunities
- A High Quality Skilled Workforce
- Vibrant Towns and Communities
- A Well Promoted Denbighshire

3.3.7 Recreational Public Open Spaces

Public open space such as sports facilities, parks and gardens or areas of amenity greenspace are recognised as being important to the quality of people's lives and to the achievement of sustainable communities. They contribute to the general well-being of the community in respect of providing for sport and recreation, encouraging physical activity and the associated health benefits that come with this. These areas encourage enjoyment of the natural environment whilst contributing to biodiversity, the conservation of nature and landscape, air quality and the protection of groundwater.

Planning policy both local and national seeks to protect and enhance the quantitative and qualitative provision of open space to meet the needs of current and future generations. This can be achieved by safeguarding and enhancing current provision and creating additional provision where demand/need is identified. Open space provisions for new developments will be of an appropriate amount and type and in the most suitable location to meet the needs of the local community.

The Denbighshire Local Development Plan 2006 – 2021 has been produced in accordance with planning legislation and national policy, and was adopted by the Council in June 2013. LDP Objective no.8 aims to seek to protect existing open space and ensure that new developments make an adequate contribution to public open space provision. 'Open space' has been defined in TAN 16, Annex A as 'all open space of public value, including land, and water areas like rivers, canals, lakes, reservoirs and disused dock basins which offer opportunities for sport, recreation and tourism'

The following principles collectively provide a way to make resilient planning decisions for open space planning:

- Ensure areas of open space are a planned and integral component of the residential layout;
- Green space must be located for best affect depending on the range of wellbeing functions and priorities it needs to address - based upon the site, its proposed use, context, wellbeing needs and priorities;
- The open space assessment and site contextual analysis should help identify wellbeing needs and priorities in the vicinity of the site, including areas in need of protection and enhancement;
- Proposals should be developed in consultation with local Ward Councillors and community consultation will be necessary where proposals concern existing open space and where new open space is intended to provide a shared resource between new residents of the development and the existing community;

a. The range of wellbeing functions that open space can incorporate is diverse and may include Social spaces for play, access to nature, informal recreation, food growing, dog walking;
b. Accessibility on foot and bicycle both within the site and to wider active travel networks;
a. Working with existing green infrastructure – conserving and enhancing natural elements such as trees, habitats, species connectivity and drainage;
b. Amenity – creating attractive safe places for people, segregation of noisy and quiet site uses, mitigating the impacts of traffic noise and emissions, surface water management to protect from flooding;

- Landscape design techniques are useful to draw the diverse physical components together into a co-ordinated place-based implementable plan. This will help ensure wellbeing functions, sense of place, and the needs of people across different age ranges and abilities are addressed;
- Standard solutions and standard play schemes do not realise wellbeing benefits to the extent that site specific planning and design can.
- Open spaces can provide can aid flooding, by reducing run off as grassland is permeable, trees and green land can act as an intersect. Furthermore, the open space can act like a floodplain by flooding occasionally in intense rainfall.

3.4 Flood Risk Management Plans, Strategies and Policies

3.4.1 Catchment Flood Management Plans

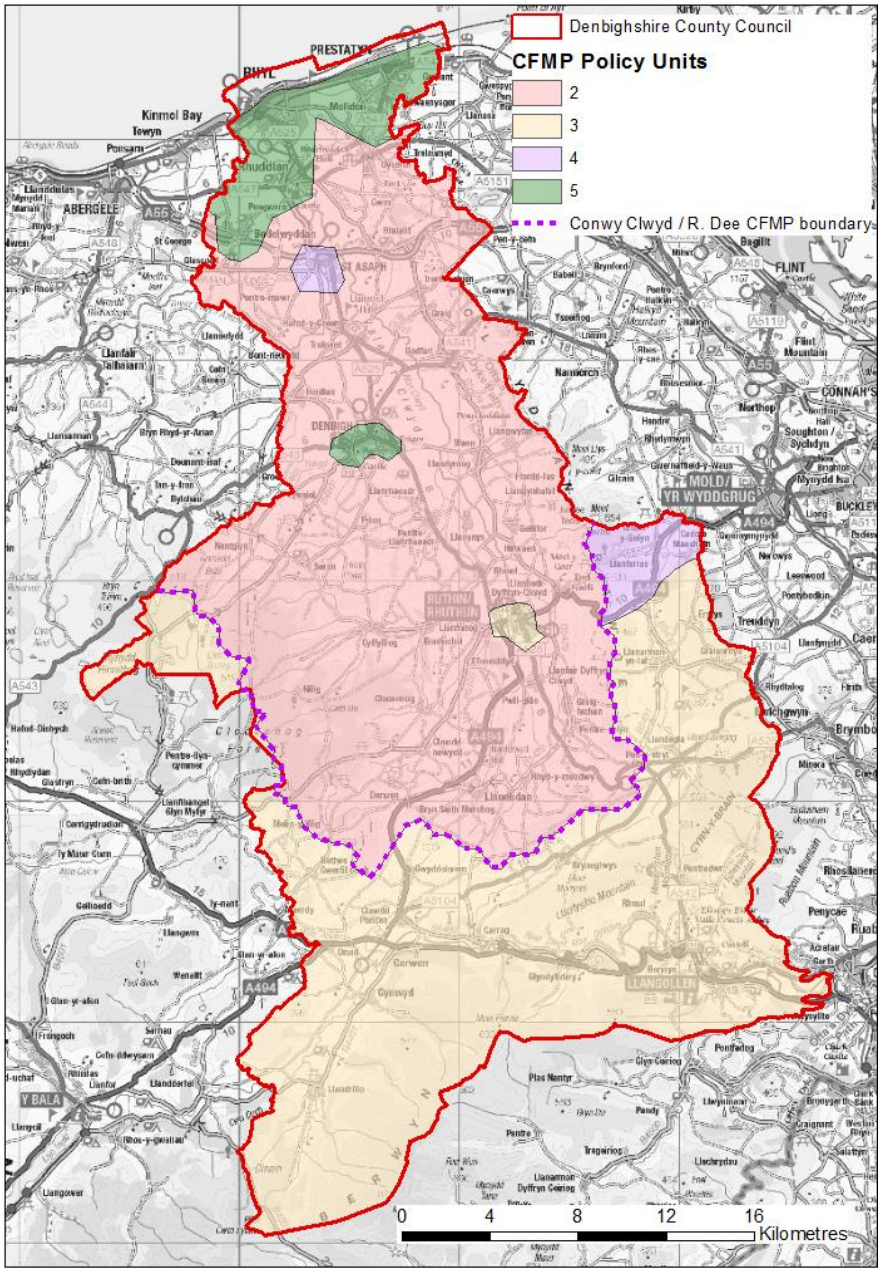
The Catchment Flood Management Plan (CFMP) is a key tool within spatial planning despite being published in 2009. It is not yet replaced in full by Flood Risk Management Plans. The CFMP provides a broad overview of flood risk mainly from main river and tidal sources, they develop complementary policies for long-term management of flood risk within the catchment that take into account the likely impacts of climate change, the effects of land use and land management, deliver multiple benefits and contribute towards sustainable development. This is critical when areas under development pressure coincide with high flood risk.

Chosen policies and actions highlight where to avoid development in those areas where deemed inappropriate to reduce flood risk now and in the future. They also indicate when water should be allowed to flood or where current flood risk measures should be reduced. Development should therefore be focused towards the more 'sustainable' areas in terms of lower risk of flooding or where flood risk management is considered viable within the short and long-term plans. Therefore, if development has been proposed in flood risk areas and the chosen policy is not to take further action to reduce flood risk, then developments will find it difficult to rely on Natural Resources Wales led FRM infrastructure investment and there will be a great reliance on private (developer) funding to reduce risk. In this instance, development may not be viable.

As part of the CFMP process each CFMP area was divided up into broad areas (known as ‘policy units’), which represent areas of similar characteristics, flood mechanisms and flood risks. Each policy unit was then assessed to decide which policy will provide the most appropriate level and direction of flood risk management both now and in the future. Whilst the policy unit simplifies direct action over vast areas of land, in reality, the chosen policy may only focus on a small urban or rural area within that policy unit.

The County of Denbighshire is covered by the Conwy and Clwyd and the River Dee CFMPs. Figure 3-4 illustrates the CFMP policies formed from each CFMP.

Figure 3-4: Denbighshire CFMP Policy Units



The areas to the South of the CFMP boundary line are within the River Dee CFMP whilst those North are within the Conwy and Clwyd CFMP. The Policies adopted from each CFMP include:

- Policy 2 - Areas of low to moderate flood risk where existing flood risk management actions can generally be reduced
- Policy 3 - Areas of low to moderate flood risk where existing flood risk is generally managed effectively
- Policy 4 - Areas of low, moderate or high flood risk where flood risk is already managed effectively but where further action may need to be taken to keep pace with climate change
- Policy 5 - Areas of moderate to high flood risk where further action can generally be taken to reduce flood risk

3.4.2 National and Local Flood Risk Management Strategies

The FWMA establishes that flood risk will be managed within the framework of National Strategies for Wales and Local Strategies for each LLFA area.

The National Strategy for Flood and Coastal Erosion Risk Management in Wales (2011) sets out principles for how flood risk should be managed and provides strategic information about different types of flood risk and which organisations are responsible for their management. The FWMA requires risk management authorities (local authorities, internal drainage boards, sewerage companies and highways authorities) to act consistently with the National Strategy in carrying out their flood and coastal erosion risk management functions.

LLFAs have responsibility for developing a Local Flood Risk Management Strategy (LFRMS) for their area covering local sources of flooding. The LFRMS produced must be consistent with the National Strategy. It will set out the local organisations with responsibility for flood risk in the area, partnership arrangements to ensure co-ordination between these, an assessment of the flood risk and plans and actions for managing the risk.

3.4.3 Denbighshire Local Flood Risk Management Strategy

The Denbighshire Local Flood Risk Management Strategy consultation was published in June 2014 and cites the following flood risk management objectives:

- Reduce the consequences for individuals, communities, businesses and the environment from flooding and coastal erosion
- Raise awareness of, and engage people, in the response to flood and coastal erosion risk
- Provide an effective and sustained response to flood and coastal erosion events; and
- Prioritise investment in the most at risk communities.

The LFRMS Consultation sets out proposed outcomes as follows;

- Improvements in the understanding of local flood risk
- Ensuring that local communities understand their responsibilities in relation to local flood risk management
- Working in partnership with other Risk Management Authorities and stakeholders
- Active management of flood risk associated with new development proposals
- Encouragement of proactive, responsible maintenance of privately owned flood defence and drainage assets
- Investigate opportunities to reduce surface water runoff from the upper catchment and for flood storage on floodplains
- Identification of affordable and sustainable flood risk management projects; and
- Ensuring that local FRM knowledge is aligned with the County Council's emergency planning procedures.

These objectives and outcomes align with national strategy objectives, and NRW plans and strategies.

3.4.4 Surface Water Management Plans

In June 2007, widespread extreme flooding was experienced in the UK. The Government review of the 2007 flooding, chaired by Sir Michael Pitt recommended "Local Surface Water Management Plans (SWMPs) … coordinated by local authorities, should provide the basis for managing all local flood risk."

The Governments guidance document[10] for SWMPs defines a SWMP as:

- A framework through which key local partners with responsibility for surface water and drainage in their area, work together to understand the causes of surface water flooding and agree the most cost-effective way of managing surface water flood risk.
- A tool to facilitate sustainable surface water management decisions that are evidence based, risk based, future proofed and inclusive of stakeholder views and preferences.

10 Surface Water Management Plan Technical Guidance - https://www.gov.uk/government/publications/surface-water-management-plan-technical-guidance

- A plan for the management of urban water quality through the removal of surface water from combined systems and the promotion of SuDS.

As a demonstration of its commitment to SWMPs as a structured way forward in managing local flood risk, Defra announced an initiative to provide funding for the highest flood risk authorities to produce SWMPs.

DCC has not produced a SWMP. The LFRMS should however recommend locations where SWMPs may be needed, in areas where there is significant surface water flood risk and / or development pressure

3.4.5 Natural Resources Wales: Flood Consequence Assessments

NRW assess FCAs and any other supporting flood risk documentation that accompany planning application consultations to identify whether the applicant has met the requirements of Planning Policy Wales and TAN15.

Natural Resources Wales produced an FCA and modelling good practice guide in 2015 to provide good preparation advice for developers and their consultants who are writing flood risk documentation to support development planning proposals associated with flood risk.

Most development proposals require planning permission from the Local Planning Authority (LPA). In gaining that permission, any development shown to be at risk of flooding will need to comply with the Welsh Government's Planning Policy Wales and Technical Advice Note 15 (TAN15)[11]. In some circumstances, a formal Flood Defence Consent or Environmental Permit is also required, either from NRW for locations at risk of flooding from main rivers or the sea, or from a Local Authority for ordinary watercourses such as streams.

Information on whether a location is at river or coastal flood risk can be found by referring to the Welsh Government's development advice map. Further detail on all sources of flood risk can be found on NRW's flood maps[12].

3.4.6 Welsh Government: Flood risk and insurance

In 2014 DEFRA and WG set out proposed changes to the insurance industry, to provide flood cover to domestic properties in the future. The new scheme adopted is now based upon introducing "Flood Re". This is a reinsurance pool of funding for high risk households and in effect caps flood insurance premiums. Premiums are set according to a property council tax band, and therefore home owners, and perspective purchasers, will know the maximum they could be asked to pay for flood insurance cover.

This scheme only applies to properties built before 2009, and therefore new developments built since this date will be subject to uncapped risk reflective premiums. Consequently, in order to ensure that insurance cover will be obtainable, new developments should only be permitted in a flood risk area where it can be made safe, resistant and resilient to flooding for a given flood event (e.g. 1 in 100 chance or 1 in 200 chance of occurring in any year), and does not increase flood risk elsewhere.

The provision of flood insurance can affect development viability and is a material planning consideration because the development needs to demonstrate that the consequences of flood risk are acceptable for the lifetime of development.

3.5 Roles and Responsibilities

The responsibilities for the risk management authorities (RMA) under the Flood and Water Management Act and Flood Risk Regulations, and relevant plans and strategies for Denbighshire are summarised below.

3.5.1 Natural Resources Wales

Natural Resources Wales has a strategic oversight role for all forms of flooding, and

11 http://gov.wales/topics/planning/policy/tans/tan15/?lang=en

12 https://naturalresources.wales/evidence-and-data/maps/long-term-flood-risk/?lang=en

- power to request information from any partner in connection with its risk management functions.
- exercise its flood or coastal erosion risk management functions in a manner consistent with the National Strategy and Local Strategies.
- must be consulted on Local Strategies, if affected by the strategy, by the LLFA.

3.5.2 Denbighshire County Council as a LLFA

- must develop, maintain, apply and monitor a strategy for local flood risk management. This must be consulted on with all RMAs, the public and all other partners with an interest in local flood risk.
- coordinate local flood risk management between relevant authorities and partners.
- request information from others when it is needed in relation to their flood risk management functions.
- where it considers this necessary or appropriate, the LLFA must investigate flooding incidents in its area.
- establish and maintain a record of structures within their area that have a significant impact on local flood risk.
- empowered to designate structures and features that affect flooding.
- establish a SuDS Approving Body (SAB) –although this provision has yet to be commenced in legislation.
- undertake works to manage flood risk from surface runoff and groundwater. Powers in relation to Ordinary Watercourses remain with district authorities.
- exercise their flood and coastal erosion risk management functions in a manner consistent with the National Strategy and the Local Strategy.
- permitted to agree the transfer of responsibilities for risk management functions (except the production of a Local Strategy) to other RMAs.
- contribute to sustainable development.
- consider flooding issues that require collaboration with neighbouring LLFAs and other RMAs.

3.5.3 Denbighshire County Council LPA

- Has a duty to act in a manner that is consistent with the National Strategy and have regard to Local Strategies;
- Must be consulted on Local Strategies, if affected by the strategy, by the LLFA;
- Has a duty to be subject to scrutiny from the LLFA;
- Has a duty to cooperate and share information with other RMAs

3.5.4 Welsh Water and Dee Valley Water

Water companies:

- have a duty to act in a manner that is consistent with the National Strategy and have regard to Local Strategies.
- must be consulted on Local Strategies, if affected by the strategy, by the relevant LLFA.

3.5.5 Denbighshire Highway Services

- duty to act consistently with the National Strategy and Local Strategies.
- responsibility for ensuring effective drainage of local roads in so far as ensuring drains and gullies are maintained.
- must be consulted on Local Strategies, if affected by the Strategy, by the relevant LL.

3.5.6 Members of the Public

- Must be consulted on Local Strategies by the LLFA.

- The public have a key role in ensuring Local Strategies are capable of being successfully delivered within the community. They should actively participate in this process and be engaged by the LLFA.

3.5.7 Riparian Owners

A riparian owner is someone who owns land or property alongside a river or other watercourses including a culvert. A watercourse is any natural or artificial channel through which water flows, such as a river including where rivers flow through a culvert, brook, beck, or mill stream.

Riparian owners have statutory responsibilities, including:

- Maintaining river beds and banks;
- Allowing the flow of water to pass without obstruction;
- Controlling invasive alien species

Further guidance for riverside property owners can be found in Natural Resources Wales's helpful booklet 'A guide to your rights and responsibilities of riverside ownership in Wales[13]' published in January 2017.

3.5.8 Private Developers

- Have a vital role in ensuring effective local flood risk management by avoiding development in areas at risk of flooding. Local Strategies should form a key element of local planning guidance.
- Providing proportional FCA for development proposals put forward for inclusion within the Local Plan and Development Management
- Demonstrating appraisal of SuDs techniques and surface water flooding
- Consulting with Risk Management Authorities on issues of flood risk

13 http://www.naturalresources.wales/media/680422/living-on-the-edge-final-jan-2017.pdf

4 Understanding Flood Risk

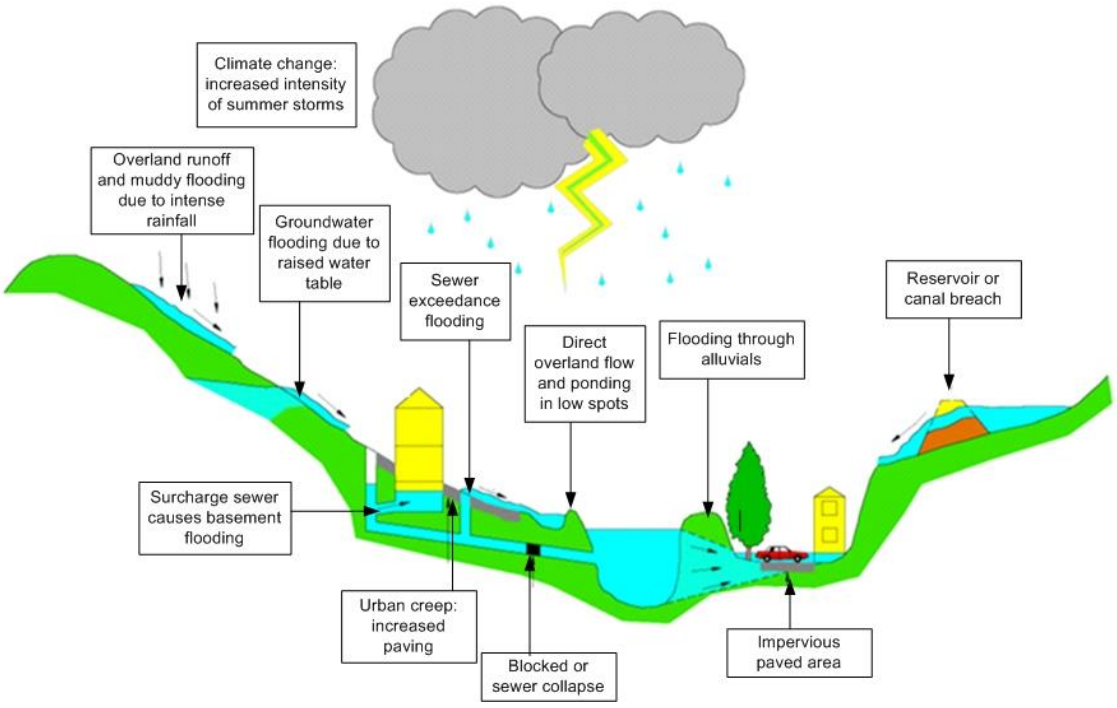
4.1 Sources of Flooding

Flooding is a natural process and can happen at any time in a wide variety of locations. It constitutes a temporary covering of land not normally covered by water and presents a risk when people and human or environmental assets are present in the area that floods. Assets at risk from flooding can include housing, transport and public service infrastructure, commercial and industrial enterprises, agricultural land and environmental and cultural heritage. Flooding can occur from many different and combined sources and in many different ways. Major sources of flooding include (also see Figure 4-1):

- **Fluvial** (rivers) - inundation of floodplains from rivers and watercourses; inundation of areas outside the floodplain due to influence of bridges, embankments and other features that artificially raise water levels; overtopping or breaching of defences; blockages of culverts; blockages of flood channels/corridors.
- **Tidal** - sea; estuary; overtopping of defences; breaching of defences; other flows (e.g. fluvial surface water) that could pond due to tide locking; wave action.
- **Surface water** - surface water flooding covers two main sources including sheet run-off from adjacent land (pluvial) and surcharging of piped drainage systems (public sewers, highway drains, etc.)
- **Groundwater** - water table rising after prolonged rainfall to emerge above ground level remote from a watercourse; most likely to occur in low-lying areas underlain by permeable rock (aquifers); groundwater recovery after pumping for mining or industry has ceased.
- **Infrastructure failure** - reservoirs; canals; industrial processes; burst water mains; blocked sewers or failed pumping stations.

Different types and forms of flooding present a range of different risks and the flood hazards of speed of inundation, depth and duration of flooding can vary greatly. With climate change, the frequency, pattern and severity of flooding are expected to change and become more damaging.

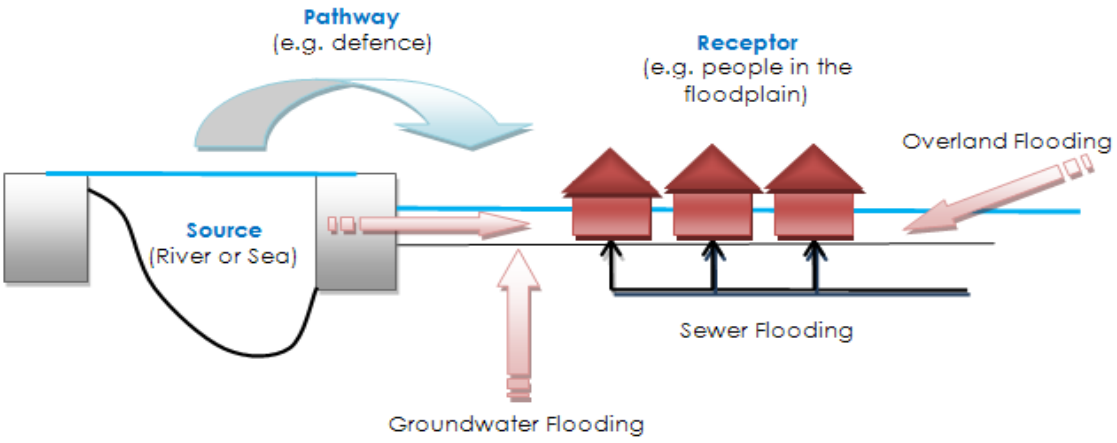
Figure 4-1: Flooding from all Sources



4.2 Likelihood and Consequence

Flood risk is a combination of the likelihood of flooding and the potential consequences arising. It is assessed using the source – pathway – receptor model as shown in Figure 4-2 below. This is a standard environmental risk model common to many hazards and should be the starting point of any flood risk assessment. However, it should be remembered that flooding could occur from many different sources and pathways, and not simply those shown in the illustration below.

Figure 4-2: Source-Pathway-Receptor Model



The principal sources are rainfall or higher than normal sea levels, the most common pathways are rivers, drains, sewers, overland flow and river and coastal floodplains and their defence assets and the receptors can include people, their property and the environment. All three elements must be present for flood risk to arise. Mitigation measures have little or no effect on sources of flooding but they can block or impede pathways or remove receptors.

The planning process is primarily concerned with the location of receptors, taking appropriate account of potential sources and pathways that might put those receptors at risk. It is therefore important to define the components of flood risk in order to apply this guidance in a consistent manner.

4.2.1 Likelihood

Likelihood of flooding is expressed as the percentage probability based on the average frequency measured or extrapolated from records over a large number of years. A 1% probability indicates the flood level that is expected to be reached on average once in a hundred years, i.e. it has a 1% chance of occurring in any one year, not that it will occur once every hundred years.

Considered over the lifetime of development, such an apparently low frequency or rare flood has a significant probability of occurring. For example:

- A 1% flood has a 26% (1 in 4) chance of occurring at least once in a 30-year period - the period of a typical residential mortgage
- And a 49% (1 in 2) chance of occurring in a 70-year period - a typical human lifetime

4.2.2 Consequence

The consequences of flooding can result in fatalities, damaging property, disrupting lives and businesses, with severe implications for people (e.g. financial loss, emotional distress, health problems). Consequences of flooding depend on the hazards caused by flooding (depth of water, speed of flow, rate of onset, duration, wave-action effects, water quality) and the vulnerability of receptors (type of development, nature, e.g. age-structure, of the population, presence and reliability of mitigation measures etc). Flood risk is then expressed in terms of the following relationship:

Flood risk = Probability of flooding x Consequences of flooding

4.3 Risk

Flood risk is not static; it cannot be described simply as a fixed water level that will occur if a river overtops its banks or from a high spring tide that coincides with a storm surge. It is therefore important to consider the continuum of risk carefully. Risk varies depending on the severity of the event, the source of the water, the pathways of flooding (such as the condition of flood defences) and the vulnerability of receptors as mentioned above.

4.3.1 Actual Risk

This is the risk 'as is' taking into account any flood defences that are in place for extreme flood events (typically these provide a minimum Standard of Protection (SoP)). Hence, if a settlement lies behind a fluvial flood defence that provides a 1 in 100-year SoP then the actual risk of flooding from the river in a 1 in 100-year event is generally low.

Actual risk describes the primary, or prime, risk from a known and understood source managed to a known SoP. However, it is important to recognise that risk comes from many different sources and that the SoP provided will vary within a river catchment. Hence, the actual risk of flooding from the river may be low to a settlement behind the defence but moderate from surface water, which may pond behind the defence in low spots and is unable to discharge into the river during high water levels.

4.3.2 Residual Risk

Even when flood defences are in place, there is always a likelihood that these could be overtopped in an extreme event or that they could fail or breach. Where there is a consequence to that occurrence, this risk is known as residual risk. Defence failure can lead to rapid inundation of fast flowing and deep floodwaters, with significant consequences to people, property and the local environment behind the defence. Several indicative tidal defence breach scenarios have been modelled for this SFCA, see Section 5.7.1 for discussion of the breach scenarios.

Whilst the actual risk of flooding to a settlement that lies behind a fluvial flood defence that provides a 1 in 100-year SoP may be low, there will always be a residual risk from flooding if these defences overtopped or failed that must be taken into account. Because of this, it is never appropriate to use the term "flood free".

4.4 Flood Risk Datasets

This section of the SFCA provides a strategic overview of flood risk from all sources within Denbighshire. The information contained is the best available at the time of publication and is intended to provide the County Council with an overview of risk. Where further detail is available, then the source of information is provided. Table 4-1 provides a summary of the key datasets used in this SFCA according to the source of flooding.

Table 4-1: Flood Source and Key Datasets

Flood Source	Datasets
Fluvial	Development Advice Maps (DAM)
	Fluvial flood modelling
	Conwy and Clwyd, River Dee CFMPs
	Denbighshire LFRMS
	Natural Resources Wales Flood Risk Mapping Studies
	Historic evidence – Natural Resources Wales Recorded Flood Outlines and Historic Flood Map
Tidal	Development Advice Maps (DAM)
	Tidal flood modelling, including flood defence breach scenarios
	Denbighshire LFRMS
	North West England and North Wales Shoreline Management Plan SMP2
	The Tidal Clwyd Flood Risk Management Strategy
	Rhyl – Prestatyn Coastal Defence Strategy Study Report
Pluvial (surface water runoff)	Natural Resources Wales Surface Water Flood Risk Maps
	Denbighshire PFRA
	Denbighshire LFRMS
Sewer	Welsh Water Historical Flood Records (DG5 Register) and Infrastructure Capacity Data
Groundwater	Natural Resources Wales Areas Susceptible to Ground Water Flooding Maps (AStGWF)
Reservoir	Natural Resources Wales Reservoir Flood Maps (available online only)
Flood Risk Management Infrastructure	Natural Resources Wales flood defence dataset

4.5 Fluvial and Tidal Flooding in Denbighshire

Flooding from rivers and the sea is assessed, within this SFCA, through existing and updated modelled outlines including the 0.1%, 1% fluvial, 0.5% tidal, 0.1% + climate change, 1% + climate change, 0.5% + climate change and the 5% AEP event outlines. To follow the requirements of TAN 15, the modelled extreme 0.1% AEP event outline was used to represent Zone C. For those areas that were not modelled as part of this SFCA, the Welsh Government's Development Advice Maps (DAMs) have been used.

The TAN 15 Development Advice Maps (DAMs) consist of flood zones where:

- Zone A includes areas considered to be at little or no risk of fluvial or coastal / tidal flooding
- Zone B includes areas known to have been flooded in the past, as evidenced by sedimentary deposits
- Zone C1 includes areas of the floodplain, defined by the NRW extreme flood outline >=0.1% AEP outline, which are developed and served by significant infrastructure, including flood defences
- Zone C2 includes areas of the floodplain, defined by the NRW extreme flood outline >=0.1% AEP outline, without significant flood defence infrastructure

Fluvial flooding is associated with the exceedance of channel capacity during higher flows. The process of flooding on watercourses depends on a number of characteristics associated with the catchment including geographical location and variation in rainfall; steepness of the channel and surrounding floodplain; and infiltration and rate of runoff associated with urban and rural catchments.

Tidal flooding, or flooding from the sea, occurs when water levels or waves overtop the crest of coastal defences, or when defences are breached or collapse. The probability of breach is dependent on four main factors: weather conditions (generating large waves); wind direction (on-

shore); high tides (particularly during spring tides) and the condition of the coastal defences. When these conditions combine the risk of flooding can be greatly enhanced as the predicted tide level can be raised by several metres.

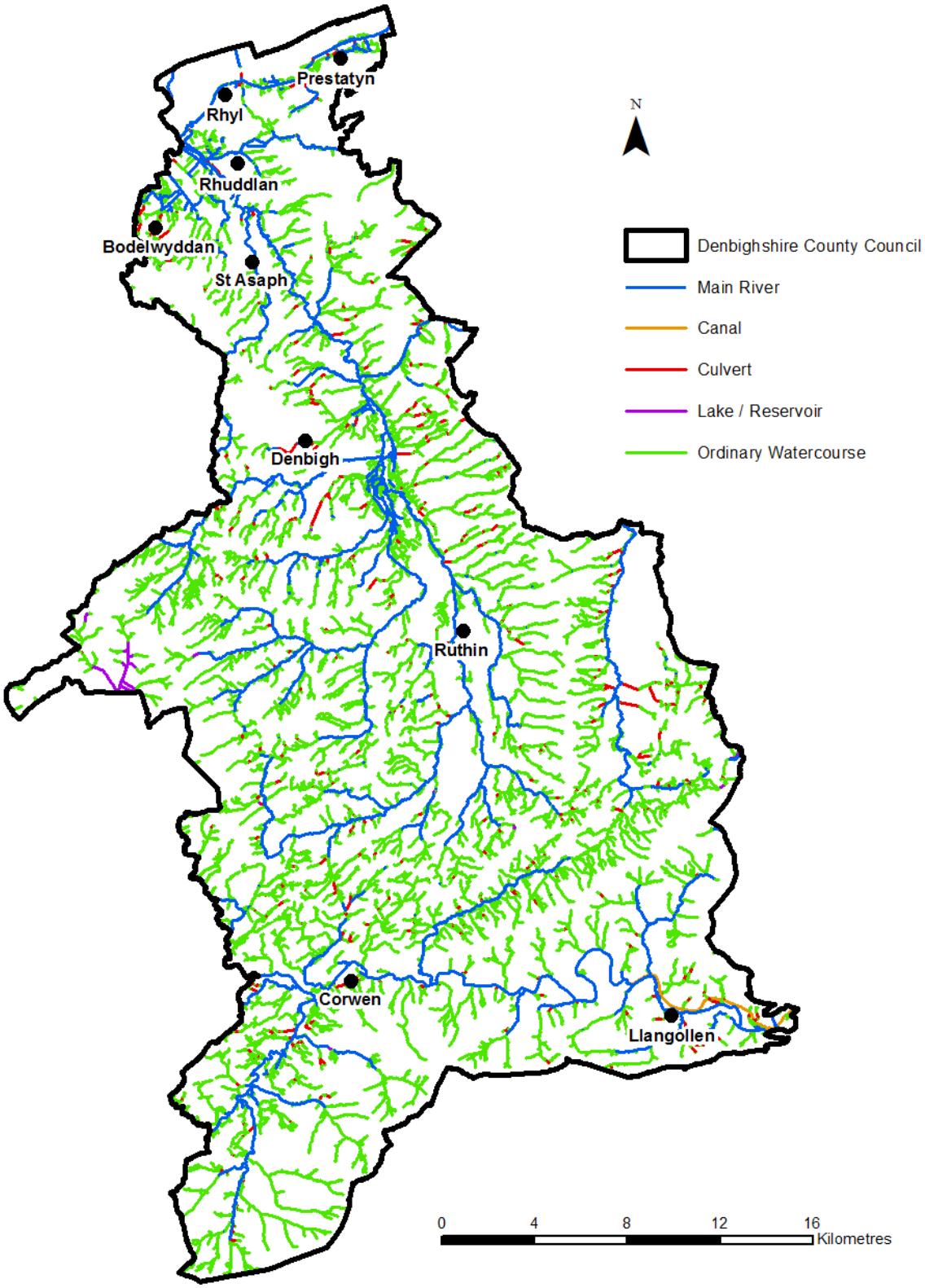
Denbighshire covers roughly 846 km2 with the majority of the county lying within the River Clwyd catchment with the exception of the approximate Southern quarter of the county lying within the River Dee catchment. There are several Main Rivers that act as tributaries to the River Clwyd such as the River Elwy whose confluence with the Clwyd is 2 km upstream of Rhuddlan; the Dwr l'al which joins just North of Ruthin; the River Clywedog which joins further downstream around 2 km Southeast of Denbigh; and the Aberham which joins East of Denbigh. In the northern downstream half of the Clwyd catchment the River Wheeler connects from the East approximately 3 km Northeast of Denbigh and the River Elwy flows North to feed the River Clwyd between St Asaph and Rhuddlan. At the coastal plain the Main Rivers become more heavily modified and act as drains to the flatter agricultural land surrounding the communities of Rhyl and Rhuddlan. On the River Dee, the Afon Alwen and the Afon Camddwr join upstream of Corwen and the Afon Morwynion joins further downstream at Carrog.

Together with the aforementioned Main Rivers, there are a number of Ordinary Watercourses, generally feeding the Main Rivers. Ordinary Watercourses consist of any watercourse that is not designated a Main River. These watercourses can vary in size considerably and can include rivers and streams and all ditches, drains, cuts, culverts, dikes, sluices, sewers (other than public sewers within the meaning of the Water Industry Act 1991) and passages, through which water flows.

Prior to the enactment of the FWMA, the responsibility for the regulation of Ordinary Watercourses was often not clearly identified. As a result, their conditions are likely to be highly variable. Consequently, it is likely that there will be several locations where structures on Ordinary Watercourses will be in a significant state of disrepair. Furthermore, the condition of the assets will continue to deteriorate over time. Figure 4-3 presents a breakdown of NRW's Detailed River Network (DRN) dataset in Denbighshire.

Tidal flood risk affects much of the coastal frontage of Denbighshire including the communities of Rhyl and Prestatyn. Risk from tidal flooding also extends up the Clwyd estuary beyond Rhuddlan. The coastal frontage is defended from high tides but residual risk of overtopping or breaching of defences remains.

Figure 4-3: Detailed River Network



4.5.1 Historical Fluvial and Tidal Flooding

Historic flood data used in the Denbighshire LFRMS[14] shows that fluvial flood risk within Denbighshire is located along the Main Rivers of the River Clwyd, most notably in Ruthin; the River Elwy, at St Asaph; and the River Dee at Corwen. The historic data also shows the majority of fluvial flood risk associated with numerous smaller, or Ordinary Watercourses, throughout the County. Communities that have suffered flooding from Ordinary Watercourses in the past include Ruthin, Denbigh, Llangollen, Corwen, Gwyddelwern, St Asaph, Dyserth, Llanbedr Dyffryn Clwyd and Pwll Glas.

The LFRMS also states that the major floods of November 2012 were due to the combination of prolonged rainfall on already saturated ground in the Clwyd and Elwy catchments which led to both of these Main Rivers overtopping as well as surface water flooding and flooding from Ordinary Watercourses.

Figure 4-4 presents a table extracted from the LFRMS which lists the most significant recent flood events. It shows that the November 2012 flood caused flooding to 550 residential properties and also shows that East Rhyl suffered tidal flooding as recently as December 2013, with 120 residential properties flooded by from sea. Note that the flooding of Ruthin in 2000 also came from Ordinary Watercourses and flooded around 200 residential properties rather than 20 as stated in the LFRMS table. There have been no significant flood events since 2013 recorded (or not yet investigated) and therefore local flooding context remains unchanged.

Figure 4-4: Significant Flood Events in Denbighshire

Year of Flood	Area Effected	Type of Flood	Consequence
2013	East Rhyl	Coastal	120 residential properties flooded
2012	St Asaph, Rhuddlan, Ruthin,	Main River	550 residential properties flooded at various locations across the county
2007	Prestatyn	Surface water	13 residential properties flooded by surface water at various locations in Prestatyn
2000	Dyserth	Ordinary Watercourse	5 residential properties flooded from Afon Ffyddion
2000	St Asaph	Ordinary Watercourse	7 residential properties flooded from Glascoed Stream
2000	Llanbedr	Ordinary Watercourse	7 residential properties flooded from un-named watercourse.
2000	Corwen	Ordinary Watercourse	23 residential properties flooded from Afon Nant y Cawrddu
2000	Ruthin	Main River	20 residential properties, 6 business properties.
1990	Rhyl & Prestatyn	Coastal	108 residential properties

Natural Resources Wales Historic Flood Map

The Historic Flood Map (HFM) shows areas of past fluvial, tidal and groundwater flooding. These outlines can be viewed on the accompanying SFCA Maps. The HFM mainly covers the length of the River Clwyd, River Elwy and the River Dee. A number of communities are within the HFM outline along these reaches. There is also flooding recorded from the Afon Ffyddion which affects a number of properties but mainly agricultural land. The agricultural drains between Rhyl and

14 Denbighshire Local Flood Risk Management Strategy, Consultation Strategy Document, Denbighshire County Council, January 2014

Prestatyn are also shown to have flooded surrounding fields and a large number of buildings in East Rhyl and the West of Prestatyn.

4.6 Surface Water Flooding

Surface water flooding, in the context of the Denbighshire SFCA, includes:

- Surface water runoff (also known as pluvial flooding); and
- Sewer flooding

Surface water flooding can occur anywhere in Denbighshire where ground levels and terrain profiles tend to cause surface water to flow and accumulate. However, there are certain locations where the probability and consequence of these mechanisms are more prominent due to the complex hydraulic interactions in the urban environment. Urban watercourse connectivity, sewer capacity, and the location and condition of highway gullies all have a major role to play in surface water flood risk.

It should be acknowledged that once an area is flooded during a large rainfall event, it is often difficult to identify the route, cause and ultimately the source of flooding without undertaking further site specific and detailed investigations.

4.6.1 Heavy Rainfall Flooding

Pluvial flooding of land from surface water runoff is usually caused by intense rainfall that may only last a few hours. In these instances, the volume of water from rural land can exceed infiltration rates in a short amount of time, resulting in water flowing over land. Within urban areas, this intensity is too great for the urban drainage network resulting in excess water flowing along roads, through properties and ponding in natural low spots as per the June 2007 flood event. Areas at risk can, therefore, lie outside of the fluvial flood zones.

Pluvial flooding within urban areas will typically be associated with events greater than the 1 in 30 year design standard of new sewer systems. Some older sewer and highway networks will have even less capacity than the 1 in 30 year event. There is also a residual risk associated with these networks due to possible network failures, blockages or collapses.

The third generation updated Flood Map for Surface Water, used in this SFCA, is extremely useful in supplementing the TAN 15 Development Advice Maps by identifying areas which may have critical drainage problems.

4.6.2 Historic Flooding from Intense Rainfall Events

As discussed in Section 3.4.4, Denbighshire County Council has not produced a Surface Water Management Plan for the County; however the LFRMS used NRW's second generation Flood Map for Surface Water (FMfSW) to assess surface water risk in Denbighshire. This assessment estimated that 5,140 properties were at risk from surface water flooding to a depth of 0.1 m and 1,579 properties were at risk from surface water flooding to a depth of 0.3 m. Of these 1,579 properties, 89% were residential.

The PFRA suggests that some areas of Rhyl and Prestatyn have been particularly prone to surface water flooding though any further detailed historic information is unavailable.

4.6.3 Risk of Flooding from Surface Water (RoFSW)

Natural Resources Wales updated the FMfSW, used in the PFRA and LFRMS, in 2013 to produce a third generation national surface water flood map, the updated Flood Map for Surface Water (uFMfSW). which has since been renamed the Risk of Surface Water Flooding map (RoFSW). The RoFSW dataset includes surface water flood outlines, depths, velocities and hazards for the following events:

- 1 in 30 AEP event (high risk)
- 1 in 100 AEP event (medium risk)
- 1 in 1000 AEP event (low risk)

The RoFSW is much more refined than the second generation map in that:

- More detailed hydrological modelling has been carried out using several design rainfall events rather than one for the second generation,

- A higher resolution Digital Terrain Model (DTM) has been used – 2 m, compared to 5 m for the second generation,
- Manual edits of DTM to improve flow routes at over 91,000 locations compared to 40,000 for the second generation,
- DTM edited to better represent road network as a possible flow pathway, this was not done for the second generation,
- Manning's n roughness (used to represent the resistance of a surface to flood flows in channels and floodplains) values varied using MasterMap Topography layer compared to blanket values for urban and rural land use applied in the second generation surface water flood map.

From looking at the outputs from the data collected and the maps there are a couple of sites at risk from surface water flooding see section 5.8.

4.6.4 Locally agreed data: Surface Water Flooding

As part of the Denbighshire PFRA, the County Council considered locally agreed surface water information, as required by NRW, to be the Flood Map for Surface Water (FMfSW). As described in Section 4.6.3, the third generation risk of flooding from surface water (RoFSW) should now be used as this is the most up-to-date national surface water dataset. DCC stated, in the PFRA, that the local surface water drainage system has generally been designed to accommodate a 1 in 5 to 1 in 30 year storm event.

4.6.5 Sewer Flooding

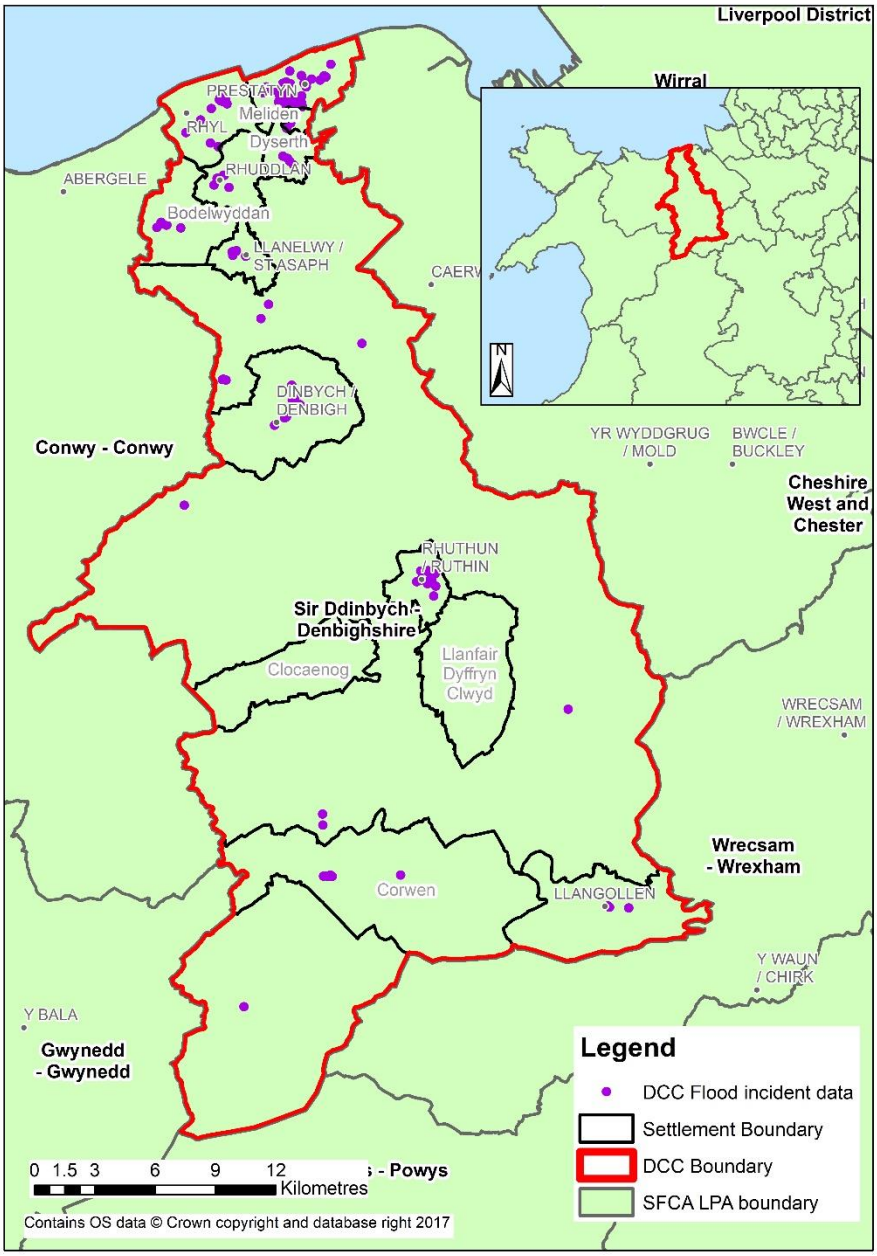
Combined sewers spread extensively across urban areas serving residential homes, business and highways, conveying waste and surface water to treatment works. Combined Sewer Overflows (CSOs), provide an overflow release from the drainage system into local watercourses or large surface water systems during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

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

Welsh Water (DCWW) is the water company responsible for managing and maintaining drainage systems, including surface water and combined sewers that serve the administrative area. DCWW are also responsible for flooding from sewage. Records of historic flooding from sewers exist within DCWW's DG5 Register and were supplied for this SFCA and is displayed in Figure 4-5. These data sets provide records for hydraulic failure date back to 1992 and show that there are 490 incidents within Denbighshire. The records entailing other causes begin in June 2003 with 441 incidents recorded across the County. Overall, Prestatyn has had the highest number of sewer flooding incidents with around 240 incidents recorded, followed by Rhyl with approximately 149 incidents recorded. Other communities with a significant number of incidents recorded include Denbigh with 87, St Asaph with 77, Llangollen with 66 and Ruthin with 57 incidents. GIS data from DCWW has been provided for this updated SFCA and relates to capacity system analysis of proposed sites and existing settlements. Further detailed analysis of site specific FCA could be developed. Additionally, a Level 2 SFCA can be carried out on specific sites or areas looking further into potential flood risk and carrying out more detailed assessment including detailed modelling on climate change projections, flood depth, velocity and hazards.

Dee Valley Water is responsible for water supply to the Dee Valley area of Denbighshire and does not deal with drainage or sewerage systems.

Figure 4-5: Historical sewer data



4.7 Groundwater flooding

Groundwater flooding is caused by the emergence of water from beneath the ground, either at point or diffuse locations. The occurrence of groundwater flooding is usually local and unlike flooding from rivers and the sea, does not generally pose a significant risk to life due to the slow rate at which the water level rises. However, groundwater flooding can cause significant damage to property, especially in urban areas, and can pose further risks to the environment and ground stability.

There are several mechanisms that increase the risk of groundwater flooding including prolonged rainfall, high in bank river levels, artificial structures, groundwater rebound and mine water rebound. Properties with basements or cellars or that are located within areas susceptible to groundwater flooding are at particular risk.

Development within areas susceptible to groundwater flooding will generally not be suited to SuDS and proposals for infiltration drainage; however, this is dependent on a detailed site investigation and risk assessment.

4.7.1 Areas Susceptible to Ground Water Flooding (AStGWF)

Groundwater is the term used to describe water that is stored underground in permeable rocks which are known as aquifers. The aquifers are fed through the process of precipitation which percolates through the ground and includes all of the water that is not lost to surface water runoff and evapo-transpiration. Groundwater forms the foundation of the base-flows of rivers and streams which are topped up by surface run-off. Groundwater flooding occurs when the water held underground rises above these levels. It is important to note that the term groundwater does not include any water that is carried in buried pipes or held underground in containers[15].

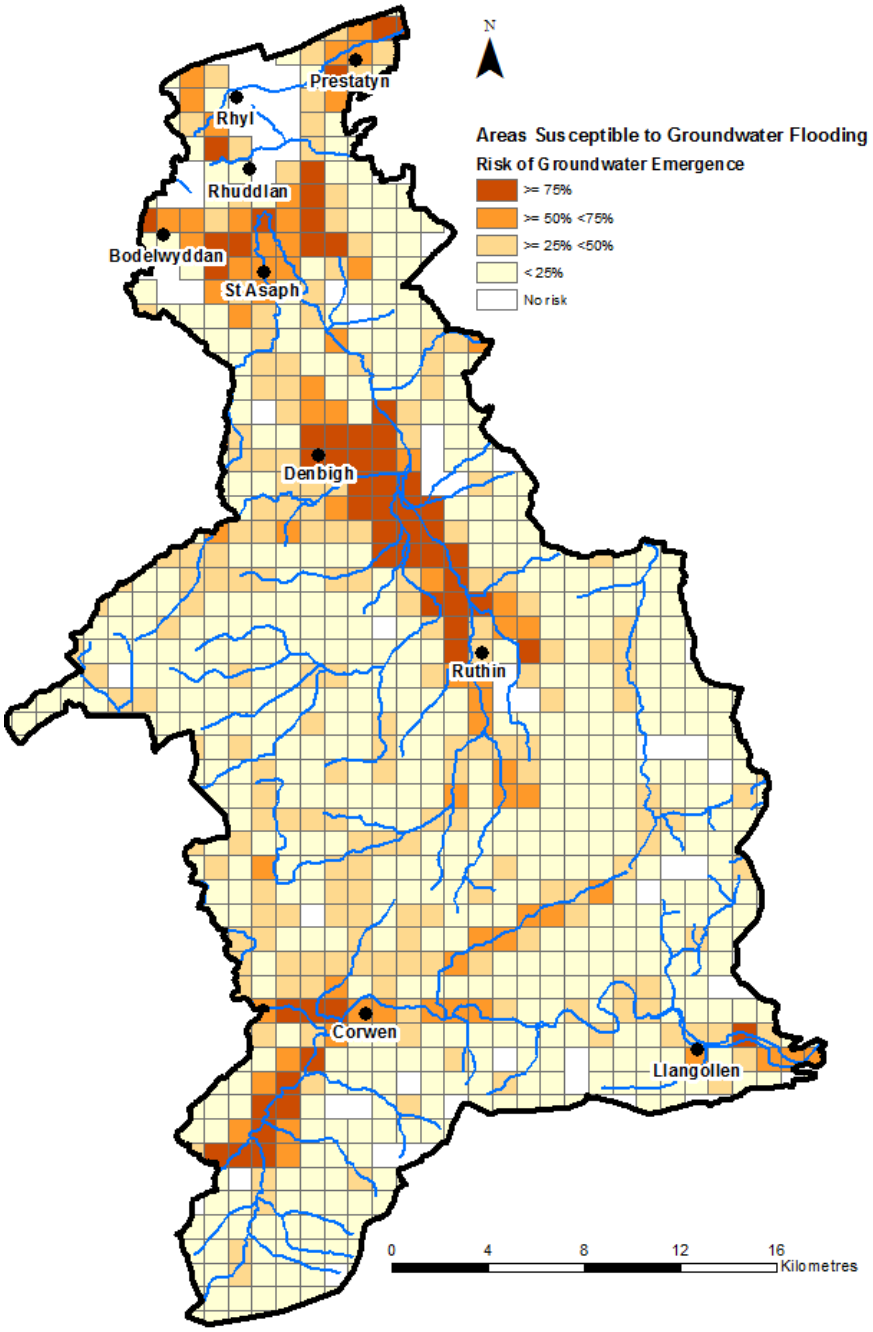
In Denbighshire, flooding attributed directly to groundwater is extremely difficult to apportion as groundwater flooding usually occurs in combination with pluvial and fluvial flooding. As groundwater flooding occurs in low lying areas, basements of residential housing are usually impacted by this type of flooding.

Natural Resources Wales's national dataset, Areas Susceptible to Groundwater Flooding (AStGWF), provides the main dataset used to assess the future risk of groundwater flooding. The maps are a low resolution which uses four susceptibility categories to show the proportion of a network of 1 km grid squares where geological and hydrogeological conditions show that groundwater might emerge. It does not show the likelihood of groundwater flooding occurring and is not suitable for planning considerations at a site-specific level. It should only be used as a trigger for further investigation as to the possibility of groundwater flooding

Figure 4-6: Areas Susceptible to Groundwater Flooding illustrates the AStGWF map. It shows that the risk of groundwater emergence is very high in parts of Denbigh and Prestatyn in 2013. There could however be localised problems in other areas, which are not identified on this strategic map. DCC has not specified any significant issues associated with groundwater flooding however.

15 https://www.denbighshire.gov.uk/en/your-council/strategies-plans-and-policies/local-flood-risk-management-strategy-en.pdf

Figure 4-6: Areas Susceptible to Groundwater Flooding



4.8 Canal and Reservoir Flood Risk

4.8.1 Canals

According to the Denbighshire LFRMS, the Llangollen Branch canal crosses the Denbighshire County border in the Southeast, near Trevor, and extends West for 10 km to the abstraction point at Horseshoe Falls near Llantysilio. This canal is owned and maintained by the Canal & River Trust and runs along the North side of the Vale of Llangollen. There has been a history of breaches to the Llangollen Canal between 1945 and 1985. The risk of flooding from the canal has not been previously assessed either as part of the 2007 SFCA, the PFRA or the LFRMS. However, the PFRA states that the Canal & River Trust aims to inform the second cycle of the PFRA process with a clearer understanding of flood risk from canals.

The risk of flooding along canals is dependent on a number of factors. As they are manmade systems and heavily controlled, it is unlikely they will respond in the same way as a natural

watercourse during a storm event. Flooding is more likely to be associated with residual risks, similar to those associated with river defences, such as overtopping of canal banks, breaching of embanked reaches or asset (gate) failure as highlighted in Table 4-2. Each canal also has significant interaction with other sources, such as watercourses that feed them and minor watercourses or drains that cross underneath.

The risks associated with these events are also dependent on their potential failure location with the consequence of flooding higher where floodwater could cause the greatest harm due to the presence of local highways and adjacent property. The focus should be on areas adjacent to raised embankments. The pound length of the canal also increases the consequence of failure, as flows will only cease due to the natural exhaustion of supply.

Stop plank[16] (log) arrangements, stop gates and the continued inspection and maintenance of such assets by the Canal & River Trust manage the overall risk of an event.

Table 4-2: Canal Flooding Mechanisms

Potential Mechanism	Significant Factors
Leakage causing erosion and rupture of canal lining leading to breach	Embankments Sidelong ground Culverts Aqueduct approaches
Collapse of structures carrying the canal above natural ground level	Aqueducts Large diameter culverts Structural deterioration or accidental damage
Overtopping of canal banks	Low freeboard Waste weirs
Blockage or collapse of conduits	Culverts

4.8.2 Reservoirs

A reservoir is usually an artificial lake where water is stored for use. Some reservoirs supply water for household and industrial use, others serve other purposes, for example, as fishing lakes or leisure facilities. Like canals, the risk of flooding associated with reservoirs is residual and is associated with failure of reservoir outfalls or breaching. This risk is reduced through regular maintenance by the operating authority. Reservoirs in the UK have an extremely good safety record with no incidents resulting in the loss of life since 1925.

Natural Resources Wales is the enforcement authority for the Reservoirs Act 1975 in Wales. All large reservoirs must be regularly inspected and supervised by reservoir panel engineers. Local Authorities are responsible for coordinating emergency plans for reservoir flooding and ensuring communities are well prepared. Local Authorities should work with other members of the Local Resilience Forum (LRF) to develop these plans.

The LFRMS states that there are six reservoirs that fall under the Reservoir Act and the maximum possible extent of flooding has been modelled by Natural Resources Wales to show the areas that would be impacted by a breach or failure of the dams. This data has not been provided as part of this SFCA though the Risk of Flooding from Reservoirs maps can be viewed online and can be found on the Environment Agency's website[17]. There are no records of reservoir failure actually occurring in Denbighshire however.

4.8.3 Reservoir Flood Maps

Natural Resources Wales has prepared reservoir flood maps for all large reservoirs that they regulated under the Reservoirs Act 1975. The Reservoirs Act 1975 requires that all large raised

16 Wooden boards for dropping into grooves at a narrows; to permit drainage for maintenance work on a canal section or to isolate a leaking section

17 http://watermaps.environment-agency.gov.uk/wiyby/wiyby.aspx?topic=reservoir

reservoirs which are designed or used for collecting and storing 10,000 cubic metres of water above the natural level of any part of the surrounding land[18].

The maps show the largest area that might be flooded if a reservoir were to fail and release the water it holds but do not give any information about the depth or speed of the flood waters. DCC Emergency Planners should have access to this information so they can develop effective Emergency Plans though the LFRMS states that Natural Resources Wales manages the emergency planning aspects. Due to the sensitivity of the information, any detailed information on reservoirs is not provided within this SFCA.

4.9 Flood Risk Management

The aim of this section of the SFCA is to identify existing Flood Risk Management (FRM) assets and previous / proposed FRM schemes in Denbighshire. The location, condition and design standard of existing assets will have significant impact on actual flood risk mechanisms. Whilst future schemes in high flood risk areas carry the possibility of reducing the probability of flood events and reducing the overall level of risk. Both existing assets and future schemes will have a further impact on the type, form and location of new development or regeneration through the County.

4.9.1 Natural Resources Wales Assets

Natural Resources Wales's provided their flood defence dataset which contains information on a number of flood defence structures in Denbighshire including asset type (embankments, walls, dunes, demountable defences, flood gates), asset maintainer (NRW, Local Authority, private) and asset description. The locations of these assets can be viewed on the SFCA Maps. The main areas include the coastal defences at Rhyl and Prestatyn; fluvial defences on the Elwy, defending St Asaph; and fluvial / tidal defences on the Clwyd estuary, defending Rhuddlan and Ruthin further upstream.

Natural Resources Wales carries out a number of other flood risk management activities that help to reduce the probability of flooding, whilst also addressing the consequences of flooding. These include:

- Maintaining and improving existing flood defences, structures and watercourses.
- Enforcement and maintenance where riparian owners carry out work detrimental to flood risk.
- Identifying and promoting new flood alleviation schemes where appropriate.
- Working with Local Authorities to influence the location, layout and design of new and redeveloped property and ensuring that only appropriate development is allowed on the floodplain.
- Operation of Flood Warnings Direct and warning services for areas along the River Clwyd and its tributaries.
- Promoting awareness of flooding so that organisations, communities and individuals are aware of the risk and are prepared in case they need to take action in time of flood.
- Promoting resilience and resistance measures for those properties already in the floodplain.

4.9.2 Water Company Assets

The sewerage infrastructure of Denbighshire is likely to be based on Victorian sewers from which there is a risk of localised flooding associated with the existing drainage capacity and sewer system. The drainage system may be under capacity and / or subject to blockages resulting in localised flooding of roads and property. Welsh Water is responsible for the overall management of the urban drainage system throughout the County, including surface water and foul sewerage. Welsh Water assets include Wastewater Treatment Works, Combined Sewer Overflows, pumping stations, detention tanks, sewer networks and manholes.

18http://www.naturalresources.wales/guidance-and-advice/environmental-topics/water-management-and-quality/reservoir-safety/guidance-for-owners-and-operators/?lang=en

4.9.3 Denbighshire County Council Assets

As a LLFA, DCC will own and maintain a number of assets throughout the County including culverts, bridge structures, trash screens, highway drains and gullies. The majority of these assets are likely to lie along the Ordinary Watercourses, especially within urban areas, where they have been culverted or diverted. These assets can have flood risk management functions as well as affect flood risk if they become blocked or fail.

As part of its FWMA duties, DCC has a duty to maintain a register of structures or features, which are considered to have an effect on flood risk, including details on ownership and condition as a minimum. The County Council does not, as yet at the time of writing, have a robust asset register though Section 6.2.1.4 of the Denbighshire LFRMS does recognise the requirement and states that an asset register should be in place.

The asset register should outline how the County Council intend to manage these assets or features including their ongoing maintenance programme. Where assets or features are located in a high risk area or have been assessed to have the potential to effect flood risk, DCC should prioritise and focus any maintenance or upgrades.

4.9.4 Future Local Flood Risk Management Work Programmes

NRW's Future Investment Programme lists a number of flood risk management work programmes that are proposed to be carried out over the next few years includes;

- St Asaph Channel Maintenance
- Prestatyn Gutter Tidal Embankment
- St Asaph Embankment Works
- Maes Ffynnon Wall Replacement, Ruthin
- Brookhouse FRM Study
- Rhyl Penstock work
- Ffordd Isa Trash Screen work
- St Asaph Phase 2
- Work at Dyserth
- River Clwyd Tidal Structures (eight structures)
- IPP Llandrillo
- IPP Lower Denbigh Road

There is also potential for several Flood Alleviation Schemes (FAS) to be put in place at Dyserth, Pwll Glas and Llanbedr.

5 Development and flood risk

5.1 Introduction

This section of the SFCA provides a strategic assessment of the suitability, relative to flood risk, of key settlements in Denbighshire, existing Local Development Plan sites to help inform the development of a new Local Development Plan.

The information and guidance provided in this chapter (supported by the SFCA mapping in Appendix A, Development Site Assessment Spreadsheet in Appendix B and NRW flood Zone maps in Appendix C) can be used by DCC to inform their new Local Development Plan, and provide the basis from which to apply the Justification and Acceptability Tests in sections 6 and 7 of TAN 15. Surface water risk is also reviewed and recommendations are made as per Section 8 and Appendix 4 of TAN 15 concerning surface water management and SuDS and requirements for further detailed SFCA Level 2 are outlined in section 6.2.1.

Detailed modelled climate change outputs are not available for this study, and therefore a cautious approach to assessing future risk to existing settlements and sites at risk has been adopted. It is can be often the case that modelled 1 in 1000 year AEP event outlines are similar to modelled climate change scenarios for the 1 in 100 year AEP event. The breach modelling outputs provided in 5.7.1 provides further details in terms of key settlements.

5.2 Justification and Acceptability Tests

The justification test is section 6 of TAN 15 and discusses that much urban development in wales has taken place alongside rivers and in the coastal plains. The justification Test in TAN 15 is to help avoid this. Section 6 paragraph 2.2 states:

New development should be directed away from zone C and towards suitable land in zone A, otherwise to zone B, where river or coastal flooding will be less of an issue. In zone C the tests outlined in sections 6 and 7 will be applied, recognising, however, that highly vulnerable development and Emergency Services in zone C2 should not be permitted. All other new development should only be permitted within zones C1 and C2 if determined by the planning authority to be justified in that location. Development, including transport infrastructure, will only be justified if it can be demonstrated that:

- Its location in zone C is necessary to assist, or be part of, a local authority regeneration initiative or a local authority strategy required to sustain an existing settlement or,
- Its location in zone C is necessary to contribute to key employment objectives supported by the local authority, and other key partners, to sustain an existing settlement or region;

And

- It concurs with the aims of PPW and meets the definition of previously developed land (PPW fig 2.1); and,
- The potential consequences of a flooding event for the particular type of development have been considered, and in terms of the criteria contained in sections 5 and 7 and appendix 1 found to be acceptable.

5.3 Flooding Consequence Test

The site has to pass both the justification and acceptability test (consequence assessment) This consequence test needs to be *completed to the satisfaction of* section 7 paragraph 7.1-7.2 of TAN 15*.*

If a development proposal in zone C1, or in C2 if it is defined as being of low vulnerability, meets the test outlined in section 6, the justification will be in the knowledge that those developments will flood and will need to be planned accordingly. This section will apply in zone C, and those parts of zone B where flooding has been identified as a material consideration to allow for localised problems.

Whether a development should proceed or not will depend upon whether the consequences of flooding of that development can be managed down to a level which is acceptable for the nature/type of development being proposed, including its effects on existing development. It would certainly not be sensible for people to live in areas subject to flooding (even in two story buildings)

where timely flood warnings cannot be provided and where safe access/egress cannot be achieved.

5.4 Denbighshire Settlement Areas

DCC have key settlements in the following areas:

- Rhyl
- Prestatyn
- Ruthin
- Rhuddlan
- Bodelwyddan
- St Asaph
- Corwen
- Denbigh
- Clocaenog
- Dyserth
- Meliden
- Llanfair Dyffryn Clwyd
- Llangollen

The SFCA reviews flood risk of existing settlement areas to provide an assessment is made of the current and likely future flood risk from fluvial, coastal and surface water sources, where applicable. This assessment provides key information required for TAN 15 regarding the suitability of land for development and application of local evidence. This SFCA also includes a breach analysis of four breach models within Denbighshire these are: Rhyl breach, Prestatyn breach, Rhuddlan Clwyd Breach and Rhuddlan Marine Lake Breach. These breach locations illustrate the risk of flooding which can be found in Appendix B the site assessment spreadsheet and can be compared to the tolerable depths found Table A1.15 of TAN15.

The tolerance condition assessment uses thresholds from Table A1.15 of TAN 15 which is described as not being prescriptive and is only indicative guidance. Therefore, the numbers provided in the tolerance condition assessment tables are estimated from a representative area of the site under assessment.

The existing Local Development Plan allocation sites have been updated (Appendix B) using a series of updated models that have been used to simulate fluvial and coastal flooding following methodologies adopted by Natural Resources Wales. The site assessment spreadsheets, in Appendix B, provide detailed breakdowns of each key site showing the Area (ha) and percentage cover of each of the TAN 15 zones and the surface water flood zones taken from the risk of Flooding from Surface Water maps. There is a column within the spreadsheets that indicates the source of the Zone C1 and C2 outline i.e. a flood model or the DAM. Furthermore, there are additional columns that display the risk of flooding from each breach location and the tolerable depths. This also details whether key sites fall within the 0.1% flood outline (Zone C) though also assesses the tolerable criteria for risks to developments associated with flood depth, rate of rise of flood waters, speed of flood water inundation and flow velocity.

DCC should use the Development Site Assessment spreadsheet in Appendix B to identify if there are updated FCA's are required for the Justification and Acceptability Test. DCC can use the combination of settlement and sites assessment to assess wider strategic objectives, against regeneration in areas already at risk of flooding, and the compatibility of vulnerability classifications and Flood Zones (refer to TAN15) for the new Local Development Plan.

5.5 Review of Existing Local Development Plan Sites

An updated GIS review of the existing Denbighshire County Council (DCC) Local Development Plan, sites has been undertaken to continue to inform the justification and acceptability tests. This review entails a high-level review of GIS screening exercise overlaying of existing development

sites allocations against Flood Zones A, B, C1 and C2, the DAM flood zones 1 and 2 and calculating the area of each site at risk.

The GIS Flood Zones A, B, C1 and C2 are sourced from Natural Resources Wales (NRW) Flood Map for Planning (Rivers and Sea). Surface water risk to potential sites is assessed by way of the NRW's Risk of Flooding from Surface Water (RoFSW) map, formally known as the updated Flood Map for Surface Water (uFMfSW).

The accompanying Development Site Assessment Excel spreadsheet provides a breakdown of each site and the area (in hectares) and percentage coverage of each fluvial/tidal flood zone and each surface water flood zone. Fluvial/tidal Flood Zones C2, C1, B and A are considered in isolation. Any area of a site within the higher risk Flood Zone C2 that is also within Flood Zone C1 is excluded from Flood Zone C1 and any area within Flood Zone C1 is excluded from Flood Zone B and NRW Flood Zone maps 2 and 3.

It is important to consider that each allocated site/settlement will require further investigation, following this review, as local circumstances may dictate the outcome of the recommendation. Such local circumstances may include the following:

- Flood depths and hazards will differ locally to each at risk site therefore modelled depth, hazard and velocity data should be assessed for the relevant flood event outlines, including climate change (using the Welsh Government Climate Change guidance), as part of a Level 2 SFCA or more detailed site-specific FRA.
- Current surface water drainage infrastructure and applicability of Sustainable Drainage Systems (SuDS) techniques are likely to differ at each site considered to be at risk from surface water flooding. Further investigation would therefore be required for any site at surface water flood risk.
- If there are sites which have planning permission but construction has not started, the SFCA will only be able to influence the design of the development e.g. finished floor levels. New, more robust flood extents (from new models) cannot be used to reject development where planning permission has already been granted.
- It may be possible at some sites to develop around the flood risk. Planners are best placed to make this judgement i.e. will the site still be deliverable if part of it needs to be retained to make space for flood water.
- Surrounding infrastructure and land use may influence scope for layout redesign/removal of site footprints from risk.
- Current land use: A number of sites included in the assessment are likely to be brownfield, thus the existing development structure could be taken into account as further development may not lead to increased flood risk.
- Existing planning permissions may exist on some sites where the NRW may already have passed comment and/or agreed to appropriate remedial works concerning flood risk. Previous flood risk investigations/FRAs may already have been carried out at some sites.
- Cumulative effects. New development may result in increased risk to other potential or existing sites which could be assessed through a Level 2 SFCA or more detailed FRA.

The above recommendations are provided as a GUIDE, based on the fluvial and tidal flood risk information made available for this Level 1 SFCA at the time of the assessment.

Information regarding local, site-specific information is beyond the scope of this Level 1 SFCA. It is DCC's responsibility to carry out JUSTIFICATION testing of each site using the information provided in this SFCA and more specifically using their local, site-specific knowledge and advice from NRW.

The recommendations and Development Site Assessment spreadsheet in Appendix B, should together assists the LPA in carrying out the Justification and Acceptability Tests for each site as part of the LDP Review.

Furthermore, in this SFCA the Appendix B site spreadsheet also assessed the risk of flooding for breach scenarios. This included four breach locations within Denbighshire; calculating whether any sites would be impacted by a breach using the worst-case scenario. However, it should be noted that Denbighshire is more likely to be impacted by overtopping than breaches.

5.6 Key Settlements at risk of Fluvial and Surface Water flooding

This section assesses Fluvial and surface water risk to each settlement in Denbighshire according to the DAM flood zones and RoFSW. Appendix C also covers the NRW flood zone maps.

The Development Site Assessment spreadsheet in Appendix B isolates each of the surface water outlines so that any area of a site within the higher risk 1 in 30 year outline is excluded from the medium risk 1 in 100 year outline and any area within the 1 in 100 year outline is excluded from the lower risk 1 in 1000 year outline. This allows a sequential assessment of risk at each site.

NOTE: This assessment of surface water risk to sites DOES NOT take account of local circumstances, only that part of a site area falls within a surface water flood outline of RoFSW.

As explained with the fluvial / tidal flood zones, the percentage thresholds are not included within any policy, it is merely considered that where a site has 10% or greater of its area at risk from the 1 in 30 or 1 in 100 year event outlines, or 20% or greater for the 1 in 1000 year event, then it could prove difficult to manage this surface water on-site. Therefore, a site-specific FCA should be carried out to investigate possible mitigation measures for flood storage or infiltration techniques through appropriate SuDS. The percentage thresholds do not consider local conditions.

The datasets used in this section of the report include the Development Advice Maps (DAM) that can be easily downloaded from the Lle website and are a national categorisation of flooding within Wales which are updated quarterly, see section 3.3.2 for further information. Also, within this section the NRW Risk of Flooding from Surface Water (RoFSW) is taken into consideration along with the DAM zones when assessing the thirteen settlements. Furthermore, the Areas Susceptible to Ground Water Flooding dataset has been considered in this section of the report and the extents are mapped out for each settlement separately. This data set has been provided by the last SFCA carried out and therefore may be out of date, however this data set has not been updated since the previous SFCA.

The above datasets listed are illustrated through mapping within this section of the report and demonstrate the risk of flooding within the different settlements within Denbighshire.

Other sources of flooding have also been assessed within this SFCA, such as the NRW Flood Zones categories' Flood Zone 1 and 2. The extent of these flood zones have been mapped by each settlement and can be seen in Appendix C and in Appendix A of the interactive maps.

The interactive maps contain all of the datasets used within this section of the report and additional data sets, such as the four re-run modelled breach locations, Risk of Flooding from Rivers and Sea, historical flood incidents and flood risk management i.e. Areas Benefiting from Defences, Flood Storage Areas and Flood Warning Areas.

5.6.1 Key Settlements at Risk of Fluvial and Surface Water Flooding

Rhyl and Prestatyn

In Rhyl, the DAM C1 zone covers most of Northeast Rhyl around The Cut and South West Rhyl (as shown in 5.6.1) to River Clwyd. These areas are at risk from surface water flooding. The NRW Flood Zone maps indicate an extensive area of Rhyl located within Flood Zone 3. This area coincides with either a 1% AEP fluvial flooding event or 0.5% AEP risk of flooding from the sea. Areas benefiting from defences are also included. Flood defences only reduce the chance of flooding. Residual risks associated with defence failure or overtopping will need to be considered further in detail.

There are linkages between Rhyl and Prestatyn in terms of tidal and fluvial flood risks. Prestatyn is also shown to be at risk from DAM C1 for an extreme 0.1% AEP event (defended scenario). The NRW Flood Zone map indicates that a significant area is located within Flood Zone 3 and is at risk during a 1% AEP fluvial event, (or 0.5% AEP tidal event). Some areas to Northeast do not benefit from flood defences. Further, there are some extensive areas at risk from surface water flooding

to the South West of Coed Y Morfa and Gallt Mellyd and to the South of Marine Road in the Northeast of Prestatyn.

Dyserth, Meliden and Rhuddlan

In Dyserth the DAM C2 correlates with flood extents for the Afon Ffyddion which travels through Dyserth. The majority of the flooding flows through Dyserth from the North East (as shown in 5.6.11). Surface water flooding also follows a similar route to fluvial flooding within Dyserth.

There is a linkage between Dyserth, Meliden and Rhuddlan in terms of the fluvial and surface water risks as both sources of flooding take a similar flow routes to the watercourse. The NRW Flood Maps show that the majority of the settlements are located in Flood Zone 3, coinciding with a 1% AEP event for fluvial risk (or a 0.5% AEP tidal event). However, within all three settlements this Flood Zone is mainly confined to areas of the watercourse and river corridor.

There are flood defences located in Dyserth along the Afon ffyddion. Similarly Meliden has flood defences located on the Prestatyn Gutter. It is important to note that flood defences only reduce the chance of flooding. Residual risks associated with defence failure or overtopping will need to be considered further in detail.

Bodelwyddan and St. Asaph

In Bodelwyddan the DAM C1 covers most of the North of the settlement (as shown in section 5.6.6). There are few areas within Bodelwyddan that are located within high risk DAM zone C2. These areas are primarily confined to the river corridor.

Areas to North East of St Asaph are located within DAM C1, (refer to section 5.6.7). Again the DAM C2 is generally confined to areas located along the watercourses.

The NRW Flood Zone map indicates extensive areas in the North of Bodelwyddan subject to Flood Zone 3, which is an area subject to 1%AEP fluvial event or 0.5% AEP event risk of flooding from the sea. Areas benefiting from defences are also included..

Additionally, within St Asaph there are areas located within Flood Zone 3 with flooding predicted to enter St Asaph from the North. Flooding tends to follow the same alignment as the watercourses in this area. Risk of Flooding from Surface Water located within Bodelwyddan and St Asaph mainly occurs in the urban areas and surrounding the watercourses.

There are flood defences located within Bodelwyddan and St Asaph, these are mainly situated in the flood warning areas. It is important to note that flood defences only reduce the chance of flooding. Residual risks associated with defence failure or overtopping will need to be considered further in detail.

Denbigh

The DAM zone C2 is predominant within Denbigh. DAM C2 enters from the North East of Denbigh. Similarly the NRW Flood Zone mapping indicates Flood Zone 3 as being confined to the watercourses.

There is a slight difference between the DAM and Flood Zone mapping to the East with DAM C2 only compared to both Flood Zones 2 and 3 as indicated in the NRW mapping.

Similarly , the Risk of Flooding from Surface Water is at highest risk 1-30 year in the East of Denbigh and follows the same flow routes as the watercourses through Denbigh.

There are flood defences located within Denbigh, the majority of the Afon Ystrad is defended. The Henllan Brook and Llweni Drain are also defended. It is important to note that flood defences only reduce the chance of flooding. Residual risks associated with defence failure or overtopping will need to be considered further in detail.

Ruthin, Clocaenog and Llanfair Dyffryn Clwyd

In Ruthin, the DAM C2 zone surrounds the River Clwyd and runs through the centre of Ruthin as shown in section 5.6.4. There are a range of flood extents and flood risk categories within Ruthin as the urban areas are located within zone C1. Areas to the North and South tend to be located in lower risk zone B.

In Llanfair Dyffryn Clwyd and Clocaenog flood risk areas are also generally confined to the watercourses. However, in Clocaenog the flood risk is located within the DAM C2 area. Flood risk

is confined to the watercourse and there is no flood risk elsewhere within the settlement. When taking into consideration the NRW Flood Zone maps for all three settlements the main flood zone is 3, 1%AEP event for fluvial flooding and this correlates with the DAM maps.

There are some extensive areas within Ruthin that have Risk of Flooding from Surface Water, these are mainly located within the urban areas. Within Clocaenog and Llanfair Dyffryn Clwyd the surface water flooding is mainly constrained to main rivers and tributaries.

Clocaenog does not have any flood defences or flood warning areas. Ruthin has some flood defences located within the urban areas and these have corresponding flood warning areas. Similarly, there are flood defences located within Llafair Dyffryn Clwyd along the Afon Hespin and Dwr Ial.

It is important to note that flood defences only reduce the chance of flooding. Residual risks associated with defence failure or overtopping will need to be considered further in detail.

Corwen and Llangollen

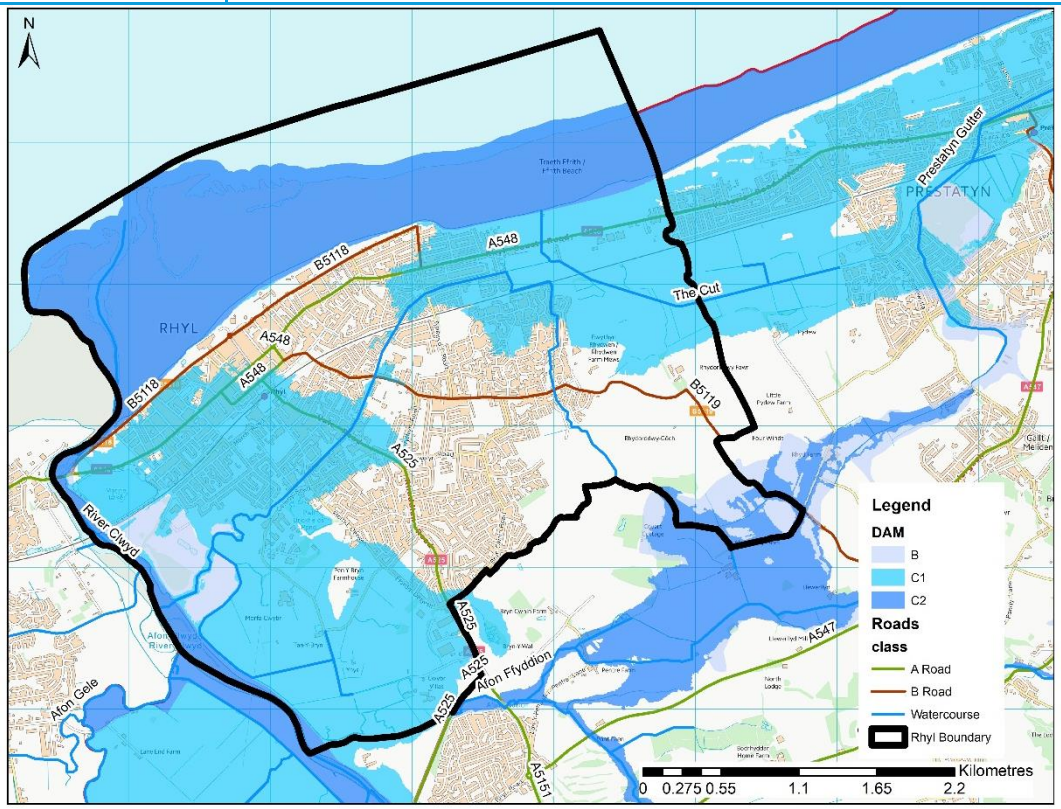
Corwen and Llangollen are both situated within the same DAM zone and both settlements have predominately DAM C2 present linked to the River Dee and tributaries. For Corwen the DAM C2 zone extent is wider. In Llangollen the DAM C2 is narrower and also includes areas classified as DAM zone B. The NRW Flood Zone maps correlate with the DAM as the extents are the same and both settlements have categories in Flood Zone 3, 1 in 100 year fluvial risk. The Risk of Flooding from Surface Water within Corwen and Llangollen is linked to the fluvial risk within the area. Llangollen appears to have fewer areas at risk in comparison to Corwen this can be seen in section 5.6.8.

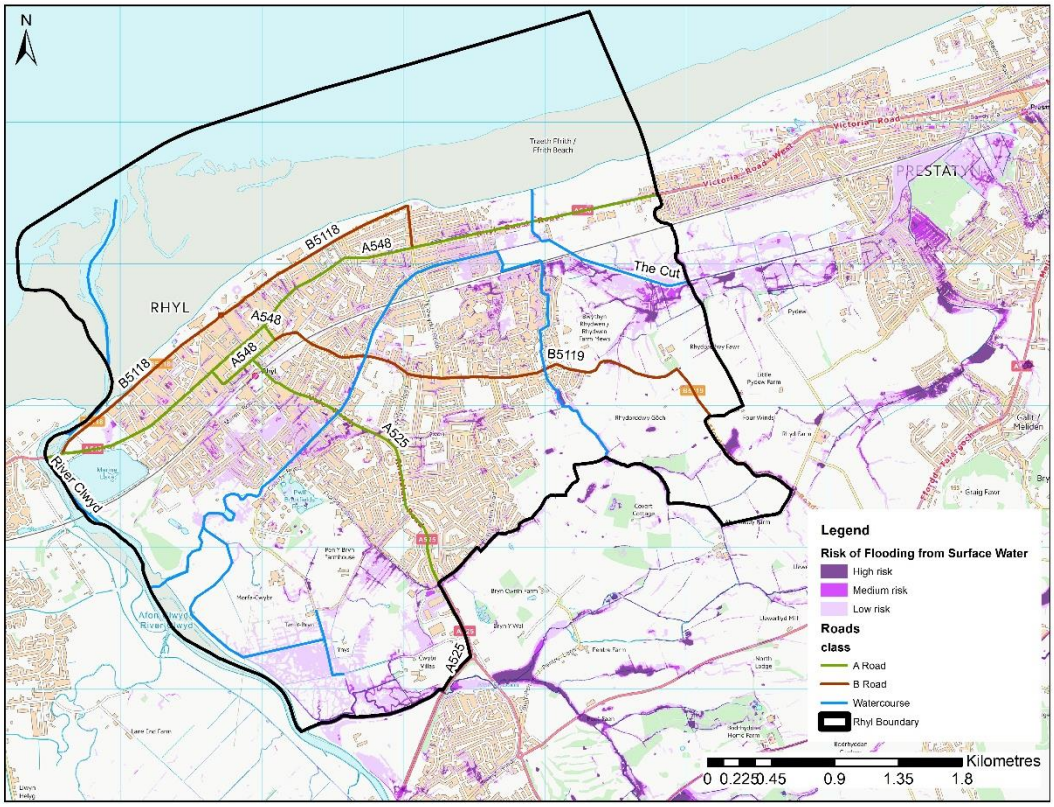
Both Corwen and Llangollen contain flood defences. In Llangollen, these flood defences are located along the River Dee. Similarly, Corwen has flood defences located along the Afon Morwynion, Afon Camddwr, Afon Alwen, Nant Ffrauar and River Dee. The flood warning areas are in place for flood defences along the River Dee. Regarding the flood warning area in Llangollen, this is located along the boundary in the North where the River Dee enters the settlement.

It is important to note that flood defences only reduce the chance of flooding. Residual risks associated with defence failure or overtopping will need to be considered further in detail.

5.6.2 Rhyl

Settlement	Rhyl
Area (ha)	1609.93
Catchment	Clwyd





Overview

Behind the coastal frontage of Rhyl there is one main river called 'The Cut' that flows East to West across Rhyl before discharging into the River Clwyd. As discussed in section 5.8 there are many tidal defence breach scenarios modelled in close proximity to Rhyl, for instance the Rhyl breach impacts the North East of Rhyl. The Rhuddlan Marine Lake and Rhuddlan Clwyd breach have similar outlines that impact the West of Rhyl and along The Cut that flows across Rhyl. In terms of historical flooding, there have been 27 recorded flood incidents in Rhyl since 2000.The main cluster of flooding occurs near The Cut in the North East area of Rhyl. Records of historic flood incidents are not shown on the SFCA maps due to sensitivity of data.

The outputs from the 2017 updated modelling of the Rhyl Cut watercourse include defended scenario outlines for the 0.1%, 1% and 5% AEP events as well as undefended scenario outlines for the 0.1% and 1% AEP events.

Fluvial and Tidal Flood Risk

The Development Advice Map shows that large parts of Rhyl are at risk from widespread fluvial and tidal flooding. The coastal frontage and along the River Clwyd to the West are at the highest risk (Zone C2) from tidal flooding. Zone C1 covers a large part of western Rhyl and is also present in the North East of the town meaning development proposals for emergency services, highly and less vulnerable uses would be subject to application of justification test including acceptability of consequences, as per TAN 15 requirements. The main central areas are however mainly with Zone A and therefore considered to be at little or no risk of tidal or fluvial flooding. It is in these areas where the LPA should be focusing new development, though a site-specific FCA should still be carried out where the RoFSW map shows any risk from surface water flooding.

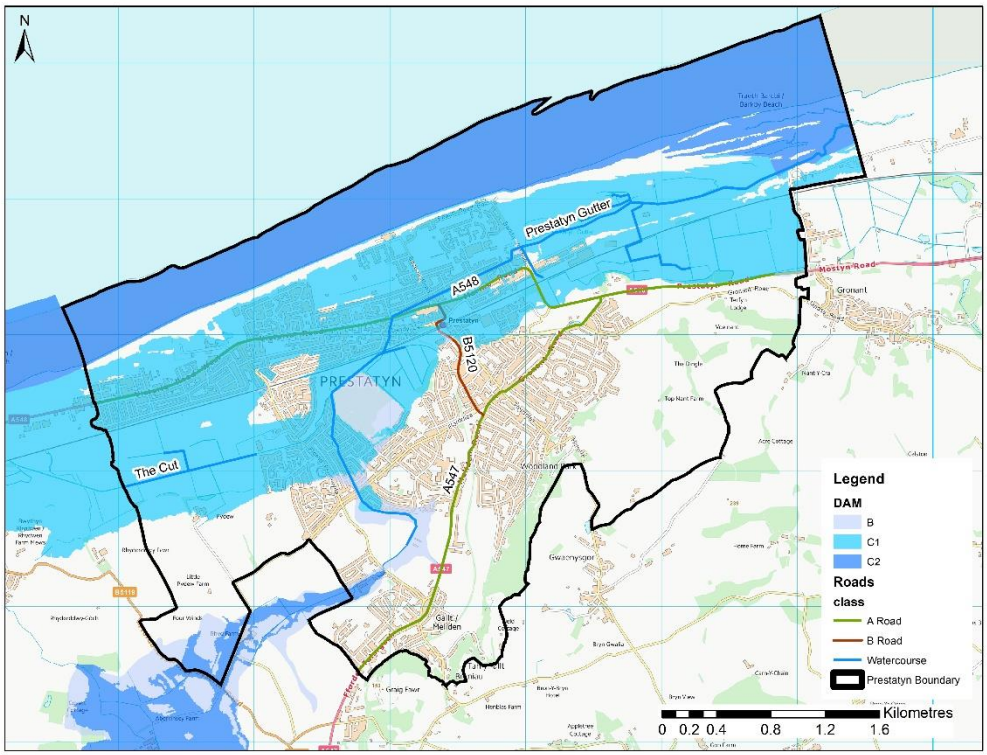
Along with fluvial flooding Rhyl is at risk of tidal flooding, the coastal frontage is defended from high tides but residual risk of overtopping or breaching of defences does remain. Nevertheless, there are coastal flood defence projects underway to reduce the risk of tidal flooding in Rhyl.

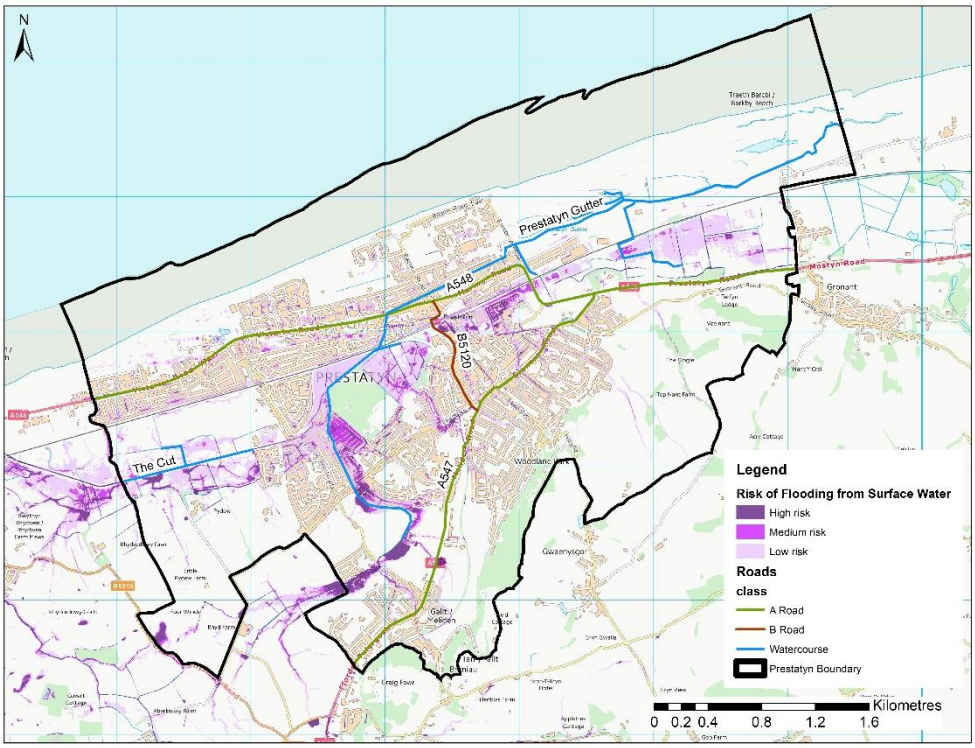
Risk of Flooding from Surface Water

Surface water flood risk exists across much of Rhyl, though many areas are at low risk, according to the RoFSW dataset. There are however several areas at high risk, such as the area between The Cut watercourse and the B5119 in the eastern part of Rhyl, and also in pockets through the central built-up areas. As mentioned above, where new development is proposed in any areas at risk from surface water flooding, a FCA should be carried out with particular focus on drainage requirements and suitable SuDS with the impetus on attenuation of surface water on-site where possible. For any larger developments with multiple units, a drainage strategy or Surface Water Management Plan may be appropriate.

5.6.3 Prestatyn

Settlement	Prestatyn
Area (ha)	1601.41
Catchment	Clwyd





Overview

Behind the coastal frontage of Prestatyn there is a main river called the Prestatyn Gutter that flows through the rural and urban areas of Prestatyn and discharge to the sea via pumping stations. Regarding the historical flood data in the area, there have been 72 flood events in Prestatyn since 1992. These historical flood events are mainly clustered in the West, with numerous clusters located in the Southwest. As discussed in section 5.8 there are two tidal defence scenarios modelled within the area of Prestatyn. The Prestatyn Breach spreads across the North of area from East to West and the Rhyl tidal breach enters Prestatyn from the West, however this only extends as far as Ffordd Penrhwylfa.

The updated modelling of Prestatyn Gutter produced defended scenario outlines for the extreme 0.1% AEP event as well as the 1% and 5% AEP events. Undefended 0.1% and 1% AEP event outlines were also produced.

Fluvial and Tidal Flood Risk

The development Advice Maps illustrates that there are large areas of Prestatyn that are at risk from widespread fluvial and tidal flooding. Tidal flooding occurs along the sea front of Prestatyn with a DAM zone of C2. Fluvial flooding occurs along the North near the coastal front of Prestatyn, with the risk being categorised as zone C1 spreading from West to East across a large part of Prestatyn. Thus meaning development proposals for emergency services, highly and less vulnerable uses would be subject to application of justification test including acceptability of consequences, as per TAN 15 requirements. However, the South Prestatyn is mainly Zone A and therefore considered to be at little or no risk of tidal or fluvial flooding. It is in these areas where the LPA should be focusing on for new development, though a site-specific FCA should still be carried out where the RoFSW map shows any risk from surface water flooding.

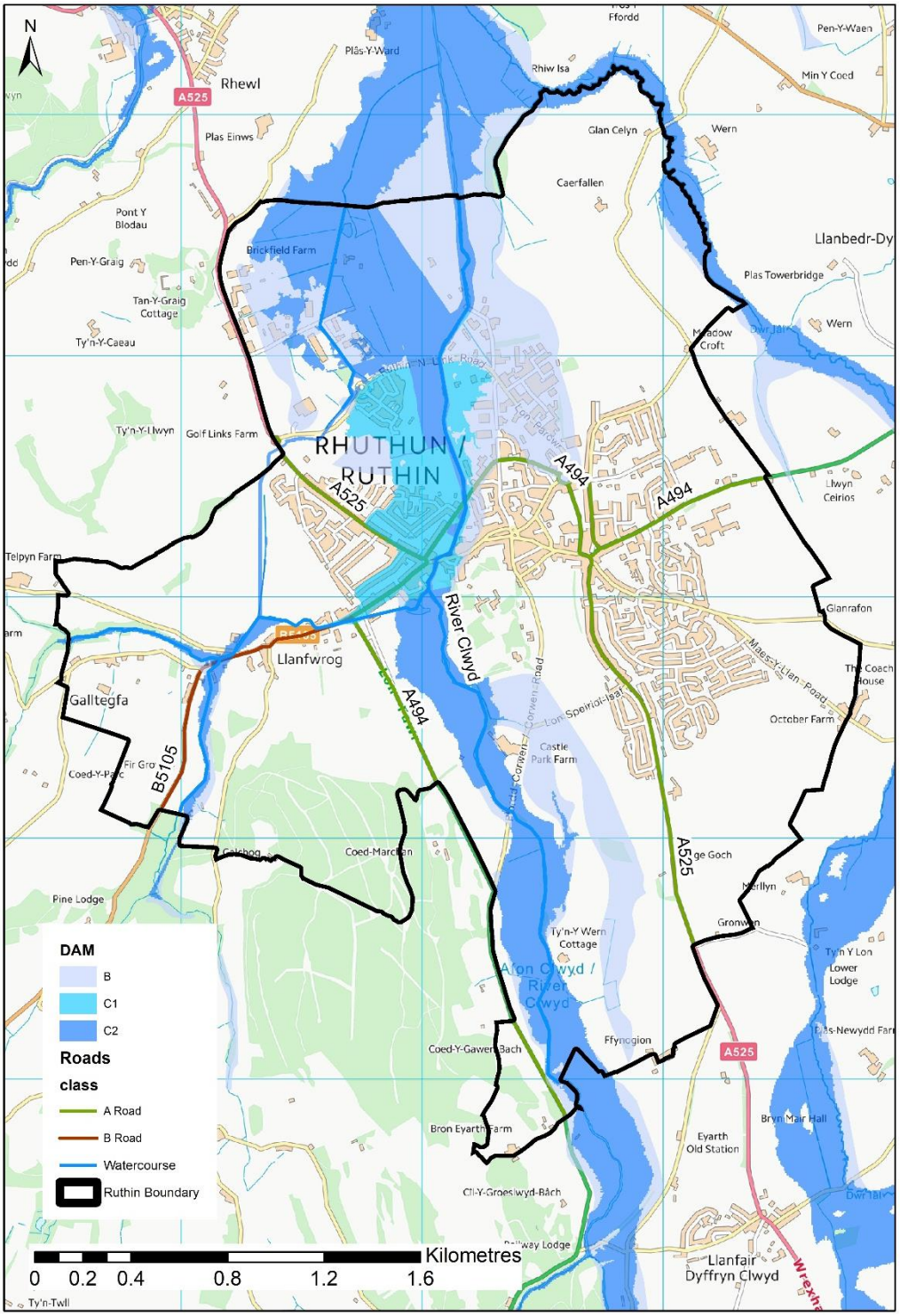
Along with fluvial flooding Prestatyn is at risk of tidal flooding, the coastal frontage is defended from high tides but residual risk of overtopping or breaching of defences does remain. In this area the DAM zone is C2 however this is mainly located within the sea and the coast of Prestatyn and not necessarily inland or in urban areas.

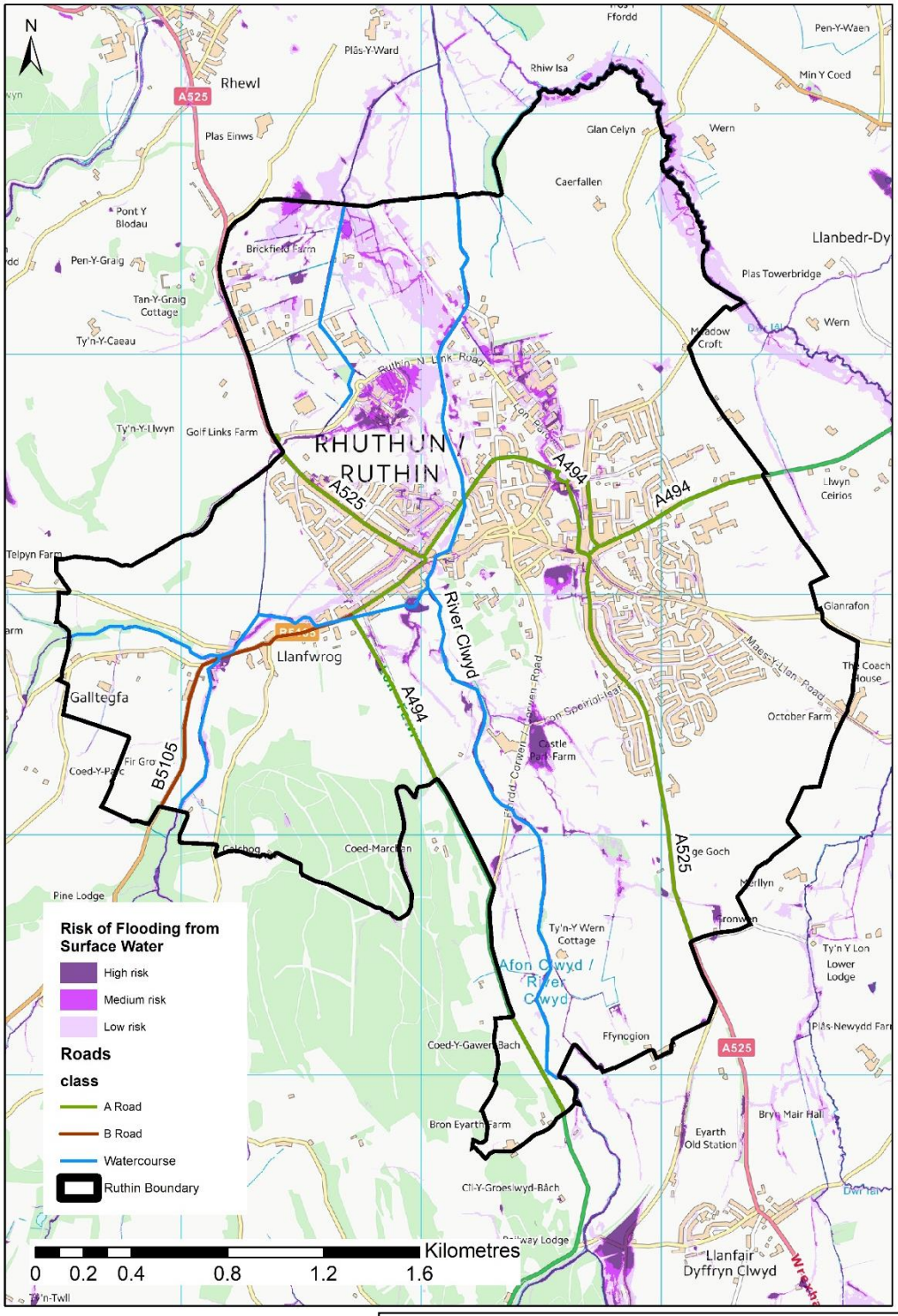
Risk of Flooding from Surface Water

Surface water flood risk exists across much of Prestatyn, though many areas are at low risk, according to the RoFSW dataset. There are however some localised areas that are of a higher risk, such as the area between Marine Road and Gronant Road there is high risk of surface water flooding and near Ffordd Penrhwylfa there is a medium risk. As mentioned above, where new development is proposed in any areas at risk from surface water flooding, an FCA should be carried out with particular focus on drainage requirements and suitable SuDS with the impetus on attenuation of surface water on-site where possible. For any larger developments with multiple units, a drainage strategy or Surface Water Management Plan may be appropriate.

5.6.4 Ruthin

Settlement	Ruthin
Area (ha)	817.54
Catchment	Clwyd





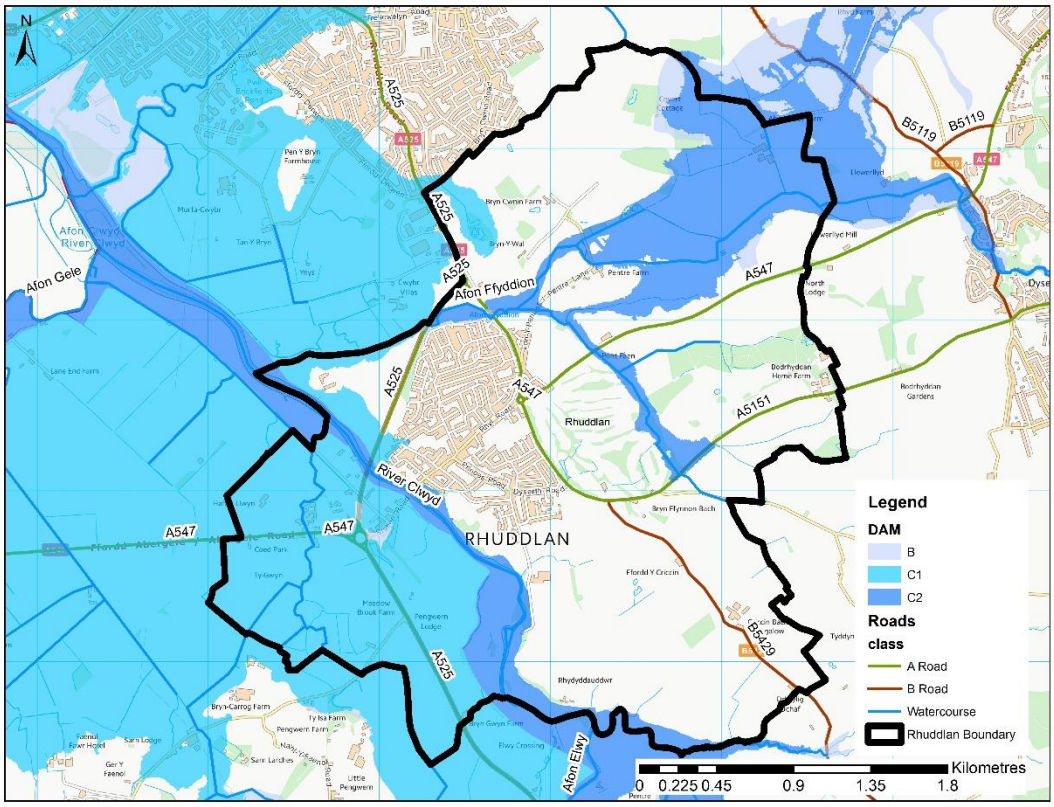
Overview

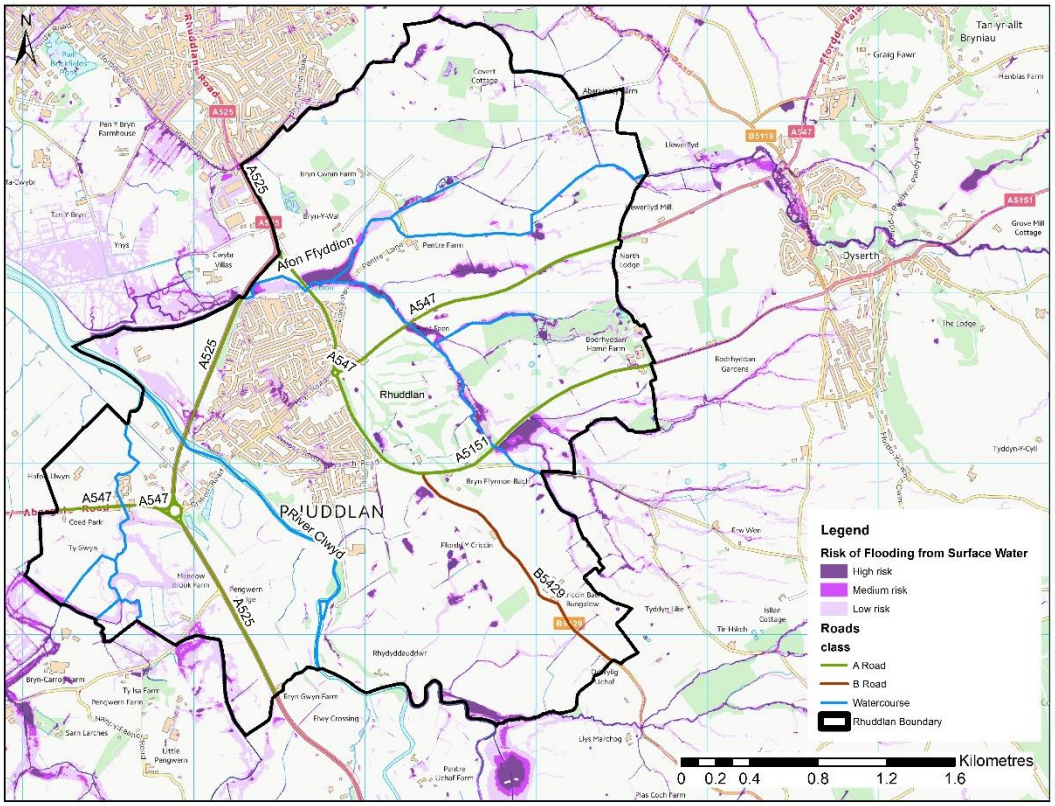
Ruthin is a small rural community of around 5,000 people with the River Clwyd running directly through the centre. The topography of Ruthin is a mixture of high and low ground with the eastern part of Ruthin being thus is outside the floodplain. There are no tidal flooding risk within Ruthin however the area is at risk of fluvial flooding. Ruthin has been subject to historic fluvial flooding with the LFRMS stating that 20 residential properties and six businesses were flooded by the River Clwyd in 2000. Flooding from Ordinary Watercourses is also known to be an issue in Ruthin. The historical flood data for Ruthin illustrates that there have been 27 flooding events that are all situated surrounding the urban areas since 2000.

Fluvial and Tidal Flood Risk
The Development Advice Maps illustrate that there is fluvial risk across Ruthin with the highest zone C2 flowing North to South, this correlates with the main River Clwyd that flows through the centre of Ruthin. There is also a fluvial risk of zone B that covers a wider extent and flows in the same location as the River Clwyd. Additionally there is a smaller pooled area of zone C1 that is situated between the Ruthin North Link Road and the A494. However, the main urban areas located in the centre and east of Ruthin that are not located adjacent to the River Clwyd are mainly Zone A and therefore considered to be at little or no risk of tidal or fluvial flooding. It is in these areas where the LPA should be focusing on for new development, though a site-specific FCA should still be carried out where the RoFSW map shows any risk from surface water flooding. The previous SFCA fluvial Clwyd Model produced extreme 0.1% AEP event outline, showing that much of the surrounding area of the River Clwyd which runs through the centre of Ruthin is at risk. This land should therefore be safeguarded from future development.
Risk of Flooding from Surface Water
In Ruthin, the surface water flooding exist across the whole boundary, however is mainly accumulating around the urbanised areas. The majority of the flooding is of low risk nevertheless, there are several clusters of high risk such as the area located adjacent to Corwen Road in the centre of Ruthin. These areas of land are not heavily urbanised and therefore is not a significant constraint to development. However where new development is proposed in any areas at risk from surface water flooding, a FCA should be carried out with particular focus on drainage requirements and suitable SuDS with the impetus on attenuation of surface water on-site where possible. For any larger developments with multiple units, a drainage strategy or Surface Water Management Plan may be appropriate.

5.6.5 Rhuddlan

Settlement	Rhuddlan
Area (ha)	984.83
Catchment	Clwyd





Overview

Rhuddlan is a small community situated adjacent to the Clwyd estuary, much of the town has been built on higher ground outside of the floodplain. Along with fluvial risk Rhuddlan is also at risk of tidal flooding and the area is heavily defended to mitigate primarily against tidal flooding from the estuary and the tidal flood risk extends far upstream of Rhuddlan. As discussed in section 5.8 there are two tidal breach scenarios that impact Rhuddlan these are the Rhuddlan Clwyd and Rhuddlan Marine Lake breaches. Rhuddlan, together with Ruthin and St Asaph, have a history of fluvial flooding and was affected by the November 2012 flooding from the Main River Clwyd and Elwy. The historical flooding data illustrates that there have been four flooding events within Rhuddlan since 2003, all occurring near the urban areas.

Fluvial and Tidal Flood Risk

Flooding within Rhuddlan is mainly caused by fluvial flooding, the Development Advice Maps illustrate that the majority of flooding occurs to the South West with a DAM zone of C2, this may be caused by the multiple tributaries off the River Clwyd. Additionally, areas surrounding the River Clwyd are located within the high risk flooding of zone C1. Furthermore, there is zone C2 risk flooding located in the North East of Rhuddlan due to the Afon Ffyddion. This means that development in these high risk areas such as proposals for emergency services, highly and less vulnerable uses would be subject to application of justification test including acceptability of consequences, as per TAN 15 requirements. However, the main central areas are however mainly with Zone A and therefore considered to be at little or no risk of tidal or fluvial flooding. It is in these areas where the LPA should be focusing on for new development, though a site-specific FCA should still be carried out where the RoFSW map shows any risk from surface water flooding.

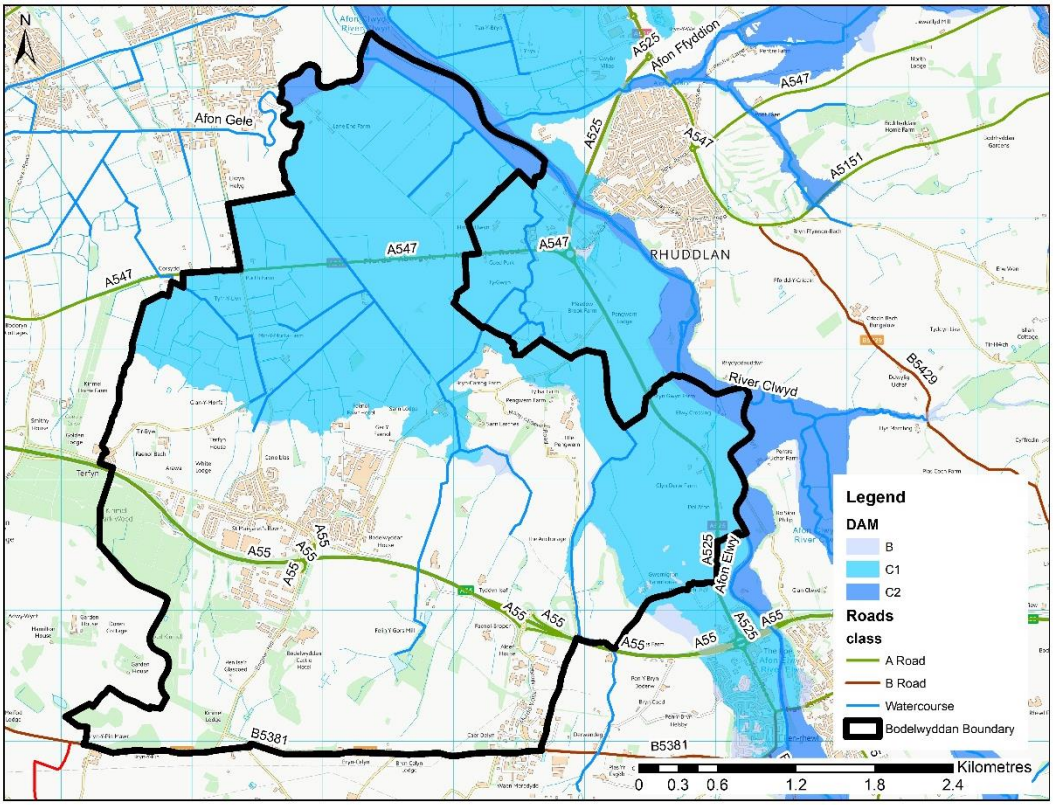
Along with fluvial flooding Rhuddlan is at risk of tidal flooding, with both the Rhuddlan Clwyd and Marine Lake breach modelling illustrating tidal risk in the West that is shown as DAM zone C1, extending along the River Clwyd near to Station Road.

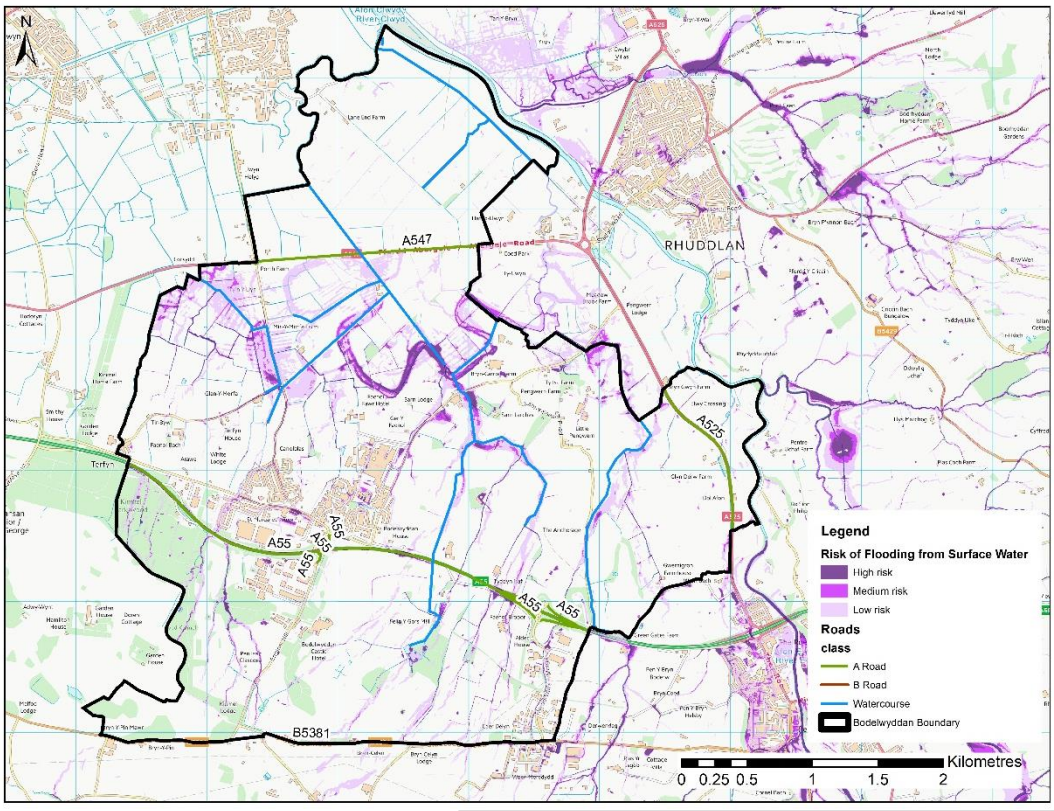
Risk of Flooding from Surface Water

The majority of surface water flood risk across Rhuddlan, is at low risk, according to the RoFSW dataset. The Surface water dataset in Rhuddlan indicates a slight correlation where the majority of severe surface water is located along the Afon Ffyddion. Surface water risk in close proximity to the Afon Ffyddion seem to be clusters of high risk. Additionally, the majority of high risk surface water is located to the North of Rhuddlan.

5.6.6 Bodelwyddan

Settlement	Bodelwyddan
Area (ha)	1674.63
Catchment	Elwy





Overview

Bodelwyddan is a small community of around 2,147 people 6 km South of Rhyl and around 2 km Southwest of Rhuddlan. Bodelwyddan is known to suffer from fluvial flooding and there is no risk of tidal flooding located within the area of Bodelwyddan. The historical flooding data indicates that there have been six flood incidents within the area since 2001, these flooding events have been situated within urban areas.

Fluvial and Tidal Flood Risk

The Development Advice Map shows that a large part of Bodelwyddan is at risk from widespread fluvial flooding. The majority of flooding in Bodelwyddan is located in the North-East area, this is due to the River Clwyd and the numerous drainage areas. The main DAM zone within the North East of the area is zone C1 with a small area being within zone C2 meaning development proposals for emergency services, highly and less vulnerable uses would be subject to application of justification test including acceptability of consequences, as per TAN 15 requirements. The main urban areas are however mainly with Zone A and therefore considered to be at little risk of tidal or fluvial flooding. Nevertheless, whilst existing properties in Bodelwyddan may be a low risk of flooding from tidal sources, it's important to note that agricultural land adjoining the settlement potentially including some of the lower lying portions could experience tidal flood risks.

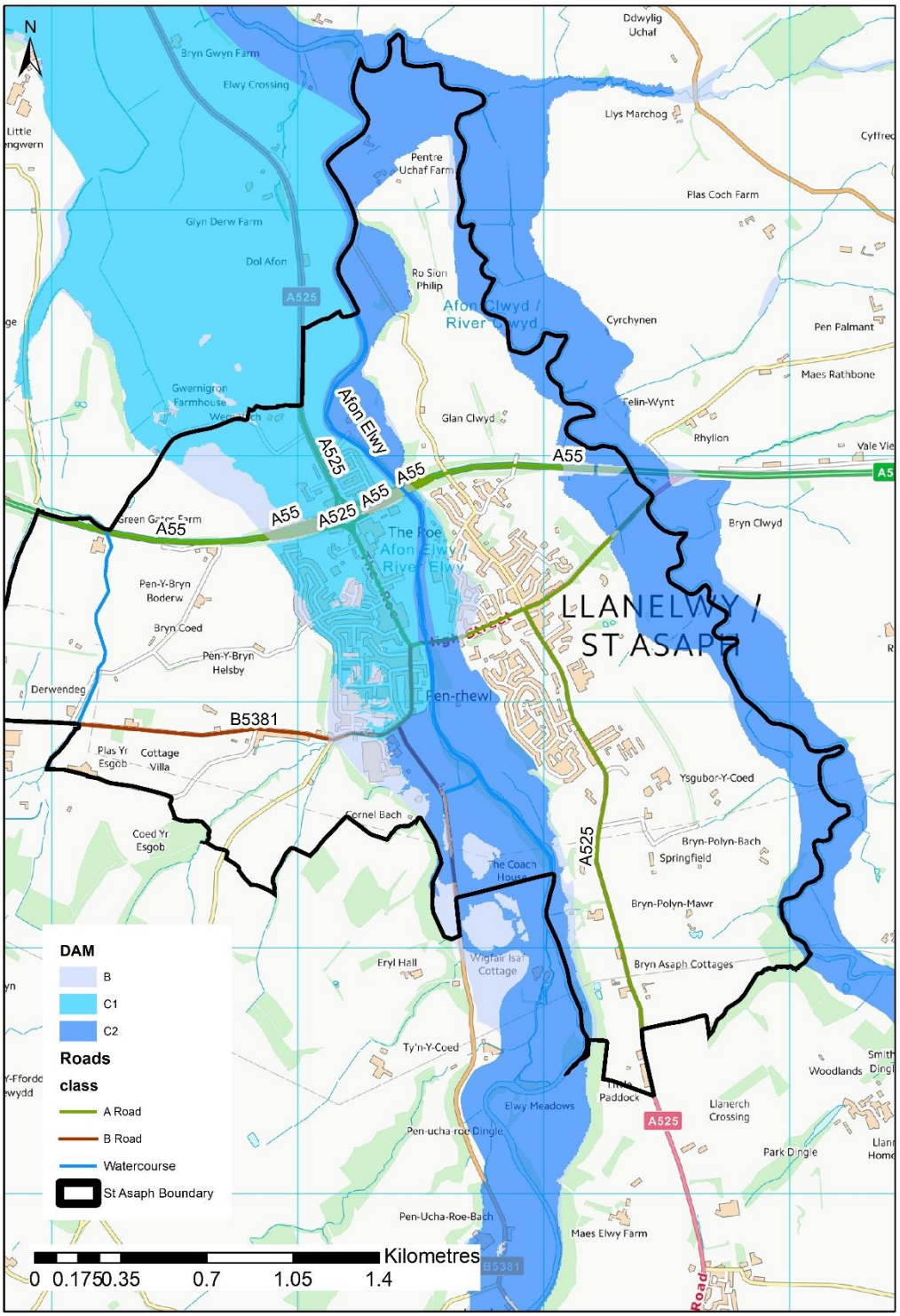
It is in these areas where the LPA should be focusing on for new development, though a site-specific FCA should still be carried out where the RoFSW map shows any risk from surface water flooding.

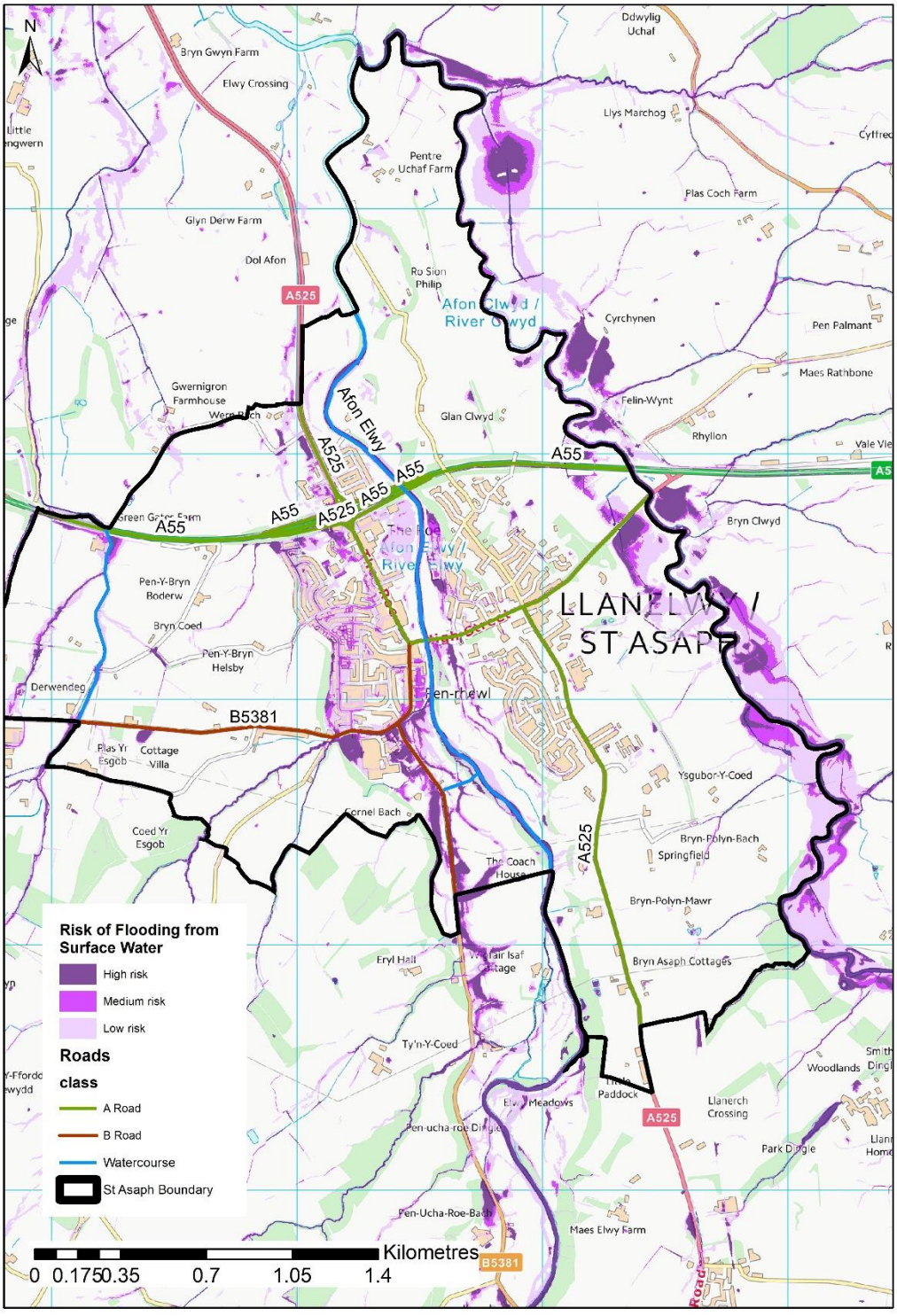
Risk of Flooding From Surface Water

Surface water flood risk exists across much of Bodelwyddan, though many areas are at low risk, according to the RoFSW dataset. The areas of high risk are mostly accumulated around the centre. The map above illustrates that there is very little surface water flooding in the North of Bodelwyddan. Where new development is proposed in any areas at risk from surface water flooding, an FCA should be carried out with particular focus on drainage requirements and suitable SuDS with the impetus on attenuation of surface water on-site where possible. For any larger developments with multiple units, a drainage strategy or Surface Water Management Plan may be appropriate.

5.6.7 St Asaph

Settlement	St Asaph
Area (ha)	644.61
Catchment	Elwy





Overview

St Asaph is a small rural community of around 1,674 people that is located on the River Elwy and the town is defended from fluvial flooding by raised embankments. In St Asaph the flood risk is contained within the floodplain. There is no tidal flood risk located within St Asaph. Historical flood records within St Asaph are mainly located along the River Elwy.

Fluvial and Tidal Flood Risk

St Asaph is prone to fluvial flooding, with many historical flooding events with the most recent being 2012, however the area is prone to flooding in the winter due to heavy rainfall. The majority of the flooding is contained within the floodplain along the River Elwy. The Development Advice Maps illustrate that there is a high risk zone C2 area that flows through the centre of St Asaph North to South following the River Elwy. In addition to this there is also an area of zone C2 located along the East boundary of St Asaph where the River Clwyd is present. Zone C1 and B are present West of the River Elwy in the North of St Asaph with zone B extending to the South of the St Asaph boundary. Therefore in any areas of high risk, development proposals for emergency services, highly and less vulnerable uses would be subject to application of justification test including acceptability of consequences, as per TAN 15 requirements. However, the main areas East of the River Elwy and between the River Clwyd are however mainly with Zone A and therefore considered to be at little or no risk of tidal or fluvial flooding. It is in these areas where the LPA should be focusing on for new development, though a site-specific FCA should still be carried out where the RoFSW map shows any risk from surface water flooding.

St Asaph 2012

As a result of the November 2012 flooding, updated hydraulic modelling was carried out to update the NRW flood map. Part of this update assessed the impact of Spring Gardens Bridge on flood risk to St Asaph as, during the 2012 event, large amounts of debris accumulated at the bridge so that the bridge railings were blocked approximately 300 – 400 mm above the bridge deck level. The hydraulic modelling tested scenarios with and without the bridge in place. It was concluded that removal of the bridge would have limited impact on flood risk in St Asaph with only the Spring Gardens area, local to the bridge, shown to have reduced flood risk were the bridge to be removed.

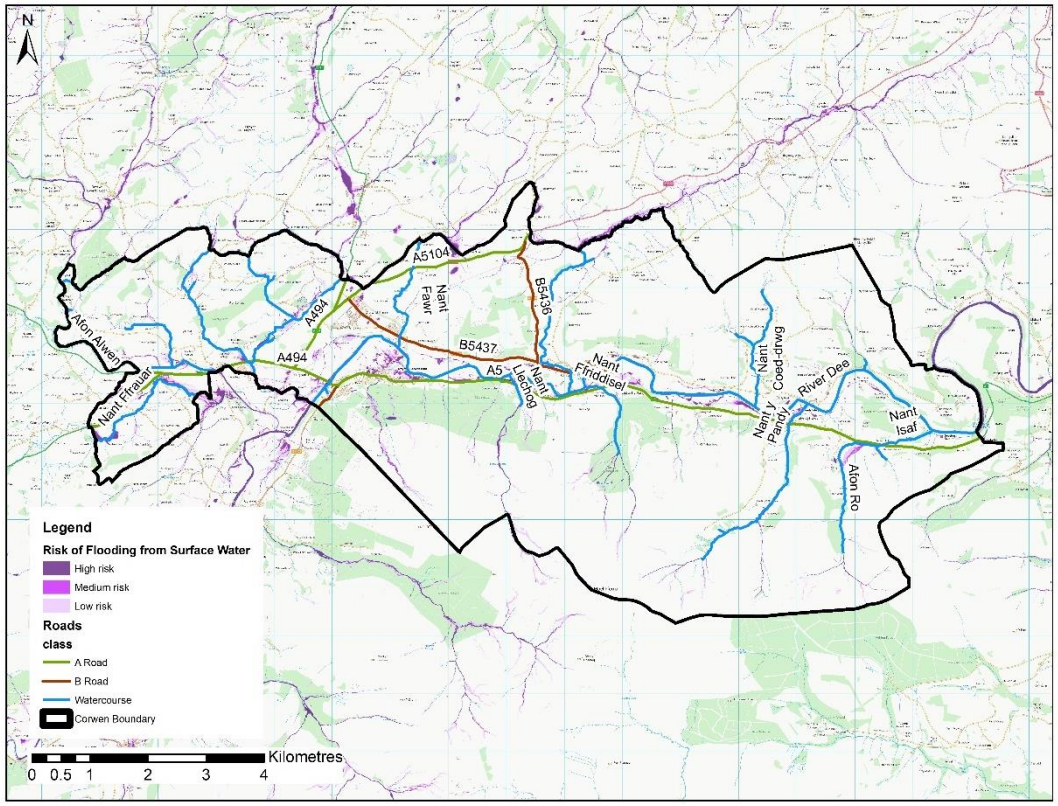
There is a flood scheme underway within St Asaph to reduce the risk of flooding. The latest information as of December 2017 discusses that the scheme is in two section, A- Spring Gardens Bridge replacement and B - new and raised defences, both these projects are underway and hope to be completed by the end of 2017. Once these schemes are complete the aim is to help significantly reduced risk of flooding to the surrounding low-lying developments near the River Elwy that were affected. Work to further strengthen the existing scour protection at the bridge will be undertaken in Summer 2018 when restrictions on in-river working are lifted. This will involve installing additional large stones to further prevent bank erosion.

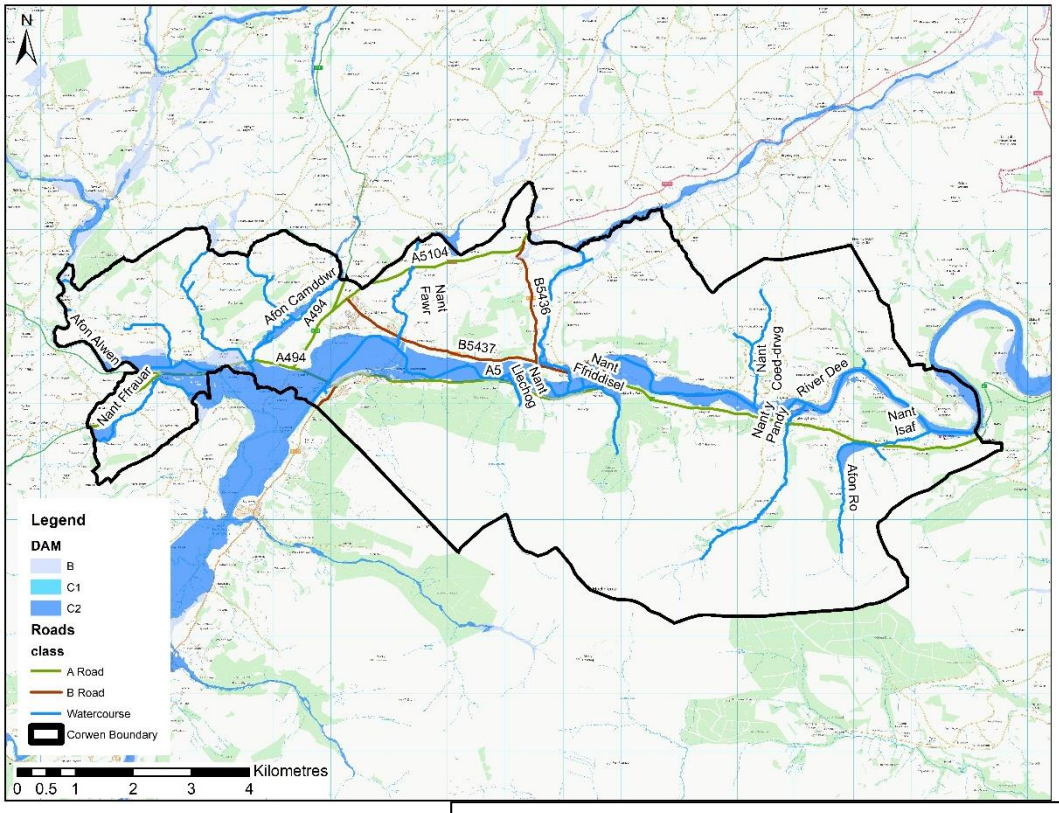
Risk of Flooding from Surface Water

Surface water flood risk exists across much of Rhyl, though many areas are at low risk, according to the RoFSW dataset. However there are clusters of higher risk areas mainly accumulating around the most urbanised areas. As mentioned above, where new development is proposed in any areas at risk from surface water flooding, a FCA should be carried out with particular focus on drainage requirements and suitable SuDS with the impetus on attenuation of surface water on-site where possible. For any larger developments with multiple units, a drainage strategy or Surface Water Management Plan may be appropriate.

5.6.8 Corwen

Settlement	Corwen
Area (ha)	6956.79
Catchment	Dee





Overview

The town of Corwen lies on the edge of the River Dee floodplain in the South of Denbighshire near the confluence with the River Alwen. The main river that flows through Corwen from West to East is the River Dee, there are many smaller tributaries that branch off from the River Dee. Frequent fluvial flooding occurs within Corwen due to the River Dee and in the past has caused the closure of roads, including the A5 and flooding of properties. The LFRMS notes flooding of 23 residential properties in the year 2000 from the ordinary watercourse Afon Nant y Cawrddu. Further flood risk arises from small watercourses running off the higher ground to the South. Regarding historical flood incidents, there have been seven known events within Corwen since 2002, these historical incidents have all been located in the urban area of Corwen located along Holyhead Road.

Fluvial and Tidal Flood Risk

The Development Advice Maps show that the fluvial flooding within Corwen is not widespread. Fluvial flooding within Corwen is localised and is contained within the floodplain along the River Dee and its tributaries, where the DAM zone risk is C2. There is a slightly bigger extent zone B surrounding the zone C2 located in the West of Corwen near the river Alwen. Any development proposals in areas of high risk for emergency services, highly and less vulnerable uses would be subject to application of justification test including acceptability of consequences, as per TAN 15 requirements. The areas that are not directly within the floodplain and are in close proximity to the River Dee and tributaries are however mainly within zone A and therefore considered to be at little or no risk of fluvial flooding. It is in these areas where the LPA should be focusing on for new development, though a site-specific FCA should still be carried out where the RoFSW map shows any risk from surface water flooding.

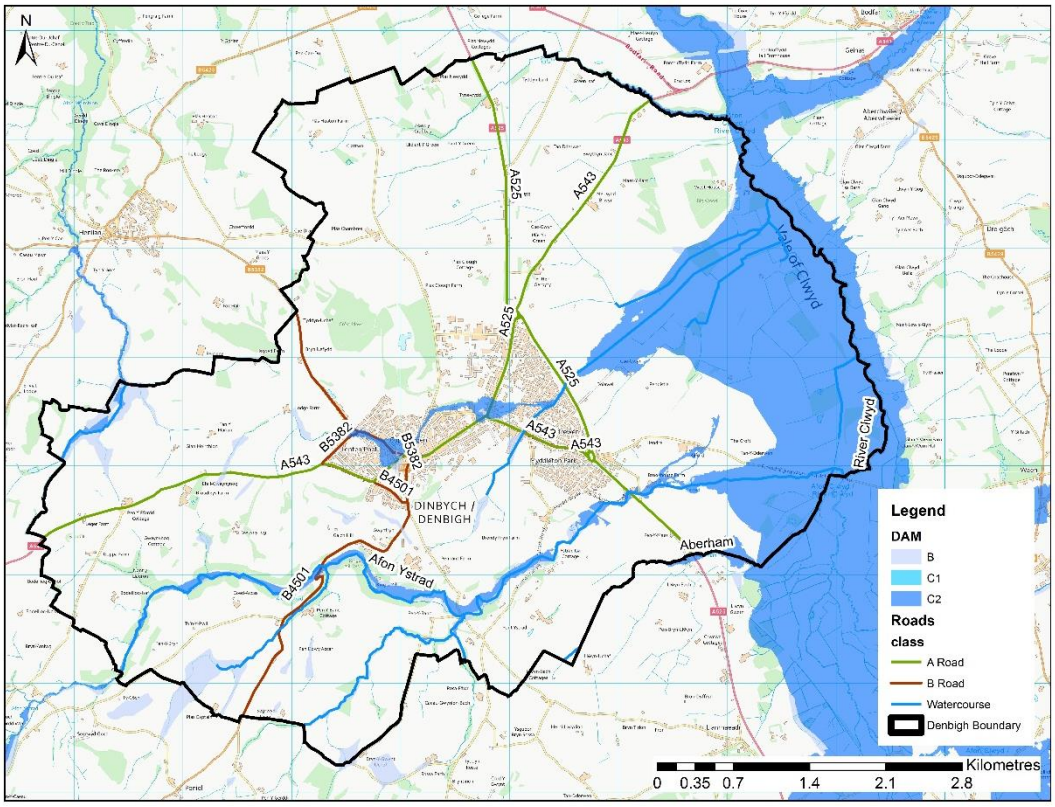
The Corwen FRMS was completed by Denbighshire County Council in May 2014. The scheme addresses flood risk from ordinary watercourses to the South of the town and involved the diversion of the Nant Cawrddu stream via Corwen Reservoir into the Nant y Pigyn stream. The standard of protection provided by the scheme is for a 1% AEP event, with additional capacity provided to make allowance for climate change. This has resulted in around 100 properties having a significantly reduced risk of flooding.

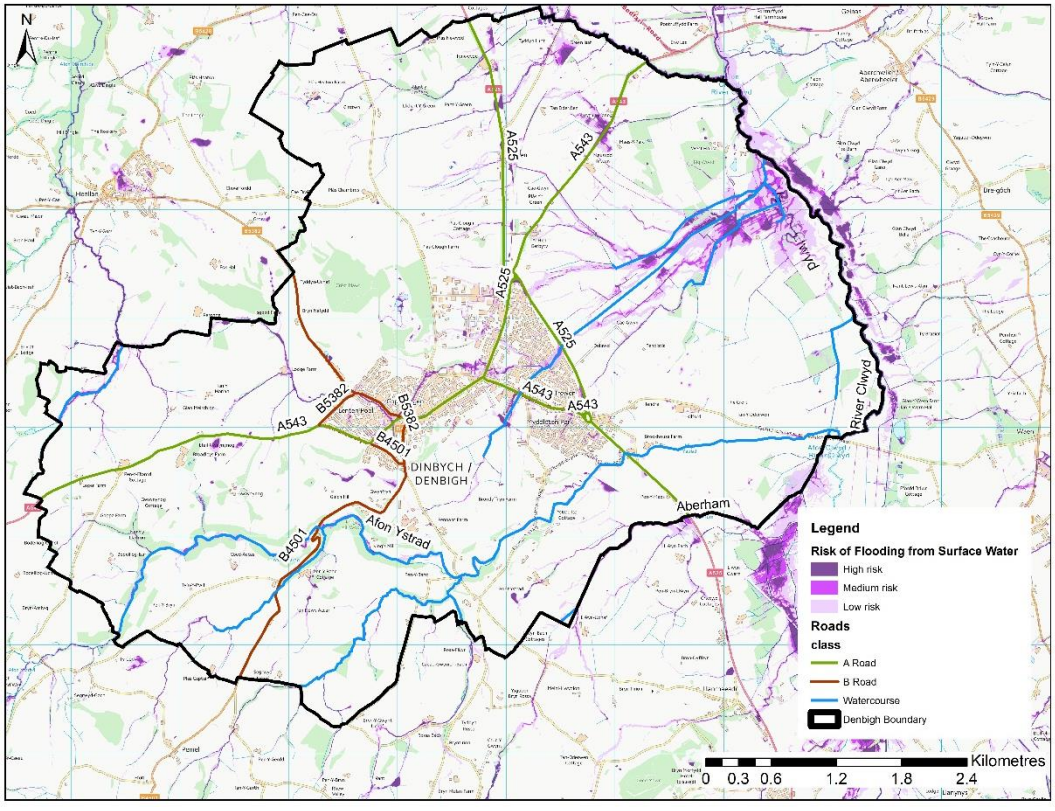
Risk of Flooding from Surface Water

Surface water flood risk exists across much of Corwen, though many areas are at low risk, according to the RoFSW dataset. The surface water risk correlates with the watercourses within Corwen, the highest risk areas are located around the floodplain of the River Dee. Along the tributaries the majority of the flooding is of low risk. As mentioned above, where new development is proposed in any areas at risk from surface water flooding, an FCA should be carried out with particular focus on drainage requirements and suitable SuDS with the impetus on attenuation of surface water on-site where possible. For any larger developments with multiple units, a drainage strategy or Surface Water Management Plan may be appropriate.

5.6.9 Denbigh

Settlement	Denbigh
Area (ha)	3137.64
Catchment	Clwyd





Overview

Denbigh has a population of around 8,500 people and is located around 20 km Southeast of Rhyl. Henllan Brook runs through the centre of Denbigh, the majority of this watercourse is culverted, before joining the River Clwyd to the East of the town. The Afon Ystrad runs South of Denbigh and acts as a tributary to the Clwyd. Denbigh is not impacted by tidal flooding. In terms of historical flooding, there has been 8 recorded historical flood incidents since 1992, they are mainly located in the urban areas along the main roads within Denbigh.

Fluvial and Tidal Flood Risk

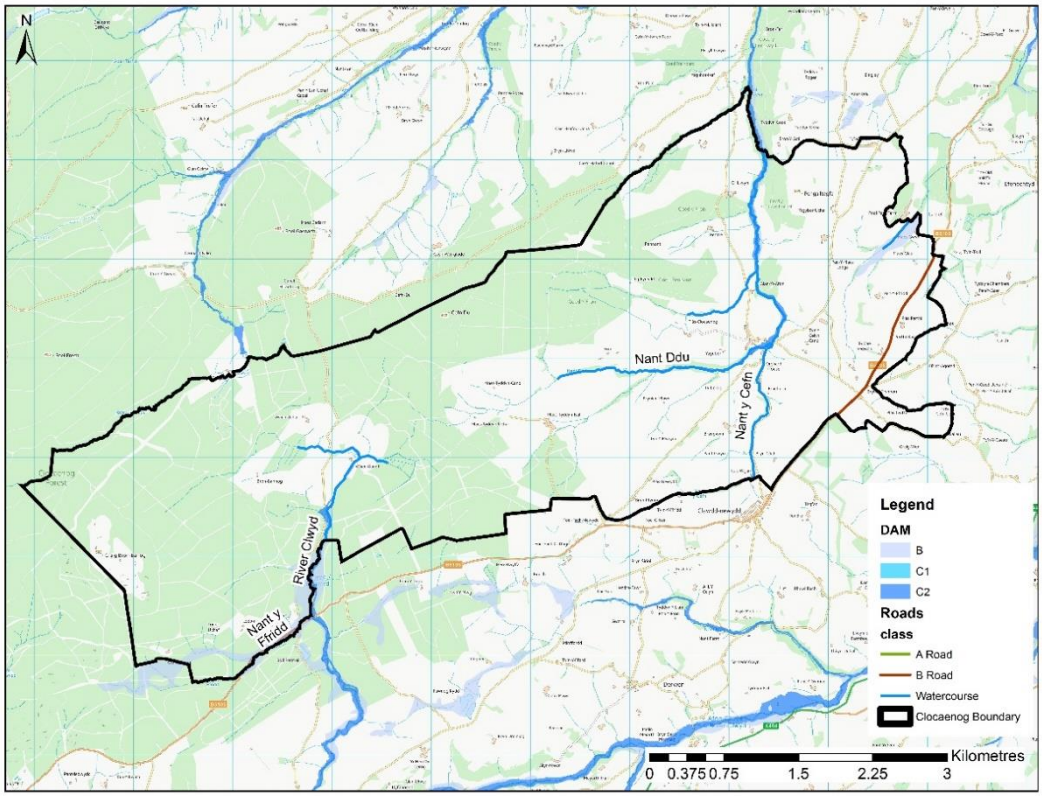
The Development Advice Map shows that large parts of the East of Denbigh are at risk from widespread fluvial flooding. The map illustrates that this flooding could be caused by the Afon Ystrad. The DAM zone in this area is of high risk and is within zone C2, this extends along the watercourses flowing from the East into the centre of Denbigh. Thus meaning development proposals for emergency services, highly and less vulnerable uses would be subject to application of justification test including acceptability of consequences, as per TAN 15 requirements. The main central areas and most of Denbigh that is not located near to the watercourses are however mainly within Zone A and therefore considered to be at little or no risk of tidal or fluvial flooding. It is in these areas where the LPA should be focusing on for new development, though a site-specific FCA should still be carried out where the RoFSW map shows any risk from surface water flooding.

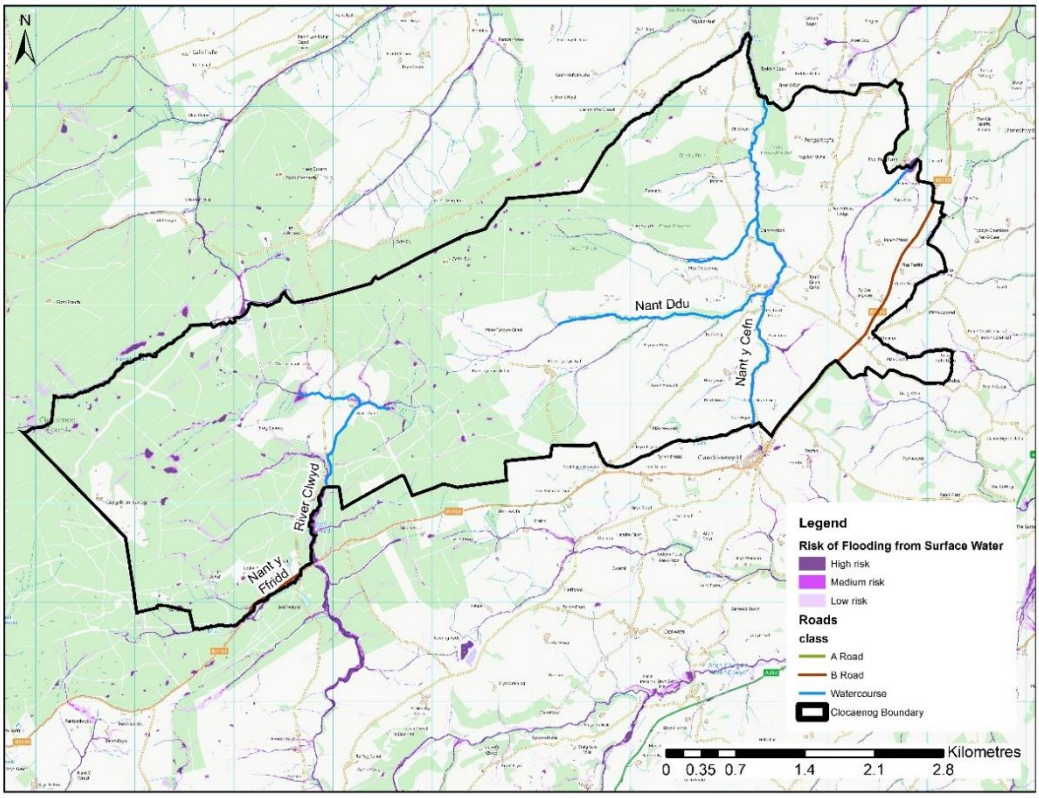
Risk of Flooding from Surface Water

Surface water flooding in Denbigh mainly occurs along the outskirts with minor high-risk surface water flooding occurring within the urbanised area of Denbigh. The main area at risk of surface water flooding accumulates near the Northeast of Denbigh near Henllan Brook however, this area of land is not heavily developed. As mentioned above, where new development is proposed in any areas at risk from surface water flooding, an FCA should be carried out with particular focus on drainage requirements and suitable SuDS with the impetus on attenuation of surface water on-site where possible. For any larger developments with multiple units, a drainage strategy or Surface Water Management Plan may be appropriate.

5.6.10 Clocaenog

Settlement	Clocaenog
Area (ha)	2413.57
Catchment	Clwyd





Overview

Clocaenog is a small village located approximately 5 km Southwest of Ruthin, at the head of a valley. The main watercourse that flows through the settlement is called the Nant Melin-dwr. The Nant Melin-dwr is a tributary to the Afon Clywedog that eventually joins the River Clwyd. Within Clocaenog there is limited fluvial risk and no risk to tidal flooding. Additionally, there are no known historical flood events within the area.

Fluvial and Tidal Flood Risk

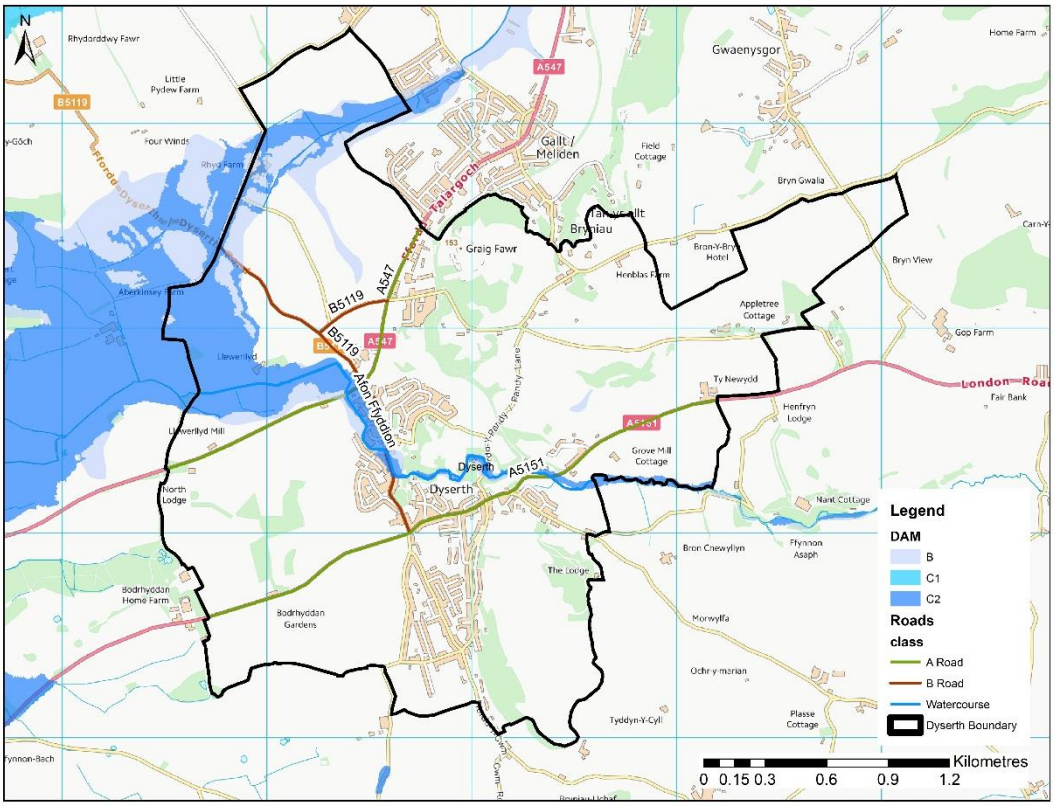
The Development Advice Map displays that there are very little areas at risk of fluvial flooding within Clocaenog. There is a small amount of zone C2 that flows along the two main rivers in Clocaenog and their tributaries. Additionally, there are two clusters of zone B located East of Clocaenog adjacent to the B5105 and another located in the Southwest along the Nant Y Ffridd. As the high risk areas are mainly localised to the functional floodplain the majority of Clocaenog is mainly within Zone A and therefore considered to be at little or no risk of tidal or fluvial flooding. It is in these areas where the LPA should be focusing on for new development, though a site-specific FCA should still be carried out where the RoFSW map shows any risk from surface water flooding.

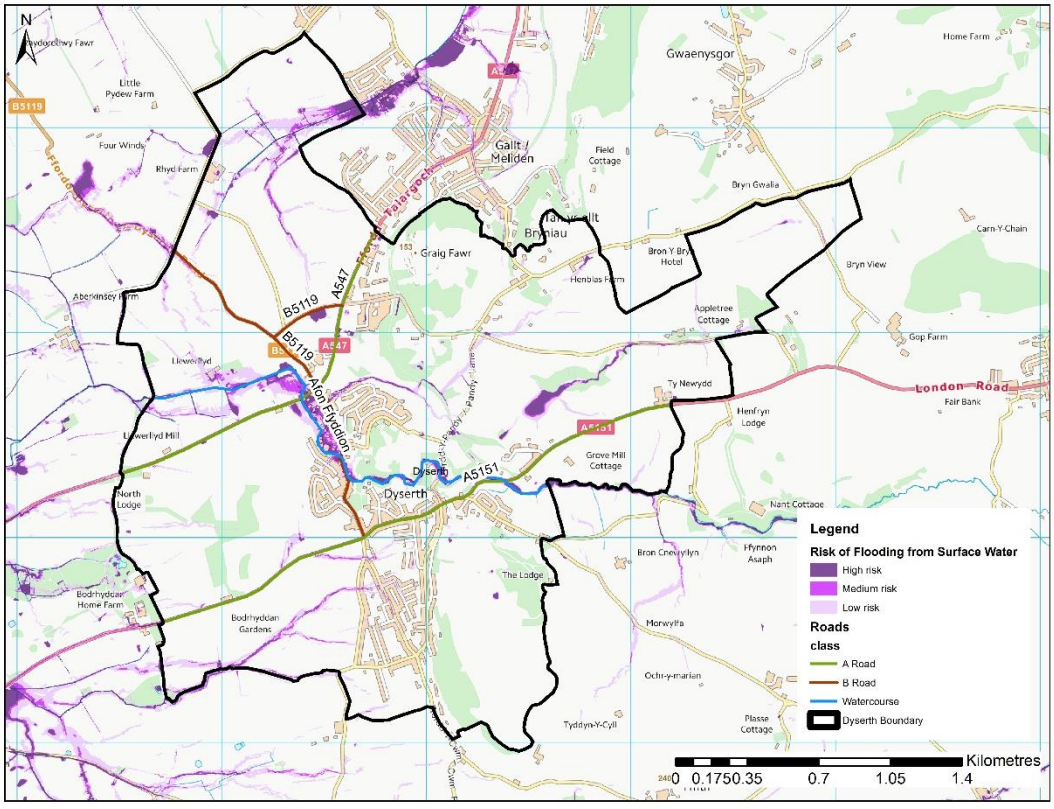
Risk of Flooding from Surface Water

Surface water flood risk exists across much of Clocaenog, though many areas are at low risk, according to the RoFSW dataset. The areas at high risk appear in the Southwest and along the floodplain of the smaller watercourses. These areas of land are not heavily urbanised and therefore is not a threat to development. As mentioned above, where new development is proposed in any areas at risk from surface water flooding, an FCA should be carried out with particular focus on drainage requirements and suitable SuDS with the impetus on attenuation of surface water on-site where possible. For any larger developments with multiple units, a drainage strategy or Surface Water Management Plan may be appropriate.

5.6.11 Dyserth

Settlement	Dyserth
Area (ha)	639.49
Catchment	Clwyd





Overview

Dyserth is a small town located approximately 2 km South of Prestatyn. There is an estimated 2,500 people living within Dyserth. The Afon Ffyddion is the main river that runs through the town and is prone to flooding before discharging into the Clwyd estuary. The Afon Ffyddion floodplain widens in the West part of Dyserth causing flood risk to properties in this part of the town, however the area is not prone to tidal flooding. The LFRMS notes that five residential properties were flooded here in 2000. There has been four recorded historical flood events within Dyserth since 2000, that area all situated within the Urban areas of Dyserth.

Fluvial and Tidal Flood Risk

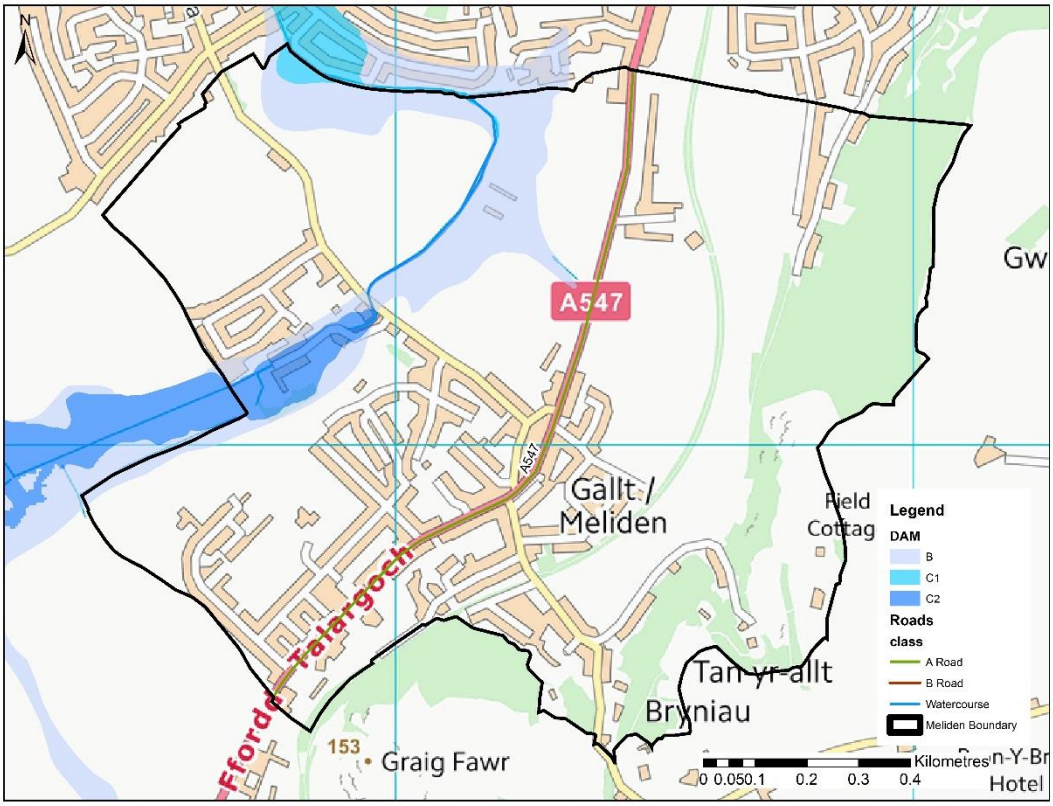
The Development Advice Map displays that the West of Dyserth is mainly at risk from widespread fluvial flooding. The DAM zone in this area is a high risk of C2 which follows the same path as the Afon Ffyddion through the centre of Dyserth from East to West. Zone C2 covers a large part of Western Dyserth meaning development proposals for emergency services, highly and less vulnerable uses would be subject to application of justification test including acceptability of consequences, as per TAN 15 requirements. Furthermore, the flood risk extends North of Dyserth however the flood risk is lower with a DAM zone of B. The main urban areas and the areas not surrounding the Afon Ffyddion are however mainly with Zone A and therefore considered to be at little or no risk of tidal or fluvial flooding. It is in these areas where the LPA should be focusing on for new development, though a site-specific FCA should still be carried out where the RoFSW map shows any risk from surface water flooding.

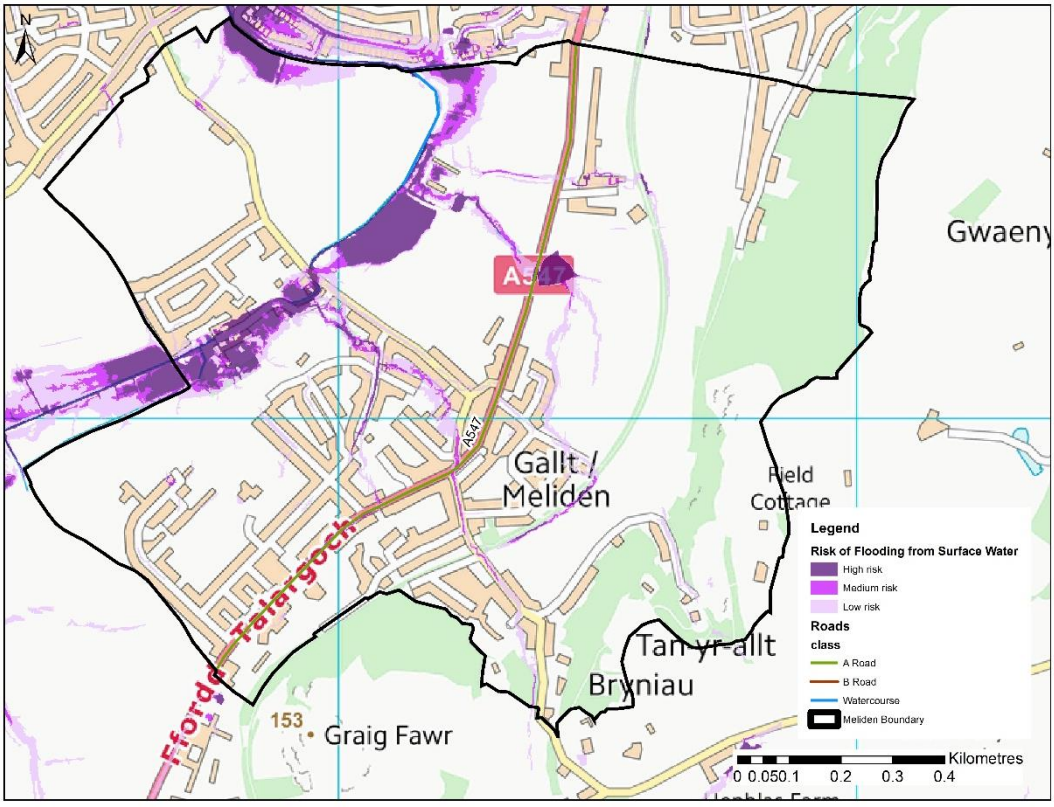
Risk of Flooding From Surface Water

Surface water flood risk exists across much of Dyserth, though many areas are at low risk, according to the RoFSW dataset. There are however several clusters of high risk, such as the areas along the Afon Ffyddion watercourse and in the North of Dyserth. As mentioned above, where new development is proposed in any areas at risk from surface water flooding, an FCA should be carried out with particular focus on drainage requirements and suitable SuDS with the impetus on attenuation of surface water on-site where possible. For any larger developments with multiple units, a drainage strategy or Surface Water Management Plan may be appropriate.

5.6.12 Meliden

Settlement	Meliden
Area (ha)	160.07
Catchment	Clwyd





Overview

The village of Meliden lies just South of Prestatyn and has a tributary of Rhyl Cut running through the Northwest of the village. The area of Meliden is at risk of fluvial flooding however is not at risk of tidal flooding. Regarding the historical flood data, within Meliden there are nine historical flood events that have occurred since 1998, these are mainly clustered in the West of Meliden.

Fluvial and Tidal Flood Risk

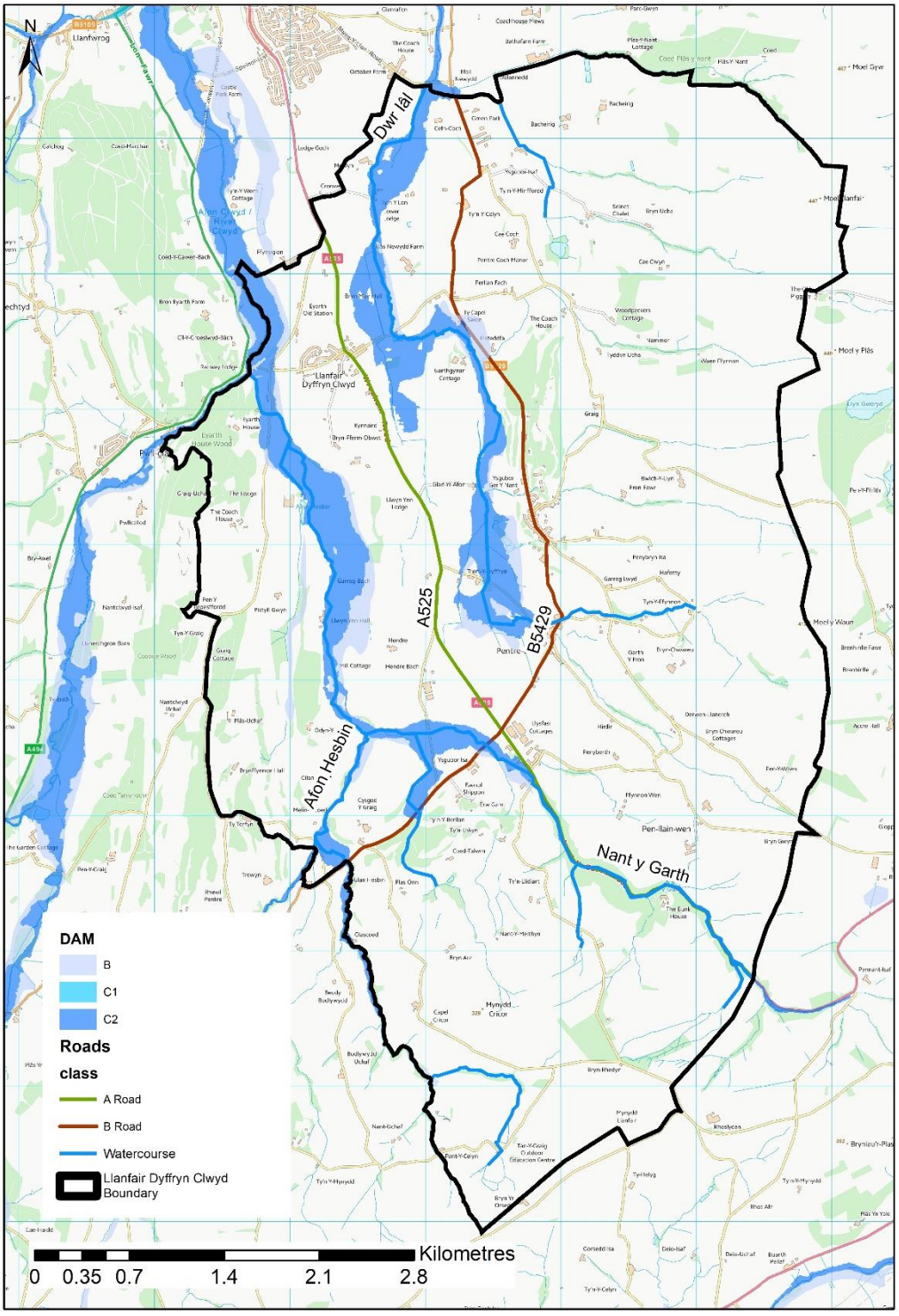
The Development Advice Map shows that there is little risk of fluvial flooding in Meliden. The fluvial risk is located around The Cut watercourse that flows through the Northwest of the village. The highest risk DAM zone C2 is located in the West of Meliden with the widest extent located West of Ffordd Penrhwylfa. DAM zone B shows a wider extent is located in the North of Meliden adjacent to the A547 and there is also a small pool of DAM zone C1 located in the North of Meliden near the border. Any development within the DAM C1 and C2 areas that are proposals for emergency services, highly and less vulnerable uses would be subject to application of justification test including acceptability of consequences, as per TAN 15 requirements. The main central urban areas are however mainly with Zone A and therefore considered to be at little or no risk of tidal or fluvial flooding. It is in these areas where the LPA should be focusing on for new development, though a site-specific FCA should still be carried out where the RoFSW map shows any risk from surface water flooding.

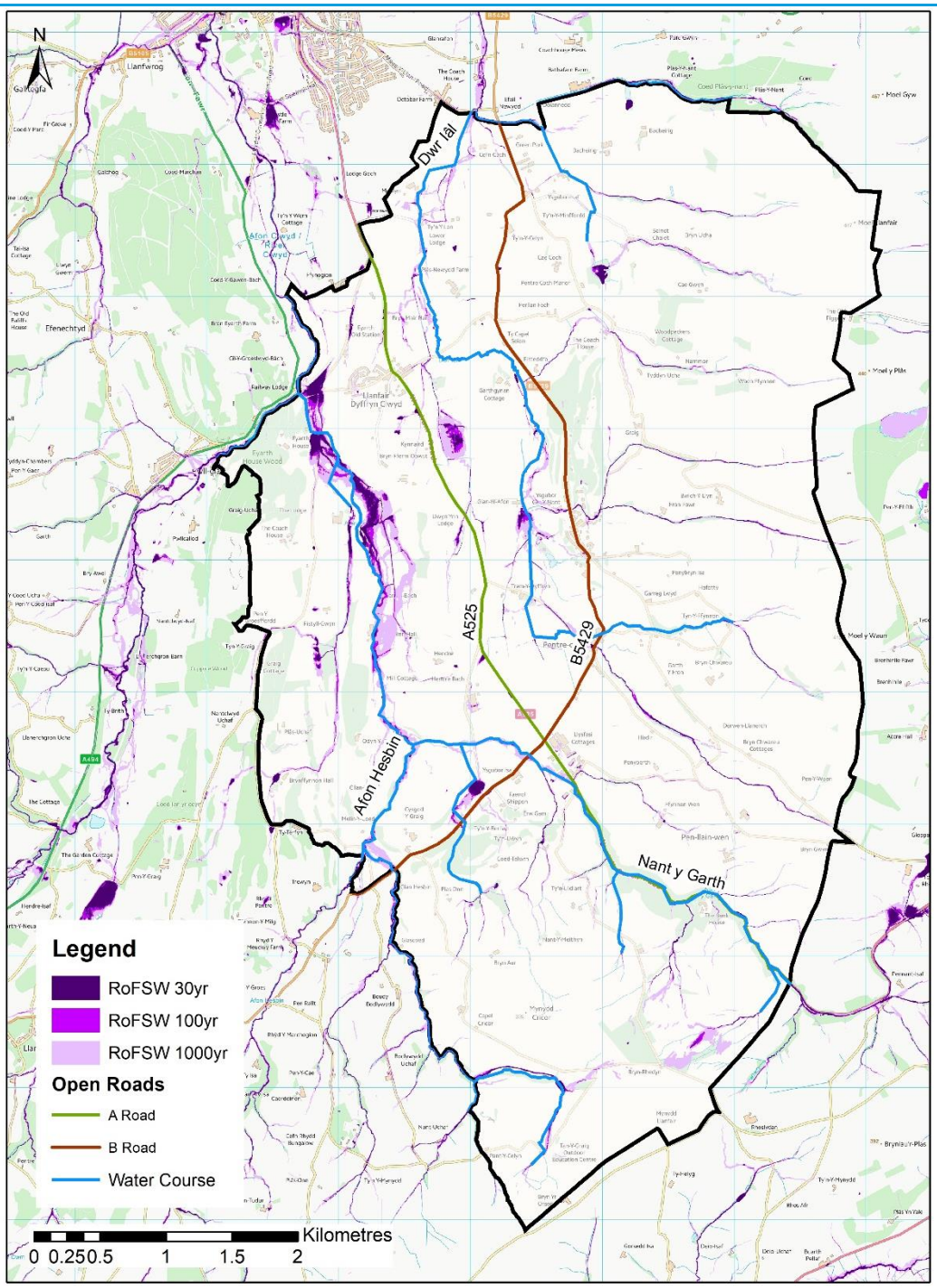
Risk of Flooding From Surface Water

Surface water flood risk exists across much of Meliden, though many areas are at low risk, according to the RoFSW dataset. There are however several areas at high risk, such as the area along the Rhyl Cut watercourse, similarly there are pockets of high risk located in the North of Meliden that correlates to the DAM zone C1, there is also a small high risk area located along the A547. As mentioned above, where new development is proposed in any areas at risk from surface water flooding, an FCA should be carried out with particular focus on drainage requirements and suitable SuDS with the impetus on attenuation of surface water on-site where possible. For any larger developments with multiple units, a drainage strategy or Surface Water Management Plan may be appropriate.

5.6.13 Llanfair Dyffryn Clwyd

Settlement	Llanfair Dyffryn Clwyd
Area (ha)	2992.74
Catchment	Clwyd





Overview

Llanfair Dyffryn Clwyd (Llanfair DC) is a small village of around 2,227 people situated in the Vale of Clwyd about one mile South of the town of Ruthin. The main river that runs through Llanfair DC is known as the Afon Hesbin and the Dwr Ial that flows through the town. Llanfair DC is prone to fluvial flooding along these watercourses, however there is no risk of tidal flooding within the area. The historical flood data illustrates that there is one flooding incident within Llanfair DC since 1992, this is located along the Dwr Ial between the B5429.

Fluvial and Tidal Flood Risk

The Development Advice Map shows that there are some areas of Llanfair DC that are at risk from fluvial flooding. The areas of highest risk within Llanfair DC are located along the main rivers

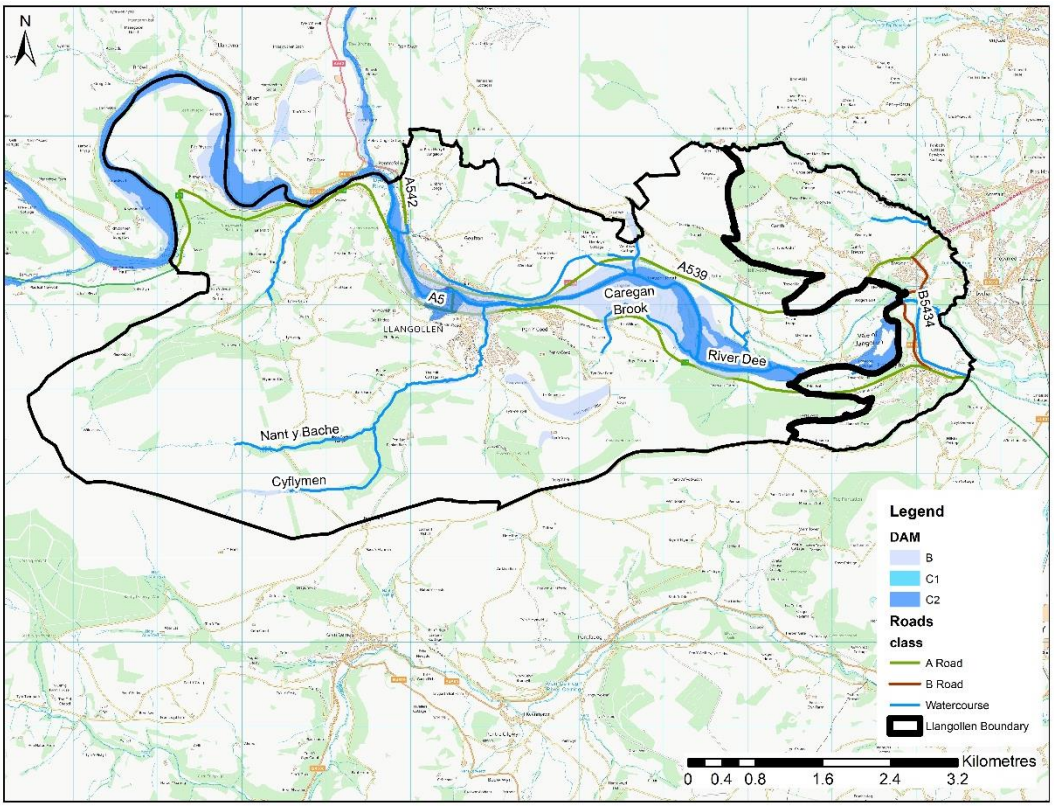
that flow through the area, these areas have a DAM zone of C2. There is slightly wider extent surrounding the DAM zone C2 areas that are of a lower risk of zone B. Zone C2 covers areas surrounding the watercourse meaning development proposals for emergency services, highly and less vulnerable uses would be subject to application of justification test including acceptability of consequences, as per TAN 15 requirements. The majority of the East of Llanfair DC and areas that are not located in close proximity to the watercourses are however mainly with Zone A and therefore considered to be at little or no risk of tidal or fluvial flooding. It is in these areas where the LPA should be focusing on for new development, though a site-specific FCA should still be carried out where the RoFSW map shows any risk from surface water flooding.

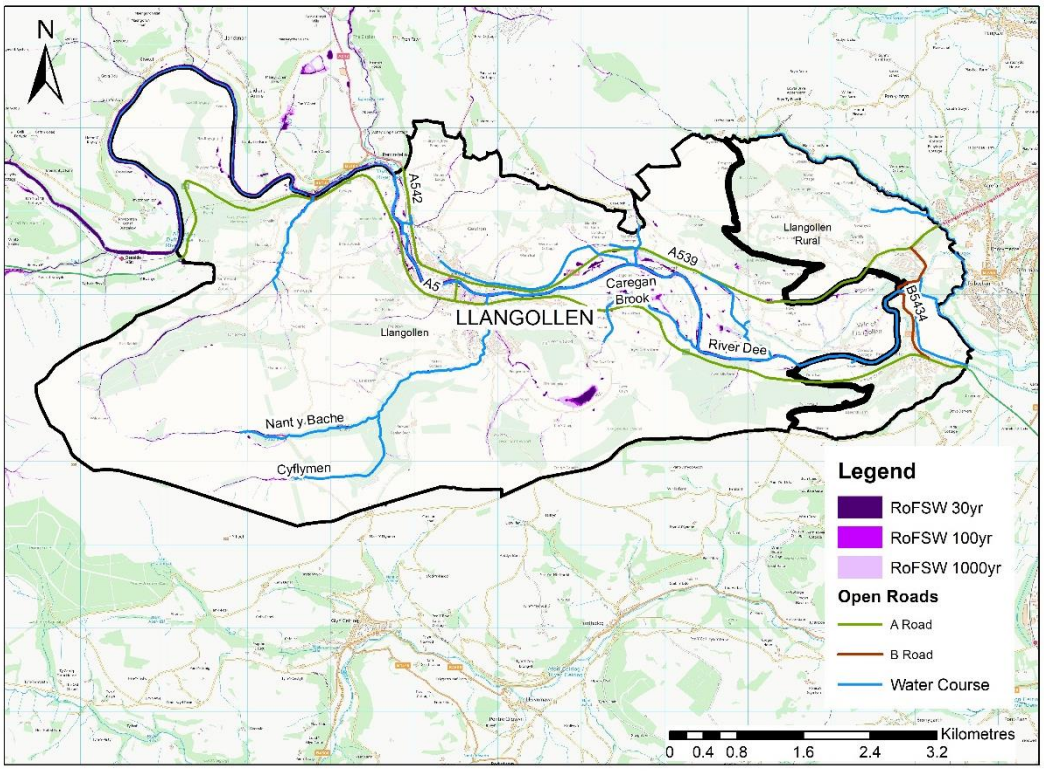
Risk of Flooding from Surface Water

Surface water flood risk exists across much of Llanfair DC, though many areas are at low risk, according to the RoFSW dataset. The surface water risk seems to correlates with the fluvial flooding within the settlement. However, there are areas of higher risk located within Llanffair DC these clusters are mainly surrounding the Afon Hesbin and between Wrexham Road and the B5429. As mentioned above, where new development is proposed in any areas at risk from surface water flooding, a FCA should be carried out with particular focus on drainage requirements and suitable SuDS with the impetus on attenuation of surface water on-site where possible. For any larger developments with multiple units, a drainage strategy or Surface Water Management Plan may be appropriate.

5.6.14 Llangollen

Settlement	Llangollen
Area (ha)	3749.76
Catchment	Dee (Ceiriog)





Overview

Llangollen is a small town of around 3,658 people situated on the River Dee and on the edge of the Berwyn mountains. The River Dee is the main river that flows through the town making Llangollen prone to fluvial flooding and there is no risk of tidal flooding within the area. Regarding historical flooding, there have been six flood events that have occurred within Llangollen since 2005, these are all clustered in the urban area of Llangollen along the River Dee.

Fluvial and Tidal Flood Risk

The Development Advice Map shows that areas surrounding the main river at risk from fluvial flooding. Fluvial flooding is most widespread East of the main urban area of Llangollen with DAM zones of B and C2. In the North of Llangollen the flood extent is narrower with the main DAM zone being C2. Where the DAM zone covers a large part of Eastern Llangollen development proposals for emergency services, highly and less vulnerable uses would be subject to application of justification test including acceptability of consequences, as per TAN 15 requirements. Any areas that are not in close proximity to River Dee are however mainly with Zone A and therefore considered to be at little or no risk of tidal or fluvial flooding. It is in these areas where the LPA should be focusing on for new development, though a site-specific FCA should still be carried out where the RoFSW map shows any risk from surface water flooding.

Risk of Flooding From Surface Water

Surface water flood risk exists across much of Llangollen, though many areas are at low risk, according to the RoFSW dataset. There are higher risks of surface water flooding mainly accumulating along watercourses and there is also a large cluster of high risk surface water located near the Tyn Dwr Road. As mentioned above, where new development is proposed in any areas at risk from surface water flooding, a FCA should be carried out with particular focus on drainage requirements and suitable SuDS with the impetus on attenuation of surface water on-site where possible. For any larger developments with multiple units, a drainage strategy or Surface Water Management Plan may be appropriate.

5.7 Key Settlements at risk of Tidal Flood Risk

The following sub-sections summarise the tidal assessment carried out at each key site at risk for each area. When reading these sections also refer to the SFCA Maps in Appendix A and the key site tidal screening spreadsheet in Appendix B. As part of this tidal flood risk assessment, defence breach scenarios have been modelled at four different locations. These locations are:

5.7.1 Tidal Breach Areas in Denbighshire

Breach locations have been selected based on a review of existing defences and to provide DCC with indicative extents of flooding at these locations. It should be noted at this stage that alternative breach locations are possible; and during extreme tidal events there is greater potential for multiple defence failures, particularly where reliance is placed on sand dunes. This analysis of breach modelling outputs does not include the overtopping modelling work completed separately to this SFCA. This details of the breach assessment and flood risks do not represent the most significant risk for coastal towns and further detailed analysis is beyond the scope of this SFCA. Once the spatial strategy for key communities has been considered, further work could be taken forward in terms of either an updated modelling study or Level 2 SFCA to understand the details of risks to settlement focussed development.

In accordance with the recent Welsh Government letter to Chief Planning Officers of 9 January 2014, consideration of climate change for a 0.1% AEP tidal flood event has also been appraised. It is clear from the resultant mapping that large extents of coastal towns could be inundated during such events. DCC in consultation with NRW will need to ensure that a pragmatic approach to regeneration within coastal towns to ensure the ongoing viability of communities and towns. Four breach scenarios were carried out, Prestatyn breach, Rhuddlan Clwyd Breach, Rhuddlan Marine Lake Breach and Rhyl Breach. Table 5-1 illustrates what key settlements may potentially be at risk from the four different breach scenarios that were modelled for Denbighshire County.

Table 5-1: Illustrates the key sites at risk from flooding if defences breached.

Settlement	Breach Location
Prestatyn	Prestatyn Breach: Much of Prestatyn is low lying and potentially at risk from coastal flooding. The eastern end of the frontage at Prestatyn is comprised of dunes behind Barkby Beach with manmade seawalls present along the rest of the town frontage. The seawall heights range from 6.8 m AOD to 7.65 m AOD meaning overtopping is unlikely, except by isolated breaking waves. The area of dunes at Barkby Beach is potentially vulnerable and the transition from hard to soft defences has been identified as a potential location for a breach in the defences. The eastern end of the dunes around the outfall of Prestatyn Gutter is lower lying and at risk from overtopping during extreme tidal events such as the 0.1% AEP event.
Rhyl	Rhuddlan Marine Lake Breach: The eastern end of the Rhyl frontage towards the golf course is made up of low lying land protected by a seawall of >7.0 m AOD. Along much of the remainder of the frontage there is higher ground >7 m AOD immediately behind the promenade so there is little flood risk in this area. There is therefore little risk of the defences along the Rhyl frontage being overtopped.
Rhuddlan	Rhuddlan Marine Lake Breach, Rhuddlan Clwyd Breach: Two main tidal models exist that are designed to assess tidal risk to Rhuddlan. Tidal risk to Rhuddlan comes from the Clwyd Estuary, where the tidal influence extends upstream of Rhuddlan. The Tidal Clwyd Model considers tidal flooding from the Clwyd Estuary only whereas the Coastal Rhuddlan Model covers tidal flooding directly from the coastline and from the estuary. Two breach scenario models have also been designed to assess possible breaches at two locations.
Bodelwyddan	Bodelwyddan is known to suffer from fluvial flooding with the main risk thought to come from coastal sources.

5.8 Impacts of Climate Change

Flooding is already a serious risk to the people, economy and environment in Wales. Climate change is expected to increase this risk over the coming decades. The effects are well documented and include rising sea levels and more frequent periods of heavy rainfall increasing the risk of flooding.

When considering new development proposals, Technical Advice Note 15: Development and Flood Risk (TAN15) states that it is necessary to take account of the potential impact of climate change over the lifetime of development. Residential development is assumed to have a lifetime of 100 years while a lifetime of 75 years is assumed for non-residential developments. To ensure future development can provide a safe and secure living and /or working environment throughout its lifetime, national planning policy requires proposals in areas of high flood risk to be accompanied by an assessment of flooding consequences to and from the development, taking into account the impacts of climate change. This SFCA does not focus on detailed mitigation measures for climate change but rather focuses on the 0.1% extreme event, as per TAN 15 requirements. However, several climate change scenarios have been appraised as part of this SFCA and the 0.1% event plus climate change has been taken account of in relation to the key development sites (see section 5.8.2).

Site specific FCAs would be required to detail possible mitigation techniques for climate change, using the information provided in this section of the SFCA as a starting point. In making an assessment of the impacts of climate change on flooding from the land, rivers and the sea as part of a FCA, the sensitivity ranges, may provide an appropriate precautionary response to the uncertainty about climate change impacts on river flows and rainfall intensities. Considering the impacts of climate change during a FCA will have implications for both the type of development that is appropriate according to its vulnerability to flooding and design standards for any SuDS or mitigation scheme proposed.

5.8.1 Welsh Government: Climate Change Allowances

The Welsh Government Chief Planning Officer letter and guide on FCA Climate Change Allowances (2016) sets out requirements. The purpose of this guide is to set out the climate change allowances that should be used in flooding consequence assessments submitted in support of relevant planning applications, and to inform development plan allocations.

Providing an allowance for the potential impacts of climate change when assessing future flood risk, allows for development proposals to incorporate design measures that help to manage that risk and improve resilience

In line with TAN15, the climate change allowances have been informed by latest available information on climate change projections and different scenarios of carbon dioxide (CO2) emissions to the atmosphere. Allowances are provided for different epochs (periods) of time over the next century.

Table 5-2 indicates the anticipated increase in peak river flows for the river basin districts that cover Denbighshire. The allowances are consistent with the A1B (medium) emissions scenario derived from latest research projects and converted into regionalised data of climate change on flood flows for the 2020s, 2050s and 2080s time-horizon, and for the B1 (low) and A1F1 (high) emissions scenarios for the 2080s time-horizon.

Estimates of peak flow increases are provided, which represent future flood risk. The allowances are based on percentage increases of change from a 1961-1990 baseline and are provided for the:

- 10th percentile (lower end estimate)
- 50th percentile (change factor/central estimate)
- 90th percentile (upper end estimate).

Table 5-2: Peak river flow allowances by Western Wales river basin district (use 1961 to 1990)[19]

River Basin	Total potential change anticipated by the 2020s	Total potential change anticipated by the 2050s	Total potential change anticipated by the 2080s
River Dee			
Upper end estimate	25%	40%	70%
Change factor /central estimate	15%	25%	30%
Lower end estimate	5%	10%	15%

Sea Level Rise Allowances

Projections of relative mean sea level rise for each epoch (period of time) is provided for the Welsh coastline in Table 5-3. These projections are consistent with the latest global predictions for sea level rise. The rate of change is projected to increase in each epoch.

Table 5-3: sea level allowance for each epoch in millimetres (mm) per year and cumulative sea level rise for each epoch.

Period	2009-2025	2026-2055	2056-2085	2086-2116	Cumulative rise to 2116
Annual Change (mm/yr)	3.5	8.0	11.5	14.5	
Total Increase (mm)	59.5	240	345	449.5	1094

To calculate sea level, add the annual allowances for each year post for the agreed lifetime of development. Table 5-4 and Table 5-5 demonstrate how to apply the calculation for 75 year and 100 year developments commencing in 2016.

Table 5-4: calculating sea level rise for a 75yr lifetime of development

Period	mm increase	Cumulative rise (mm)
2009-2025	17 (years inclusive) x 3.5	59.5
2026-2055	30 x 8.0	240.0
2056-2085	30 x 14.5	345.0
2086-2091	6 x 14.5	87.0
75 year lifetime	**add**	**731.5**

Developments built in 2016 with a 75 year lifetime must be resilient to sea level rises until 2091. This table demonstrates that an allowance for an increase of 731.5mm should be made.

19http://bailey.persona-pi.com/Public-Inquiries/M4-Newport/C%20-%20Core%20Documents/17.%20Road%20Drainage%20and%20the%20Water%20Environment/17.2.22.pdf

Table 5-5: calculating sea level rise for a 100yr lifetime of development

Period	mm increase	Cumulative rise (mm)
2009-2025	17 x 3.5	59.5
2026-2055	30 x 8.0	240.0
2056-2085	30 x 11.5	345.0
2086-2091	31 x 14.5	449.5
100 year lifetime	**add**	**1094.00**

Developments built in 2016 with a 100 year lifetime must demonstrate resilience to sea level rises until 2116. This table shows that an allowance for an increase of 1094mm should be made.

When considering proposals with a lifetime of development beyond 2116, an additional allowance of 14.5mm should be added for each subsequent year[20].

5.8.2 Climate Change scenarios

The modelled climate change scenarios used the new Welsh Climate Change guidance for planning, as detailed in Section 5.8.1. For this SFCA fluvial climate change scenarios were not modelled due to there being no change in the allowances. However, the Welsh Climate Change guidance has been used to establish the cumulative sea level rise due to climate change for the year 2117. This equates to an increase of 1.11m (from the year 2009). As the previous study was carried out in 2014, 1.09m has been added to the tidal curves for the T200 and T1000 events to represent the additional sea level rise from 2014-2117.

These updated climate change events were then run through the 4 breach model locations (shown in Appendix A):

- Prestatyn breach,
- Rhyl breach,
- Rhuddlan Marine Lake breach
- Rhuddlan Clwyd breach

Rhyl Breach

The 0.5% AEP + climate change tidal breach outline from the Rhyl breach model shows extensive flooding to the East of Rhyl. The 0.1% AEP event + climate change covers a larger area mainly by expanding eastwards further into Prestatyn and extending further along the Rhyl Cut. Additionally, the 0.5% AEP + climate change tidal breach depth results from the Rhyl breach scenario model shows that the deepest depths surround Rhyl Cut with depths of >600mm, these depths decrease with distance away from The Cut. The 0.1% AEP event + climate change has the same pattern of deep water, however the extent is slightly wider with a noticeable area in Prestatyn along Clive Avenue that has depths of approximately 0.1m. The maximum velocities are generally within the 1.6 m/s threshold located within the North of Rhyl though these are only small areas and the average velocity is approximately 0.5 m/s. The hazard mapping for both 0.5% and 0.1% AEP + climate change outlines are mainly at the Significant flood hazard as indicated in Appendix A.

Prestatyn Breach

The 0.5% AEP + climate change tidal breach outline from the Prestatyn breach model illustrates much more extensive flooding across the whole of Prestatyn from Barkby beach and decreasing in risk as the flow reaches the Southwest, closer to Rhyl. The 0.1% AEP + climate change event extends further West, taking in a larger area of the caravan park and the surrounding residential streets to the South and West. Interrogation of representative flood depths produced from the modelled 0.5% AEP + climate change event across the area reveals that the deepest depths are located near the costal front of Prestatyn adjacent to the Prestatyn Gutter with the depths of around

20 http://gov.wales/docs/desh/publications/160831guidance-for-flood-consequence-assessments-climate-change-allowances-en.pdf

>1m. The 0.1% AEP event + climate change has the same areas of deep waters, however the extent is slightly wider with a noticeable area located East Rhyl along The Cut that has depths of approximately 0.2m. The maximum velocities are generally within the 1.1 m/s threshold located within the North Prestatyn along the coastline though these are only small areas and the average velocity is low with the majority of the area having a velocity of approximately 0.3 m/s. The hazard mapping for both 0.5% and 0.1% AEP + climate change outlines are mainly at the Significant flood hazard with a large area located along the coastal front of Prestatyn being categorised as extreme flood hazard as indicated in Appendix A.

Rhuddlan Marine Lake Breach

The 0.5% + climate change tidal breach outline from the Marine Lake breach model shows most of the West end of Rhyl and the agricultural land to the West is inundated. The 0.1% AEP event + climate change covers a larger area, mainly in the built up centre of Rhyl. Interrogation of representative flood depths produced from the modelled 0.5% AEP + climate change event across the area reveals that a large area of Rhyl is located within deep waters of >2m. However, there is a distinctive deep cluster located in the North west of Rhyl near the costal front with depths of >3m. The 0.1% AEP event + climate change has the same areas of deep waters, however the extent is slightly wider with a noticeable area towards the East of Rhyl along The Cut with depths that are approximately 0.4m. The maximum velocities are generally within the >3m/s threshold located within the West of Rhyl along the River Clwyd the velocity flows reduce with distance away from the river with the average velocity being approximately <2 m/s and closer to the centre of Rhyl the velocity is approximately <0.5 m/s. The hazard mapping for both 0.5% and 0.1% AEP + climate change outlines are mainly are categorised as extreme flood hazard as indicated in Appendix A.

Rhuddlan Clwyd Breach

The Clwyd Estuary climate change breaches cover the same areas of Rhyl as the Marine Lake breach climate change outlines, velocity, hazard and depths.

Key Settlements at risk from Climate Change

Rhyl and Prestatyn:

These two settlements may be at risk of climate change as they are both located on the coast. Many areas at risk are located within Flood Zone C1 with surrounding areas of Rhyl being located within Flood Zone C2.

Ruthin and St Asaph:

Both Ruthin and St Asaph may be at risk of climate change due to extensive catchment areas draining through and into the area. Both the River Clwyd in Ruthin and the River Elwy in St Asaph run through the most urban areas within the settlements. Therefore, the surrounding areas along the main rivers are loctaed within high risk Flood Zones C1 and C2.

Rhuddlan and Bodelwyddan:

Rhuddlan and Bodelwyddan could potentially be impacted by climate change due to the high flood zone categories from the DAM that are located and caused due to watercourses flowing through the area. However, the high flood risk areas are mainly situated within the rural areas of Rhuddlan and Bodelwyddan.

When comparing the further seven settlements to the DAM flood zones, these settlements do not seem to be at risk from climate change as these settlements have a smaller risk of fluvial flooding. Nevertheless, it should be noted that these settlements do include areas of Flood Zone C2 located along the river. However, the flooding does not seem to extend out the river channel.

5.8.3 Future Impacts of Climate Change

This section will look into the future impacts of climate change on small coastal settlements and the impacts on coastal process and increasing pressures on coastal defences.

How climate change could affect sea level rise in coastal communities

Sea level rise is projected to increase by between about 0.1m and 0.32m by the 2050s. Due to climate change and sea level rise it is expected that the coastline will be subjected to more frequent and severe storms and wave action which will increase coastal erosion, damage to coastal defences and the likelihood and consequences of coastal flooding. Increased erosion rates can lead to a loss of land, damage to railway lines and roads that are located in close proximity to the coast. Additionally, this may threaten beaches and therefore tourism in Wales, which contributes over £2.5 billion each year to the Welsh economy[21]. In relation to local community impacts, climate change may also lead to longer-term effects on neighbourhoods. For instance, areas that suffer the impacts of climate change or are considered to be at high risk may be affected by increased flooding and a reduction in housing values, increase insurance, development and investment.

What are the impacts of climate change on coastal processes and wave action

According to many researchers climate change will cause a rise in sea levels and wave heights and accelerate coastal erosion making coastal areas more vulnerable, especially communities relying on the immediate coastal area for their residence, communications and economic and social activities[22].

The coast is subject to both erosion and accretion. It is estimated that about 23% of the Welsh coastline is eroding (346km of a total of 1,498km). The combination of sea level rise and erosion is likely to reduce the area of beaches and affect other coastal features. It is assumed that urban areas will continue to be protected against sea level rise and coastal erosion. However, this is likely to require significant future investment and, in some cases, may not be sustainable[23].

What are the increase pressures on sea defences and tidal flood embankments due to climate change

Coastal defences currently protect nearly 28% of the Welsh coastline and £8 billion of assets from coastal erosion and flooding. However, these defences do not sufficiently manage the existing risk of coastal erosion, and climate change and sea level rise will further reduce their efficiency. Building coastal defences can be technically difficult and may not be affordable in all locations in the future.

The previous Welsh Government invested £39 million during 2010-11in flood and coastal erosion risk management in Wales. If investment in flood risk management is maintained at current levels then by 2035 the number of properties in Wales at significant likelihood of flooding would increase from 65,000 to 115,000, with a consequent increase in expected annual damages. To maintain the number of properties at flood risk in 2035 at levels comparable to now may require trebling investment levels, while reducing the number of properties at risk would require further investment again. A wider range of actions may be necessary to manage the impacts of current and future flooding[22].

The coastal management strategy (e.g., hard coastal defences, beach nourishment, managed realignment) is a key aspect for determining the long-term response of the coast to climate change effects, including sea-level rise. Managed realignment is likely to increase in the future as a key management strategy and although this will result in increased local erosion rates, the enhanced erosion may benefit other sections of coast by reducing erosion or even causing accretion. Adaptation is emerging as the key coastal management paradigm to cope with coastal erosion[24].

21 http://www.cynulliad.cymru/NAfW%20Documents/ki-025.pdf%20-%2003112011/ki-025-English.pdf

22 https://www.jrf.org.uk/report/impacts-climate-change-disadvantaged-uk-coastal-communities

23 A climate change risk assessment for Wales (Defra)

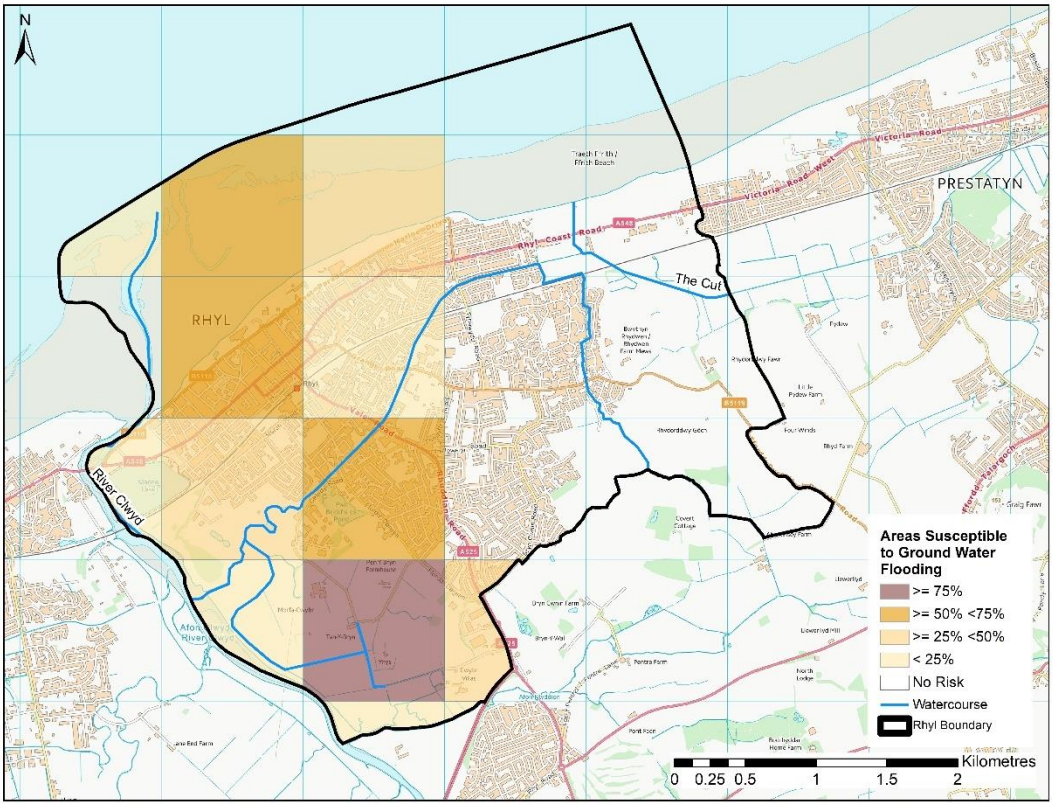
24 http://www.mccip.org.uk/media/1256/2013arc_sciencereview_09_ce_final.pdf

5.9 Key Settlements with Areas Susceptible to Ground Water Flood Risk

This section discusses the Areas Susceptible to Ground Water Flooding by each settlement. This data set is taken from the previous SFCA and therefore may be out of date. However a updated version of AStGWF is not available at this time. This data source should be assessed alongside historical flood incidents. A more detailed assessment in conjunction with the development of spatial strategy for the Local Development Plan should be considered.

5.9.1 Rhyl

Settlement	Rhyl
Area (ha)	1609.93
Catchment	Clwyd

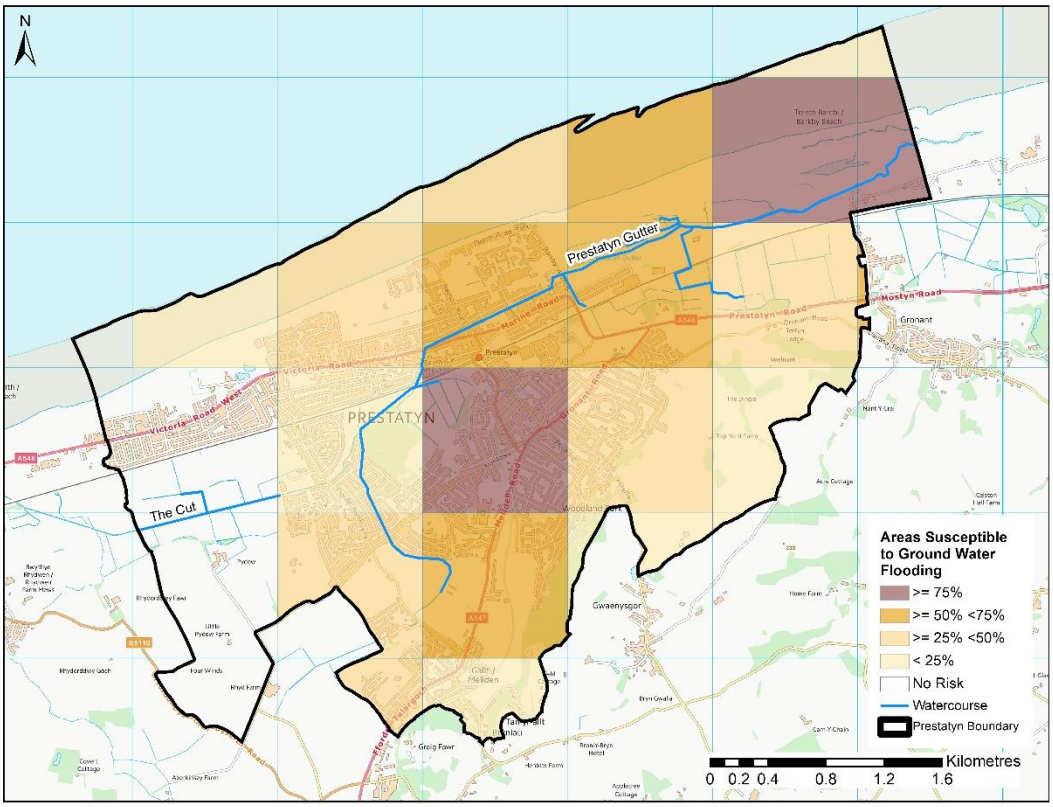


Ground Water Flooding

The areas susceptible to ground water flooding illustrates that the ground water flooding in Rhyl is varied. The majority of the area is at risk of 25% or more ground water flooding. Particularly the Southwest area of Rhyl is most susceptible to ground water flooding and has a risk of 75%.

5.9.2 Prestatyn

Settlement	Prestatyn
Area (ha)	1601.41
Catchment	Clwyd

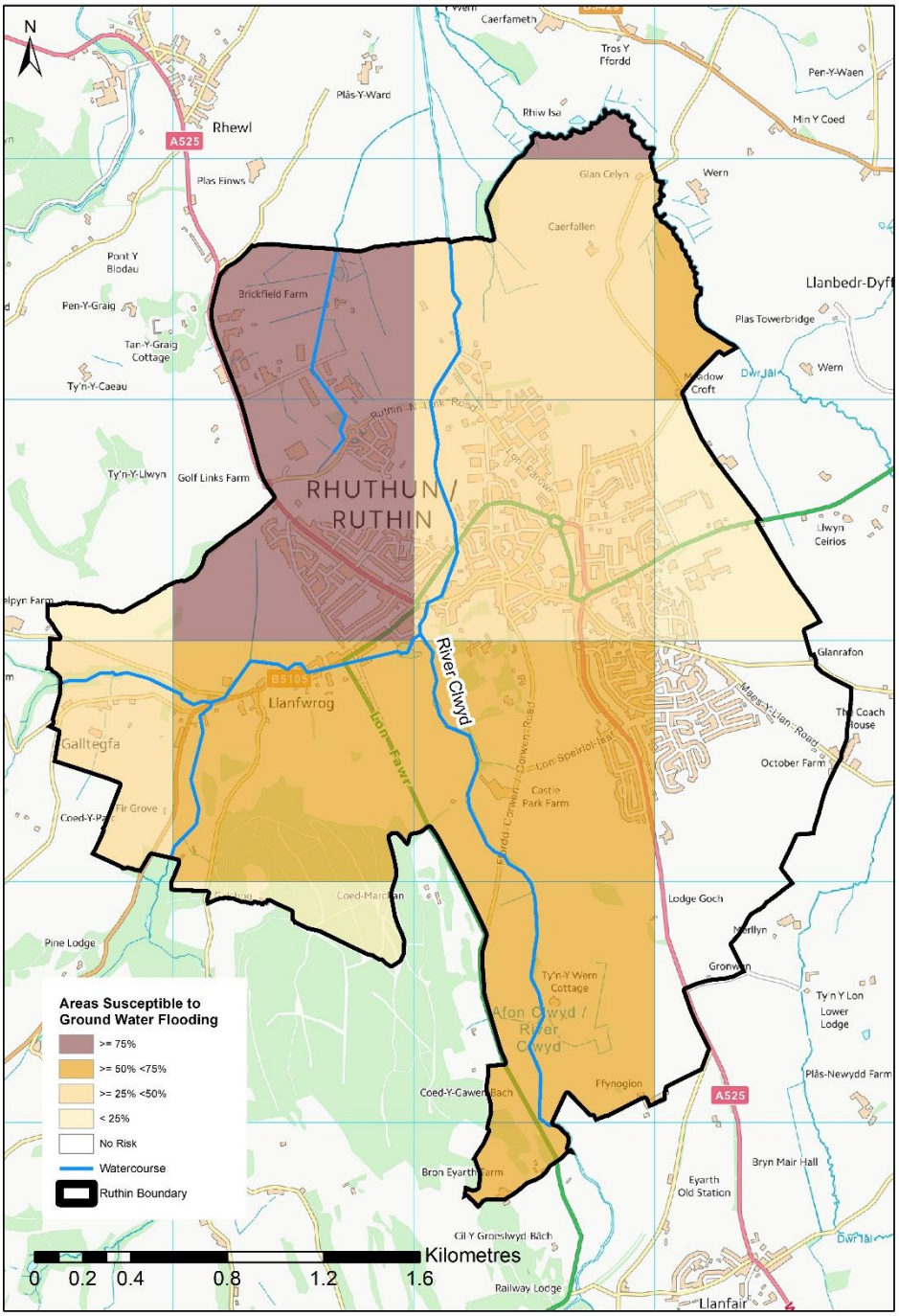


Ground Water Flooding

the areas susceptible to ground water flooding data illustrates that the flooding in Prestatyn is varied. However, the majority of the area is at risk of 25% or more. The centre and Northeast areas of Prestatyn are most at risk of ground water flooding with the susceptibility being 50-75% and 75%.

5.9.3 Ruthin

Settlement	Ruthin
Area (ha)	817.54
Catchment	Clwyd

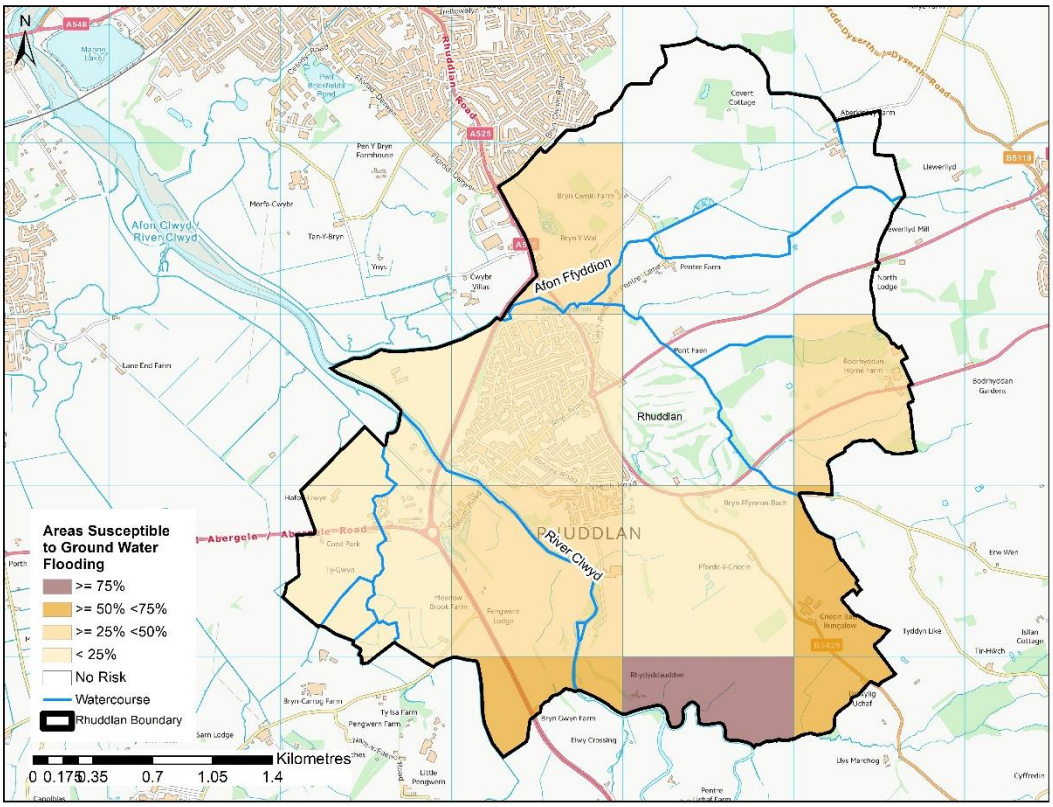


Ground Water Flooding

The areas susceptible to ground water flooding illustrates that flooding in Ruthin is varied. The majority of the area is at risk of 25% or more ground water flooding. Particularly the surrounding areas near the River Clwyd where Ruthin is most susceptible to ground water flooding and has a risk of 50-75% and 75%. In these areas where ground water and fluvial flooding is high development should be avoided.

5.9.4 Rhuddlan

Settlement	Rhuddlan
Area (ha)	1674.63
Catchment	Clwyd

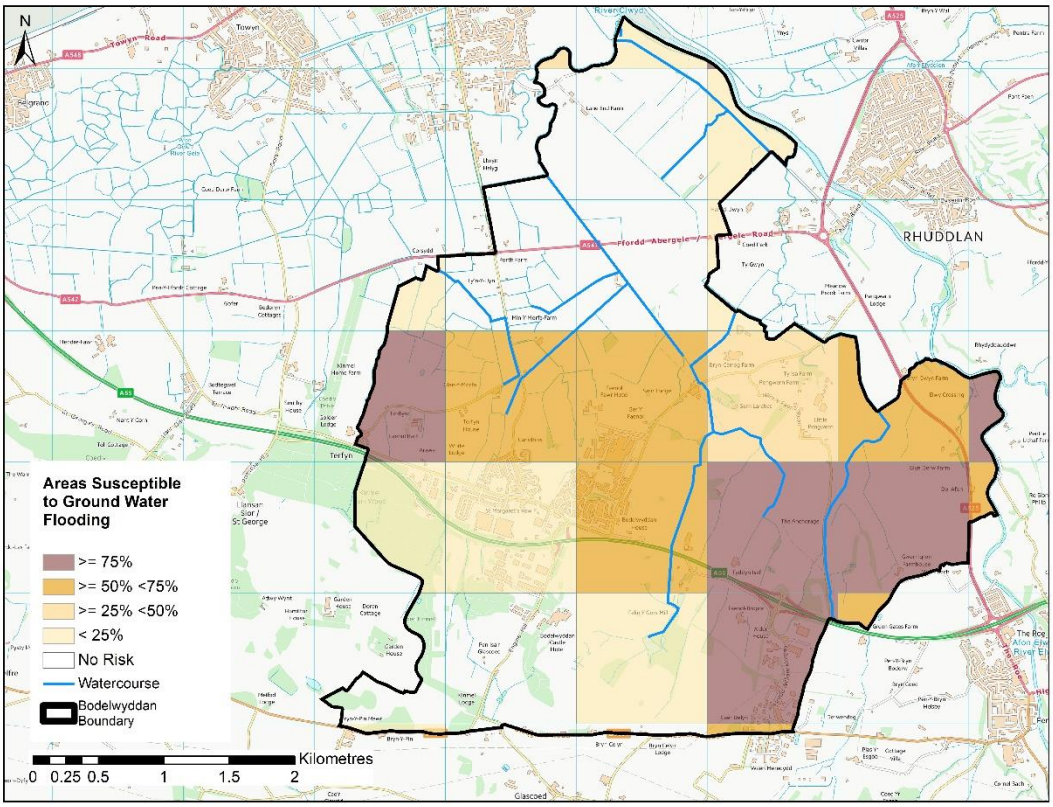


Ground Water Flooding

Data for areas susceptible to ground water flooding is not available for the whole area of Rhuddlan, however the data provided does illustrate that the ground water flooding in Rhuddlan is varied. The majority of the area is at risk of 25% or more ground water flooding. The South of Rhuddlan is most susceptible to ground water flooding and has a risk of 75%.

5.9.5 Bodelwyddan

Settlement	Bodelwyddan
Area (ha)	1674.63
Catchment	Clwyd

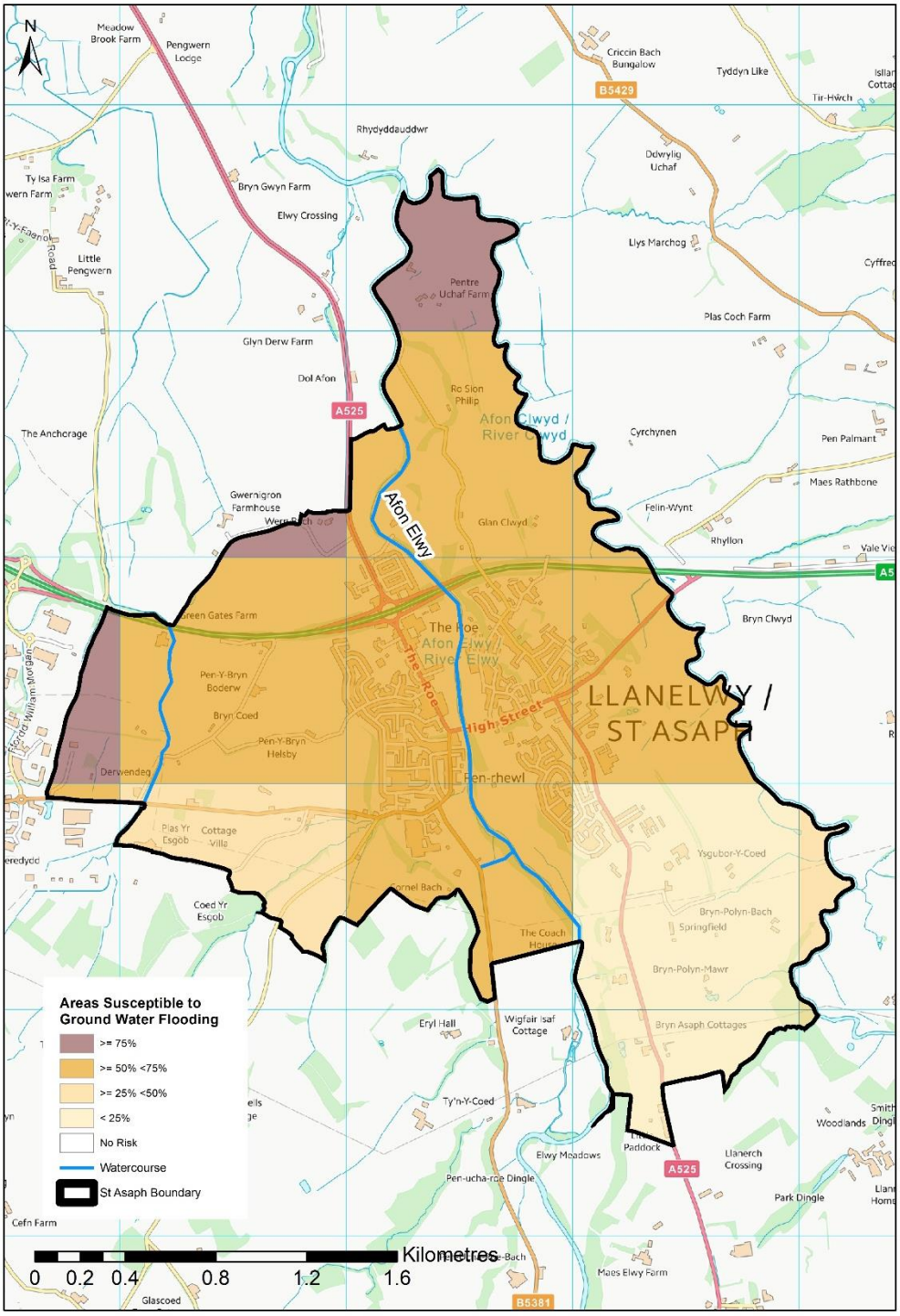


Ground Water Flooding

Data provided for areas susceptible to ground water flooding illustrates there is a defined area diagonally across Bodelwyddan from Northwest to Southeast that then raises up again towards the Northeast, these areas are most susceptible to groundwater flooding with the risk rate being 50-75% and 75%. The surrounding areas are also at risk of ground water flooding however the risk is much lower with a risk rate of 25%.

5.9.6 St Asaph

Settlement	St Asaph
Area (ha)	644.61
Catchment	Clwyd

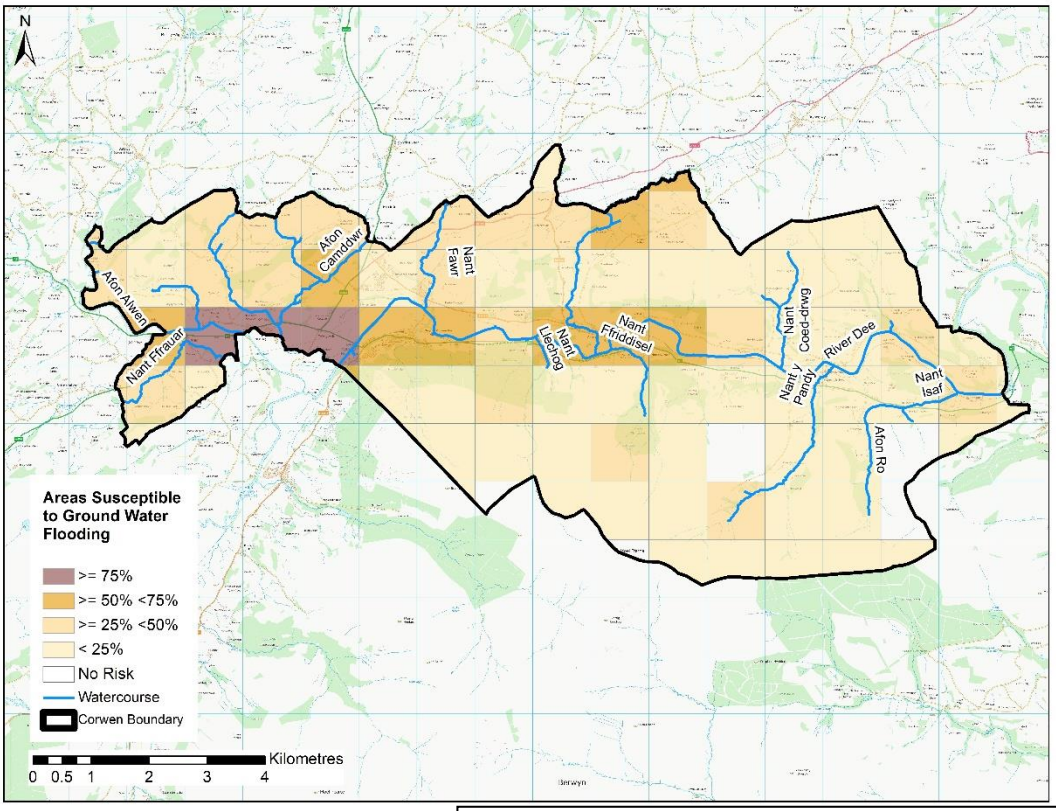


Ground Water Flooding

Areas susceptible to ground water flooding illustrate that the ground water flooding in St Asaph is high. The majority of the area is at risk of 50-75% % or more ground water flooding. Particularly the Southwest area of Rhyl is most susceptible to ground water flooding and has a risk of 75%.

5.9.7 Corwen

Settlement	Corwen
Area (ha)	6956.79
Catchment	Clwyd

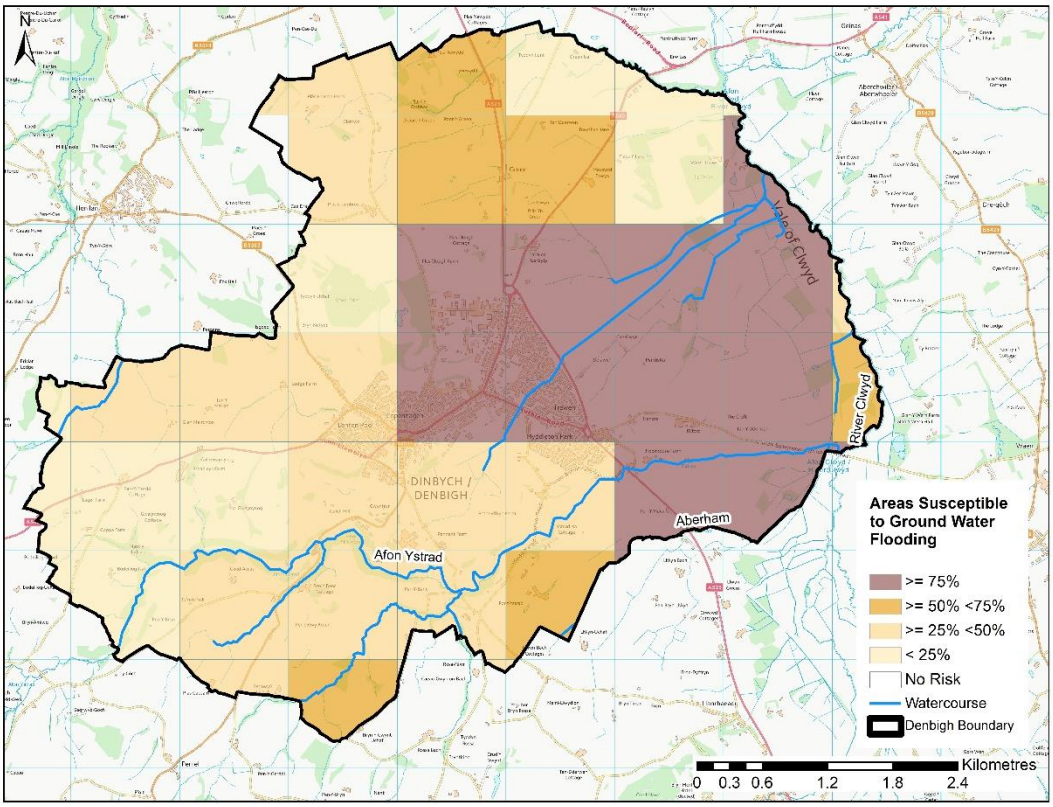


Ground Water Flooding

The majority of Corwen is at low risk of ground water flooding with the main percentage across the area being 25%. However there is a correlation between the areas susceptible to ground water flooding and the River Dee. Areas located surrounding the River Dee have a higher risk percentage than those elsewhere. The ground water risk around the River Dee is 50-75%, development should be avoided in these areas as there is a high risk of ground water flooding and fluvial.

5.9.8 Denbigh

Settlement	Denbigh
Area (ha)	3137.64
Catchment	Clwyd

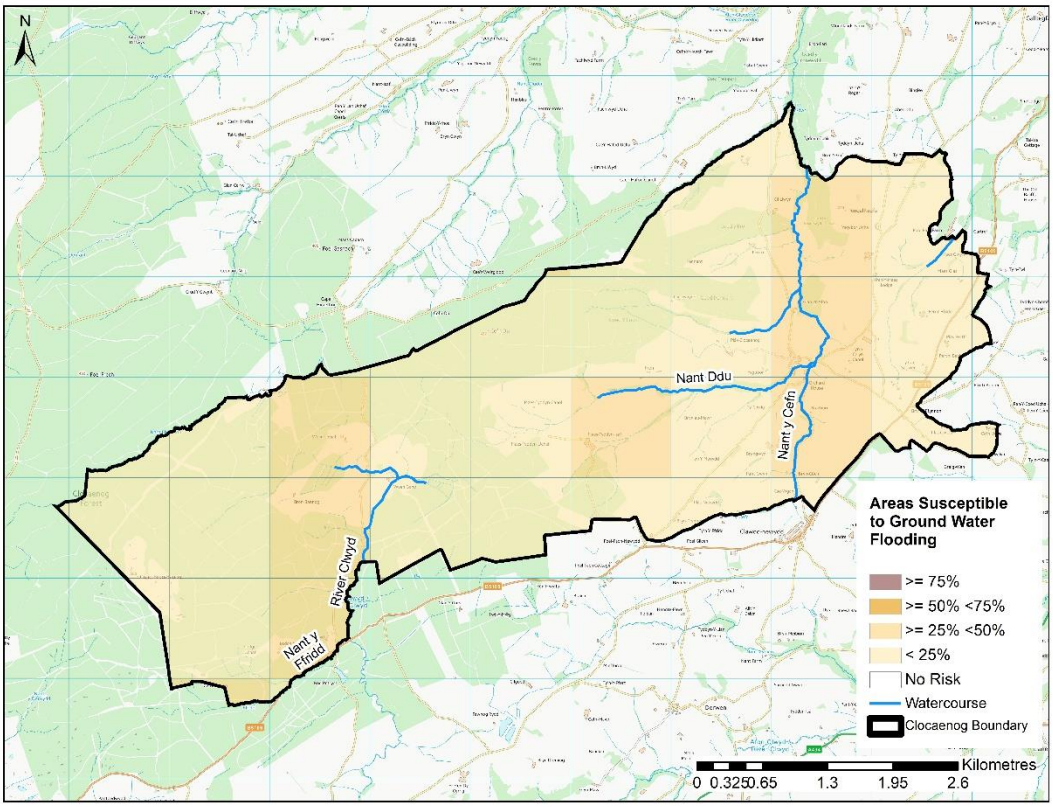


Ground Water Flooding

Area susceptible to ground water flooding in Denbigh are variable, with the majority of being at a low risk of 25%. However, a third of the settlement is at high risk of flooding from ground water with a percentage of 75%. The areas that have the highest risk of ground water related to those areas that have a high risk of fluvial flooding which is located to the East of Denbigh. It is also notable that to the North of Denbigh there is a 50-75% risk of ground water flooding. Therefore, development should avoid these high risk areas.

5.9.9 Clocaenog

Settlement	Clocaenog
Area (ha)	2413.57
Catchment	Clwyd

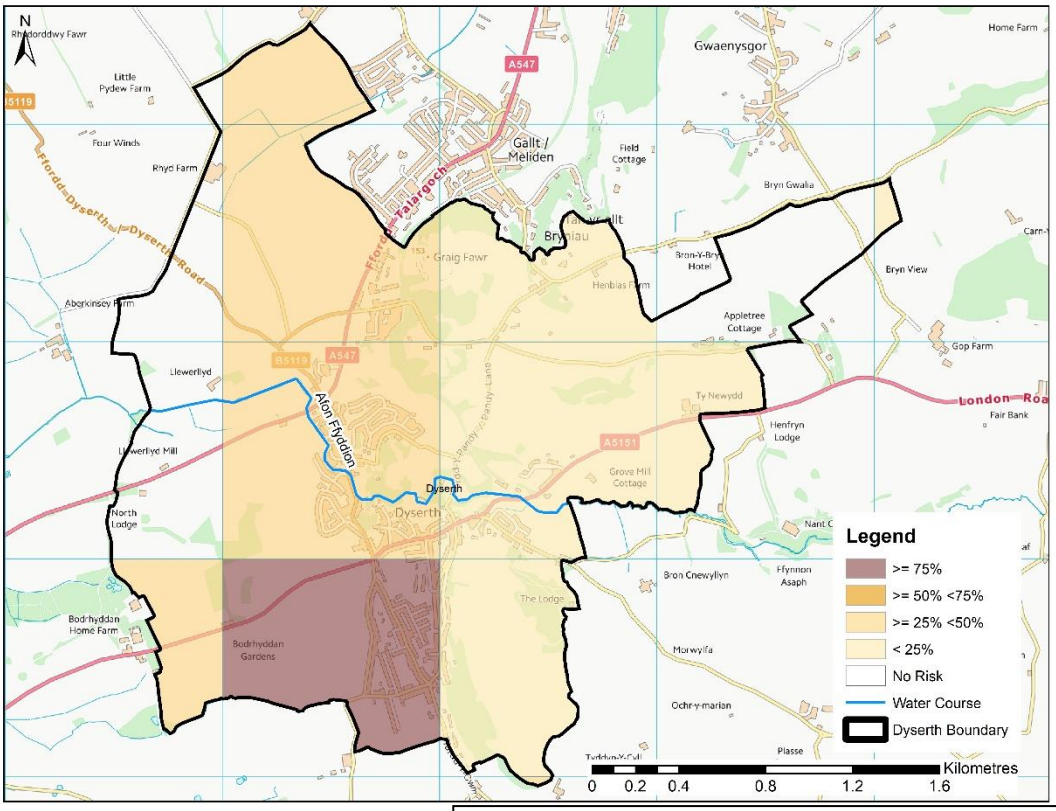


Ground Water Flooding

The areas susceptible to ground water data illustrates that there are no high risk areas within Clocaenog. The highest percentage is 25-50% which are located near the water courses in the area. The surrounding areas of Clocaenog have a <25% risk of ground water flooding. Therefore, taking into consideration the limited fluvial and groundwater flooding this area is developable.

5.9.10 Dyserth

Settlement	Dyserth
Area (ha)	639.49
Catchment	Clwyd

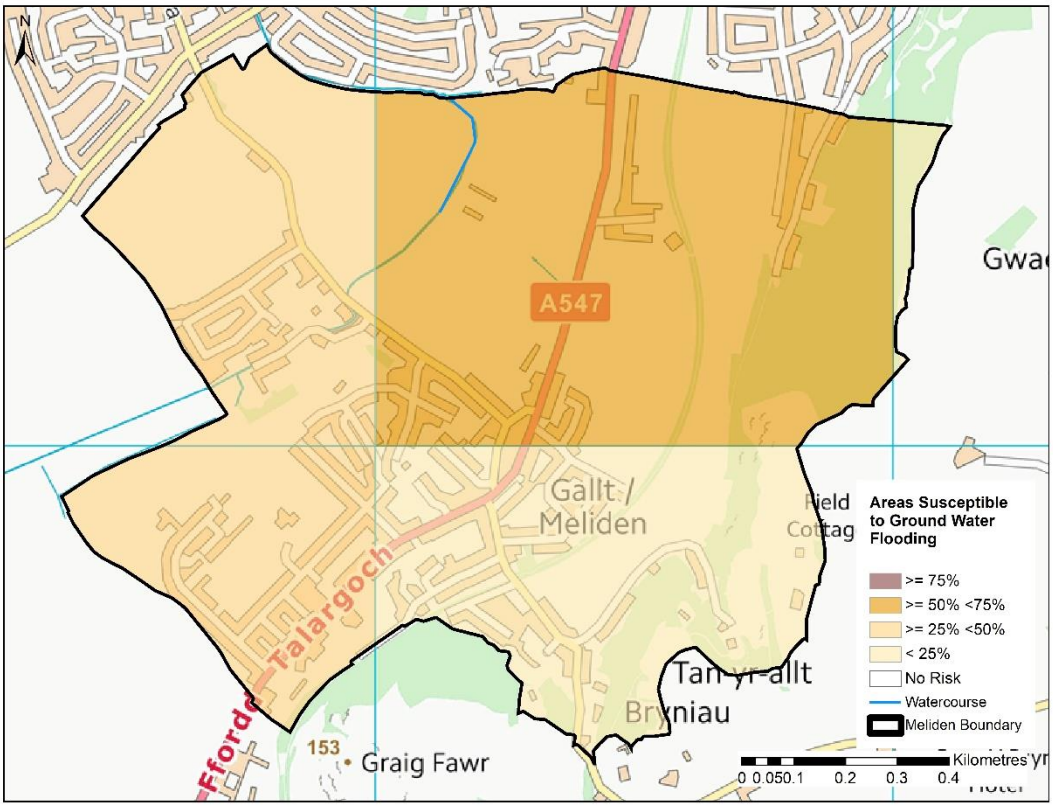


Ground Water Flooding

The areas susceptible to ground water flooding illustrates that the majority of Dyserth is not at high risk. Nevertheless, the South of Dyserth does have a 75% risk of ground water flooding, however there is no correlation between water courses and ground water flooding.

5.9.11 Meliden

Settlement	Meliden
Area (ha)	160.07
Catchment	Clwyd

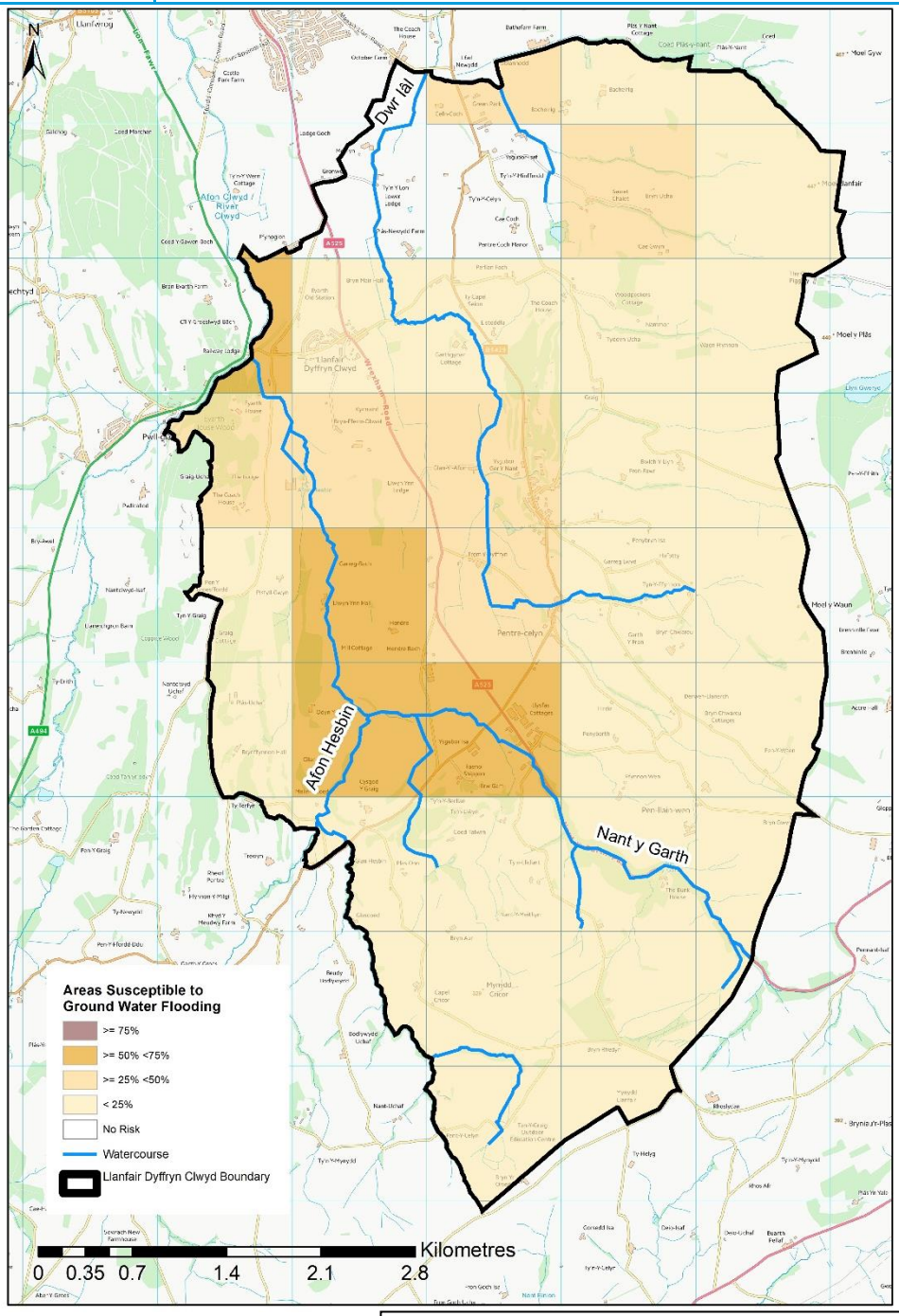


Ground Water Flooding

According to the areas susceptible to ground water data, Meliden is not at high risk from ground water flooding. However the Northeast area of Meliden has a ground water flooding risk of 50-75%. Development can occur, however the advice would be to avoid areas of fluvial and high ground water flooding.

5.9.12 Llanfair Dyffryn Clwyd

Settlement	Llanfair Dyffryn Clwyd
Area (ha)	2992.74
Catchment	Clwyd

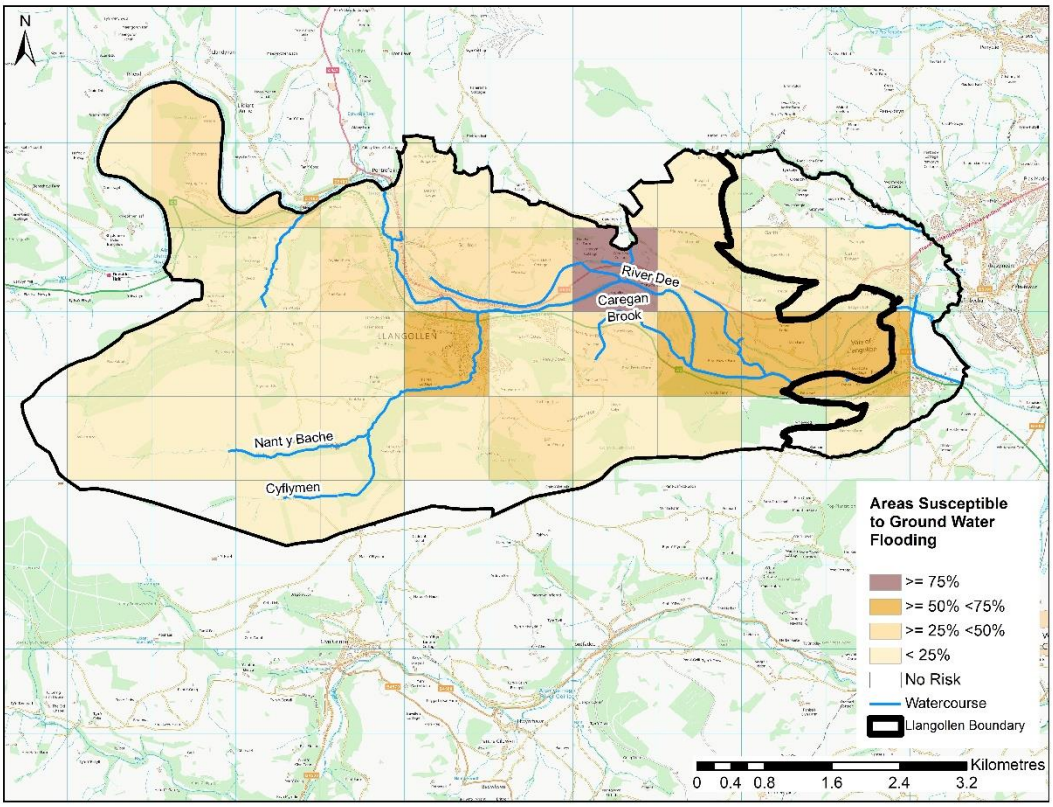


Ground Water Flooding

The majority of Llanfair Dyffryn Clwyd is not at high risk of ground water flooding, with the majority of the area being at 25% risk. However there is a correlation between fluvial risk and ground water. The ground water flooding is higher in areas that are located near the River Clwyd with percentages as high as 50-75% located to the West of Llanfair Dyffryn Clwyd.

5.9.13 Llangollen

Settlement	Llangollen
Area (ha)	3749.76
Catchment	Clwyd



Ground Water Flooding

Areas susceptible to ground water flooding illustrate that there is a variation in flood risk from ground water. However the majority of the area is at low risk from ground water flooding with the main percentage of risk being <25%. Nevertheless, there are some areas with higher risk percentages, these areas correlate to those of water courses. For instance, the higher percentage ground water flooding areas are located near the River Dee, the area's most at risk are located to the East of Llangollen with ground water flooding rates of 50-75%. However, in the North of Llangollen the risk of ground water flooding is 75%.

6 Conclusion and Recommendations

6.1 Conclusions

This SFCA provides a single repository planning tool relating to flood risk and development in the County of Denbighshire. Key flood risk stakeholders namely Natural Resources Wales, Welsh Water and Denbighshire County Council were consulted to collate all available and relevant flood risk information on all sources into one comprehensive assessment. Together with this report, this SFCA also provides a suite of interactive GeoPDF flood risk maps (Appendix A) and a Development Site Assessment spreadsheet (Appendix B) illustrating the level of risk to the existing Local Development Plan sites identified by the Council, with subsequent recommendations.

The flood risk information, assessment, guidance and recommendations of the SFCA will provide strategic planners with the evidence base required to develop a spatial strategy for their new Local Development Plan and apply the justification and acceptability tests of TAN 15 to help assess what type and scale of development should be located, where and demonstrate a risk based approach has been applied.

This SFCA should provide the necessary links between spatial development, wider flood risk management policies, local strategies / plans and on the ground works by combining all available flood risk information together into one single repository for both the Local Planning Authority and Lead Local Flood Authority. This is a strategic study, based on all detailed local information available at this time. Not all flood risks and combination of risks are accounted for, and there could be a furthermore detailed assessment of specific areas or sites, within a Level 2 SFCA which could be carried out following on from the completion of this Level 1 assessment. Key settlements have for example not been assessed against the policy units of the North West SMP2 and the breach assessments have been updated to take account of climate change allowances. The developing spatial strategy and SMP2 policy units could identify areas where more detailed work is required. It is recognised at this time current work is underway with the Coastal Risk Management Programme, Tidal Dee strategy and East flood defence project, as separate projects to this SFCA.

6.2 Recommendations for further Work

The SFCA can be developed into a useful planning tool and evidence base to inform decision making for the Local Development Plan. Sitting alongside the LFRMS, PFRA, CFMPs and SMP2, it can be used to provide a much broad assessment tool for integrated, strategic and local flood risk management and delivery.

There are a number of plans and assessments listed in Table 6-1 that would be of benefit to DCC and / or the County Council as the LLFA, in combining their flood risk evidence base to support the delivery of their Local Development Plan and help fill critical gaps in flood risk information.

Table 6-1: Recommended Further Work

Type	Study	Reason	Timeframe
Data Collection	Flood Incident Data	DCC has a duty to investigate and record details of significant flood events within their area. General data collected for each incident, should include date, location, weather, flood source (if apparent without an investigation), impacts (properties flooded or number of people affected) and response by any RMA. DCC note in their LFRMS that this is underway	Ongoing
Data Collection	Asset Register	DCC should formulate, update and maintain a register of structures and features, which are considered to have an effect on flood risk. The requirement for this is noted in the LFRMS	Short term / ongoing
Risk Assessment	Asset Register Risk Assessment	DCC should carry out a strategic flood risk assessment of structures and features on the Asset Register to inform capital programme and prioritise maintenance programme.	Short term / ongoing
Designating Authorities	Designation of Assets	DCC have permissive powers to designate assets which are considered to affect flood risk and are not owned by the LLFA or NRW	Short term / ongoing
Capacity	SAB	Under the FWMA, DCC as an LLFA is required to establish a SAB. DCC should identify internal capacity required to deal with SuDS applications, set local specification and set policy for adoption and maintenance of SuDS.	Short term-Long term
Partnership	Welsh Water, Dee Valley Water	DCC should continue to work with the water companies on sewer and surface water projects.	Ongoing
Partnership	Natural Resources Wales	DCC should continue to work with NRW on fluvial flood risk management projects. DCC should also identify potential opportunities for joint schemes to tackle flooding from all sources.	Ongoing
Partnership	Canal & River Trust	DCC should develop a partnership with the Canal & River Trust to understand the residual risks associated with canals and reservoirs.	Short term
Partnership	Joint Emergency Planning Unit	DCC should continue to work with the members of the NWRF to ensure appropriate preparedness to enable multi-agency response to flooding.	Ongoing

6.2.1 Level 2 SFCA

The Council should review the settlements and existing allocated sites against where they expect the main housing numbers and employment sites to be delivered, using Section 5.6 of this report, the SFCA Maps in Appendix A and the Development Site Assessment spreadsheet in Appendix B.

A Level 2 SFCA will be required if a large settlement, or site, or group of sites, are within Flood Zone C and have strategic planning objectives, which means they cannot be relocated or avoided. A Level 2 SFCA may also be required if the majority of the sites are within Flood Zone C or are at significant risk of surface water flooding. Residual and cumulative flood risks should also be taken account of when considering options for future work. The risks identified for sites and potential recommendations for further work should be taken into account during the LDP review and Sustainability Appraisal scoping and objective setting for the Council as flood risk should be considered a significant issue with impacts of climate change and appropriate assessment needs to be completed, which includes detailed assessment of alternatives and cumulative impacts, and any potential mitigation or compensation to ensure the delivery of sustainable development.

A Level 2 assessment could also review existing river and tidal breach modelling studies undertaken to date. To review against the developing spatial strategy and development sites being considered and fully understand the quality of information and certainty to enable decision makin

Appendices

A Appendix - SFCA Settlement Maps

Interactive GeoPDF Maps

Open the Overview Map in Adobe Acrobat (2017s5683_DCC_SFCA_Overview.pdf). The Overview Map contains a set of key settlements covering the county. Clicking on one of the settlements will open up a settlement specific map for that area, by way of a hyperlink.

Each of the settlement maps has detailed sublayers, which can be used to zoom in/out and pan around the open detailed map.

In the legend on the right-hand side of the detailed settlement maps, each of the layers can be switched on and off when required by way of a dropdown arrow.

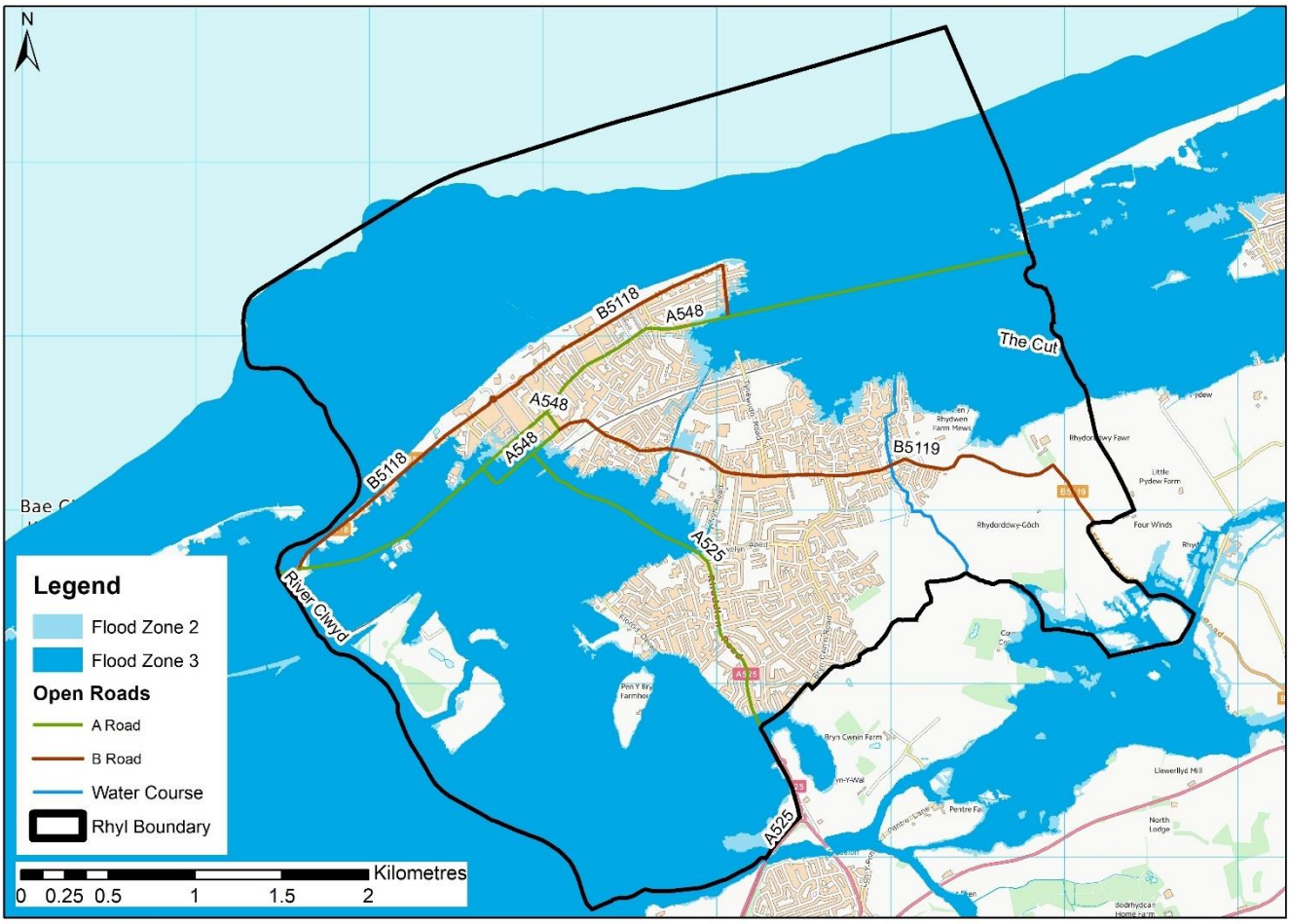
B Appendix - Development Site Assessment spreadsheet

Excel spreadsheet containing an assessment of flood risk to the potential development sites based on Flood DAM Zones B, C1, C2, as delineated through this SFCA, and also the updated Flood Map for Surface Water (RoFSW) and Natural Resources Wales Flood Map Zone 2 and 3.

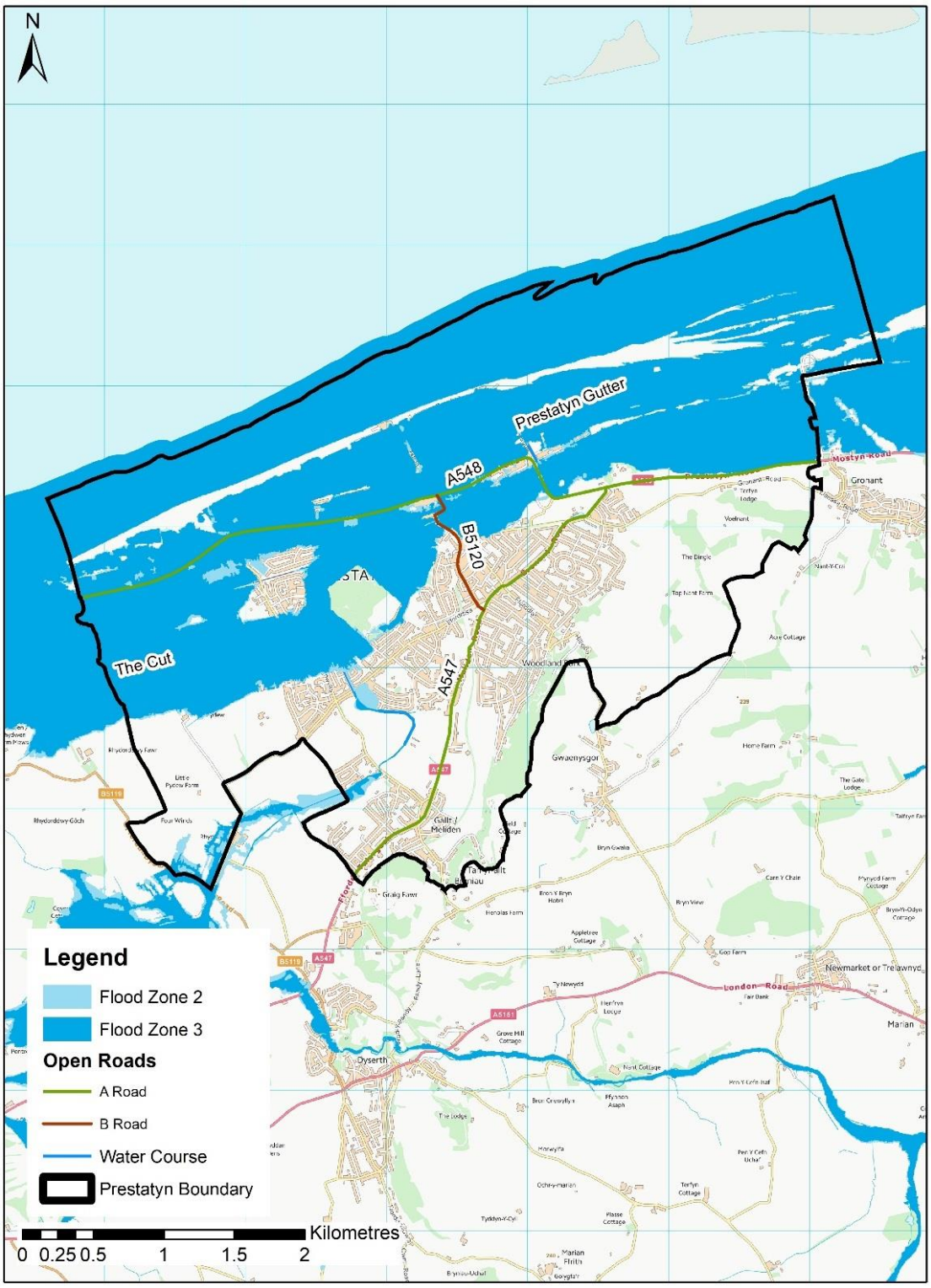
C Appendix - NRW Flood Zones

An assessment of flood risk to the settlements based on NRW Flood Zones 1 and 2.

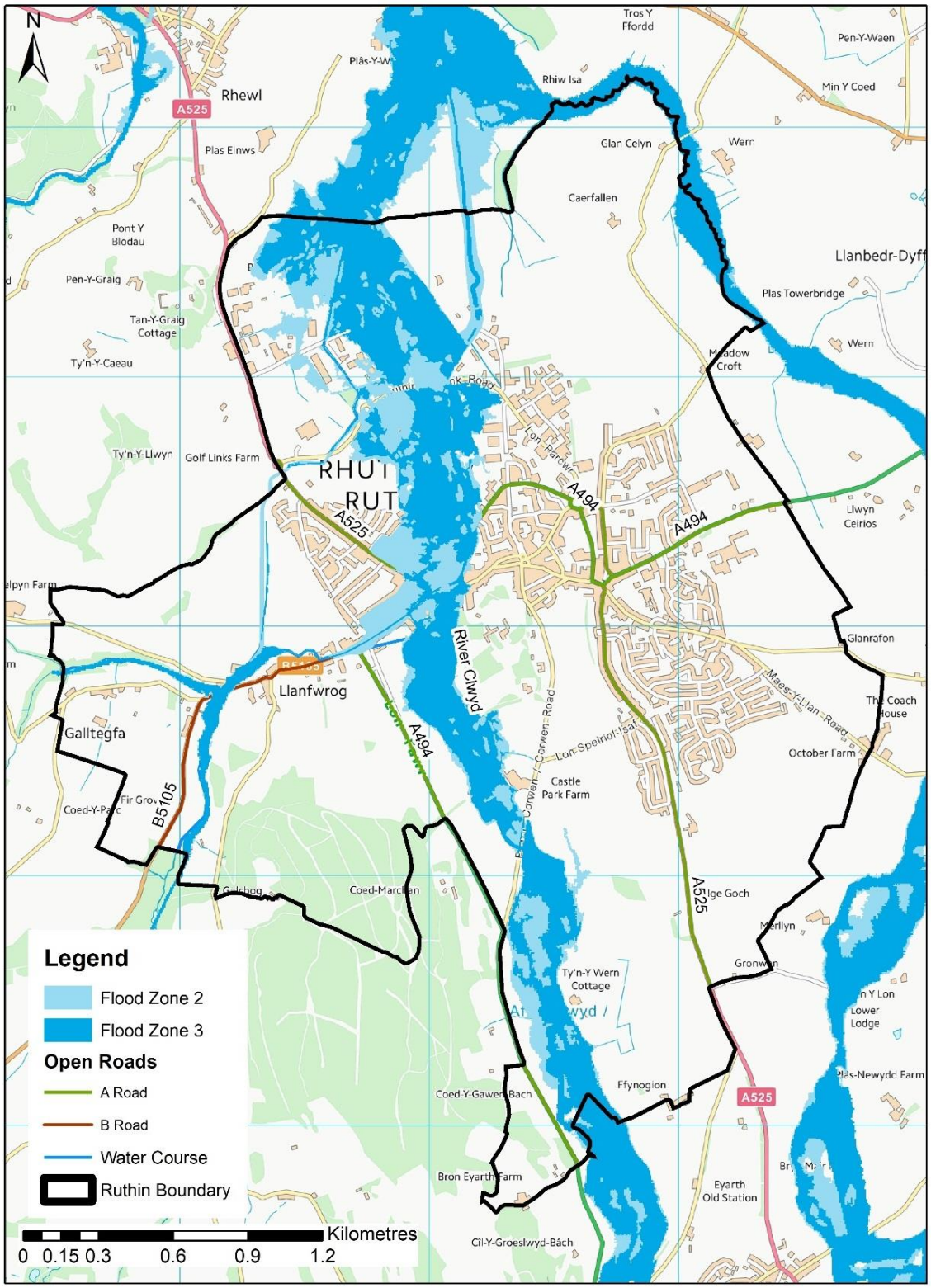
Rhyl



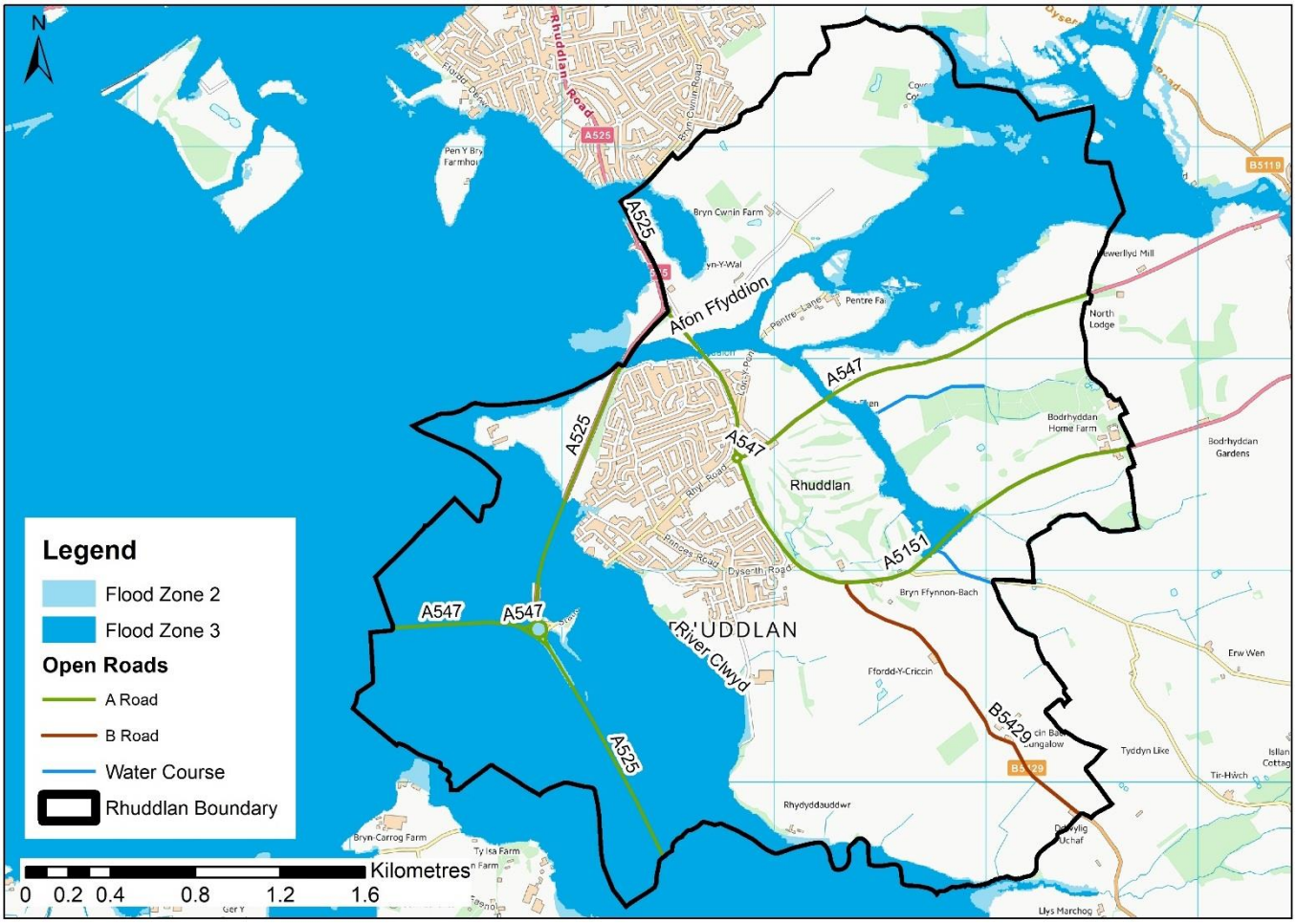
Prestatyn


N
Prestatyn Gutter
A548
B5120
A547
The Cut
Legend
Flood Zone 2
Flood Zone 3
Open Roads
A Road
B Road
Water Course
Prestatyn Boundary
Kilometres
0 0.25 0.5 1 1.5 2

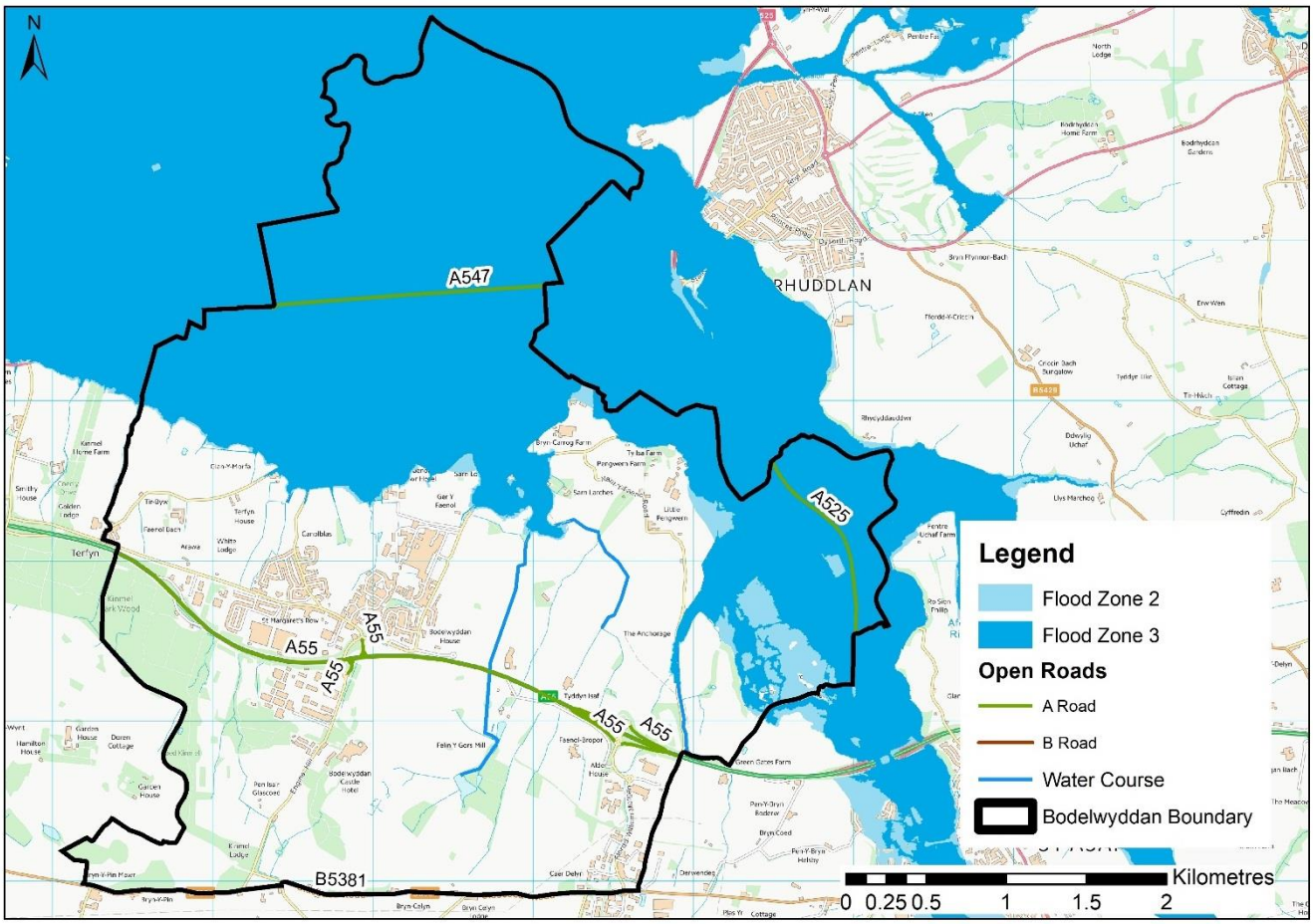
Ruthin


N
Rhewl
A525
Plas Einws
Pont Y Blodau
Pen-Y-Graig
Tan-Y-Graig Cottage
Ty'n-Y-Caeau
Ty'n-Y-Llwyn
Golf Links Farm
RHUT
RUT
A525
Llanfwrog
Galltegfa
B5105
Coed-Marchan
River Clwyd
A494
A494
A494
Rhiw Isa
Tros Y Ffordd
Pen-Y-Waen
Min Y Coed
Glan Celyn
Wern
Caerfallen
Llanbedr-Dyff
Plas Towerbridge
Wern
Meadow Croft
Llwyn Ceirios
Glanrafon
October Farm
Castle Park Farm
Ty'n-Y Wern Cottage
Ffynogion
Coed-Y-Gaweg Bach
Bron Eyarth Farm
Cil-Y-Groeslwyd-Bach
Eyarth Old Station
A525
A525
Plas-Newydd Farm
Lower Lodge
Legend
Flood Zone 2
Flood Zone 3
Open Roads
A Road
B Road
Water Course
Ruthin Boundary
Kilometres
0 0.15 0.3 0.6 0.9 1.2

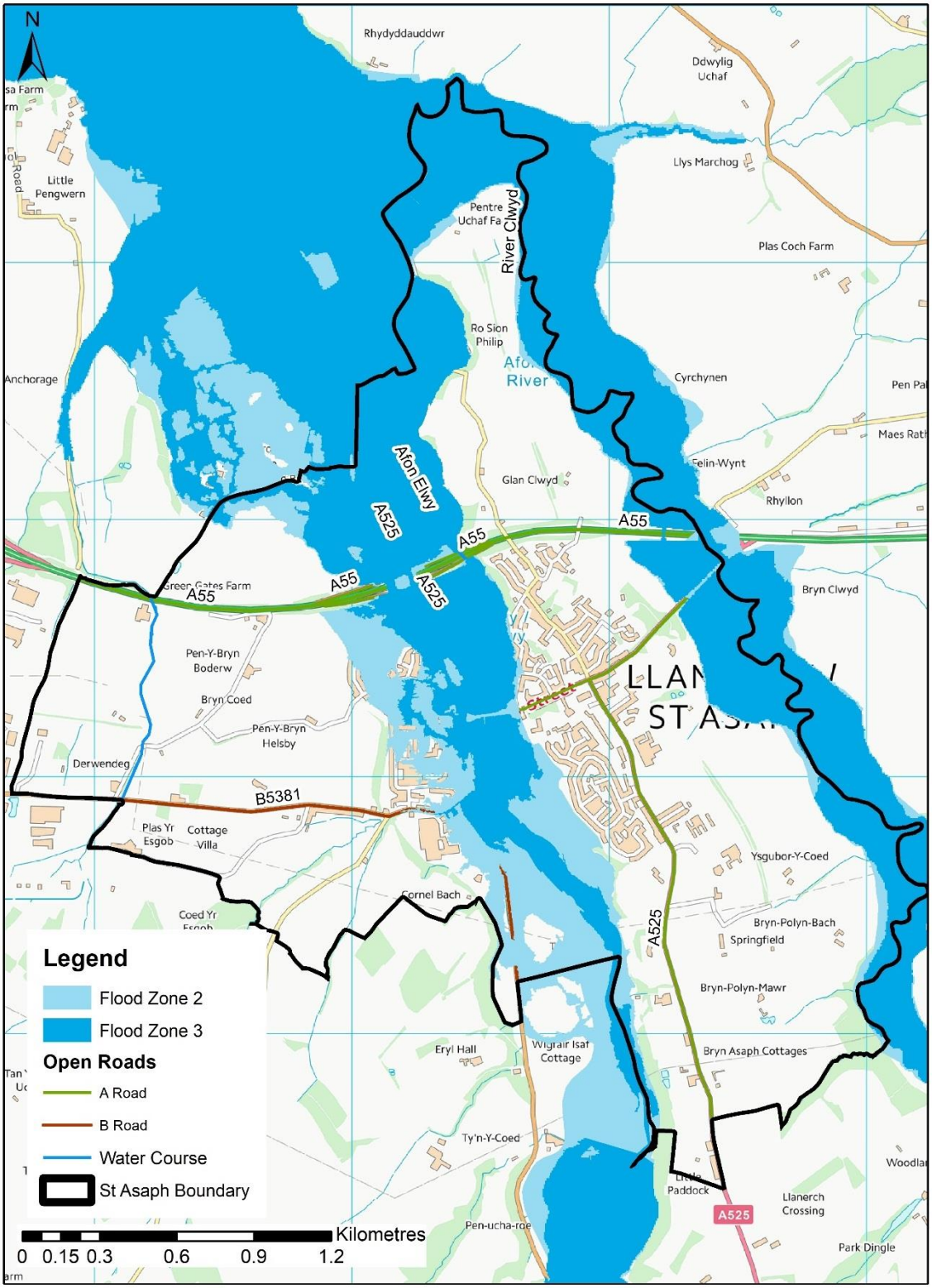
Rhuddlan


N
Legend
Flood Zone 2
Flood Zone 3
Open Roads
A Road
B Road
Water Course
Rhuddlan Boundary
Kilometres
0 0.2 0.4 0.8 1.2 1.6
A525
A547
A5151
B5429
Afon Ffyddion
Rhuddlan
River Clwyd
Rhuddlans Road
Bryn Cwnin Farm
Bodrhyddan Home Farm
Bodrhyddan Gardens
Bryn Ffynnon-Bach
Ffordd-Y-Criccin
Tyddyn Like
Rhydyddauddwr
Bryn-Carrog Farm
Ty Isa Farm
Llys Marchog

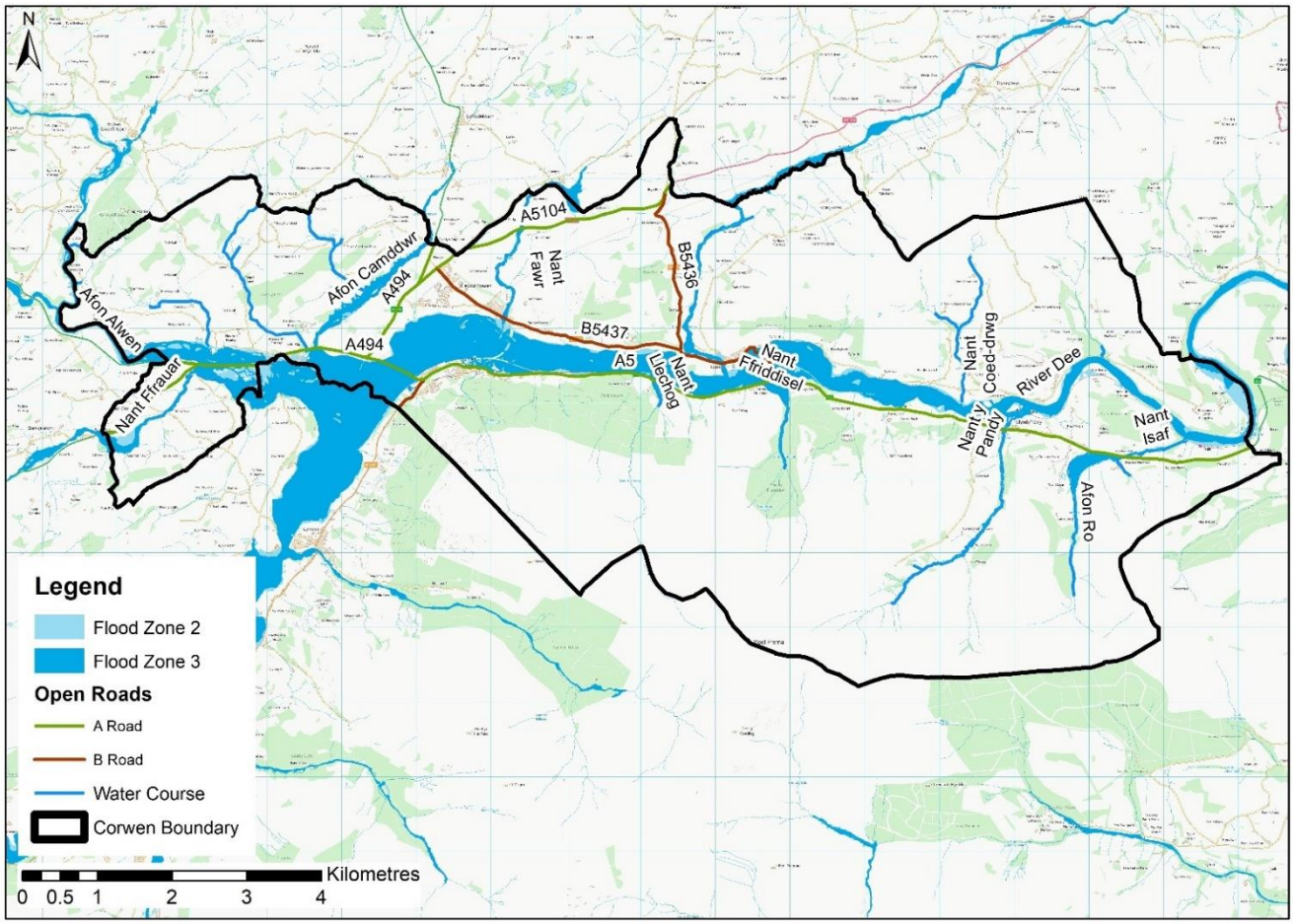
Bodelwyddan



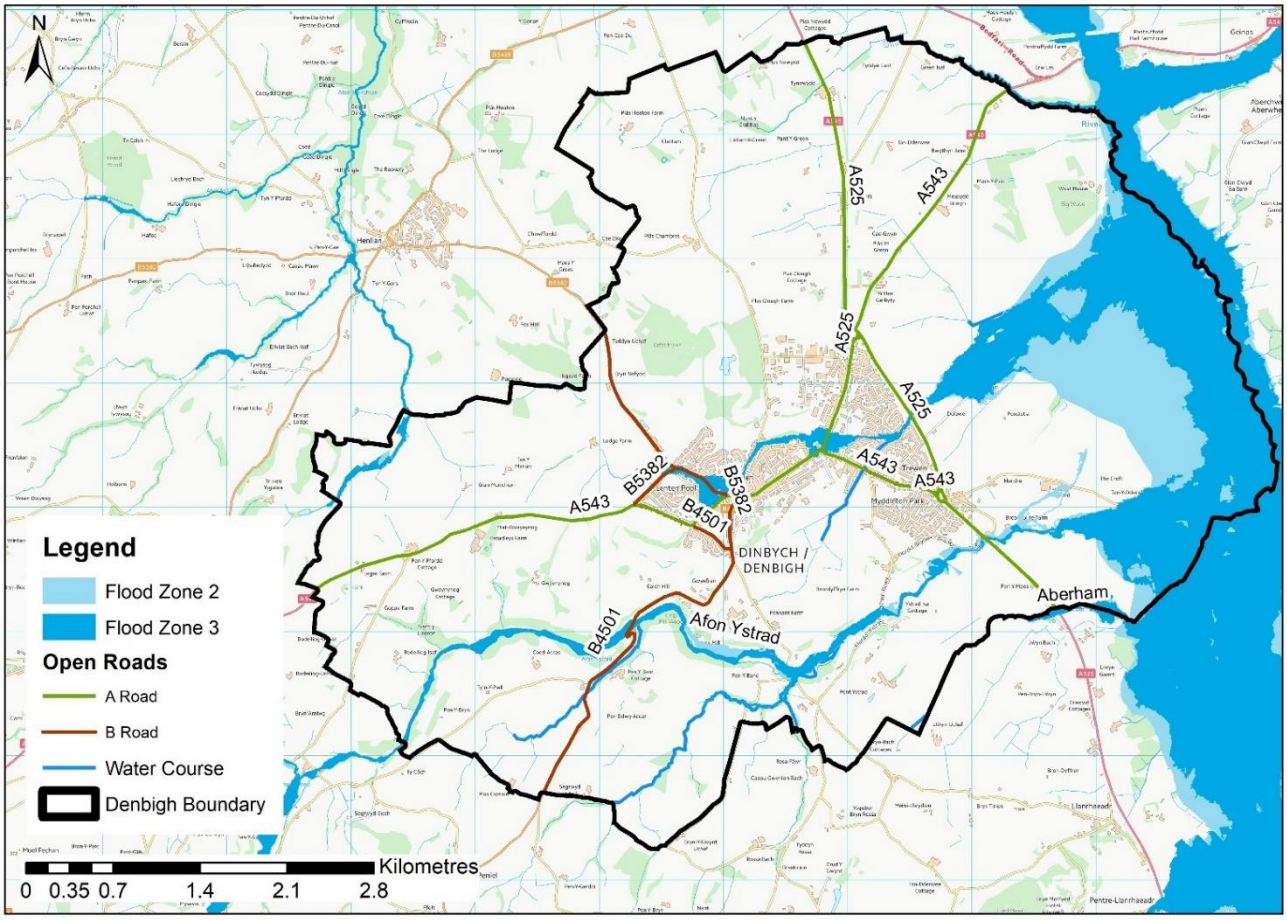
St Asaph


N
Rhydyddauddwr
Ddwylig Uchaf
Llys Marchog
Little Pengwern
Pentre Uchaf Fa
River Clwyd
Plas Coch Farm
Ro Sion Philip
Anchorage
Cyrchynen
Afon Elwy
A525
A55
Glan Clwyd
Felin-Wynt
Rhyllon
Green Gates Farm
Bryn Clwyd
Pen-Y-Bryn Boderw
Bryn Coed
Pen-Y-Bryn Helsby
Derwendeg
B5381
Plas Yr Esgob
Cottage Villa
Cornel Bach
Ysgubor-Y-Coed
Bryn-Polyn-Bach
Springfield
Bryn-Polyn-Mawr
Eryl Hall
Wigfair Isaf Cottage
Bryn Asaph Cottages
Ty'n-Y-Coed
Llanerch Crossing
Pen-ucha-roe
Park Dingle
Legend
Flood Zone 2
Flood Zone 3
Open Roads
A Road
B Road
Water Course
St Asaph Boundary
Kilometres
0 0.15 0.3 0.6 0.9 1.2

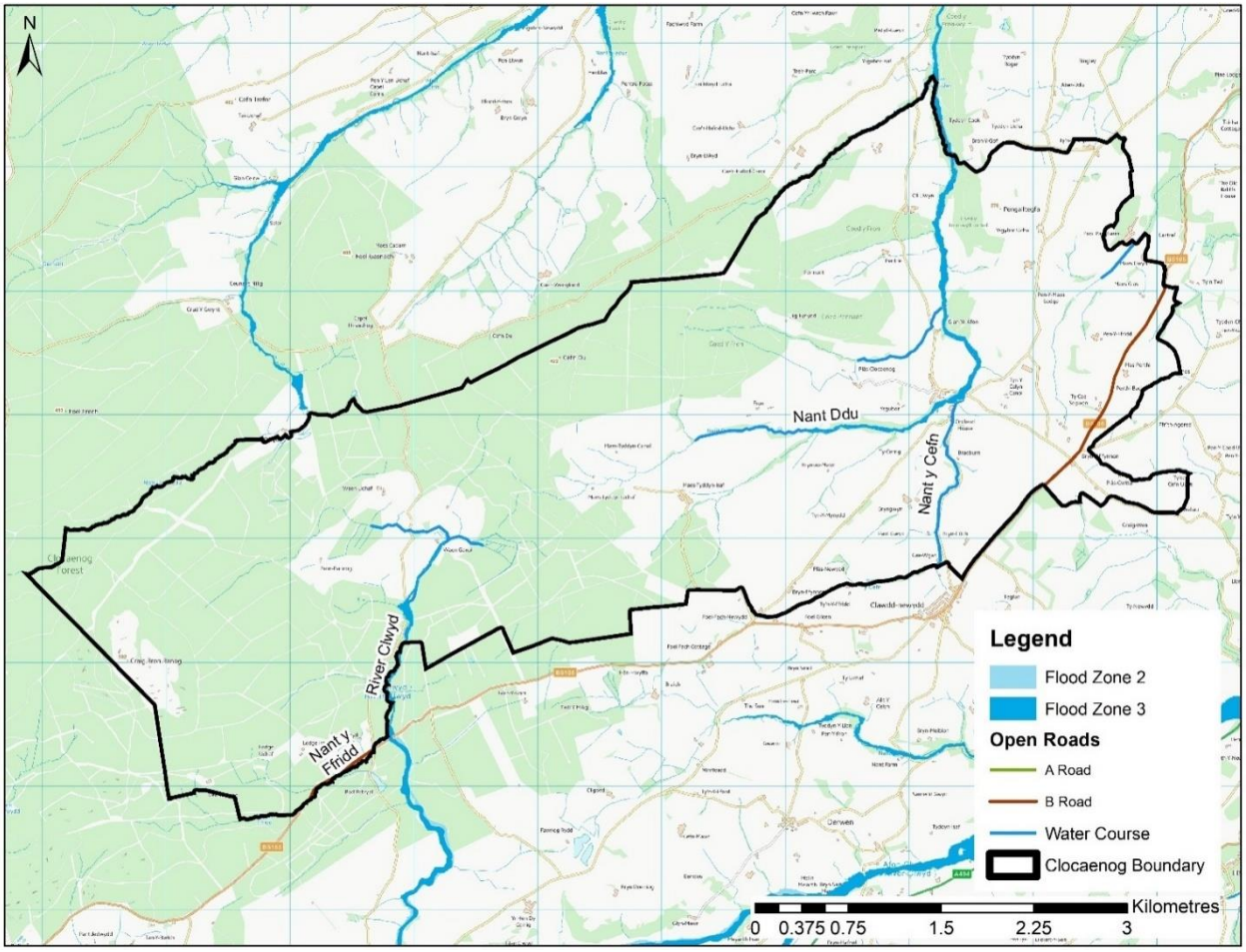
Corwen


N
A5104
Afon Camddwr
A494
Nant Fawr
B5436
Afon Alwen
A494
B5437
A5
Nant Llechog
Nant Ffriddisel
Nant Coed-drwg
River Dee
Nant y Pandy
Nant Isaf
Afon Ro
Nant Ffrauar
Legend
Flood Zone 2
Flood Zone 3
Open Roads
A Road
B Road
Water Course
Corwen Boundary
Kilometres
0 0.5 1 2 3 4

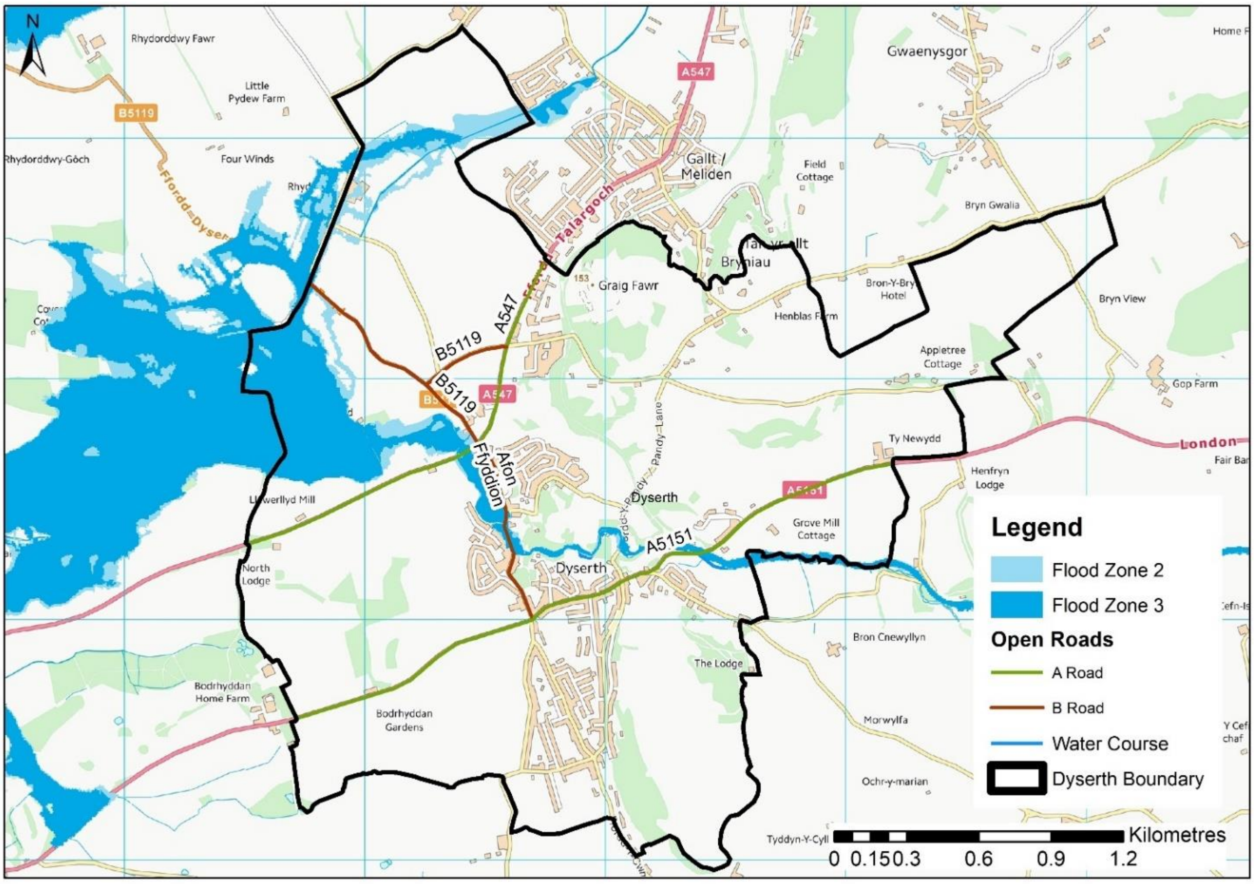
Denbigh


N
Legend
Flood Zone 2
Flood Zone 3
Open Roads
A Road
B Road
Water Course
Denbigh Boundary
Kilometres
0 0.35 0.7 1.4 2.1 2.8
A525
A543
B5382
B4501
DINBYCH / DENBIGH
Afon Ystrad
Aberham,

Clocaenog

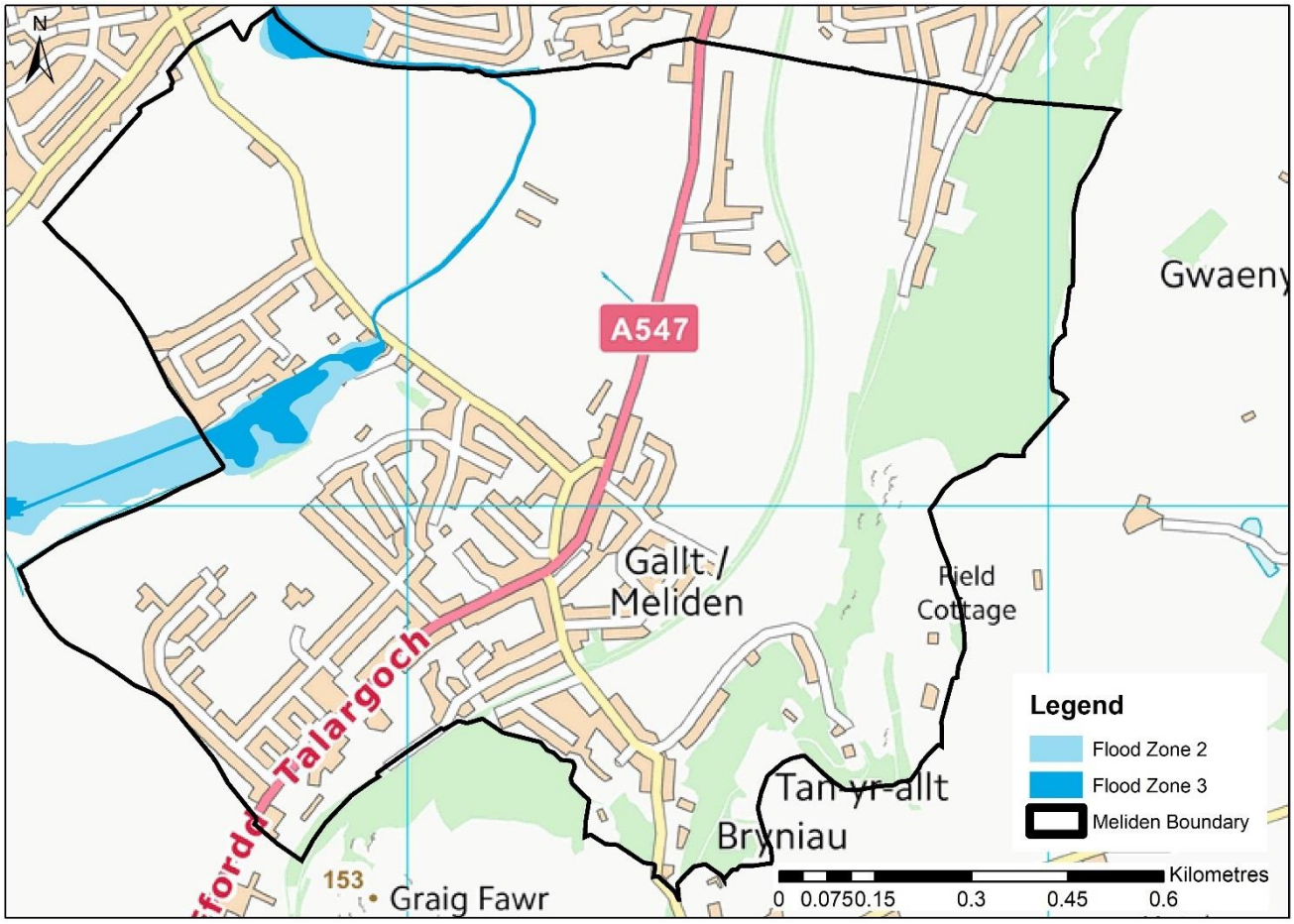

N
Nant Ddu
Nant y Cefn
River Clwyd
Nant y Ffridd
Clocaenog Forest
Legend
Flood Zone 2
Flood Zone 3
Open Roads
A Road
B Road
Water Course
Clocaenog Boundary
Kilometres
0 0.375 0.75 1.5 2.25 3

Dyserth

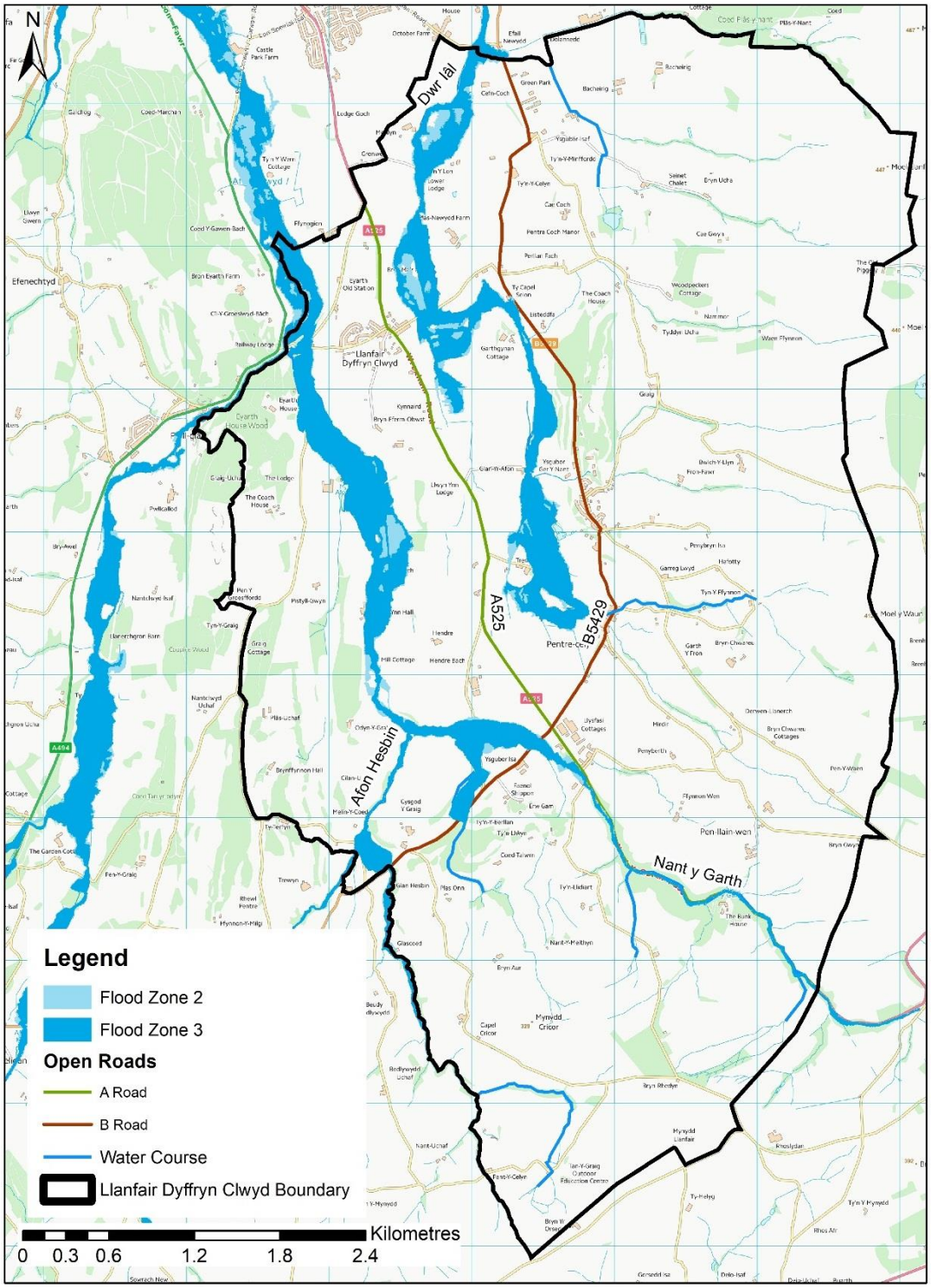


Legend
Flood Zone 2
Flood Zone 3
Open Roads
A Road
B Road
Water Course
Dyserth Boundary
Kilometres
0 0.15 0.3 0.6 0.9 1.2
Dyserth
Gwaenysgor
Gallt / Meliden
Graig Fawr
A547
B5119
A5151
Afon Ffyddion

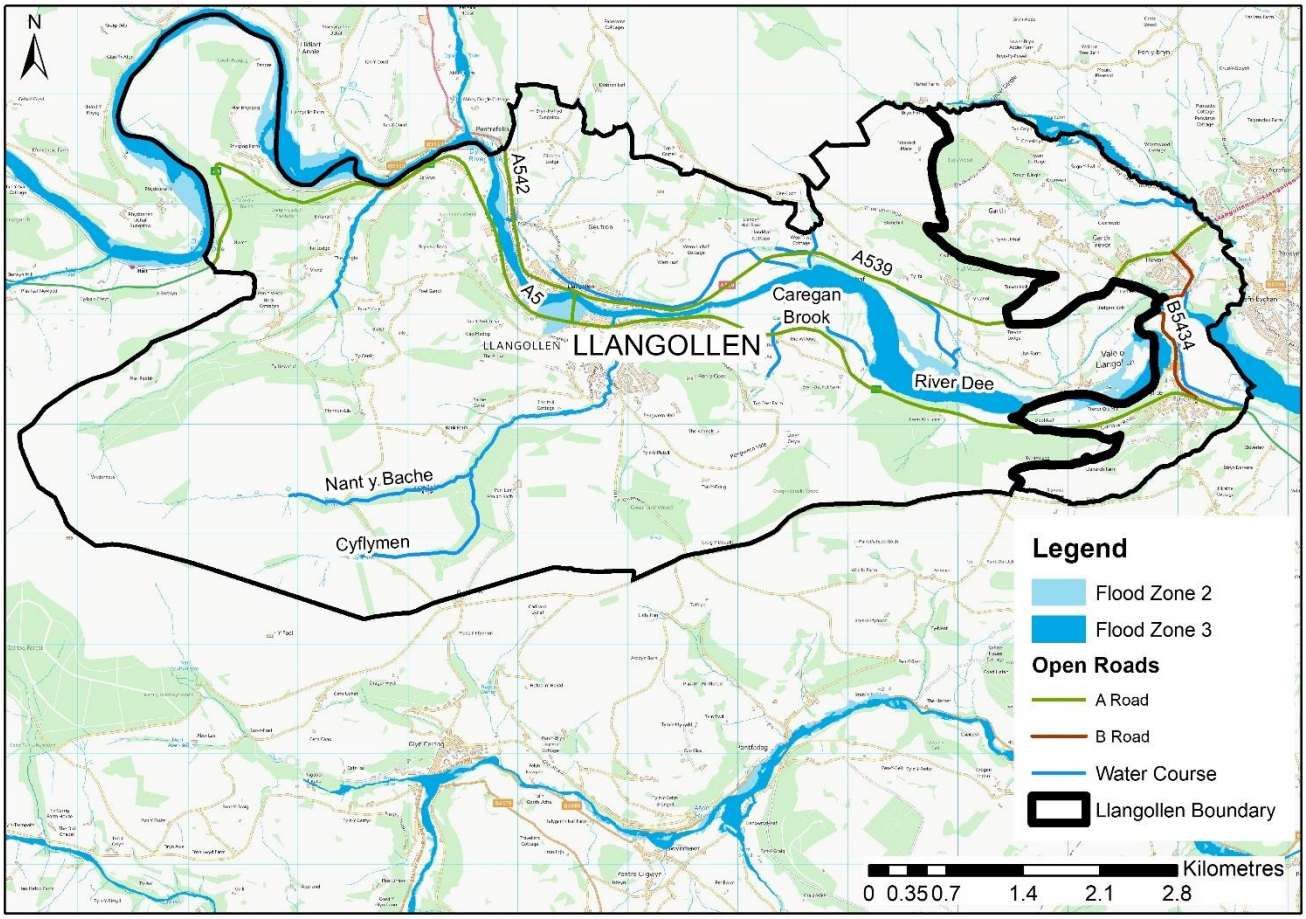
Meliden


N
A547
Gallt /
Meliden
Field
Cottage
Gwaeny
Talargoch
Tan-yr-allt
Bryniau
153
Graig Fawr
Legend
Flood Zone 2
Flood Zone 3
Meliden Boundary
Kilometres
0 0.0750.15 0.3 0.45 0.6

Llanfair Dyffryn Clwyd



Llangollen


N
A542
A5
A539
Caregan Brook
LLANGOLLEN
LLANGOLLEN
River Dee
B5434
Nant y Bache
Cyflymen
Legend
Flood Zone 2
Flood Zone 3
Open Roads
A Road
B Road
Water Course
Llangollen Boundary
Kilometres
0 0.35 0.7 1.4 2.1 2.8

References

Defra and Environment Agency (2004). Modelling and Decision Support Framework: User Guide.

Defra, Environment Agency and Welsh Assembly (2004). Modelling and Decision Support Framework: Procedures

Defra (2009) Surface Water Management Plan Guidance version 0.1

Department of the Environment Welsh Office (1992) Planning Policy Guidance 20: Coastal Planning

Defra (2008) Making Space for Water, Urban flood risk & integrated drainage (HA2), IUD pilot summary report

Defra (2004) Making Space for Water: Developing a new Government Strategy for Flood & Coastal Erosion Risk Management in England – Consultation, London: Defra

Defra (2005) Making Space for Water: Developing a new Government Strategy for Flood & Coastal Erosion Risk Management in England – Consultation, First Government response to the autumn 2004 Making space for water consultation exercise, London: Defra

Denbighshire County Council (2011) Preliminary Flood Risk Assessment

Denbighshire County Council (2013) Denbighshire Local Development Plan 2006-2021

Denbighshire County Council (2013) Denbighshire Local Flood Risk Management Strategy

Environment Agency Wales (2009) River Clwyd Catchment Flood Management Plan

HM Office Stationary (2009) Flood Risk Regulations 2009

HM Office Stationary (2010) Flood and Water Management Act 2010

Natural Resources Wales (2016) River Dee Flood Risk Management Plan

Welsh Assembly Government (2004) Technical Advice Note 15 Development and Flood Risk

Welsh Government (2011) National Strategy for Flood and Coastal Erosion Risk Management in Wales 2011

Welsh Government Programme (2014) Economic and community Ambition Strategy (2013-2023)

Welsh Government (2015) Local Development Plan Manual Edition 2

Welsh Government (2016) Planning Policy Wales Edition 9

Welsh Government (2016) Chief Planning Officer Climate Change Allowances

Offices at
Coleshill
Doncaster
Dublin
Edinburgh
Exeter
Glasgow
Haywards Heath
Isle of Man
Limerick
Newcastle upon Tyne
Newport
Peterborough
Saltaire
Skipton
Tadcaster
Thirsk
Wallingford
Warrington

Registered Office
South Barn
Broughton Hall
SKIPTON
North Yorkshire
BD23 3AE
United Kingdom

t:+44(0)1756 799919
e:info@jbaconsulting.com

Jeremy Benn Associates Ltd
Registered in England
3246693

JBA Group Ltd is certified to:
ISO 9001:2015
ISO 14001:2015
OHSAS 18001:2007

Visit our website
www.jbaconsulting.com