This strategy was published under Cumbria County Council's administration as the single Lead Local Flood Authority in Cumbria prior to 1 April 2023.
Following the disaggregation of the former County Council as part of the Local Government Reorganisation in April 2023, Westmorland and Furness Council and Cumberland Council became the new Lead Local Flood Authorities in Cumbria. The contents of this strategy contain elements relevant to both new Authorities.
Annex B is the strategic assessment and provides a high-level screening tool which assesses the relative risk of flooding across Cumbria.

Whilst some of the content of this Annex remain relevant, transitional arrangements are in place as a new Cumbria Flood and Coastal Erosion Risk Management Partnership is developed. This Annex will be updated once new partnership arrangements have been finalised.

The 2022 Strategy is due to be updated in 2027, at which time the content relevant to Cumberland Council will be removed.

Local Flood Risk Management Strategy

Risk Assessment
Annex B

Cumbria County Council

Project number: 60656809

22 December 2021

DRAFT

Delivering a better world

Quality information

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Revision History

Revision	Revision date	Details	Authorized	Name	Position
P01	13/01/22	Revised based on PD and CCC comments	HM	Hazel Macleod	Principal Consultant
P02	20/05/22	Revised AoR numbers	HM	Hazel Macleod	Principal Consultant
P03	25/07/22	Revised based on CCC comments	HM	Hazel Macleod	Principal Consultant

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Table of Contents

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List of Acronyms and Abbreviations

A full definition of these terms is provided in the Glossary, included in **Section 6**

AEP Annual Exceedance Probability

Defra Department of the Environment, Food & Rural Affairs

EA Environment Agency

ICM Integrated Catchment Model

LLFA Lead Local Flood Authority

NFM Natural Flood Management

PVA Potentially Vulnerable Area

SWMP Surface Water Management Plan

UU United Utitilies

SuDS Sustainable urban Drainage Systems

WCRT West Cumbria Rivers Trust

AoR Area of Risk

1. Introduction

1.1 Plan overview

The Cumbria Surface Water Management Plan (SWMP) has been undertaken in three stages so that the whole of Cumbria can be assessed for surface water flood risk before focusing in on the higher priority locations. The following stages have been completed:

- Stage 1 – strategic, county scale risk assessment (AECOM, October 2021)
- Stage 2a – intermediate town or Burrough scale risk assessment (AECOM, December 2021)
- Stage 2b – Area of Risk (AoR) Identification and Action Plans (Section 4 of this report)

1.2 Stage 1 – Strategic Risk Assessment

1.2.1 Strategic Approach Principles

The aim of the strategic assessment is to provide a high-level screening tool which assesses the relative risk of flooding across the county in an efficient manner. It is based on reliable and readily derivable information and informs the identification of those areas most vulnerable to the impacts of flooding. The approach makes use of the best available data and builds upon the extensive local knowledge of Cumbria County Council based on their previous work.

The approach is predictive, using modelled flood outputs rather than reacting to past events. This allows larger flood events to be considered; future proofing the SWMP. Verification is built into the approach to recognise that there are uncertainties in any modelling output which must be sense-checked against real world experience. The approach is risk-based, resulting in those areas at higher risk being prioritised for further action and dedication of resources.

1.3 Stage 1 Methodology

A source – pathway - receptor - impact approach is a well-established framework in flood risk management. At this strategic level, the source and pathway elements can be understood from the National Pluvial Mapping Datasets. Receptors were assessed at a national level by the Environment Agency (EA) in 2014. The National Receptor Database (NRD) developed by the EA (2014) is used to assess the impact of flooding. AECOM's method expands the understanding of receptors by considering vulnerability on a more local scale. This is key to classifying flood risk across Cumbria County.

Environment Agency 1% Annual Exceedance Probability (AEP) pluvial mapping was used to define surface water flood risk across Cumbria. Using GIS, the number of receptors at risk of surface water flooding in the 1% AEP event were identified and collated into 1km^2 grid cells. This allows a standard unit from which to compare flood risk across Cumbria. At this resolution, small settlements of less than 1000 people are still identifiable, allowing reasonable definition of risk in a shorter timeframe than a more refined grid. The 1km^2 resolution offers a balance between efficiency and accuracy.

The 1km^2 grid squares were categorised into rural and urban in order to consider different vulnerability of receptors in these settings. For example, flooding of a GP surgery in a large urban area would result in a lower impact, as there would be other care facilities in the area. However, a small village may be very far from an alternative GP surgery if it were to be flooded, resulting in a more significant impact.

1.3.1 Flood Risk Receptors and Indicators

The 1km^2 grid square analysis was carried out using six flood risk indicators related to receptors impacted by flooding.

Receptors are the people, industries, built and natural environments that can be impacted by flooding. Impacts are the effects on receptors. The severity of any impact will vary depending on the vulnerability of the receptor. A flood risk assessment is dependent upon the consideration of factors representing physical, social, economic, and environmental elements. The receptor groups were therefore categorised as set out in **Table 1-1**.

Table 1-1 Flood Risk Receptors and Indicators

Category	Sub-category	Indicator
Social	People	No. of residential properties within 1% AEP flood extent
Social	Community	Important facilities within 1% AEP flood extent that could cause community disruption if affected e.g. school, hospital, with various grades of impact
Economic	Business	No. of non-residential properties within 1% AEP flood extent
Economic	Transport	Flooded transport links including roads, railways, and airports with various grades of impact
Environment	Agriculture	Land use providing value within 1% AEP flood extent
Environment	Cultural and Natural Heritage	Areas designated for natural heritage purposes and/or cultural sites such as UNESCO world heritage sites within 1% AEP flood extent

This process enables each 1km^2 grid square to be categorised as Very High, High, Medium, Low or Very Low risk based on total grid score as laid out in **Table 1-2** below. This process carried out in ArcGIS gives a spatial and visual understanding of flood risk across Cumbria.

Table 1-2 Grid Square Risk Categories

Grid Risk Category	Descriptor of Grid Square Receptor Risk	Grid Square Score
Very High	Four or more categories show a high flood risk, or 1 category shows a very high flood risk	>125
High	Two or more categories show a high flood risk	50-125
Medium	One category shows a high flood risk, or three or more categories show a high flood risk	25-50
Low	Five or more categories at low risk or three or more categories at medium risk	15 - 25
Very Low	Three categories at medium risk or 1 or more at low or very low risk	0 - 15

1.3.2 Climate Change Sensitivity

Changes in our climate are likely to affect the nature and frequency of flooding. Understanding the potential changes is a significant challenge, given the uncertainty in climate predictions and the consequent response of different flooding mechanisms. It is important to understand how climate change could affect flood risk over time in order to develop a strategy that can adapt to a range of future climate change scenarios.

Recently updated EA guidance on flood and coastal risk projects, schemes, and strategies related to climate change allowances[1] has been used to assess catchment sensitivity to climate change. Peak river flow allowances show the anticipated changes to peak flow by management catchment across Cumbria County. It can be simplistically assumed that increases in rainfall resulting in peak river flow uplifts will be reflected in surface water flooding trends. A review of this data indicates potential increases in river flows of between 25 – 49%.

The PVAs have therefore been categorised as having low, medium, and high sensitivity, based on these uplifts as summarised in **Table 1-3** and shown in **Figure 1-1.** It should be noted that this does not consider coastal influence, therefore specific joint probability analyses would be required during Stage 3 to assess the impact of coastal influences on PVAs.

[1] Flood and coastal risk projects, schemes and strategies: climate change allowances, 21st July 2021, Environment Agency

Table 1-3 PVA Sensitivity to Climate Change

Sensitivity (based on % uplift of river flows)	PVA
Low (</=35% uplift)	• Cockermouth • Maryport • Nent
Medium (</=36 – 45% uplift)	• Ulverston • Barrow in Furness • Whitehaven • Bootle
High (>45% uplift)	• Windermere • Kendal • Cleator Moor • Carlisle • Burton in Kendal • Kirkby Stephen

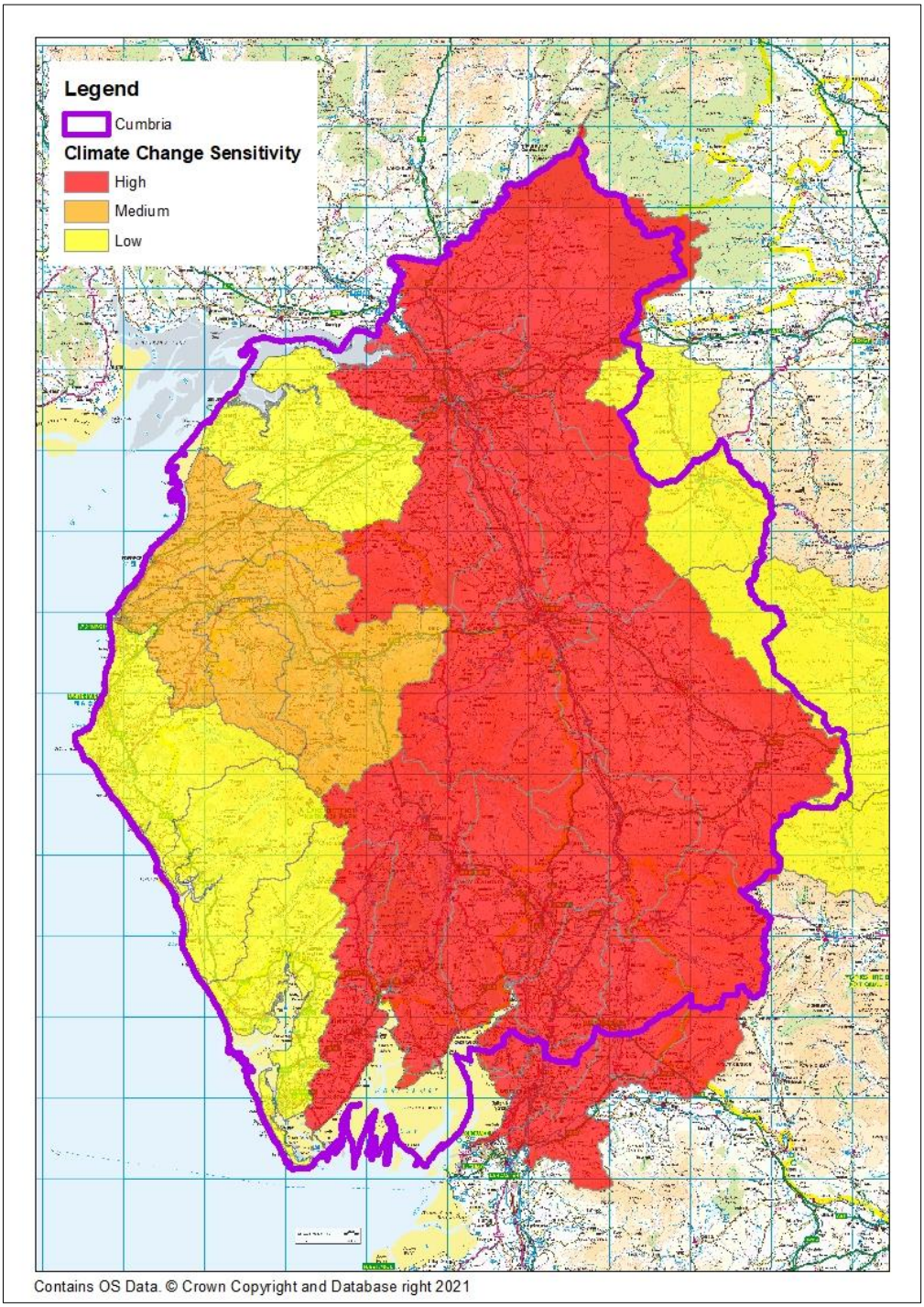


Figure 1-1-1 Climate Change Sensitivity

1.4 Catchment Approach

The grid analysis provides a strategic quantitative analysis of the impact predicted and that which historic (recorded) floods have to human health, economic activity, environment, and cultural heritage, utilising strategic flooding information.

It is important to recognise that actions which affect part of a catchment can have impacts elsewhere. Surface water management planning is therefore most effective when it is considered on a catchment scale that is uninhibited by human imposed boundaries such as towns which have no connection to floodwaters.

The outputs from the grid analysis are therefore translated into subcatchment units to allow "Potentially Vulnerable Areas" (PVAs) to be identified, as illustrated in **Figure 1-2**. PVAs are catchments identified as being at risk of flooding and where the impact of flooding is sufficient to justify further assessment and appraisal. The identification of PVAs allows flood risk to be managed in a more holistic and joined up manner. with connected impacts and benefits assessed at a catchment scale. This catchment approach has been adopted by Scottish Environment Protection Agency (SEPA) for their National Flood Risk Assessments, and has been successful in creating an integrated and risk-based approach for flood risk at a regional scale. This has filtered down to local plans and led to detailed actions, which is the ultimate goal for this project.

Surface water tends to arise in flashy and steep, as well as urban catchments and can have a more localised impact than other types of flooding (e.g. fluvial or coastal). It is therefore appropriate to divide larger river basins (e.g. main rivers) into smaller subcatchments to allow for more detailed analysis. The Water Framework Directive Cycle 2 River Water Body Catchments dataset therefore offers a suitable geographic and hydrological scale to consider catchment wide impacts for surface water rather than those driven by fluvial flooding.

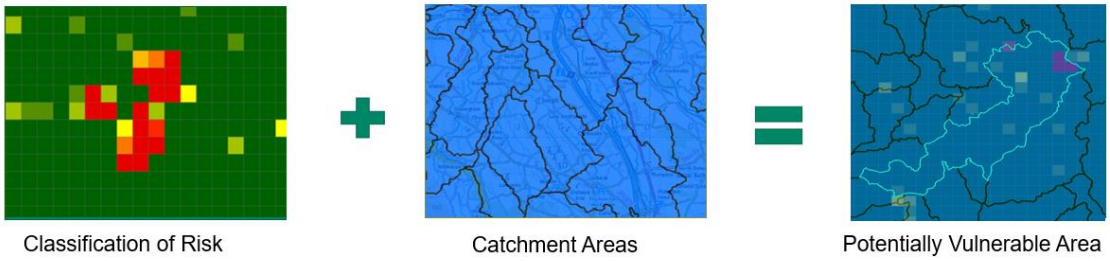


Figure 1-2 Schematic of PVA identification

The PVA identification approach utilised for Cumbria is as follows:

2. Stage 1 Strategic Risk Assessment Results

The following section outlines the findings of the strategic assessment and the resultant PVAs. Catchments are sorted into risk levels ranging from 'Very Low' to 'Very High'. This is based on the total of 1km^2 risk squares score within the catchment boundary set out in **Table 2-1** below.

Table 2-1 PVA Scoring

Category	Catchment Score
Very High	>1000
High	700 - 1000
Medium	300 - 700
Low	110 - 300
Very Low	<110

A qualitative verification review of the output catchment units was carried out on 8th September 2021 with Cumbria County Council (CCC). All catchments were reviewed and the proposed PVA's to be taken forward to Stage 2 were discussed. CCC utilised the opportunity to review the proposed catchments against areas where work has or is currently being carried out or where flooding is a known issue. This use of local knowledge provided additional confidence in the outputs.

Specific at-risk areas have been identified by CCC based on local knowledge. Where the at-risk areas have identified works that form part of CCC's Comprehensive Spending Review (CSR) and are outwith the PVA, these additional catchments have been included in the final PVA list. These were added to the final PVA list for completeness to ensure all vulnerable areas were considered within this assessment.

The resultant risk grid squares, all of the catchments and their scoring are shown in **Figure 2-1**. A total of 19 PVAs have been identified in Cumbria, as shown in **Figure 2-2**. 12 of these were deemed to be at highest risk and were taken forward to Stage 2 where flood risk was assessed at a more local level.

If an area has not been identified as a PVA this does not mean it is not at risk of flooding. the results mean that the catchment it is in has not reached the threshold to categorise it as a PVA, as outlined in the methodology in **Section 1.4**.

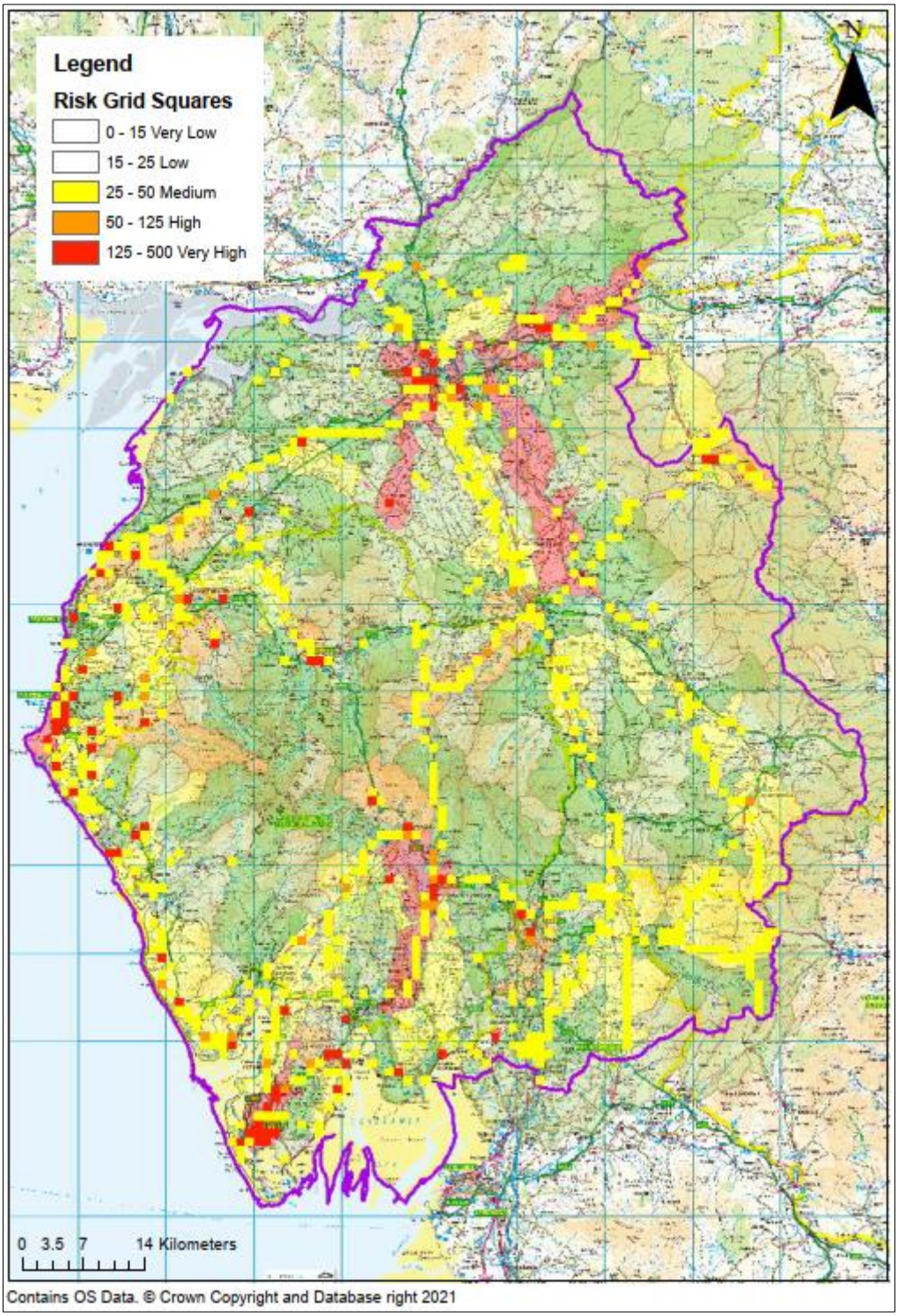


Figure 2-1 Risks Grid Squares

*Note that 'Very Low' and 'Low' risk squares are not shown on the above figure.

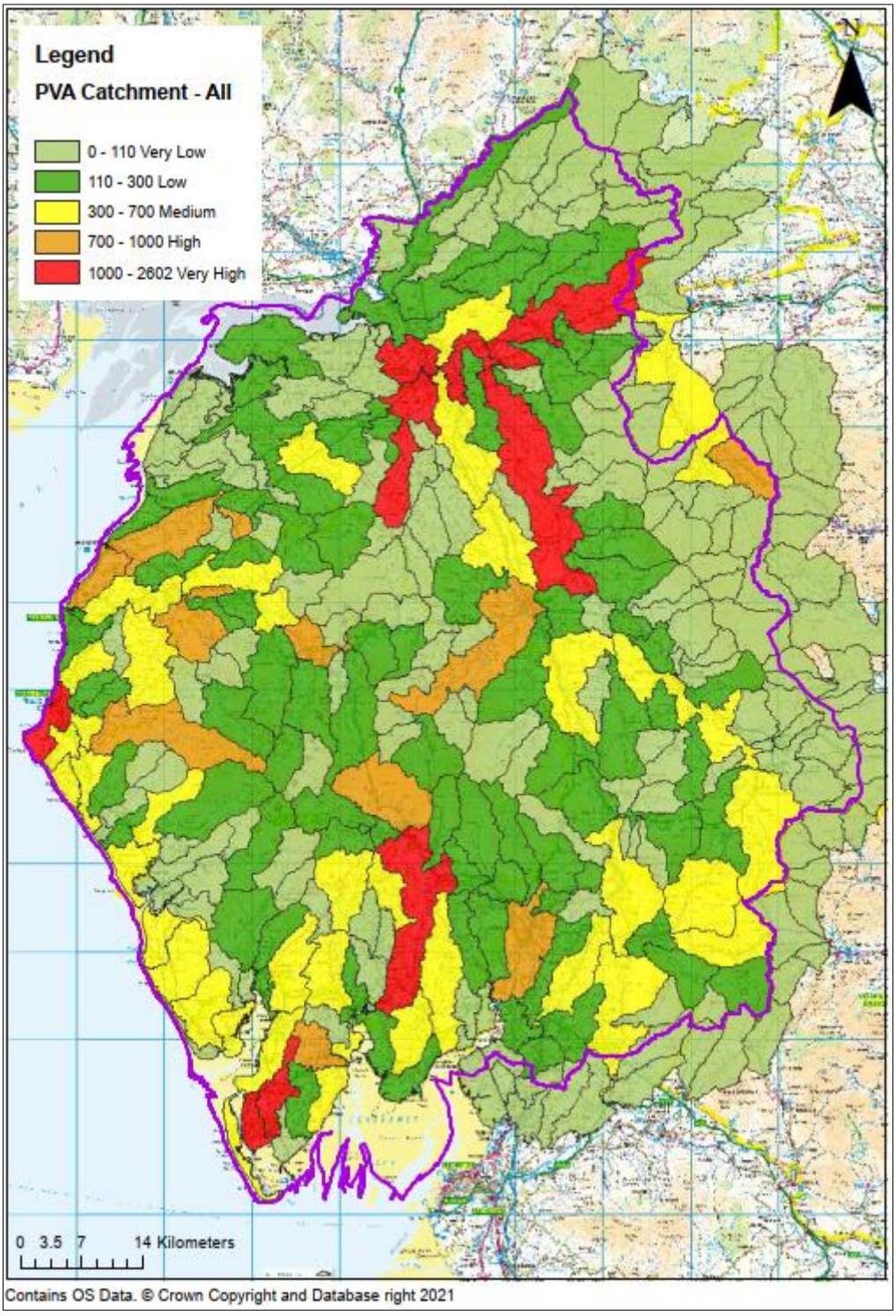


Figure 2-2 All PVAs

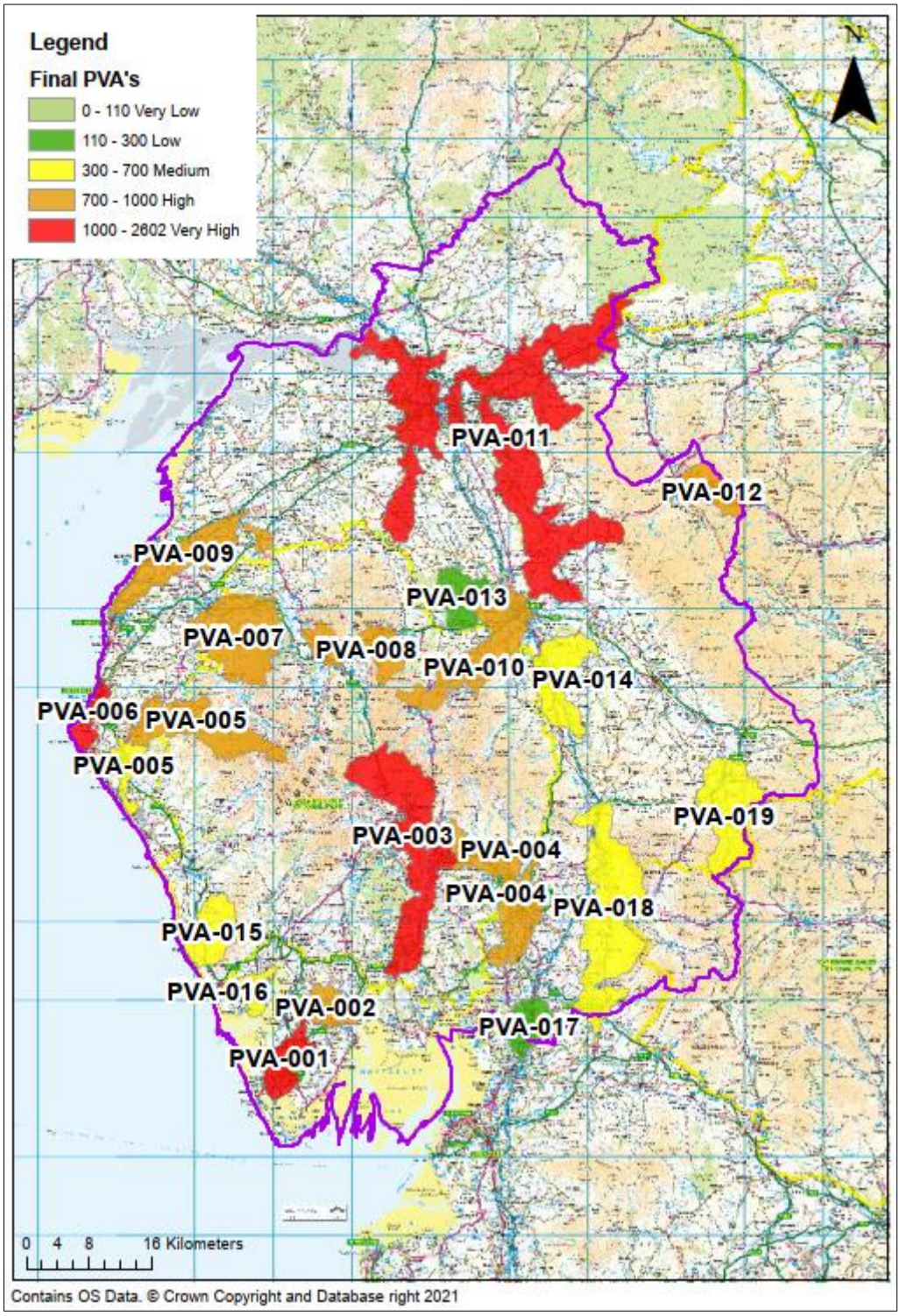


Figure 2-3 PVA's taken forward to Stage 2

A qualitative verification review of the output catchment units with CCC was carried out on 8th September 2021. All catchments were reviewed and the proposed PVA's to be taken forwards to Stage 2 discussed. CCC utilised the opportunity to review the proposed catchments against areas where work has or is currently being carried out or where flooding is a known issue. This use of local knowledge provided additional confidence in the outputs. Specific at-risk areas have been identified by CCC based on local knowledge. Where the at-risk areas have identified works that form part of CCC's Comprehensive Spending Review (CSR) and are out with of the identified PVA, these additional catchments have been included in the final PVA list. These were added to the final PVA list for completeness to ensure all vulnerable areas were taken into account within this assessment.

A total of 19 PVAs have been identified in Cumbria and set out in Table 2-2.

Table 2-2 – Summary of Final PVA's and Risk Scores

PVA Name	PVA Number	PVA Risk Score
Barrow-in-Furness	001	1562
Ulverston	002	707
Windermere	003	2226
Kendal	004	115/1020
Cleator Moor	005	541/839
Whitehaven	006	1582
Cockermouth	007	958
Keswick	008	731
Maryport	009	1061
Penrith	010	929
Carlisle	011	2602
Neat	012	725
Greystoke	013	182
Shap	014	368
Bootle	015	468
Millom	016	469
Burton in Kendal	017	213
Sedburgh/Kirkby Lonsdale/Tebay	018	623
Kirkby Stephen	019	496

If an area has not been identified as a PVA this does not mean it is not at risk of flooding. The catchment it is in has not reached the threshold to categorise it as a PVA.

During the Stage 1[2] assessment a number of the PVA's listed above were removed mainly due to a number of CSR actions already being underway within the catchment. A list of the PVA taken forwards to Stage 2a can be seen in Table 4-1.

[2] Cumbria Surface Water Management Plan, Stage 1 – Strategic Assessment, AECOM, November 2021

3. Stage 2 Intermediate Risk Assessment

The highest risk PVAs with lower levels of historic and scheduled CSR investment, are taken forward to Stage 2 of this SWMP. Stage 2 represents an "Intermediate Assessment" as outlined in Defra SWMP Guidance. The intermediate assessment is considered to be applicable at the town, city, and catchment scale.

Stage 2 was carried out on a more detailed spatial scale and ought to provide an improved understanding of surface water flooding, to identify localised flood Area's of Risk (AoR's) , support decisions on whether these may require further assessment, and to identify mitigation measures to reduce surface water flooding. In order to make the process as efficient as possible Stage 2 was split into two phases as detailed in **Section 3.1** and **3.2**.

3.1 Stage 2a – AoR Identification

More detailed information relating to the highest ranked PVAs is collated. The data is analysed to improve the understanding of surface water flooding and to identify flood AoR's within the PVA's. The following steps were carried out:

- **Prepare** – building upon work in Stage 1 and previous assessments, the following data is reviewed in more detail:
    - Existing asset data or models (drainage, 'ordinary' watercourses, highway drainage, rivers, coast, groundwater levels);
    - Historic flood reports;
    - Locations of proposed new developments;
    - Additional evidence collated from Lead Local Flood Authority (LLFA) site visits, surveys or modelling; or,
    - Major works proposals.
- **Catchment assessment** – following data review, AoR's were identified based on flood extents, receptors and flood history. The source of flooding is noted where possible to inform action planning.
- **Understand flood risks** – using existing datasets flood sources were confirmed where possible and AoR's ranked based on PVA priority
- **AoR's appraisal –** AoR's were placed into one of three groups:
    - AoR's requiring no further assessment – sites with little historical flooding, where works are already proposed, or where an individual receptor may be skewing the results.
    - AoR's recommended for further discussion with key stakeholders (e.g. United Utilities (UU), Environment Agency (EA)) to either carry forward to detailed assessment or not.
    - AoR's required for detailed assessment; where there is a clear risk of surface water flooding which would benefit from detailed modelling to develop a business case for mitigation options. Taken forward to Stage 2b.
- **Communicate -** Prioritised list of AoR's communicated in Stage 2a report.

AoR's not moving forward for detailed assessment will remain on the long list and can be re-assessed in the future. It is proposed a "quick win" assessment is carried out for these AoR's where suitable to determine any immediate actions such as improved maintenance, and resilience and resistance measures which could be implemented in these areas. This would be carried out in Stage 3: Identify Options.

3.2 Stage 2b – Action Plans

AoR's taken forward for detailed assessment are more complex or extensive and require computer-based modelling to quantify the current and future flood risk, and ultimately to test mitigation measures.

Based on desktop analysis, action plans for each AoR were developed to manage flood risk. Generally these fall into seven categories:

- **SWMP -** 2D modelling software will be utilised to construct a fully 2D pluvial model that covers the study area and contributing catchment. Modelled rainfall hyetographs will be applied directly to a 2D grid and the event run to establish overland flow paths and flood extents.
- **SWS –** identification of surface water management measures typically focused on retrofit of SuDS.
- **ICM -** where the urban area is expansive and the interaction between the surface water and sewer flooding is evident in Stage 2a, then a 1D-2D modelling exercise will be carried out. Where possible existing sewer network models from UU will be utilised. It is assumed at this stage no updates to these models will be required beyond adding a base 2D grid from LiDAR data. Where fluvial/coastal flooding is also a known source and contributes to surface water flooding within the AoR, these were also be considered within the ICM. This allows a realistic understanding of flood risk and mitigation options to be suitably designed.
- **NFM –** study to identify natural measures e.g. ditch blocking, wetland restoration, tree planting etc. to reduce and attenuate flows in upper catchments, to reduce runoff impacting surface water flooding. Initially this would be undertaken as a desk study, with a targeted site walkover.
- **Fluvial study –** hydrologic and hydraulic analysis of a watercourse, likely using linked 1D-2D model to analyse channel conveyance and interactions with drainage and overland flows.
- **Maintenance –** formalising or updating plans relating to watercourse/drainage inspection, clearance, and repair under the duties of LLFAs.
- **Consultation –** meeting with key stakeholders, including the EA and UU, to share the findings of the SWMP to date and what studies/works have been carried out by the stakeholders themselves within the PVA's/AoR's . This includes nformation sharing between responsible authorities to ensure resources are being used efficiently towards shared goal of reducing flood risk.

A workshop with CCC on 24th November 2021 was used to finalise the AoR appraisal and action plans.

4. Stage 2 Results

Within the 13 highest risk PVAs, 138 AoR's at highest risk of surface water flooding were identified. At AoR level, recommendations for solutions or more detailed work were made depending on the level of information available. Ultimately the aim of identifying AoR's is to bring these areas to the attention of all parties who may be able to influence and reduce flood risk. In addition, a key objective is to prioritise flood risk areas and target funding first to those areas at highest risk.

Table 4-1 below summarises the actions to manage flood risk in the PVAs. **Sections 4.1 – 4.14** provides further detail for each of these listed. A hyperlink is provided for digital readers, please click on the PVA reference e.g. PVA-001.

Where AoR's are not taken forward, this is because the planned works have been identified or the current risk levels is not sufficient to merit works in comparison to other AoR's . Actions highlighted in this Annex do not include planned activities identified as part of CSR by CCC up to 2027. These are summarised in **Table D.2, Annex D**.

Table 4-1 Ranking of PVAs

PVA[3]	Risk	Location	SWMP	SWS	ICM	NFM	Fluvial Study	Maintenance	Consultation
PVA-001	Very High	Barrow-in-Furness	0	1	2	0	1	0	11
PVA-002	Medium	Ulverston	1	0	0	0	0	0	2
PVA-003	High	Windermere	1	0	1	1	0	0	0
PVA-004	High	Kendal	0	0	4	0	0	0	2
PVA-005	High	Cleator Moor	1	0	0	1	0	1	0
PVA-006	Very High	Whitehaven	0	0	3	0	0	0	1
PVA-007	High	Cockermouth	1	0	0	0	0	0	1
PVA-009	High	Maryport	2	0	3	0	0	0	0
PVA-011	Very High	Carlisle	0	0	1	0	1	0	2
PVA-012	High	Nent	1	0	0	0	1	0	0
PVA-015	Medium	Bootle	1	1	0	0	0	0	1
PVA-017	Low	Burton in Kendal	1	0	0	0	0	0	0
PVA-019	Medium	Kirkby Stephen	1	0	0	0	0	0	1

[3] Note PVA-016 Millom has dropped off due to large scale scheme currently being developed

4.1 PVA-001 Barrow-in-Furness

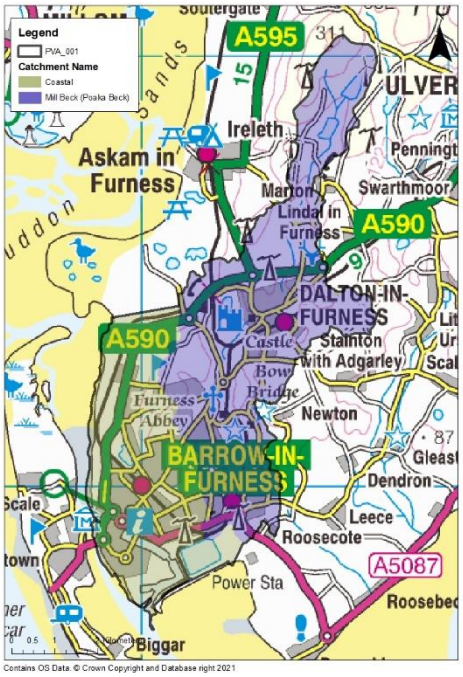
Barrow in Furness (Potentially Vulnerable Area 001)

Total risk classification: Very high

River basin district name:	Management catchment:	Operational catchment:	Waterbody name:
North West	South West Lakes	Duddon	Mill Beck (Poaka Beck) and Barrow-in-Furness Coastal

Background

This Potentially Vulnerable Area is centred around Barrow-in-Furness and is formed of two catchment areas; Mill Beck and a western coastal catchment which is located in the south of Cumbria. It has an area of approximately 38km².



The catchment is drained by a number of modified watercourses. The Poaka Beck originates from the north east flowing south west and joining the Gold Mire Beck upstream of Park Road to form the Mill Beck. Both sub-catchments are largely rural, dominated by fields with railway and road crossings. The Gold Mire Beck may also be influenced by a series of ponds/reservoirs in the upper catchment.

The Mill Beck continues south towards the coast and is joined by another tributary from the west; the Dane Gill Beck. The catchment of this watercourse is rural on the east, but is more influenced by urban land use to the west. The Mill Beck becomes more modified and constrained at the south of the catchment north of Roose railway station.

All watercourses are largely open but have been influenced by structures including road culverts and bridges. Parts of the watercourses have potentially been canalised for agricultural purposes which will result in less attenuation of flows particularly downstream of Abbey Road.

Based on knowledge of historic flood records the area is served by a combined sewer system. This will have capacity limitations, likely to result in flooding.

Summary of flooding impacts

The risk of flooding to people and property are summarised in **Table 4-2**. Based on the 100 year pluvial flood extents 56 residential properties, seven community assets and 15 non-residential properties are at risk of flooding. Major infrastructure such as the A590 and railway links are also affected by the 100 year pluvial flood extents along with several natural and heritage assets. The PVA has been classified as at very high risk from surface water flooding.

The location of the historic flood events and results of the Stage 1 strategic assessment for flood risk are shown in **Figure 4-1**.

Table 4-2 Risk of flooding within PVA 001 (1% AEP Scenario)

Category	Mill Beck catchment	Coastal catchment
Social - People	37 residential properties	19 residential properties
Social - Community	2 community assets	5 community assets
Economic - Businesses	13 non-residential properties	2 non-residential properties
Economic - Transport	A590, A5087, Railway at multiple locations,	A5087, A590, Railway at multiple locations,
Environment - Agriculture	Nothing of significance, town parks present	Poaka Beck Farm, town parks present
Environment – Cultural and Natural Heritage	1 listed building, South Walney and Piel Channel Flats, Morecambe Bay and Duddon Estuary, North Walney and Sandscale Haws nature reserves, Barrow Park.	None
Verification – Number of recorded flood events	9	9

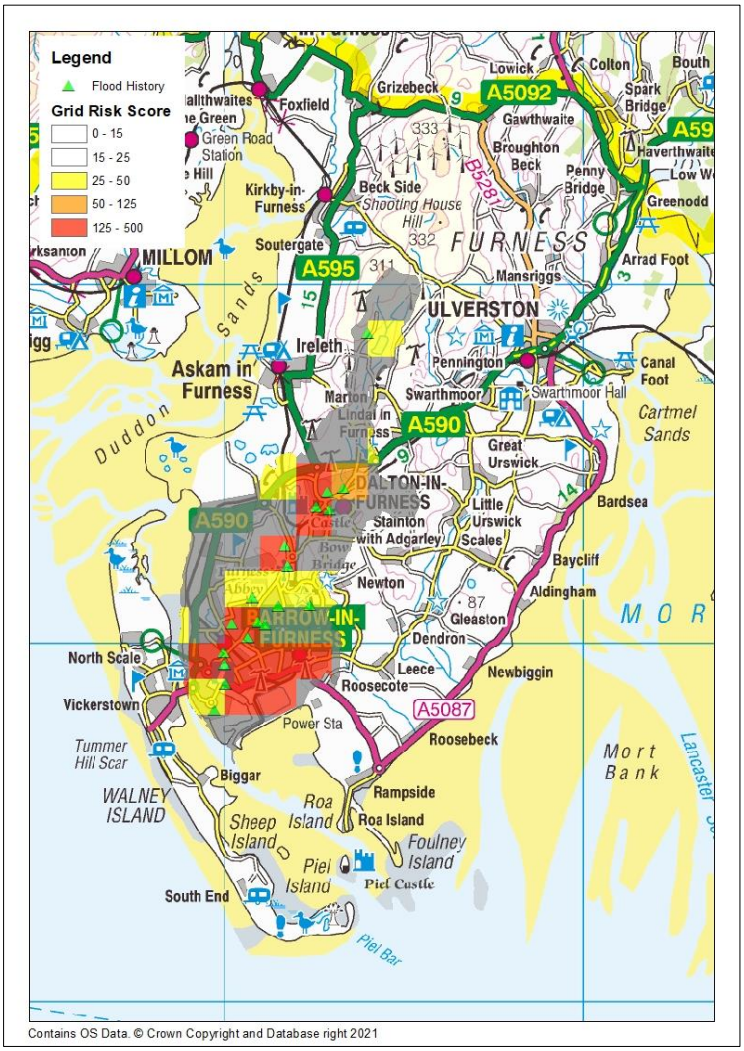


Figure 4-1 Risk and flood history for PVA-001

Sensitivity to Climate Change

Based on peak flow climate change uplifts, the catchment is deemed to be **moderately sensitive** to climate change, which maybe increased due to the coastal nature of the PVA. This indicates the potential for a greater frequency and magnitude of flooding in the future, at a scale which could significantly reduce the effectiveness of any mitigation measures designed to present day data. This may require a central allowance to be used as a design scenario for any future flood scheme development.

It should also be noted, given the prevalence of urban areas in this catchment, that flooding from overwhelmed drainage networks is likely to increase in frequency and magnitude.

Given the coastal setting of this catchment, sea level rise may increase surface water flooding due to increased occurrence of tide locking at outfalls.

History of flooding

The earliest modern flood record was in 2007. The Dalton South and North areas in the north of this PVA have been regularly affected by surface water flooding. More than 20 properties, gardens and some highways have been affected including Holygate Road and Goose Green. Flooding appears to be due to overwhelmed gullies. The drainage network is also likely to be influenced by the Poaka Beck and an integrated assessment would be required here. Partnership working with the EA will be required to resolve issues from the watercourses.

Less regularly impacted areas include Newton Village and Hawkswood Terrace. These areas have been subjected to past property flooding (<10 properties) in 2016. This has been linked to capacity in the combined sewer network to manage surface water drainage. Partnership working with UU and CH is required.

Regular issues with gullies and combined sewer network are also reported in the Parkside and Hawcoat areas to the south west of the catchment boundary.

Area of Risk Identification

AoR's identified in the Barrow-in-Furness PVA are shown in the Figure 4-2 to Figure 4-4 below. Analysis of flood history, predicted flood extents, receptors affected, topography, review of CCC flood reports, likely flood mechanisms and consultation with CCC staff has been used to identify priority AoR's to be taken forward for this PVA (**Table 4-3**). The relevant actions to reduce surface water flood risk are outlined in **Table 4-4.**

Table 4-3 Stage 2a Barrow-in-Furness AoR Identification Summary

No of AoR s	AoR s not taken forward	AoR s taken forward for consultation	AoR s taken forward for detailed assessment
21	AoR621	AoR603 AoR604 AoR607, AoR608 AoR605 AoR611 AoR610 AoR612 AoR622 AoR617 AoR616	AoR606 AoR609 AoR623 AoR619 AoR620 AoR615 AoR613, AoR614 AoR618

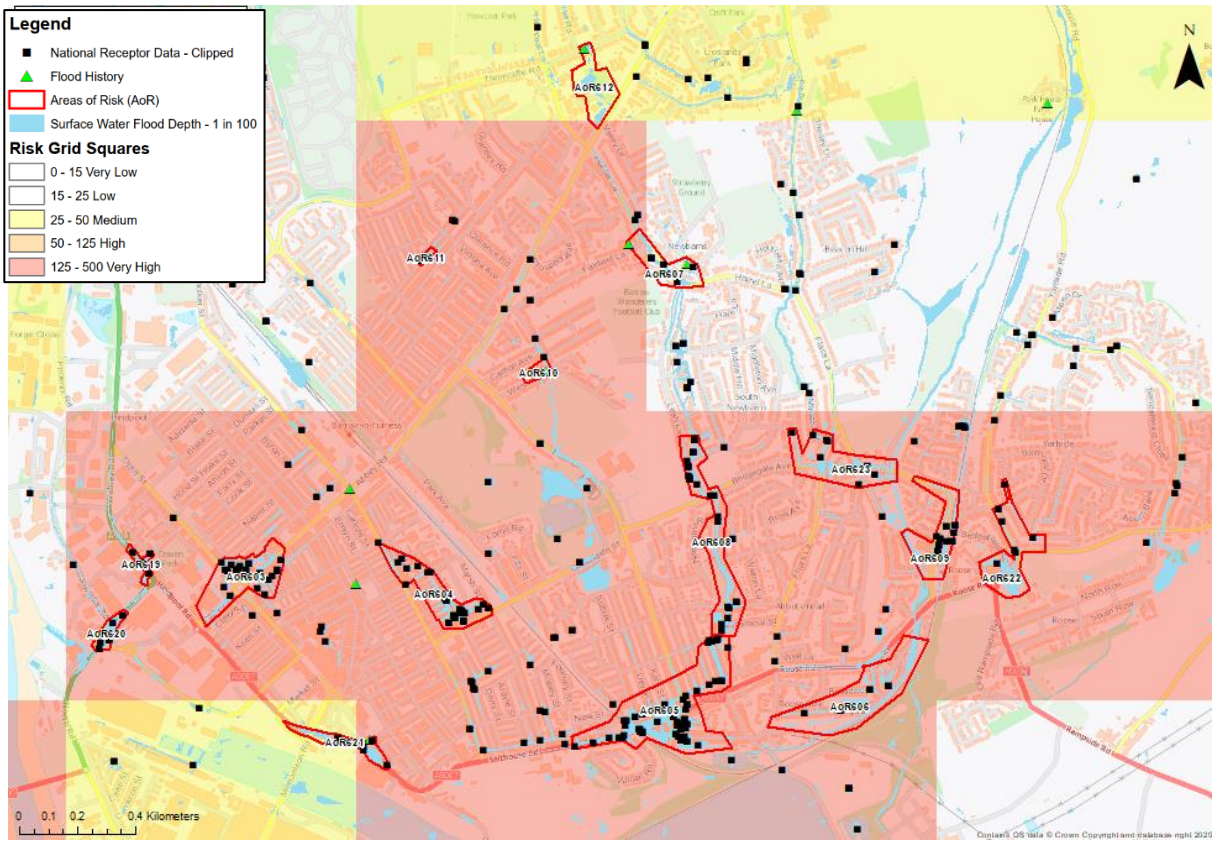


Figure 4-2 AoR's for Barrow-in-Furness (1 of 3)

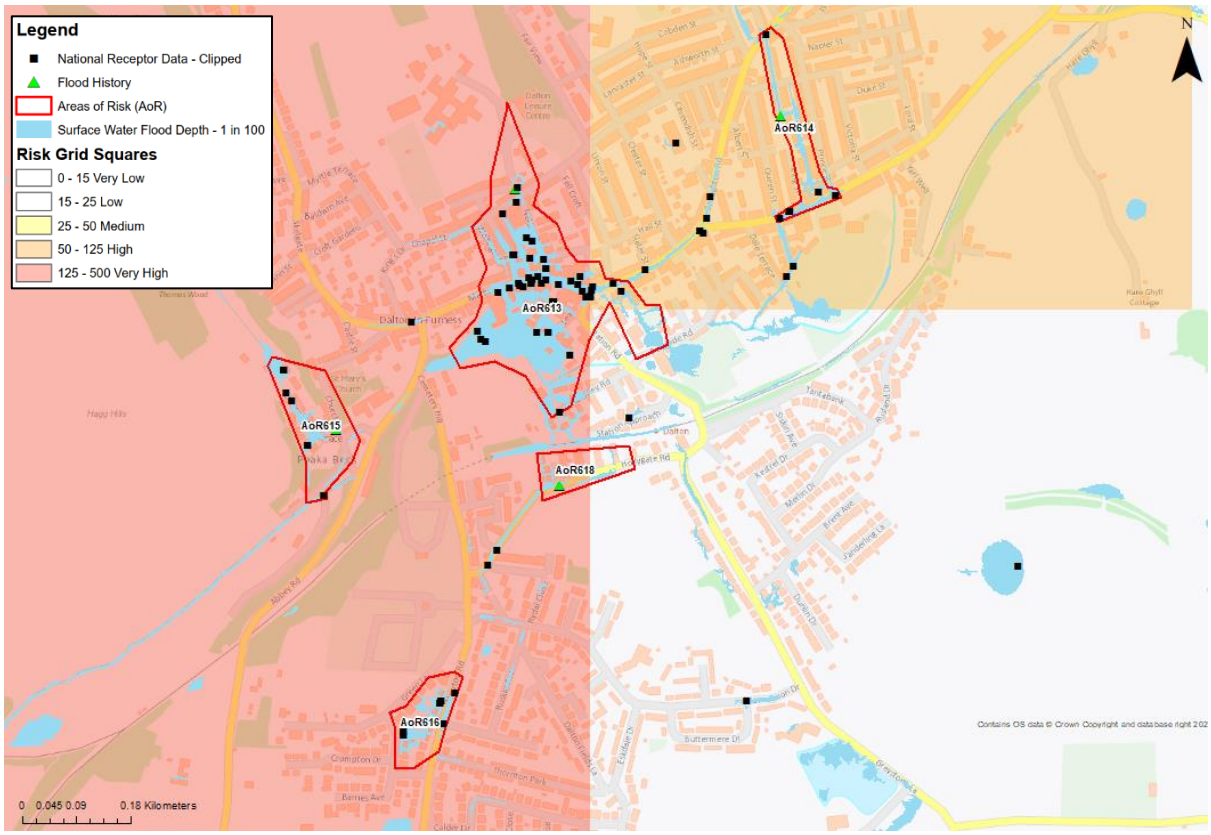


Figure 4-3 AoR's for Barrow-in-Furness (2 of 3)

Figure 4-4 AoR's for Barrow-in-Furness (3 of 3)

Action Plan

Table 4-4 Barrow-in-Furness Stage 2b Action Plan

Type of Action	Location	AoR s	Delivery lead	Action
SWMP - ICM	Barrow-in-Furness	AoR607 AoR608 AoR605 AoR606 AoR609 AoR623, AoR619 AoR620	CCC/UU	SWMP for Barrow-in-Furness - Build integrated model of watercourse and drainage discharges. Detail focused on multiple AoR's utilising UU model as starting point.
SWMP - ICM	Dalton in Furness	AoR613 AoR614 AoR618 AoR615	CCC	SWMP for Dalton in Furness - Build integrated model of watercourse and drainage discharges. Detail focused on multiple AoR's utilising UU model as starting point.
Fluvial Study	Church Street, Dalton in Furness	AoR615	CCC	Flood Study of Hagg Hill watercourse
SWS (SuDS retrofit)	Walney Island	AoR617	UU	Surface Water Strategy for Walney Island. Consultation with UU required.

4.2 PVA-002 Ulverston

Ulverston (Potentially Vulnerable Area 002)

Total risk classification: Medium

River basin district name:	Management catchment:	Operational catchment:	Waterbody name:
North West	Kent and Leven	Leven	Dragley Beck

Background

This Potentially Vulnerable Area is centred around Ulverston and is formed of Dragley Beck catchment which is located in the south of Cumbria. It has an area of approximately 21km².

Dragley Beck meets Lund Beck at Morecambe Road in the south of the catchment. Lund Beck is fed by Gill Banks Beck to the North West which is open north of the town before becoming culverted at Beckside Town in the urban area. Short reaches emerge in open channel within green spaces in town. A number of agricultural ditches upstream also contribute to the Lund Beck.

Dragley Beck originates from the west and flows east towards Ulverston. The watercourse is largely rural becoming more urban downstream of Springfield Road. The watercourse is open throughout. There is likely to be significant interaction between drainage networks for each watercourse given urban setting. Additionally, groundwater and tidal influence on rivers are known to impact this catchment. The Ulverston Canal will impact the hydrology in this catchment.

Summary of flooding impacts

The risk of flooding to people and property are summarised in Table 4-5.

There are less purely surface water flooding issues in this catchment and it has been classified as medium risk due to the lower number of non-residential and community assets at risk. The main area of surface water flood risk identified by the MSFG is in the south of the catchment. Ulverston is low lying and the drainage system is under capacity and prone to backing up form a Main River and the sea.

The location of the impacts of flooding is shown in Figure 4-5.

Table 4-5 Risk of flooding PVA 002 (1% AEP Scenario)

Category	Dragley Beck
Social - People	56 residential properties
Social – Community	3 community assets
Economic – Businesses	16 non-residential properties
Economic – Transport	A5087, A590, B5281, Railway and other minor roads.
Environment - Agriculture	Nothing of significance, city parks present
Environment – Cultural and Natural Heritage	Devils Bridge South West of Horrace, Eller Barrow (round barrow), Kirkby Moor SSSI
Verification – Number of recorded flood events	3

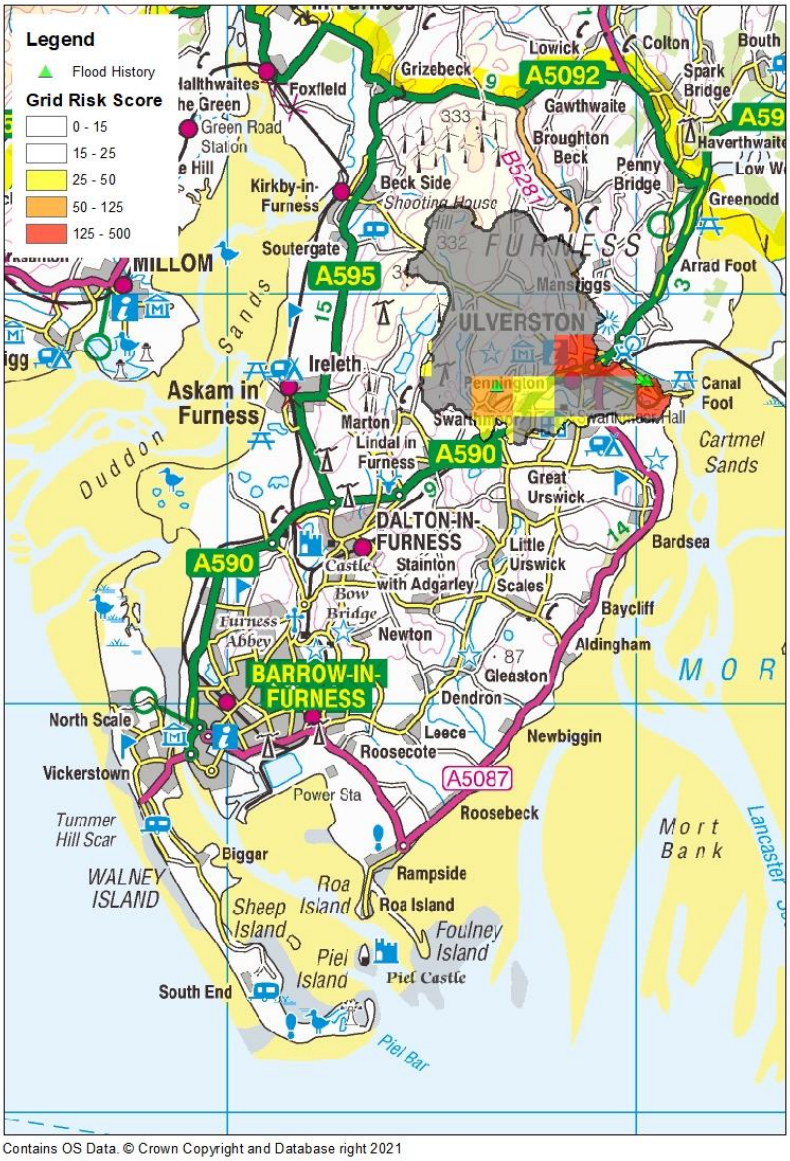


Figure 4-5 Risk and flood history PVA-002

Sensitivity to Climate Change

Based on peak flow climate change uplifts the catchment is deemed to be **moderately sensitive** to climate change. This indicates potential greater frequency and magnitude of potential flooding in the future at a scale which could significantly reduce any mitigation measures designed to present day data. This may require a low to medium to be used as a design scenario for scheme development.

It should also be noted given the prevalence of urban areas in this catchment flooding from overwhelmed drainage networks is likely to increase in frequency and magnitude.

History of flooding

In 2014 surface water flooding resulted in widespread road and property flooding.

Significant fluvial flooding has been reported from Dragley Beck most notably in 2009. This affected more than 100 properties around Steel Street North and Lonsdale Road to the east of the catchment. An existing flood defence bund was overtopped in this event. Although this event was largely driven by river overtopping there will be surface water impacts due to interaction between drainage and overtopping as well as river levels at outfalls. Partnership working with UU, EA and LLFA will be required here.

Kennedy Street in the south east of the catchment is most regularly affected by annual flooding which has been linked to groundwater sources. St Marys Hospice in this area has been impacted in 1990 and 2012 which may be linked to interaction between watercourse/drainage here. The roadway at Red Lane has also been subjected to frequent flooding.

Area of Risk Identification

AoR's identified in the Ulverston PVA are shown in the figures below. Analysis of flood history, predicted flood extents, receptors affected, topography, review of CCC flood reports, likely flood mechanism and consultation with CCC staff has been used to identify priority AoR's to be taken forward for this PVA (Table 4-6) and relevant actions to reduce surface water flood risk (**Table 4-7**).

Table 4-6 Stage 2a Ulverston AoR Identification Summary

No of AoR s	AoR s not taken forward	AoR s taken forward for consultation	AoR s taken forward for detailed assessment
7	AoR520 AoR516 AoR517	AoR518 AoR515	AoR519 AoR521

Figure 4-6 AoR's Ulverston (1 of 2)

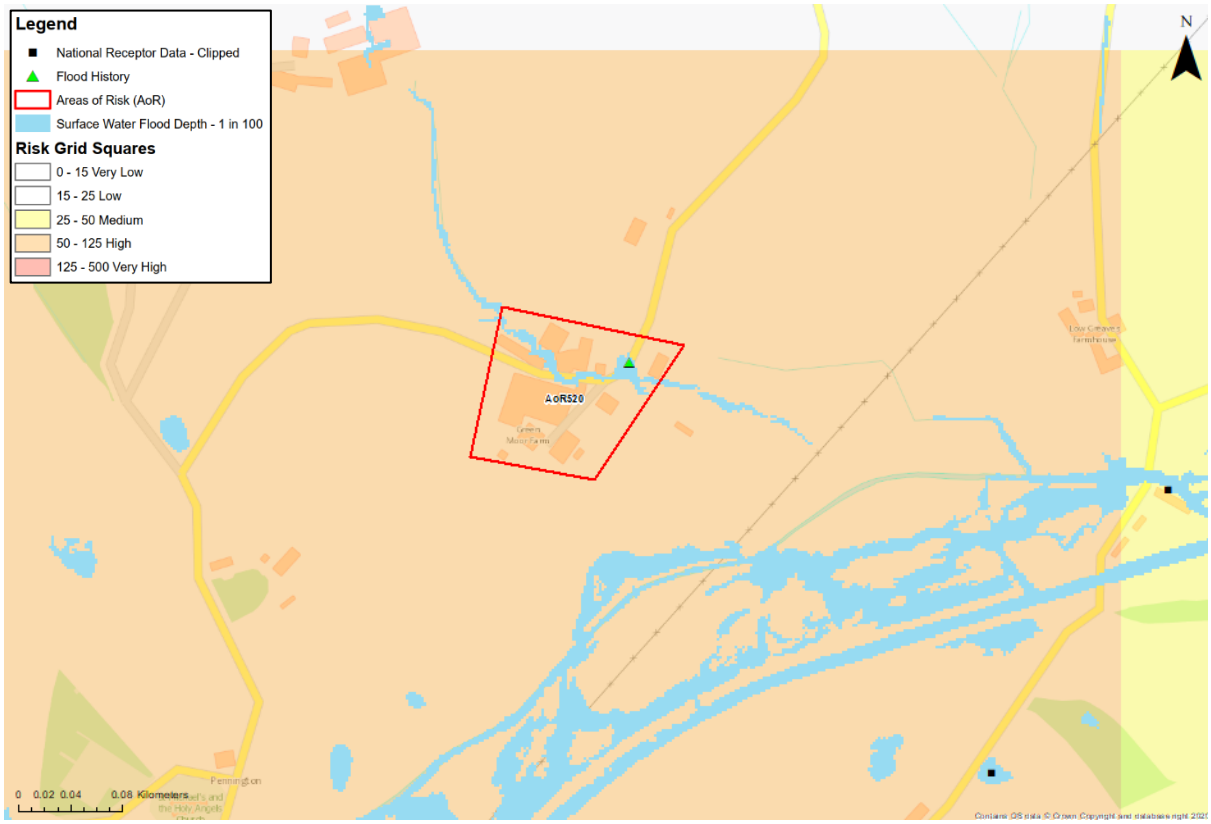


Figure 4-7 AoR's Ulverston (2 of 2)

Action Plan

Table 4-7 Stage 2b Ulverston Action Plan

Type of Action	Location	AoR s	Delivery lead	Action
SWMP	Victoria Park, King's Road Ulverston	AoR519 AoR521	UU/CCC	Review existing flood outputs and carry out 2D Pluvial Studies at both locations
Consultation	Oxford Street, Ulverston	AoR518	EA/CCC	Consult EA on planned scheme around railway embankment looking at surface water flows under railway impacting Lightburn Road
Consultation	Kennedy Street, Ulverston	AoR515	EA/CCC	Consult with EA to share findings of their planned groundwater monitoring in the area.

4.3 PVA-003 Windermere

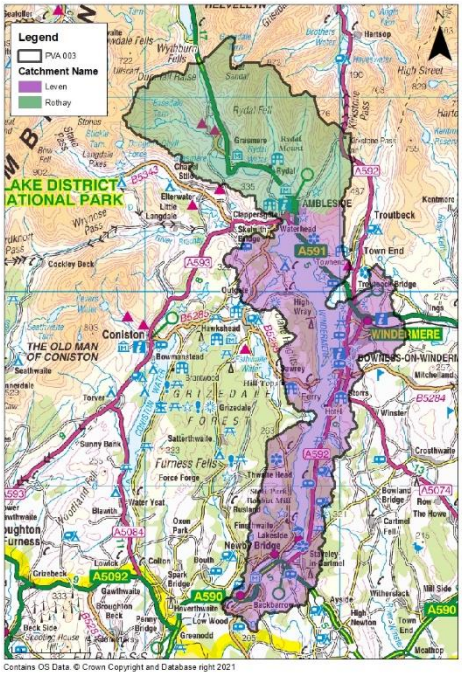
Windermere (Potentially Vulnerable Area 003)

Total risk classification: Very high and high

River basin district name:	Management catchment:	Operational catchment:	Waterbody name:
North West	Kent and Leven	Leven	Rothay and Leven

Background

This Potentially Vulnerable Area is centred around Windermere and is formed of Leven the upstream tributary of Rothay which are located in the south of Cumbria. It has an area of approximately 151km².



The Windermere PVA is formed of the Rothay and Leven catchments. The sewer system is known to be under significant pressure due to operational constraints such as infiltration of flows into sewers which are laid on bedrock and are prone to leakage. Additionally, some manholes are not adequately constructed, having been built directly into rock with rubble wall construction.

The surrounding catchment draining to Windermere is steep therefore subject to significant overland flow from surrounding hills which do not have adequate drainage or managed flow paths. Watercourses are also steep therefore convey flow rapidly to flatter sections of the watercourse within the town. This results in flooding in the urban areas as a result of surcharging of watercourse culverts and interaction with drainage systems. Additionally levels in the Lake Windermere will influence discharges from watercourses leading to direct flooding and backing up of the outfalls.

Summary of flooding impacts

The risk of flooding to people and property are summarised in Table 4-8.

This PVA containing two catchments has been classified as a very high and high risk from surface water flooding. As can be seen from Table 4-8 over 130 residential properties and numerous other assets are at risk from surface water flooding based on the strategic assessment.

The location of the impacts of flooding is shown in Figure 4-8.

Table 4-8 Risk of flooding PVA 003 (1% AEP Scenario)

Category	Rothay	Leven
Social - People	105 residential properties	27 residential properties
Social - Community	2 Community assets	1 community assets
Economic - Businesses	41 non-residential properties	14 non-residential properties
Economic - Transport	A590(T), A591, A5074, A592, A593, A5075, B5278, B5360, B5285, B5284, B5286, other minor roads, Railway	A591, A593, A592, A5075, B5287
Environment - Agriculture	None of note	None of note
Environment – Cultural and Natural Heritage	Lake District National Park, Blelham Bog NNR, Yewbarrow Woods (SAC), 5 scheduled monuments, 4 areas of park/gardens registered by Historic England, 4 listed buildings, 12 SSSI's.	Rydal hall and mount, 4 scheduled monuments, 11 listed buildings, 2 SSSI's (loughrigg fell flushes and pets quarry), Lake District National Park
Verification – Number of recorded flood events	12	6

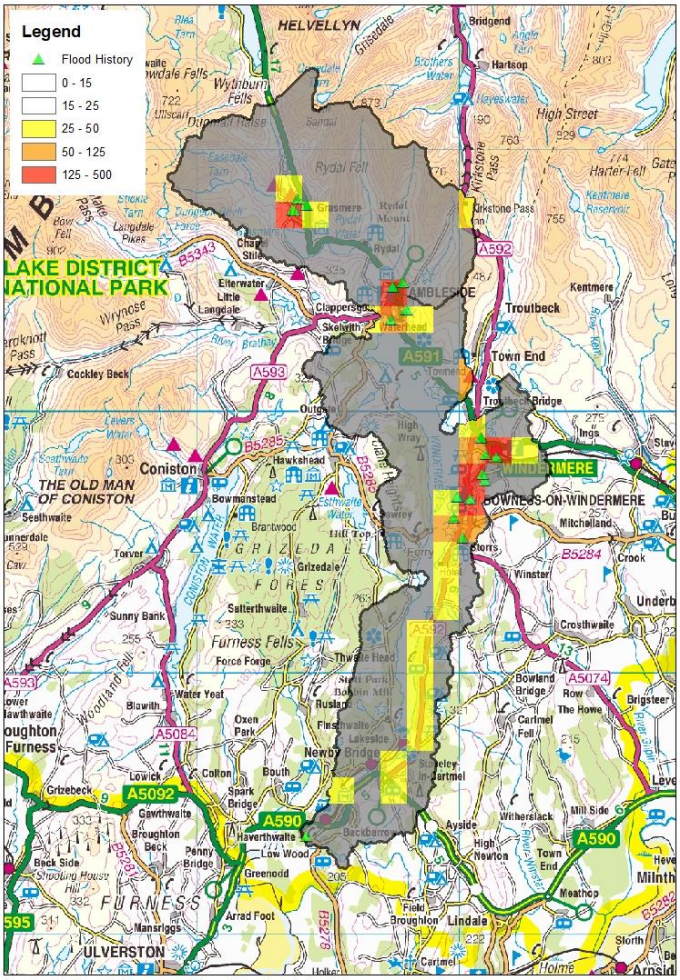


Figure 4-8 Risk and flood history PVA-003

Sensitivity to Climate Change

Based on peak flow climate change uplifts the catchment is deemed to be **highly sensitive** to climate change. This indicates potential greater frequency and magnitude of potential flooding in the future at a scale which could significantly reduce any mitigation measures designed to present day data. This may require a higher allowance to be used as a design scenario for scheme development.

It should also be noted given the presence of urban areas in this catchment flooding from overwhelmed drainage networks is likely to increase in frequency and magnitude.

History of flooding

Frequent flooding is reported in the north of the PVA. This has occurred in the Grassmere area with up to 3 residential properties affected annually. This has been linked to sewer flooding and infiltration to sewers therefore UU will be a key stakeholder in this PVA. Additionally a collapsed culvert in the area caused issues in 2011. Overland flows from agricultural land and fluvial influence from River Rothay and it's tributaries also causes more infrequent issues (2- 5 years). This is likely to have an integrated response with the drainage system.

Significant sewer surcharging was reported in 2009 as a result of the sewer systems constraints noted previously.

Another area of past flooding lies in the east of the PVA. Upper Oak Street in Windermere is the most frequently impacted area with flooding reported annually at 4 residential basements. Anecdotally, this is reported to be a result of overland flow

from watercourse due to a newly installed trash screen. Consultation is required with EA to determine if this has been resolved.

External flooding of property and gardens has also occurred in the east of the PVA around Lake Road and at Birthwaite Road in the West. Highway drainage as well as interaction with watercourses have been reported as sources frequently.

Working with landowners to manage sheet flows and reduce overland flows entering the drainage network will be key to option development in this PVA.

Area of Risk Identification

AoR's identified in the Windermere PVA are shown in the figures below. Analysis of flood history, predicted flood extents, receptors affected, topography, review of CCC flood reports, likely flood mechanism and consultation with CCC staff has been used to identify priority AoR's to be taken forward for this PVA (**Table 4-9**) and relevant actions to reduce surface water flood risk (Table 4-10)

Table 4-9 Windermere Stage 2a AoR Identification Summary

No of AoR s	AoR s not taken forward	AoR s taken forward for consultation	AoR s taken forward for detailed assessment
15	AoR530, AoR527 AoR546, AoR523 AoR531 AoR534 AoR535, AoR536	N/A	AoR522 AoR524 AoR525 AoR526 AoR532 AoR529, AoR533

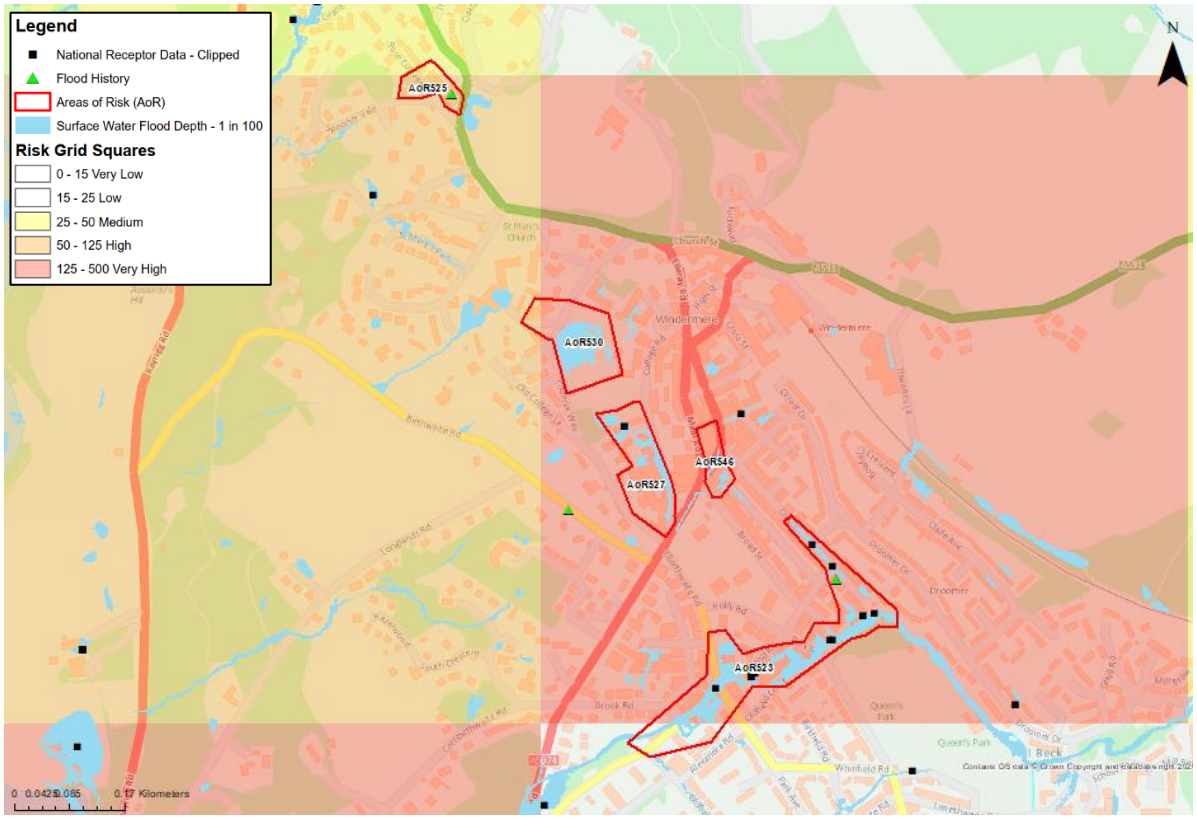


Figure 4-9 AoR's Windemere (1 of 5)

Figure 4-10 AoR's Windemere (2 of 5)

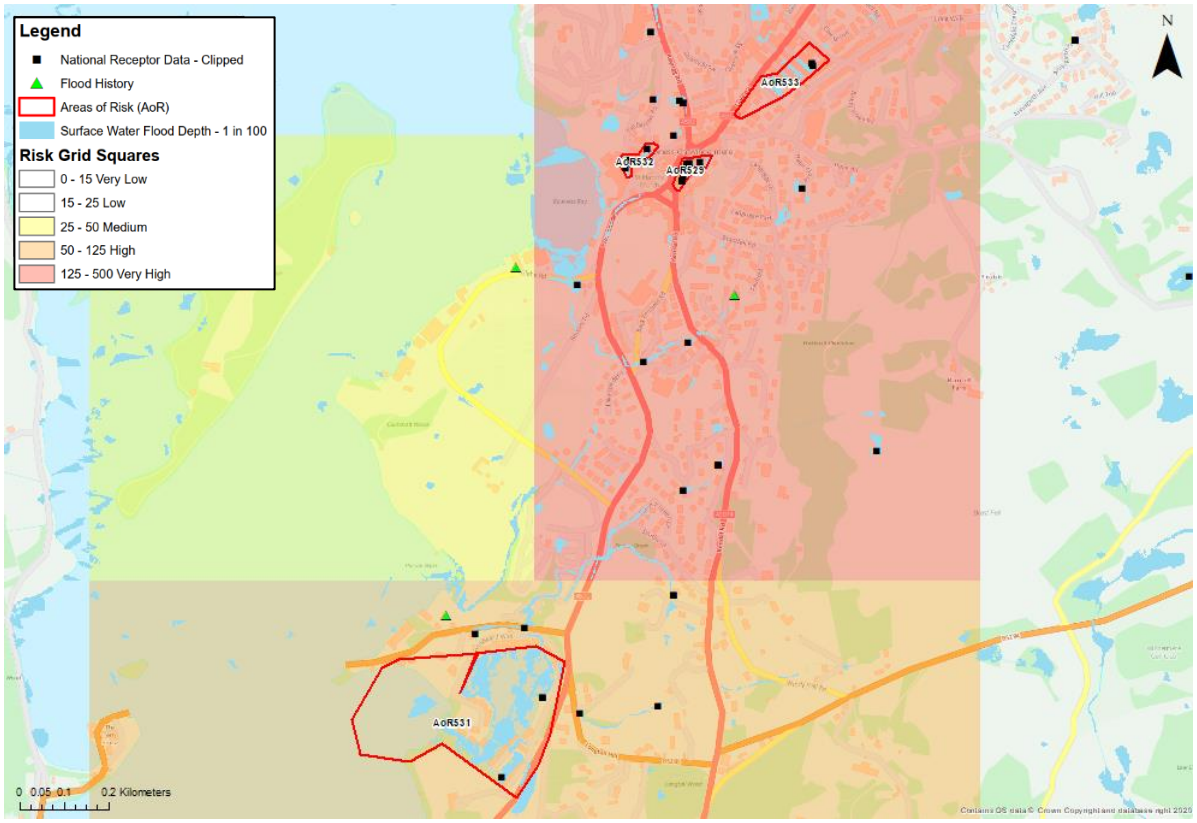


Figure 4-11 AoR's Windermere PVA (3 of 5)

Figure 4-12 AoR's Windermere PVA (4 of 5)

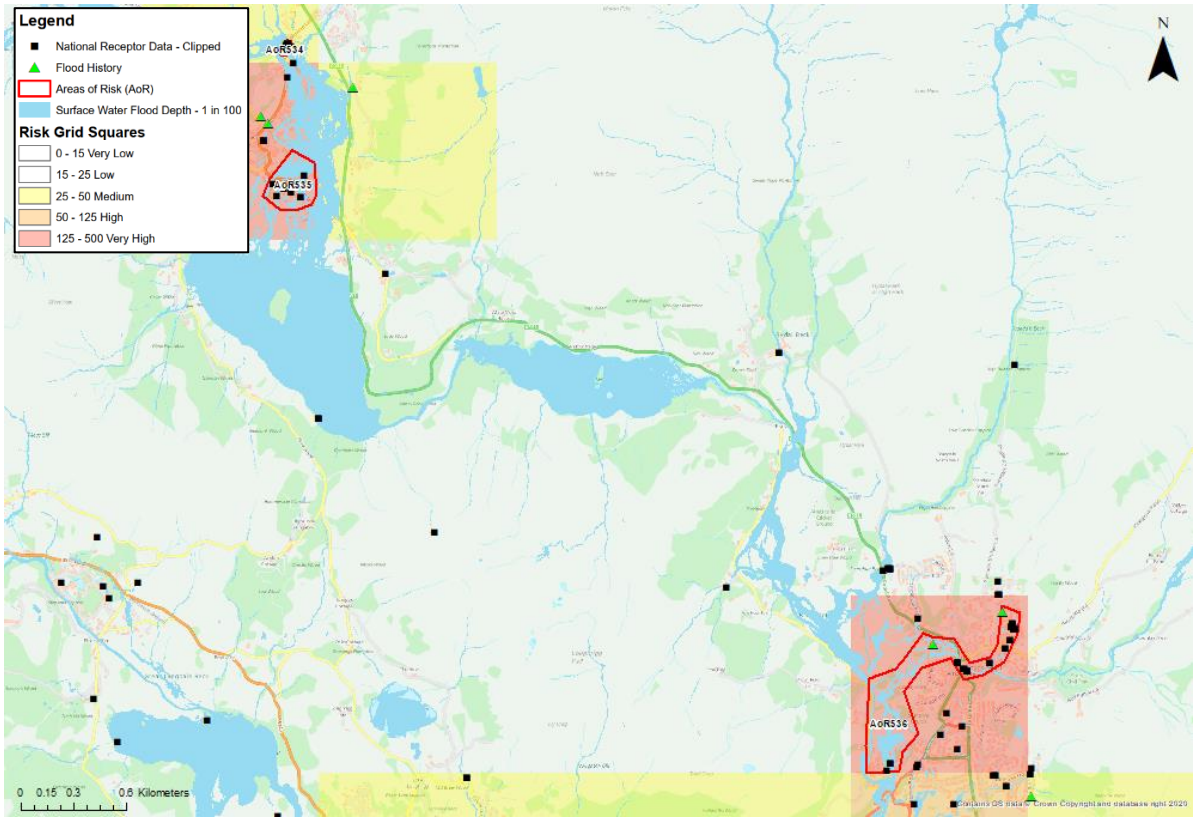


Figure 4-13 AoR's Windermere PVA (5 of 5)

Action Plan

Table 4-10 Windemere PVA Stage 2b Action Plan

Type of Action	Location	AoR s	Delivery lead	Action
SWMP - ICM	Bowness-on-Windermere	AoR532 AoR529 AoR533	CCC	SWMP for Bowness-on-Windermere involving ICM modelling
SWMP	Lake Road Cheerslake Road, Windermere	AoR522 AoR524	CCC/UU	2D pluvial study - Further analysis is needed to understand surface water flooding in the area.
NFM	Mountain Ash Court, Phoenix Way	AoR525 AoR526	CCC	NFM Study desk study on Wynlass Beck catchment to scope opportunities to slow flows reaching Windermere

4.4 PVA-004 Kendal

Kendal (Potentially Vulnerable Area 004)

Total risk classification: High.

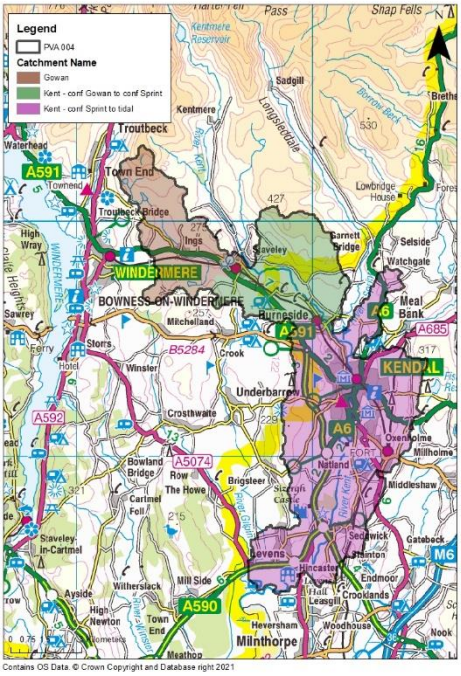
River basin district name:	Management catchment:	Operational catchment:	Waterbody name:
North West	Kent and Leven	Kent	Kent - conf Sprint to tidal

Background

This Potentially Vulnerable Area is centred around Kendal and is formed of the River Kent catchment which is located in the south of Cumbria. It has an area of approximately 52km².

The catchment is served by the River Kent. The River Kent rises from hills to the north west continuing west where the River Mint joins immediately upstream of Kendal. The catchment draining to Kendal is rural and very steep. The river continues in open channel through Kendal but it's floodplain is heavily developed.

There are limited open channels joining the river further downstream indicating the likely presence of smaller culverted watercourses. Both the main watercourse and culverts will interact with artificial drainage systems. It has been seen in past flood events that interaction between outfalls and Combined Sewer Overflows have resulted in prolonged periods of inundation around the Mintsfeet and New Road areas.



Summary of flooding impacts

The risk of flooding to people and property are summarised in Table 4-11.

The Kendal PVA is at high risk from surface water flooding based on the strategic assessment. Recent flood events would confirm this with 9 reported events of properties and assets. Kendal is the focal point for flooding with some risk within the wider catchment. A review of the 1 in 100 year pluvial flood extent shows the potential for significant flooding of residential properties, infrastructure and heritage assets.

The location of the impacts of flooding is shown in Figure 4-14.

Table 4-11 Risk of flooding PVA 004 (1% AEP Scenario)

Category	Kent (conf Sprint to Tidal)	Kent (conf Gowan to Sprint)	Gowan
Social - People	78 residential properties	3 residential properties	None
Social - Community	1 community asset	0 community assets	None
Economic - Businesses	18 non-residential properties	0 non-residential properties	None
Economic - Transport	A685, A6, A65, A684, A590(T), A591, A5284, B6254, Railway, other minor roads.	A591, other minor roads and Railway	None
Environment - Agriculture	None of note	None of note	None of note
Environment – Cultural and Natural Heritage	Lake District National Park, 3 listed buildings, 8 scheduled monuments, 2 areas of park/gardens registered by Historic England, 2 SSSI's, 2 SAC's.	Lake District National Park, 1 scheduled monument, 1 SAC (River Kent), 2 SSSI's.	Lake District National Park
Verification – Number of recorded flood events	9	1	0

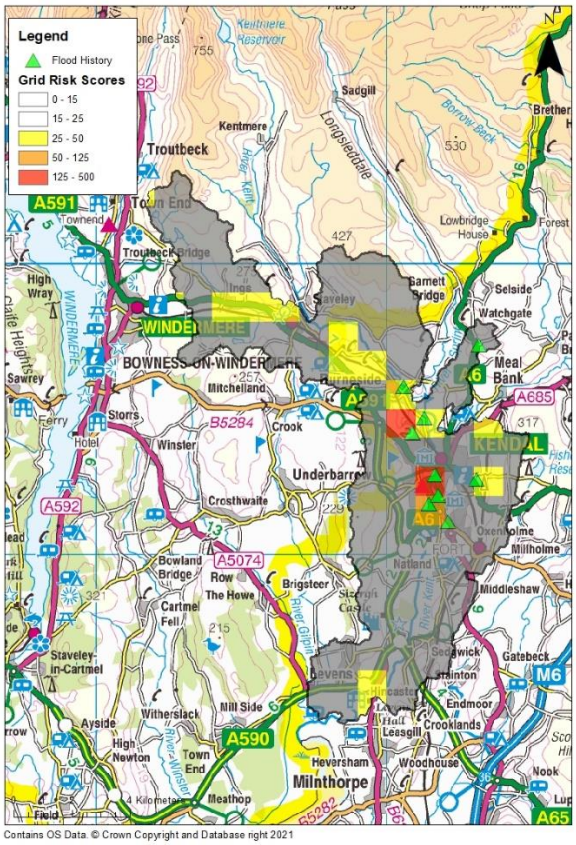


Figure 4-14 Risk and flood history PVA-004

Sensitivity to Climate Change

Based on peak flow climate change uplifts the catchment is deemed to be **highly sensitive** to climate change. This indicates potential greater frequency and magnitude of potential flooding in the future at a scale which could significantly reduce any mitigation measures designed to present day data. This may require a higher allowance to be used as a design scenario for scheme development.

It should also be noted given the prevalence of urban areas in this catchment flooding from overwhelmed drainage networks is likely to increase in frequency and magnitude.

History of flooding

The most significant past flooding reported occurred in the Mintsfeet area over the following periods; Dec 1954, Dec 1964, Dec 1968, Dec 1985, Feb 2004, Jan 2005, Nov 2009, Dec 2015. In 2005, 20 residential properties and 40 non-residential properties were impacted. Flooding is largely a result of insufficient drainage systems which are managing additional flows from steep, hilly catchments upstream. The culverted nature of watercourses will likely result in need for an integrated approach to any future modelling.

The flooding experienced in Kendal on the 5th and 6th of December 2015 was the largest flood event ever recorded in the town and was the result of the effects of Storm Desmond. The main source of flooding was river flooding from the River Kent, Mint and Stock Beck. However, in specific areas, surface water flooding, groundwater flooding, and flooding from drainage systems played a critical role.

At the beginning of the event, flooding from drains was reported across Kendal and at Ullswater Road surface water flooding from run-off from upstream fields was observed. Approximately 2,150 properties were directly affected by flooding, with the majority of these located in the Mintsfeet and Sandylands areas of Kendal. Overtopping of defences in the Mintsfeet area occurred when the water level exceeded the height of the defence and flowed over the flood defence embankment structures. In Sandylands, initial flooding from Stock Beck occurred as the capacity of the underground culverted watercourse system was exceeded, followed by overtopping of the Stock Beck Flood Storage Basin.

External and internal property flooding has been reported in the north of the PVA at Carras Green, Low Garth & Sparrowmire and Hallgarth. Up to 8 residential properties are affected almost annually most recently in 2016. This has been linked to sewer issues as well as choked gullies. Partnership working with UU and the Highways Authority will be required. Surface water flooding has been reported around Ambleside and Vicarage Drive impacting garages and gardens annually. This may be linked to insufficient drainage.

Groundwater flooding has been reported as an issue in the centre of the PVA affecting up to 12 properties annually at Aynam Road.

Area of Risk Identification

AoR's identified in the Kendal PVA are shown in Figure 4-15and Figure 4-16 below. Analysis of flood history, predicted flood extents, receptors affected, topography, review of CCC flood reports, likely flood mechanism and consultation with CCC staff has been used to identify priority AoR's to be taken forward for this PVA (**Table 4-12**) and relevant actions to reduce surface water flood risk (Table 4-13).

Table 4-12 Stage 2a Kendal AoR Identification Summary

No of AoR s	AoR s not taken forward	AoR s taken forward for consultation	AoR s taken forward for detailed assessment
7	AoR538 AoR542	AoR537 AoR539 AoR540 AoR541 AoR543	AoR537 AoR539 AoR540 AoR541 AoR543

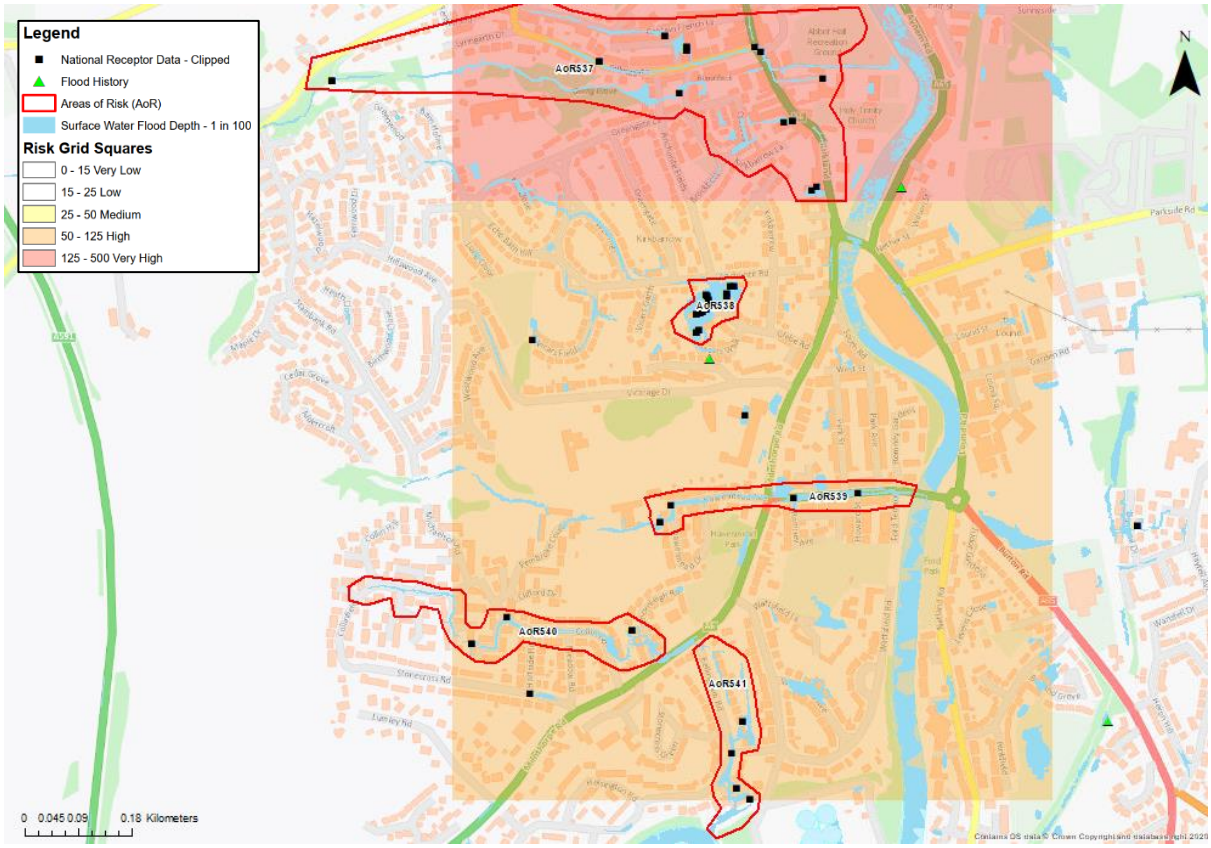


Figure 4-15 AoR's Kendal PVA (1 of 2)

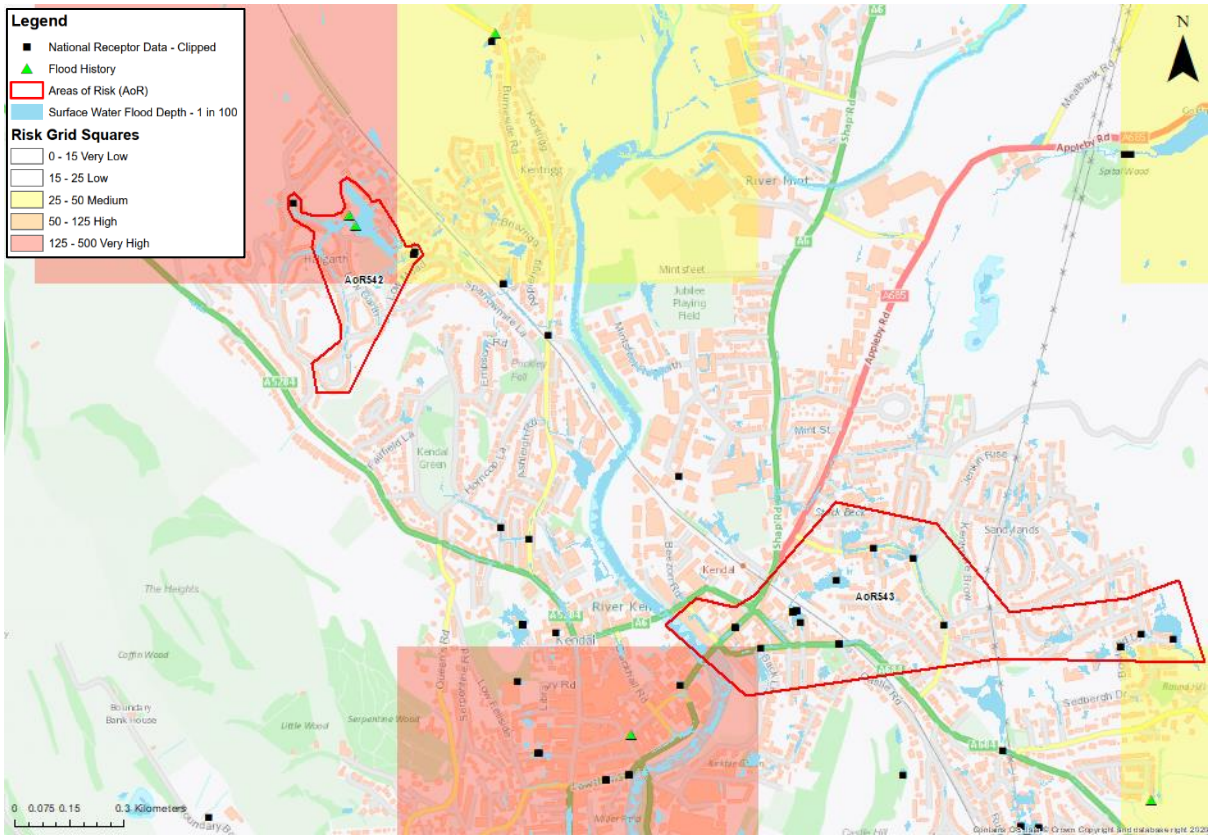


Figure 4-16 AoR's Kendal PVA (2 of 2)

Action Plan

Table 4-13 Kendal PVA Stage 2b Action Plan

Type of Action	Location	AoR s	Delivery lead	Action
SWMP - ICM	Stonecross Road, Kendal	AoR540 AoR541	CCC	Joint ICM study to generate SWMP
SWMP - ICM	Blind Beck	AoR539	CCC	ICM study to generate SWMP
SWMP – ICM/ Consultation	Highgate	AoR537	CCC/EA	Consultation with EA regarding EA Kendal Scheme ICM study to generate SWMP and review of culvert capacity
SWMP - ICM	Sandylands	AoR543	CCC	ICM study to generate SWMP
Consultation	Kendal	AoR537 AoR539 AoR540, AoR541 AoR543	EA/UU/CCC	Consult with EA Review existing Kendal ICM and UU model

4.5 PVA-005 Cleator Moor

Cleator Moor (Potentially Vulnerable Area 005)

Total risk classification: High

River basin district name:	Management catchment:	Operational catchment:	Waterbody name:
North West	South West Lakes	Ehen-Calder	Ehen (upper and lower)

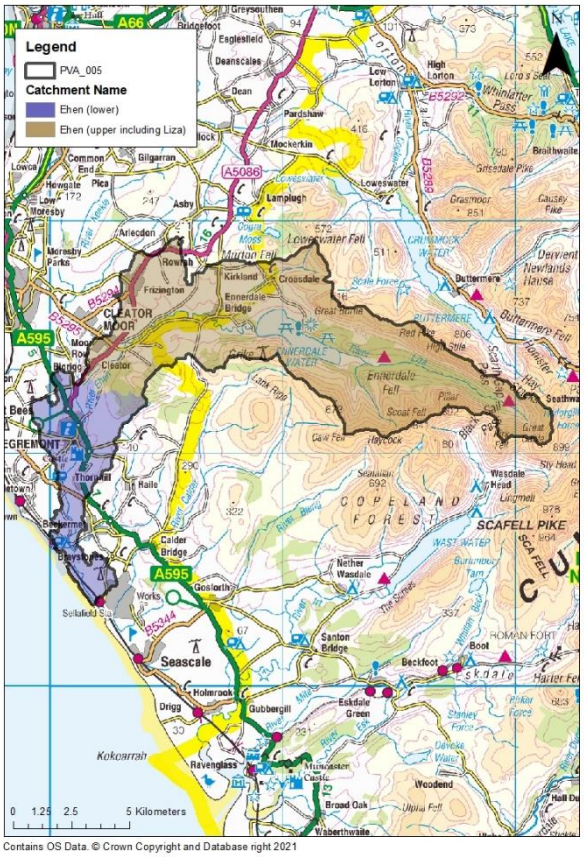
Background

This Potentially Vulnerable Area is centred around Ennerdale and Cleator Moor and is formed of upper Ehen catchment which is located in the west of Cumbria. It has an area of approximately 89km².

The River Ehen arises in the hills of the Lake District National Park as Liza Beck and flows as a natural stream down to Ennerdale Water.

Downstream of the lake the River Ehen flows through Ennerdale Bridge village and Cleator before being joined by the River Keekle. It then flows through Egremont and is joined by Kirk beck before discharging to the sea. The land use is predominantly agriculture with large areas of forestry and small urban settlements.

There is a flood protection embankment in the lower end of the River Ehen which protects to a 1 in 100 year event. High water levels are believed to influence UU sewer outfalls discharging to this watercourse. United Utilities will cease abstracting from Ennerdale Water by 2022.



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Summary of flooding impacts

The risk of flooding to people and property are summarised in Table 4-14.

The Cleator Moor PVA is at high risk from surface water flood along with known fluvial flood risk. A scheme promoted by the EA is being progressed and is detailed below. Flood events have historically occurred frequently within the two catchments. Based on the strategic assessment there are a number of residential properties at risk along with a higher number of infrastructure assets.

The location of the impacts of flooding is shown in Figure 4-17.

Table 4-14 Risk of flooding PVA 005 (1% AEP Scenario)

Category	Ehen Upper	Ehen Lower
Social - People	12 residential properties	3 residential properties
Social - Community	None	None
Economic - Businesses	None	1 non-residential property
Economic - Transport	A5086, B5295, B5294, minor roads at multiple locations,	B5345, A595(T), A5086, Railway at 1 location, minor roads at multiple locations
Environment - Agriculture	Salter Hall Farm and Low White Banks Farm	None of note
Environment – Cultural and Natural Heritage	Lake District National Park, 8 Scheduled monuments, 5 SSSI's, 2 SAC's (River Ehen and Lake District High Fells),	1 Schedule monument (Egremont Castle), 3 SSSI's, 1 SAC (River Ehen),
Verification – Number of recorded flood events	11	8

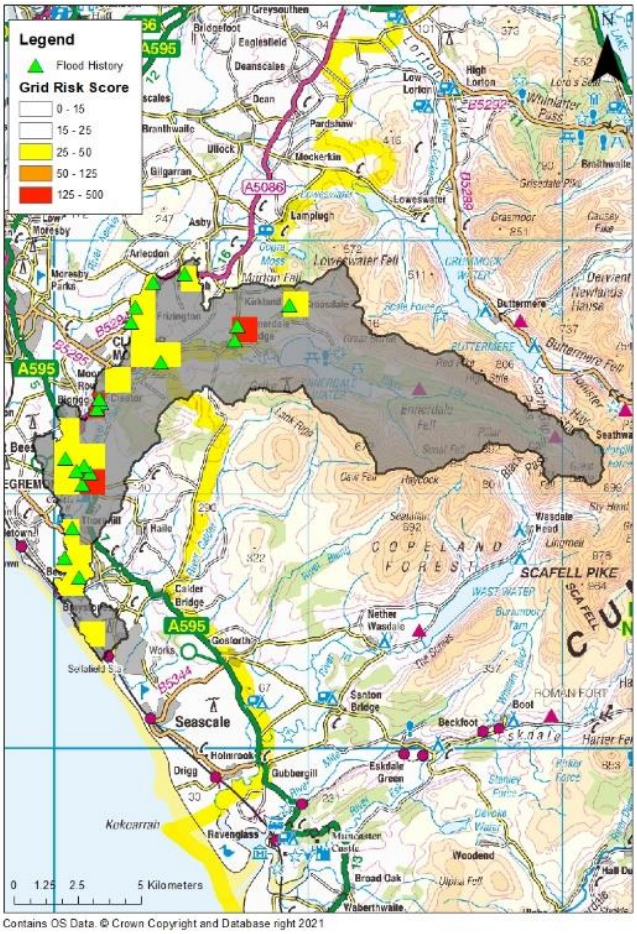


Figure 4-17 Risk and flood history PVA-005

Sensitivity to Climate Change

Based on peak flow climate change uplifts the catchment is deemed to be **highly sensitive** to climate change. This indicates potential greater frequency and magnitude of potential flooding in the future at a scale which could significantly reduce any mitigation measures designed to present day data. This may require a higher allowance to be used as a design scenario for scheme development.

It should also be noted given the prevalence of urban areas in this catchment flooding from overwhelmed drainage networks is likely to increase in frequency and magnitude.

History of flooding

Regular flooding impacts the highway at Croasdale Bridge due to insufficient drainage capacity. Less regular flooding is also predicted at Blackhow Bridge / Millers Walk highway due to limited drainage.

The most significant past reports of flooding are in the south west at Hilden Road where roadways and up to 38 properties were flooded internally. This is linked to the River Ehen. Currently flood defences are installed to protect to a 1 in 100 year event.

Surface water flooding due to drainage capacity restrictions impacts several properties.

Area of Risk Identification

AoR's identified in the Cleator Moor PVA are shown in figures below. Analysis of flood history, predicted flood extents, receptors affected, topography, review of CCC flood reports, likely flood mechanism and consultation with CCC staff has been used to identify priority AoR's to be taken forward for this PVA (**Table 4-15**) and relevant actions to reduce surface water flood risk (Table 4-16).

Table 4-15 Stage 2a AoR Identification Summary

No of AoR s	AoR s not taken forward	AoR s taken forward for consultation	AoR s taken forward for detailed assessment
9	AoR404 AoR409 AoR403 AoR408 AoR405	N/A	AoR406 AoR407 AoR402

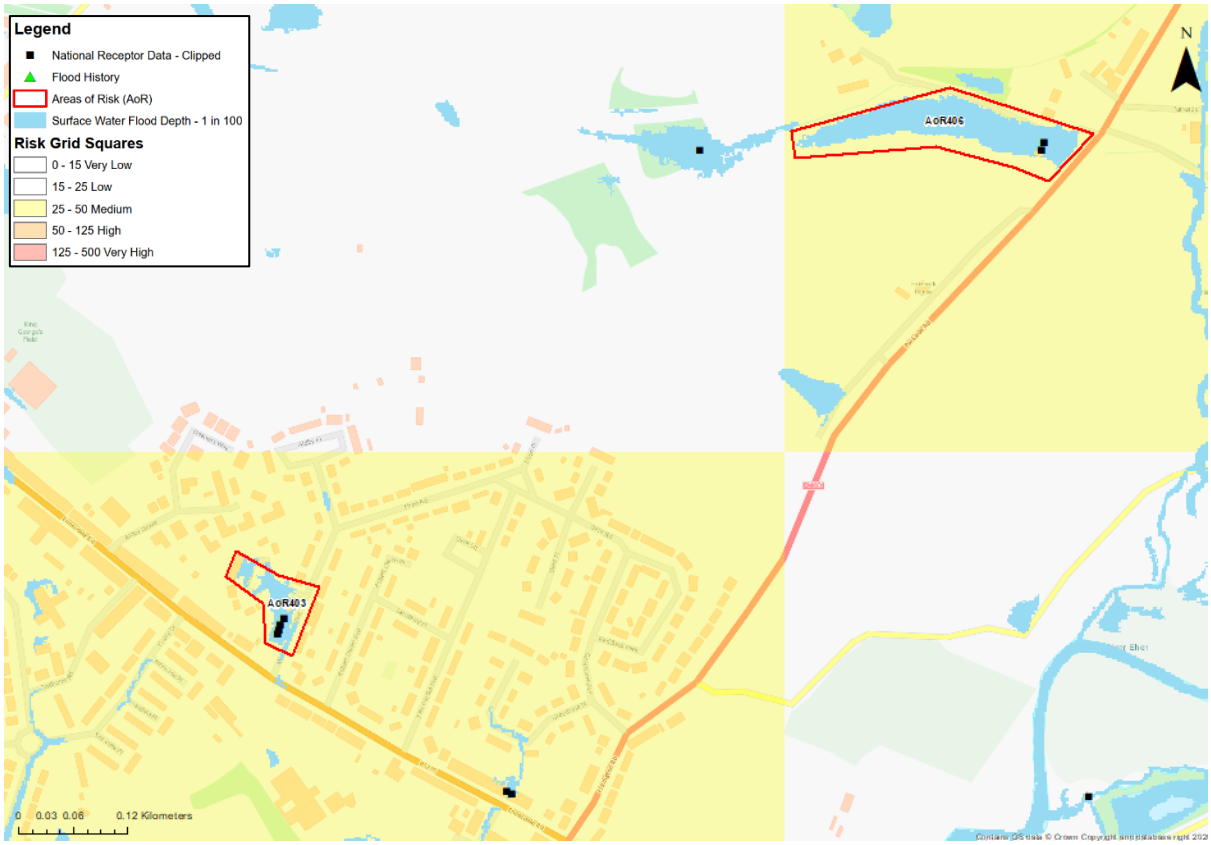


Figure 4-18 AoR's Cleator Moor PVA (1 of 5)

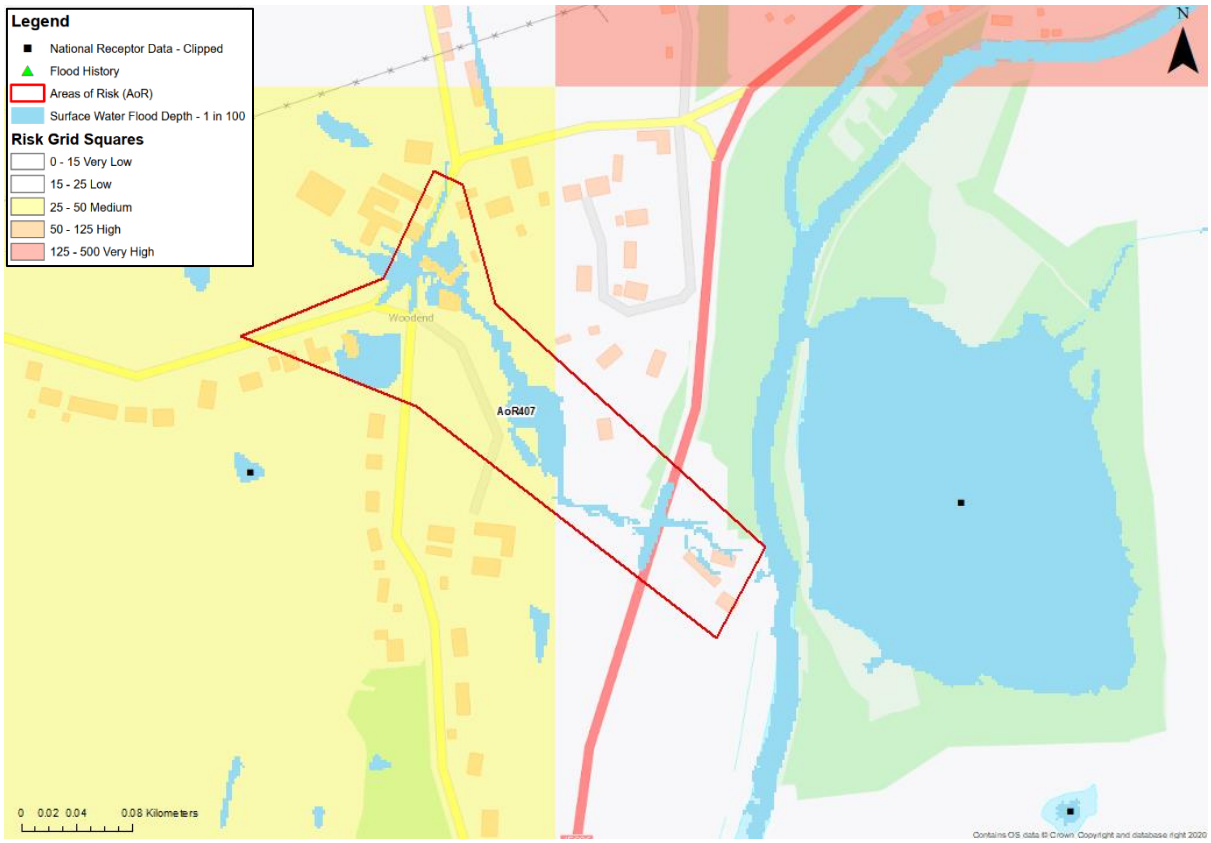


Figure 4-19 AoR's Cleator Moor PVA (2 of 5)

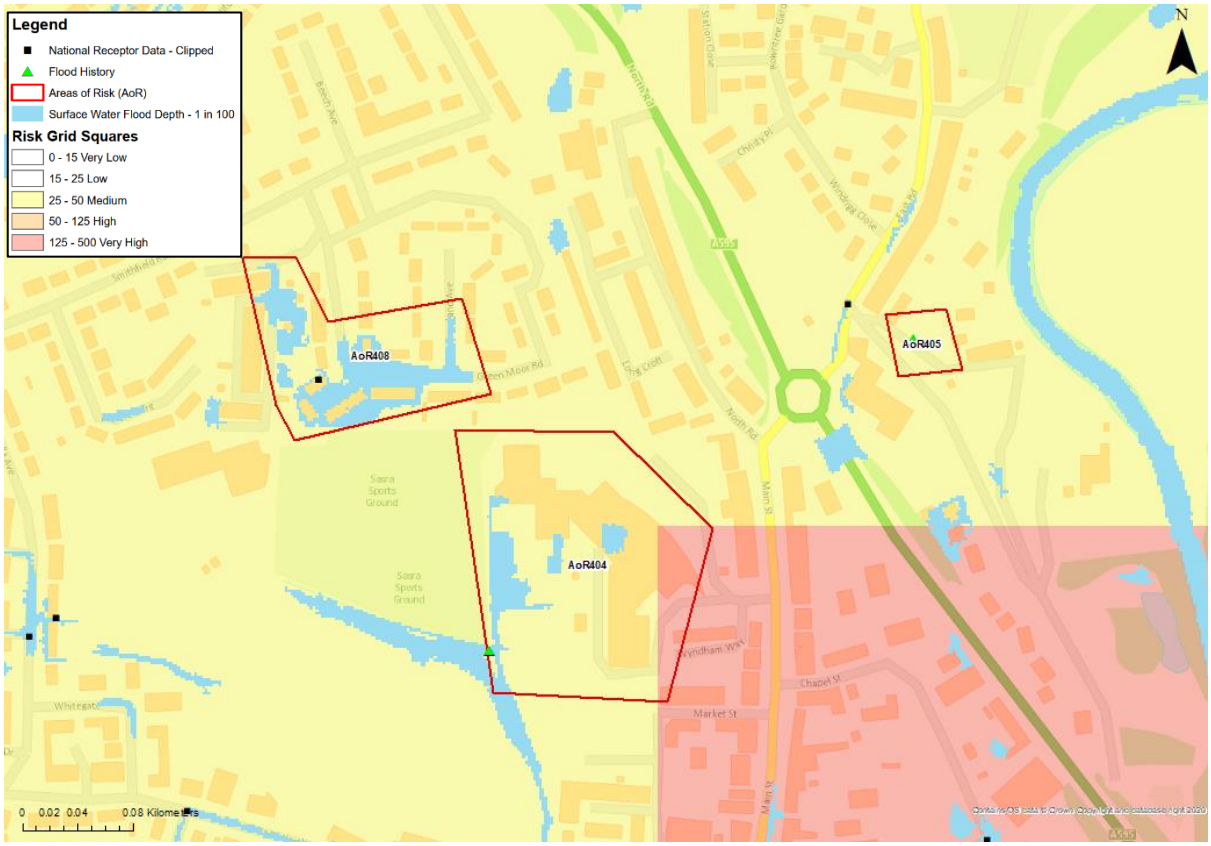


Figure 4-20 AoR's Cleator Moor PVA (3 of 5)

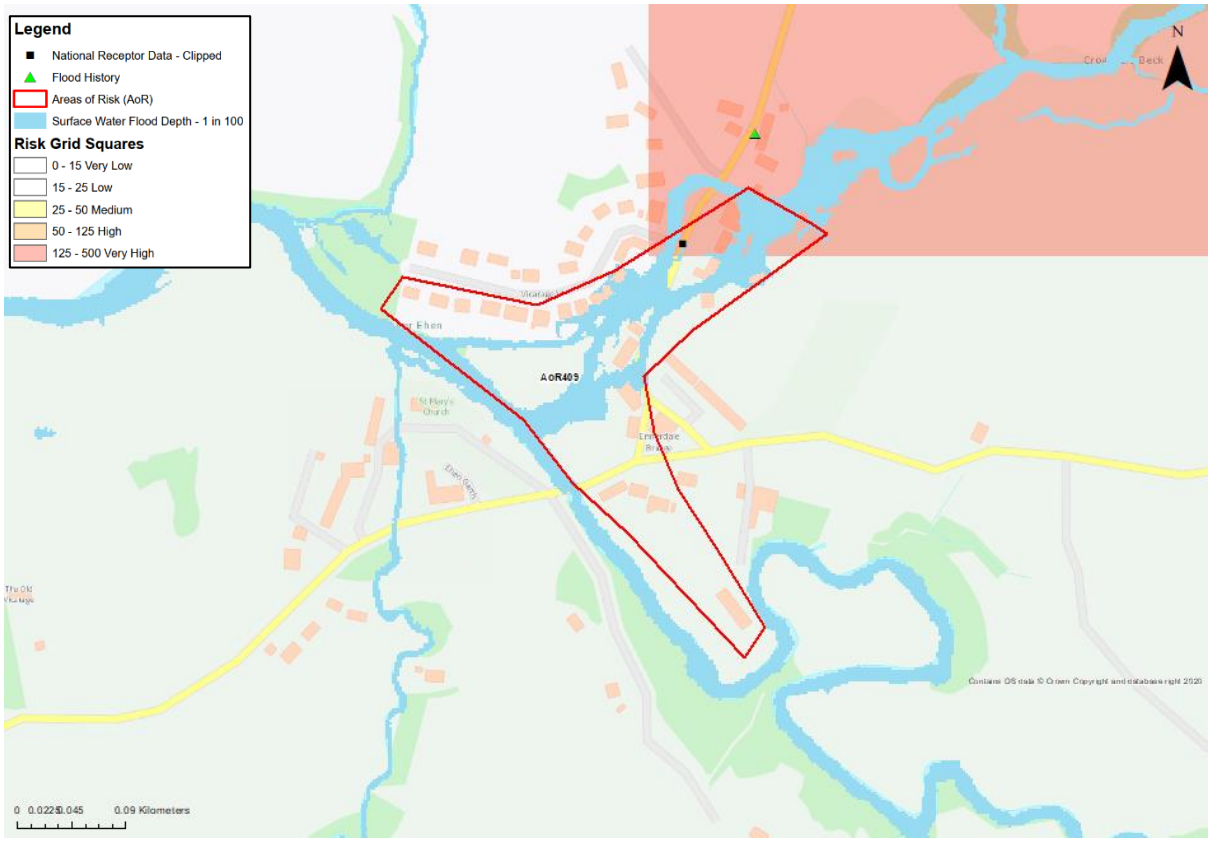


Figure 4-21 AoR's Cleator Moor PVA PVA (4 of 5)

Figure 4-22 AoR's Cleator Moor PVA PVA (5 of 5)

Action Plan

Table 4-16 Cleator Moor PVA Stage 2b Action Plan

Type of Action	Location	AoR s	Delivery lead	Action
SWMP	William Morris Avenue, Cleator Moor	AoR406	CCC	Review existing flood outputs Possible localised 2D Pluvial Study
NFM	Woodend	AoR407	CCC	Consult land owner on potential NFM solutions
Maintenance	Lingla Beck	AoR402	CCC	Propose maintenance schedule

4.6 PVA-006 Whitehaven

Whitehaven (Potentially Vulnerable Area 006)

Total risk classification: Very high

River basin district name:	Management catchment:	Operational catchment:	Waterbody name:
Coastal catchment	Coastal catchment	Coastal catchment	Coastal catchment

Background

This Potentially Vulnerable Area is centred around Whitehaven and is formed of a coastal catchment which is located in the west of Cumbria. It has an area of approximately 21km².

Pow Beck in Whitehaven is a short stream arising to the north of Mirehouse and flowing through the town to the sea at Whitehaven Harbour, mainly through culverts.

Historic flooding records indicate issues with capacity and condition of some urban culverts as well as capacity in highway drains and combined sewer systems. Many of the problems are related to private sewers and smaller watercourses.

Small watercourses, surface water drains and Pow Beck have also been known to back up during high tide levels, resulting in property flooding. However, improvements have been made to reduce this source of flooding. The Environment Agency reached an agreement with the harbour authority regarding the operation of the gates controlling water levels in the harbour. This has resulted in the reduction of tide locking of Pow Beck and the surface water sewers.

Summary of flooding impacts

The risk of flooding to people and property are summarised in Table 4-17.

The Whitehaven PVA has been classed a at very high risk from surface water flooding. A high number of reported flood events have been recorded within the catchment. Strategic assessment highlights 41 properties at risk from the 1 in 100 year flood extents.

The location of the impacts of flooding is shown in Figure 4-23.

Figure 4-23.

Table 4-17 Risk of flooding PVA 006

Category	1% AEP Scenario
Social - People	41 residential properties
Social - Community	Electrical Sub Station
Economic - Businesses	3 non-residential properties
Economic - Transport	A959(T), A5094, B5295, B5345, Railway at multiple locations, minor roads at multiple locations,
Environment - Agriculture	None of note
Environment – Cultural and Natural Heritage	2 Scheduled monuments, 1 listed building, 1 SSSI (St Bees Head), 1 World Heritgae Site (Hadrians Wall fort)
Verification – Number of recorded flood events	24

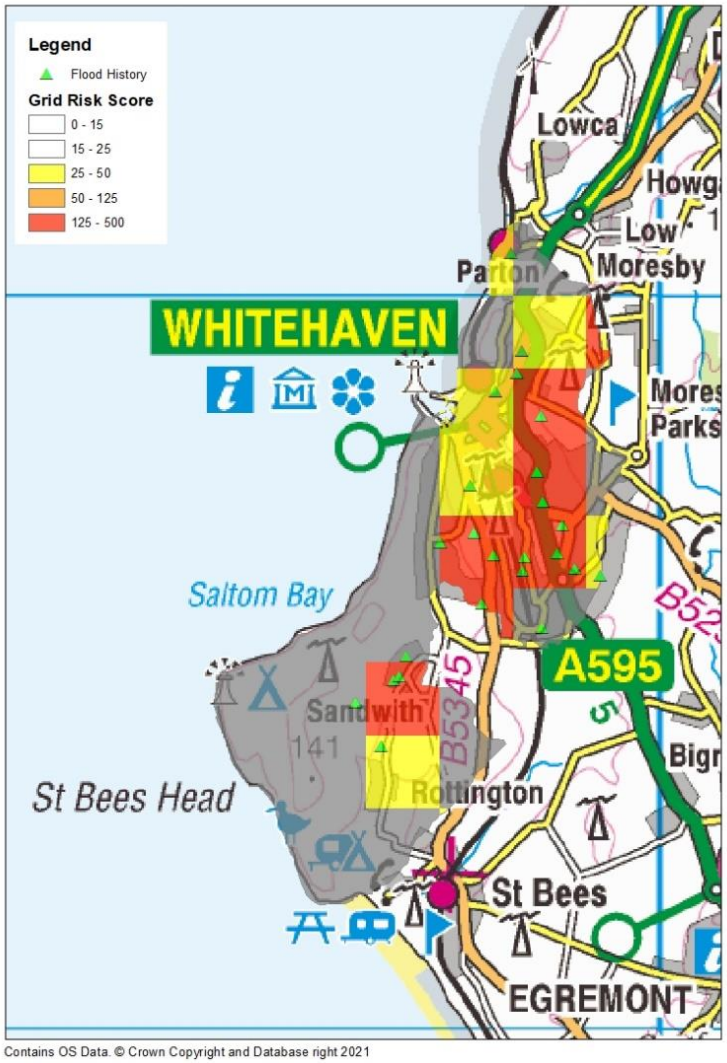


Figure 4-23 Risk and flood history PVA-006

Sensitivity to Climate Change

Based on peak flow climate change uplifts the catchment is deemed to be **moderately sensitive** to climate change. This indicates potential greater frequency and magnitude of potential flooding in the future at a scale which could significantly reduce any mitigation measures designed to present day data. This may require a low to medium allowance to be used as a design scenario for scheme development.

It should also be noted given the prevalence of urban areas in this catchment flooding from overwhelmed drainage networks is likely to increase in frequency and magnitude. Given the coastal setting of this catchment sea level rise may increase surface water flooding due to increased occurrence of tide locking at outfalls.

History of flooding

Carriageway flooding at Homewood Road and New Road has been reported as an ongoing issue since 2013. It is believed to be caused by groundwater from former ash pits as well as overland flows. Borrowdale Avenue and Link Road are also noted to be impacted by groundwater flooding. The main AoR's is now near the top end of Pow Beck, at Mirehouse. UU sewers struggle to drain in this location and carry significant amounts of surface water. Many culverts/sewers have collapsed, causing flooding around Mirehouse.

Surface water flooding at Victoria Road and Coronation Drive has been reported regularly since 2016 affecting properties and carriageway. The former is due to poor field drainage and the latter due to improperly place drains.

Flood from the combined sewer network has been reported irregularly around Springfield Avenue resulting from insufficient culvert capacity. Sewer flooding is widespread across the east of the PVA impacting; Coach Road, Victoria Road, Whinlatter Road and Lakeland Avenue. Many of these issues are linked to defective, silted or over capacity culverts and highway drains or sewers taking flows from insufficient field drainage. Partnership working with UU will be required to resolve this.

Area of Risk Identification

AoR's identified in the Whitehaven PVA are shown in the figures below. Analysis of flood history, predicted flood extents, receptors affected, topography, review of CCC flood reports, likely flood mechanism and consultation with CCC staff has been used to identify priority AoR's to be taken forward for this PVA (**Table 4-18**) and relevant actions to reduce surface water flood risk (Table 4-19).

Table 4-18 Stage 2a AoR Identification Summary

No of AoR s	AoR s not taken forward	AoR s taken forward for consultation	AoR s taken forward for detailed assessment
11	N/A	AoR410	AoR420 AoR416 AoR411 AoR412 AoR413 AoR414 AoR415 AoR418 AoR417 AoR419

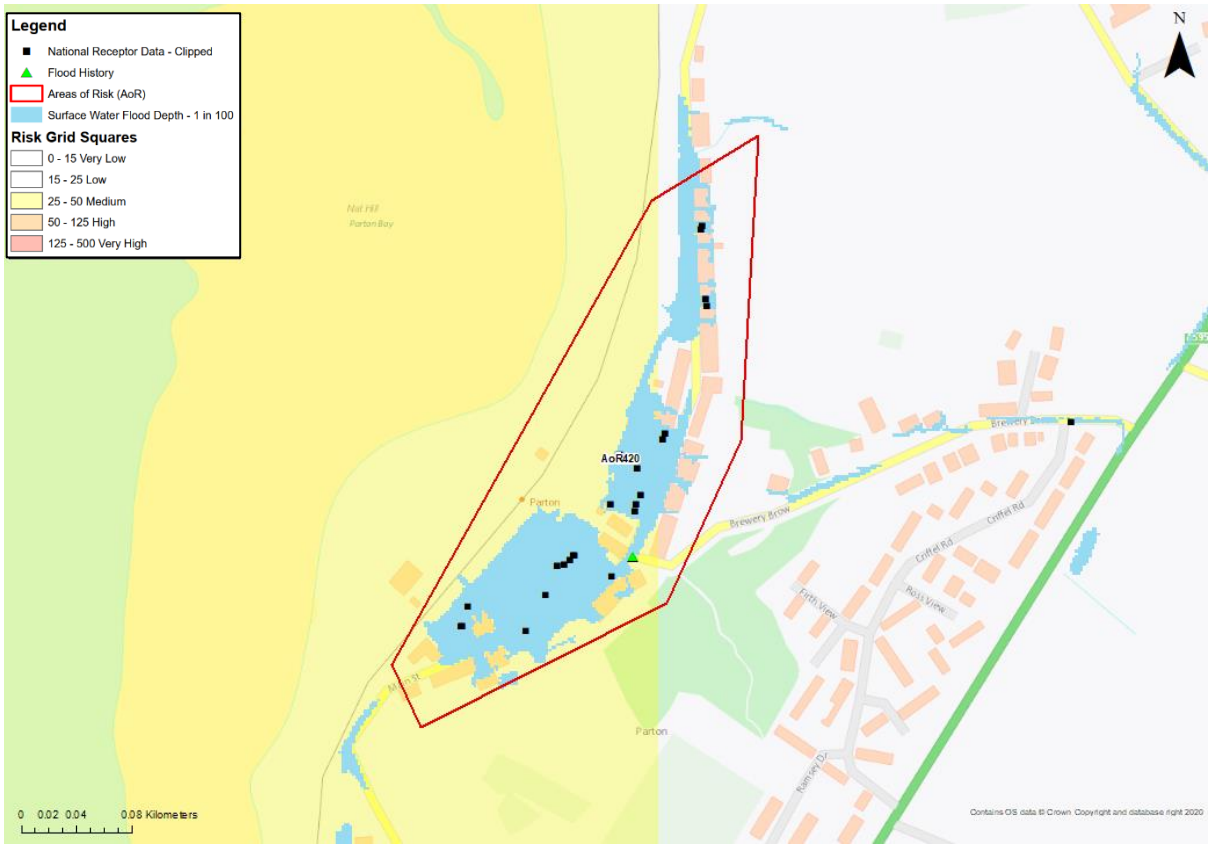


Figure 4-24 AoR's Whitehaven PVA (1 of 3)

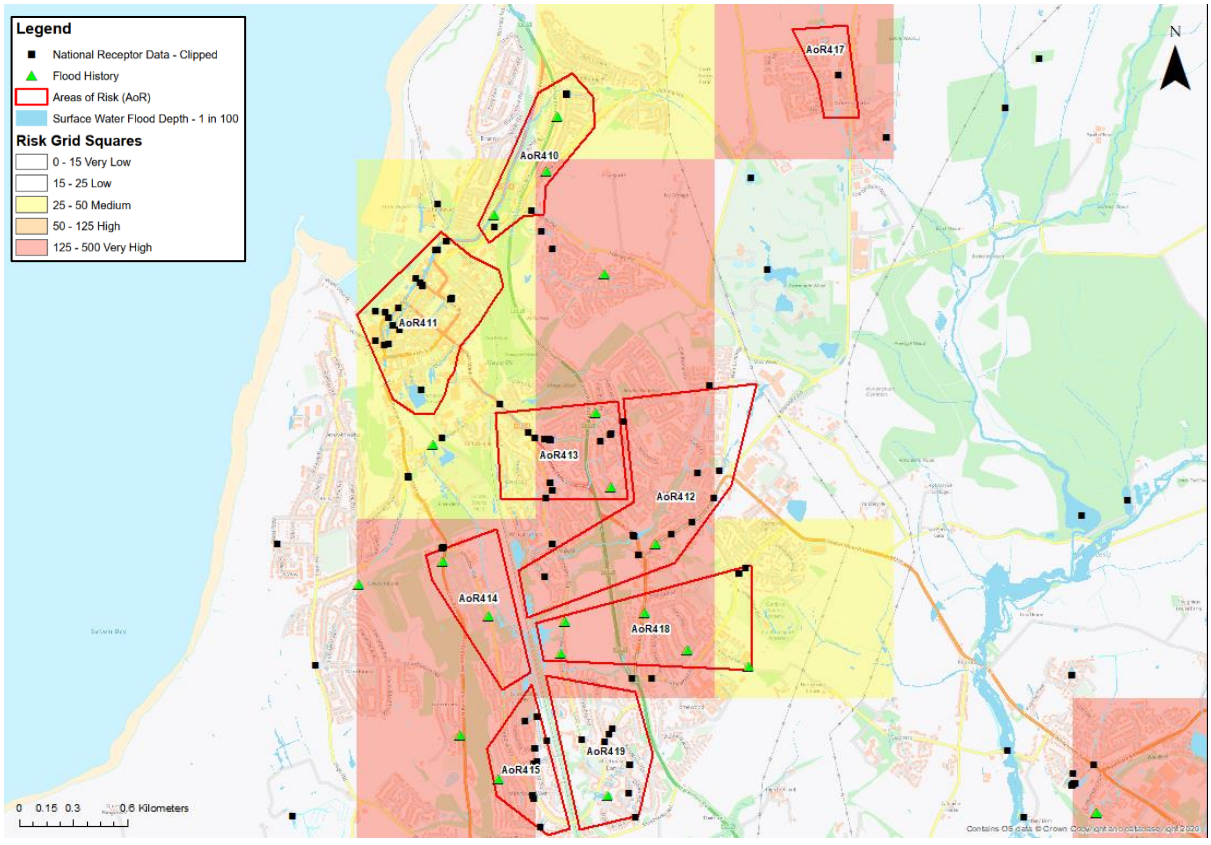


Figure 4-25 AoR's Whitehaven PVA (2 of 3)

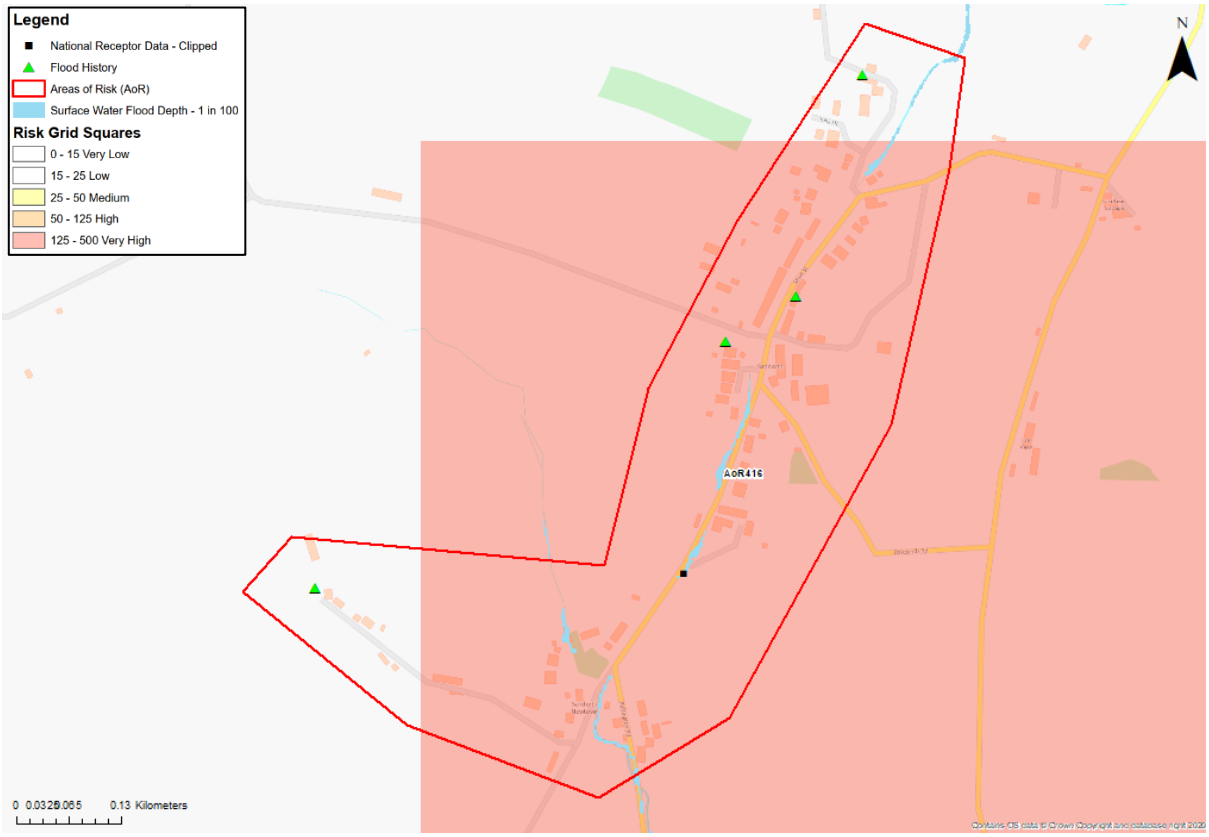


Figure 4-26 AoR's Whitehaven PVA (3 of 3)

Action Plan

Table 4-19 Whitehaven PVA Stage 2b Action Plan

Type of Action	Location	AoR s	Delivery lead	Action
Consultation	Bleach green	AoR410	EA/CCC	Consult EA regarding proposed scheme
SWMP – ICM	Parton	AoR420	CCC	Separate SWMP/ICM modelling
SWMP - ICM	Sandwith	AoR416	CCC	Separate SWMP/ICM modelling
SWMP - ICM	Whitehaven	AoR411 AoR412 AoR413 AoR414 AoR415 AoR418 AoR419	CCC/UU/ EA	• Review UU model • Consult with UU and EA • SWMP/ICM modelling for Whitehaven – detailed focus on multiple AoR's utilising UU model/EA fluvial models

4.7 PVA-007 Cockermouth

Cockermouth (Potentially Vulnerable Area 007)

Total risk classification: High

River basin district name:	Management catchment:	Operational catchment:	Waterbody name:
North West	Derwent North West	Cocker	Cocker - conf Whit Beck to conf Derwent

Background

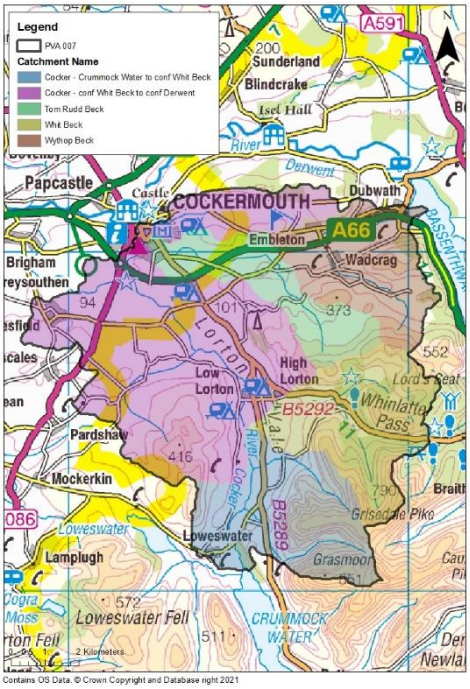
This Potentially Vulnerable Area is centred around Cockermouth and is formed of the cocker catchment which is located in the west of Cumbria. It has an area of approximately 42km².

There are two main tributaries of the River Cocker; Gatesgarth Beck arises on the west side of Honister pass and flows through Buttermere Lake, and Park Beck flows out of Loweswater. Both flow through Crummock Water to form the River Cocker which flows through Lorton Vale and into Cockermouth town, where it joins with the River Derwent.

A number of small becks join upstream of Low Lorton to form the River Cocker. The river continues west where it is joined by the Sandy Beck and Gray Beck upstream of the village of Southwaite. Tom Rudd Beck and Bitter Beck join the River Cocker in Cockermouth.

There are a number of small villages within the catchment including Lorton, Loweswater, Eaglesfield and Buttermere.

Pastoral agriculture is the main land use in the floodplains and low lying areas. The catchment contains several small areas of native woodland, the western half of the Whin-latter Forestry England plantation and extensive areas of blanket bog.



Summary of flooding impacts

The risk of flooding to people and property are summarised in Table 4-20.

The Cockermouth PVA is made from wider catchments as the contribution of flooding sources could be from the multiple catchments that converge on Cockermouth. Flood history here is limited but the strategic assessment shows residential and non-residential properties at risk within the cocker sub-catchment.

The location of the impacts of flooding is shown in Figure 4-27.

Table 4-20 Risk of flooding PVA 007 (1% AEP Scenario)

Category	Cocker – conf Whit Beck to conf Derwent	Whthop Beck	Tom Rudd Beck	Whit Beck	Cocker – Crummock Water to conf Whit Beck
Social - People	15 residential properties	2 residential properties	None	None	None
Social - Community	1 Sports facility	None	None	None	None
Economic - Businesses	10 non-residential properties	None	None	None	None
Economic - Transport	A66(T), A5086, B5292, B5289, Minor roads at multiple locations,	A66(T), B5291, minor roads at multiple locations,	B5292, minor roads at multiple locations	B5292, minor roads at multiple locations	B5289, minor roads at multiple locations
Environment - Agriculture	None of note	None of note	None	None	Agricultural land at Lorton Vale
Environment – Cultural and Natural Heritage	Lake District National Park, 3 listed buildings, 2 SSSI's, 2 SAC's, 1 NNR (Sandybeck Meadow),	Lake District National Park, 1 SSSI and NNR (Bassenthwaite Lake), 1 SAC (River Derwent & Bassenthwaite Lake	Lake District National Park	Lake District National Park	Lake District National Park, 2 SSSI's, 2 SAC's
Verification – Number of recorded flood events	5	2	1	0	0

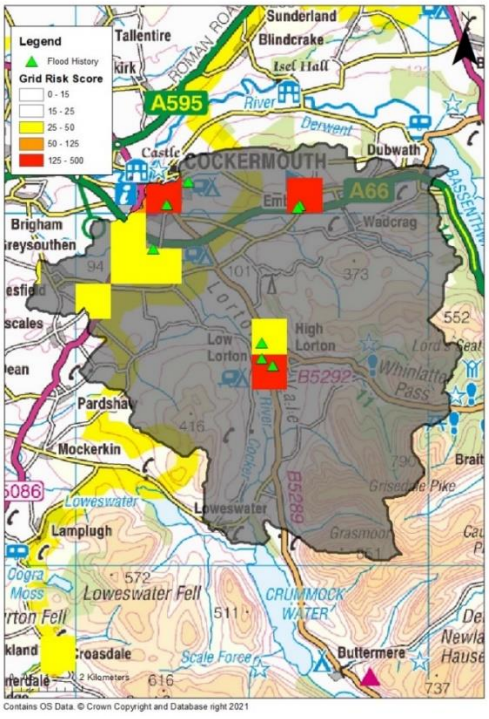


Figure 4-27 Risk and flood history PVA-007

Sensitivity to Climate Change

Based on peak flow climate change uplifts the catchment is deemed to be **sensitive** to climate change. This indicates potential greater frequency and magnitude of potential flooding in the future at a scale which could significantly reduce any mitigation measures designed to present day data. This may require a medium allowance to be used as a design scenario for scheme development.

It should also be noted given the prevalence of urban areas in this catchment flooding from overwhelmed drainage networks is likely to increase in frequency and magnitude.

History of flooding

The village of Lorton at High Road has been subject to regular flooding from field runoff and culvert blockage impacting up to 8 properties as well as the highway.

In the south east of the PVA, within Cockermouth, regular surface water flooding is reported multiple times annually at High Field Estate. This has impacted roadway and up to 20 properties. This has been attributed to field runoff in the past. Existing flood defences in Cockermouth should offer protection up to a 1 in 100-year fluvial flood event but have been overtopped in bigger storms.

Previous issues with highway drainage were reported at Low Lorton on the Cockermouth Approach and at Gote Road and Simonscales Lane in Cockermouth. Upgraded drainage infrastructure appears to have resolved these regular issues.

Area of Risk Identification

AoR's identified in the Cockermouth PVA are shown in the figures below. Analysis of flood history, predicted flood extents, receptors affected, topography, review of CCC flood reports, likely flood mechanism and consultation with CCC staff has been used to identify priority AoR's to be taken forward for this PVA (**Table 4-21**) and relevant actions to reduce surface water flood risk (Table 4-22).

Table 4-21 Stage 2a Cockermouth PVA AoR Identification Summary

No of AoR s	AoR s not taken forward	AoR s taken forward for consultation	AoR s taken forward for detailed assessment
4	AoR310 AoR313	AoR312 AoR311	-

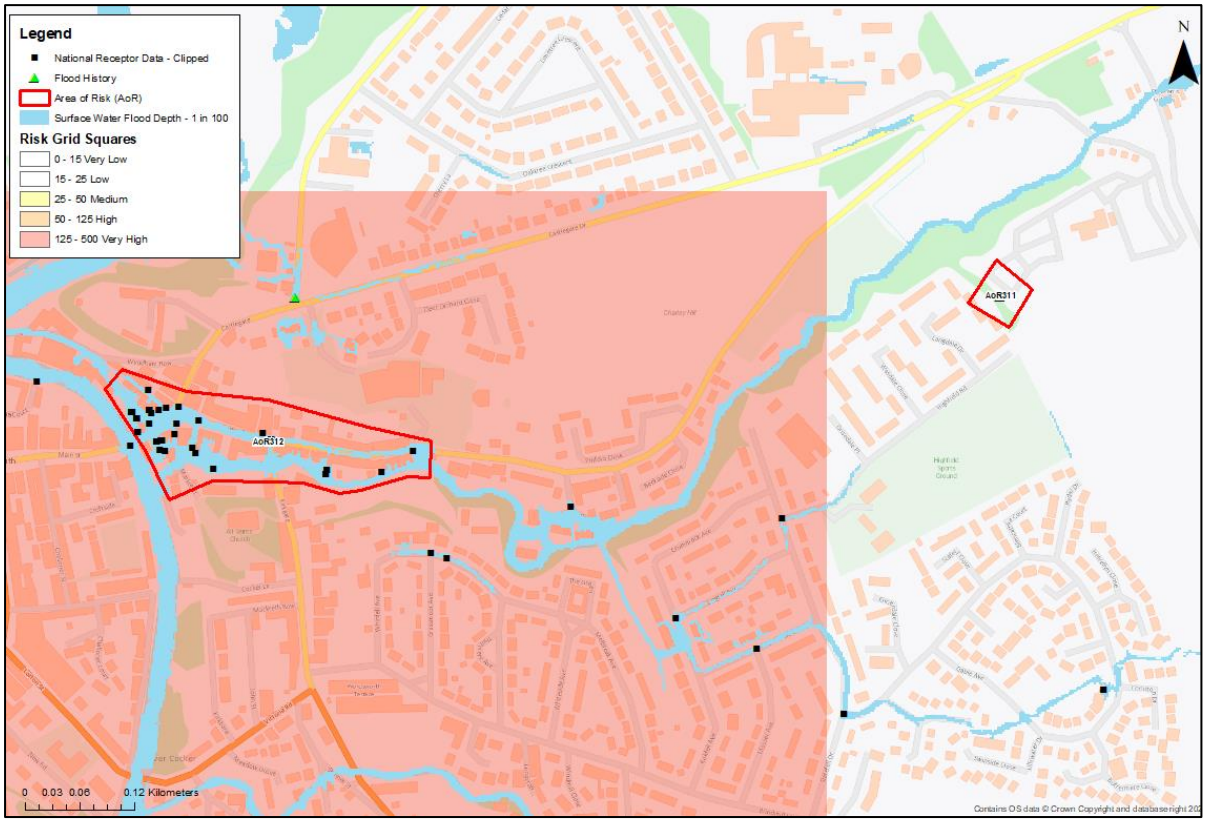


Figure 4-28 AoR's Cockermouth PVA (1 of 3)

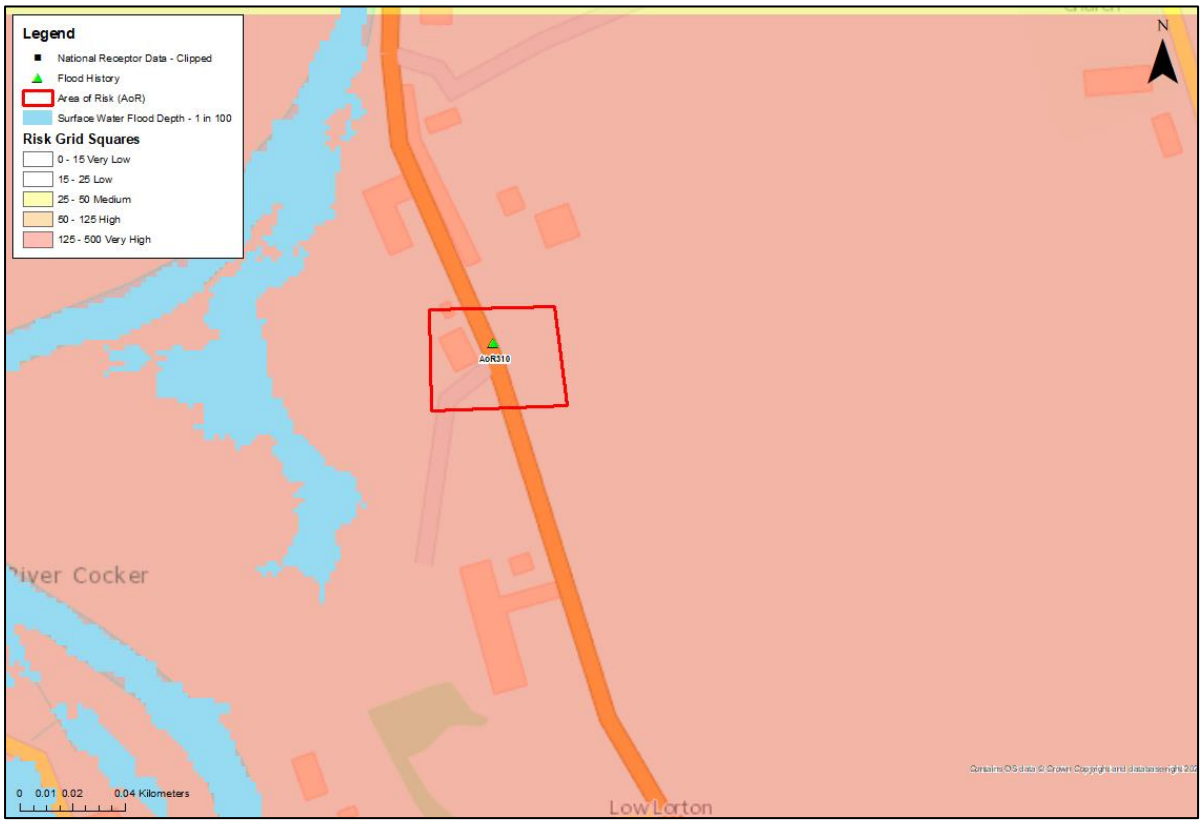


Figure 4-29 AoR's Cockermouth PVA (2 of 3)

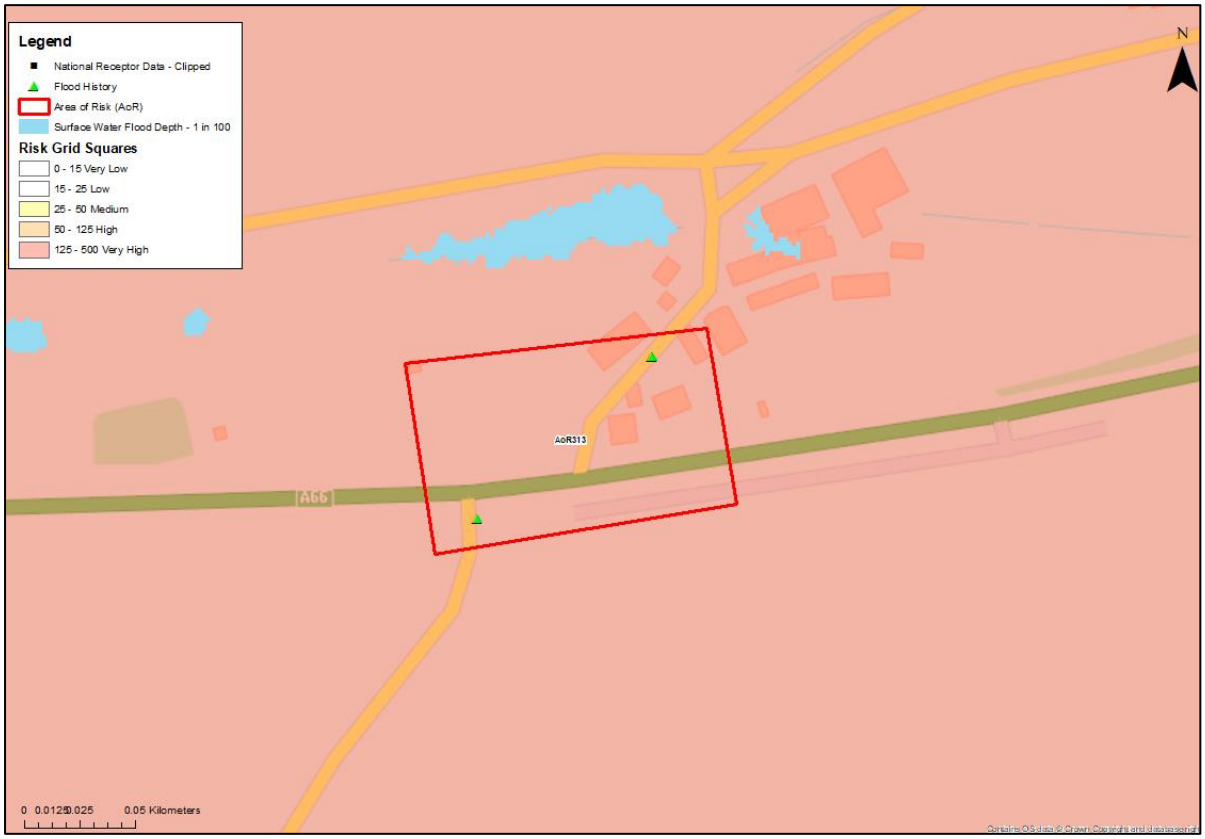


Figure 4-30 AoR's Cockermouth PVA (3 of 3)

Action Plan

Table 4-22 Cockermouth PVA Stage 2b Action Plan

Type of Action	Location	AoR s	Delivery lead	Action
Consultation	Marketplace Cockermouth	AoR312	CCC	Review UU model outputs
SWMP	High field, Cockermouth	AoR311	CCC	2D Pluvial Study

4.8 PVA-009 Maryport

Maryport (Potentially Vulnerable Area 009)

Total risk classification: High

River basin district name:	Management catchment:	Operational catchment:	Waterbody name:
North West	Derwent North West	Ellen and West Coast	Ellen (lower) and coastal catchment

Background

This Potentially Vulnerable Area is centred around Maryport and is formed of the lower Ellen catchment and a coastal catchment which is located in the west of Cumbria. It has an area of approximately 76km².

The River Ellen originates in the northern Lake District fells and flows west to the sea at Maryport. It has two main tributaries; Threapland Gill and Cockshot Beck, as well as a number of smaller streams joining it.

Much of the catchment is underlain by limestone, sandstone, siltstone and mudstone and coal formations which would allow infiltration. Soils tend to be loamy and clayey soils offering slow permeability.

The steep upper reaches of the Ellen are dominated by sheep grazing with two reservoirs, Overwater and Chapelhouse. In its middle and lower reaches the Ellen meanders through the north Cumbria plain. The predominant land uses are pastoral farming and cereal growing.

There are a number of villages within the catchment and the small town of Aspatria. Within the urban area there are believed to be capacity or hydraulic constraints within the UU network.

The Dearham area of the catchment is at particular risk of surface water flooding due to overland flow from the former open cast coal sites to the rear of Central Road and Maryport Road. The existing surface water drainage system in Dearham, includes many old stone culverts, of insufficient capacity to manage flash flooding. There are also poor connections with sewers entering the main culvert. New developments have placed more pressure on the surface water drainage system.

Summary of flooding impacts

The risk of flooding to people and property are summarised in Table 4-23.

The Maryport has a large amount of grid cells that have been highlighted at risk from surface water flooding. The coastal catchment especially has a large number of residential properties at risk with the wider PVA having a large number of medium risk grid cells highlighting the large number of infrastructure and transport links that have the potential to be at flood risk.

The location of the impacts of flooding is shown in

Figure 4-31.

Table 4-23 Risk of flooding PVA 009 (1% AEP Scenario)

Category	Ellen	Coastal
Social - People	5 residential properties	45 residential properties
Social - Community	2 locations at sewage works	3 community assets (including playground and village hall)
Economic - Businesses	7 non-residential properties	6 development sites.
Economic - Transport	A596, A595, A591, A594, B5301, minor roads at multiple locations, Railway at multiple locations.	A597, A596, Railway in 2 locations, minor roads at multiple locations.
Environment - Agriculture	None	None
Environment – Cultural and Natural Heritage	1 scheduled monument, 1 listed buildings, 1 World Heritage Sites.	2 scheduled monument, 2 SSSI's (Siddick Pond and Maryport Harbour), LNR Siddick Pond, World Heritage Site (Roman ruin).
Verification – Number of recorded flood events	11	5

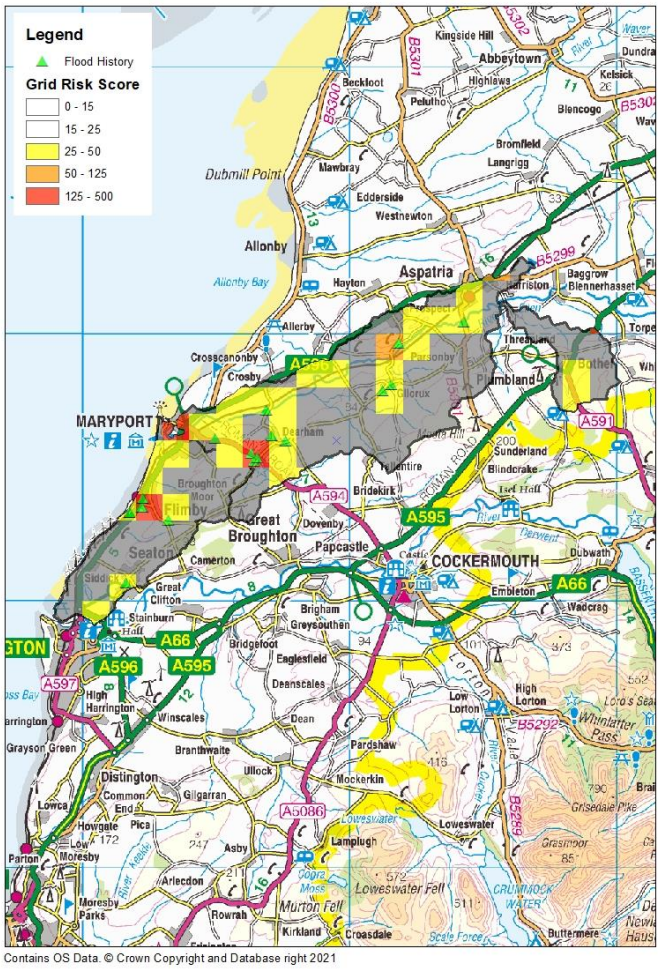


Figure 4-31 Risk and flood history PVA-009

Sensitivity to Climate Change

Based on peak flow climate change uplifts the catchment is deemed to be **sensitive** to climate change. This indicates potential greater frequency and magnitude of potential flooding in the future at a scale which could significantly reduce any mitigation measures designed to present day data. This may require a medium allowance to be used as a design scenario for scheme development.

It should also be noted given the prevalence of urban areas in this catchment flooding from overwhelmed drainage networks is likely to increase in frequency and magnitude.

History of flooding

Maryport was affected by significant surface water flooding in December 2015. Anecdotal reports indicate this was due to intense rainfall (30mm over 3 hours) causing drains and streams to become overwhelmed. 70 properties were reported to be flooded. Elbra Farm Close and Hawthorn Avenue was flooded from Gill Beck. The Grasslot Street and Solway Trading Estate areas suffered from water flowing out of Eel Syke. Surface water flooding affected properties on Selby Terrace and Lawson Street.

Flooding at Flimby in the west of the PVA has been a frequent occurrence every 2 to 5 years as a result of culvert blockage impacting properties. The Flimby Cat Gill Culvert has flooded up to 24 properties internally whilst the Bragg Beck culvert has impacted 3 properties externally. These culverts interact with UU systems, highway drainage and new housing drainage infrastructure therefore will need a partnership approach to be resolved.

The Dearham area has also a history of flood risk largely attributed to sewer flooding, surface water ponding and exceedance of highway drainage. Sewer flooding has been experienced every 2 to 5 years at the post office due to poor drainage infrastructure at a low point.

Commercial Corner and Gill Beck Culvert have also been subject to flooding in the past with up to 10 properties affected. Externally, flooding has also been reported frequently at Dearham Bridge affecting one property. Given the connections between drainage and watercourses in these locations an integrated consideration of flood risk should be considered and partnership working undertaken with UU.

Groundwater is also noted to be an issue in this PVA particularly at Crakia Road and Newlands Park where up to 6 properties have been affected annually.

Previous tidal flooding has been reported in Nelson Street with works put in place in 2014 to resolve this issue. Given the PVAs coastal discharge, sea level rise and interaction with overland flows, rivers and drainage outfalls will need to be considered in future surface water and resilience planning.

Area of Risk Identification

AoR's identified in the Maryport PVA are shown in the figures below. Analysis of flood history, predicted flood extents, receptors affected, topography, review of CCC flood reports, likely flood mechanism and consultation with CCC staff has been used to identify priority AoR's to be taken forward for this PVA (**Table 4-24**) and relevant actions to reduce surface water flood risk (Table 4-25).

Table 4-24 Stage 2a Maryport PVA AoR Identification Summary

No of AoR s	AoR s not taken forward	AoR s taken forward for consultation	AoR s taken forward for detailed assessment
8	AoR302 AoR303 AoR305	N/A	AoR304 AoR306 AoR307 AoR308 AoR309

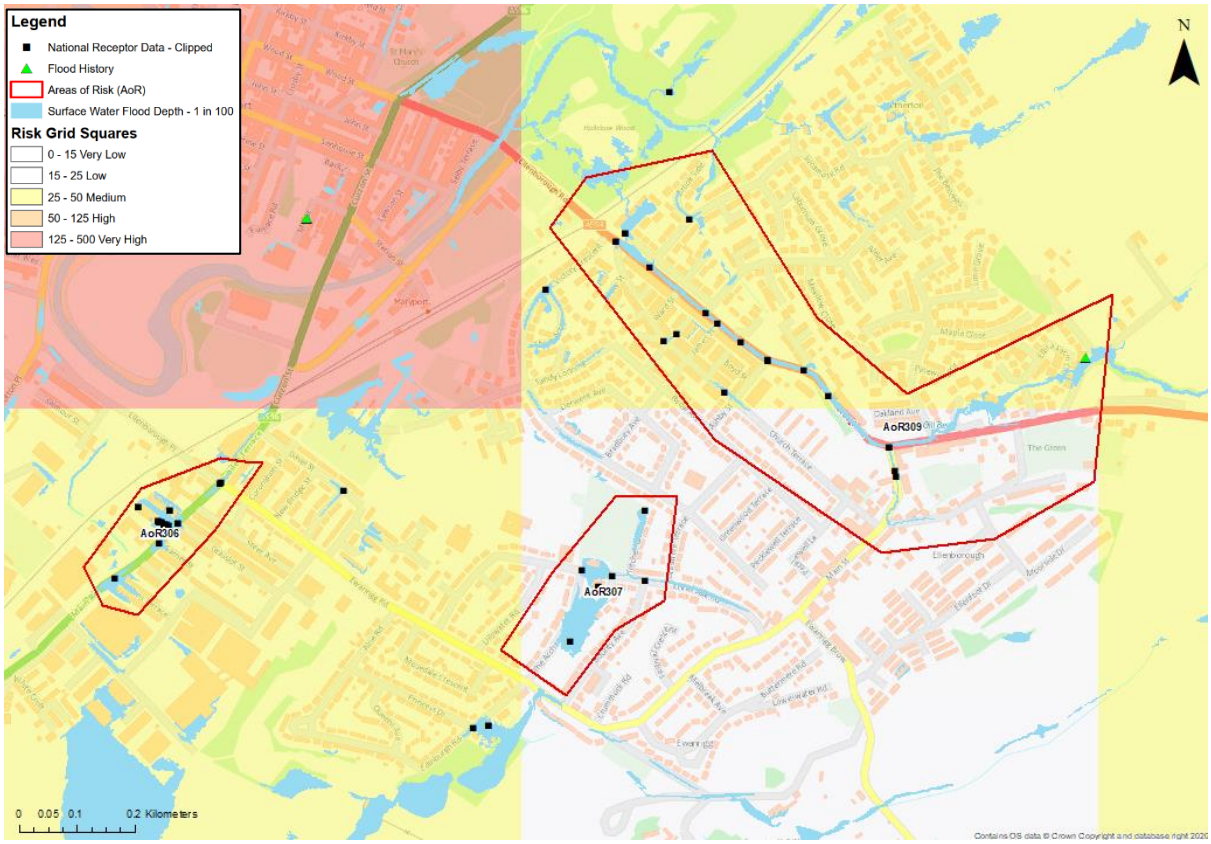


Figure 4-32 AoR's Maryport (1 of 6)

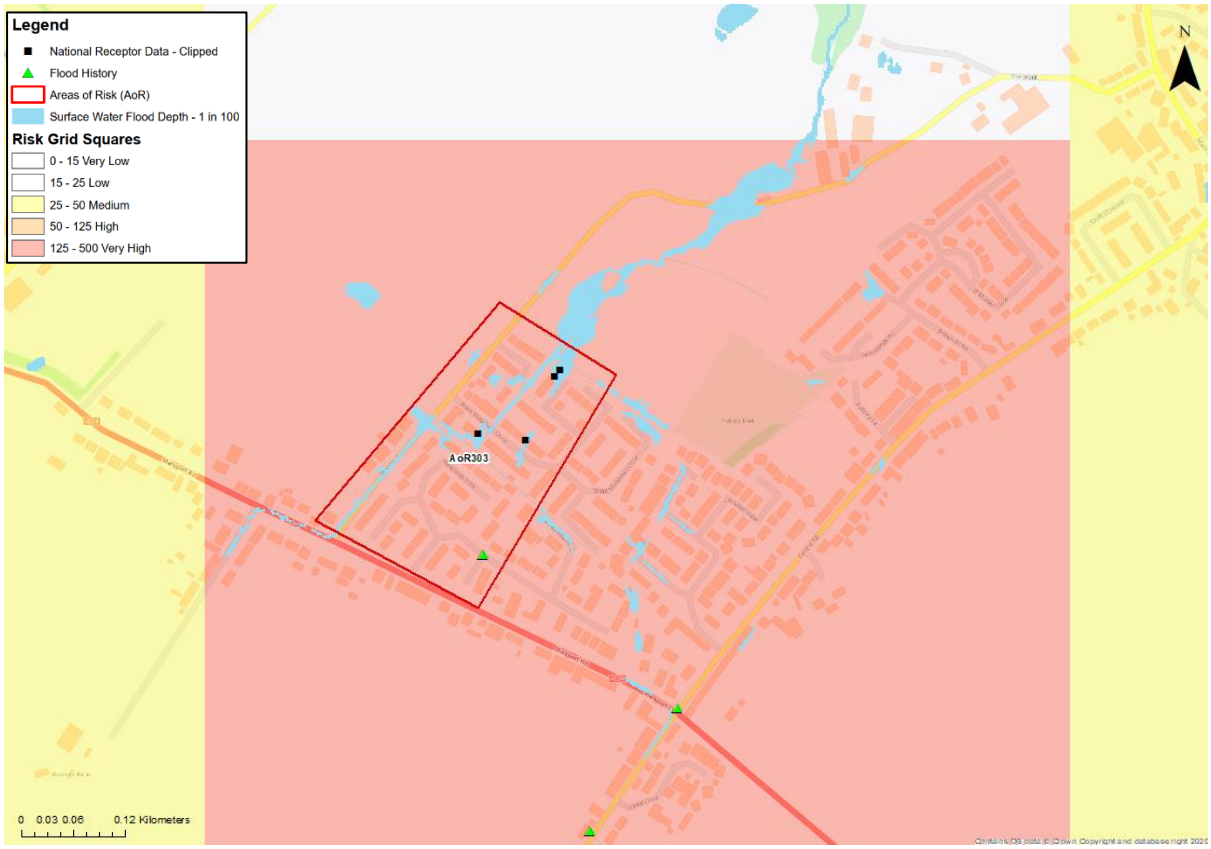


Figure 4-33 AoR's Maryport PVA (2 of 6)

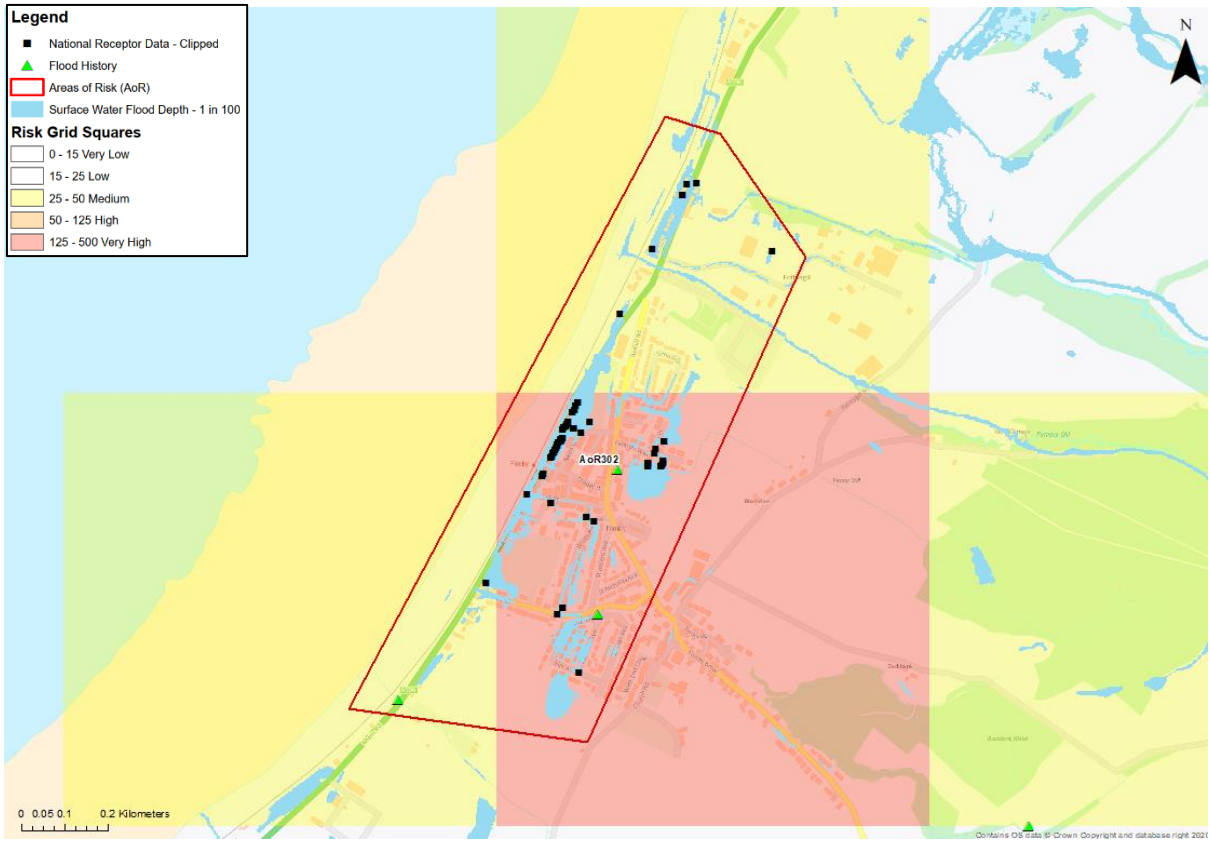


Figure 4-34 AoR's Maryport PVA (3 of 6)

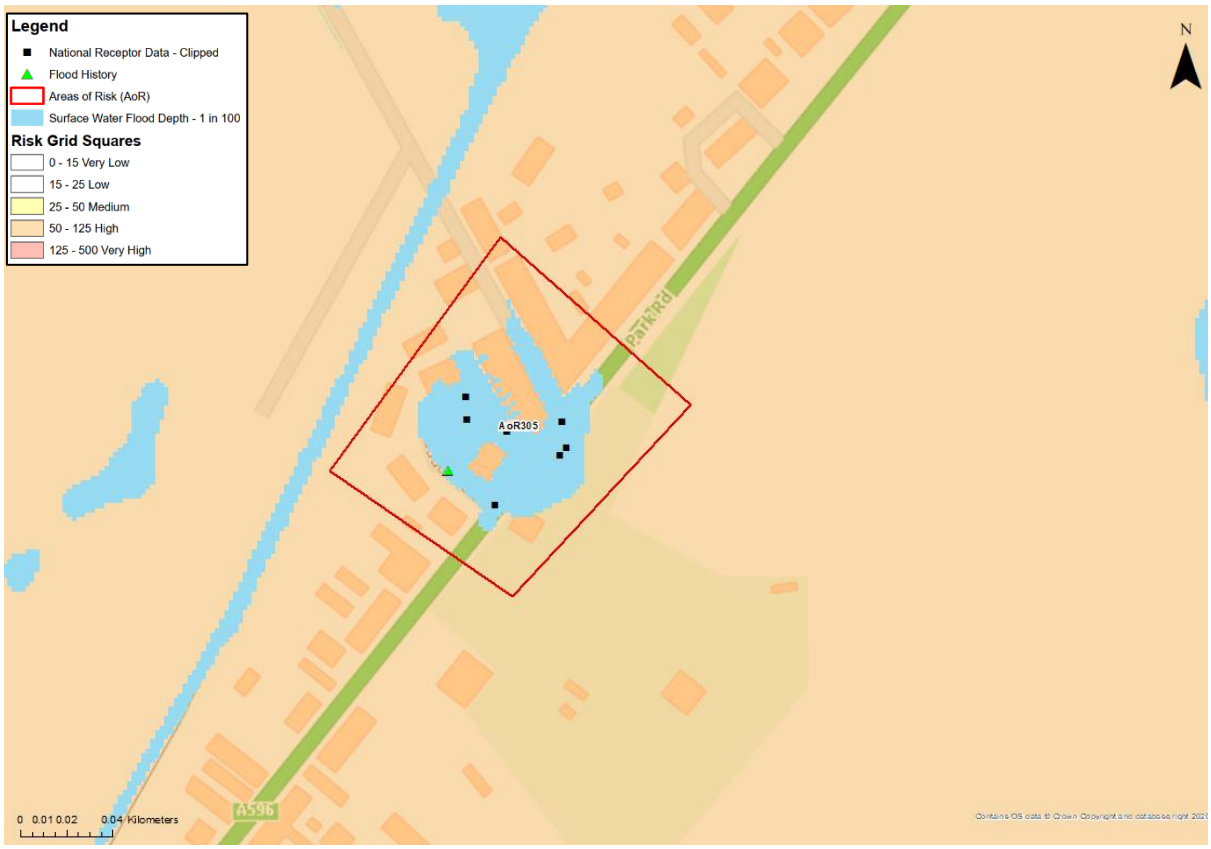


Figure 4-35 AoR's Maryport (4 of 6)

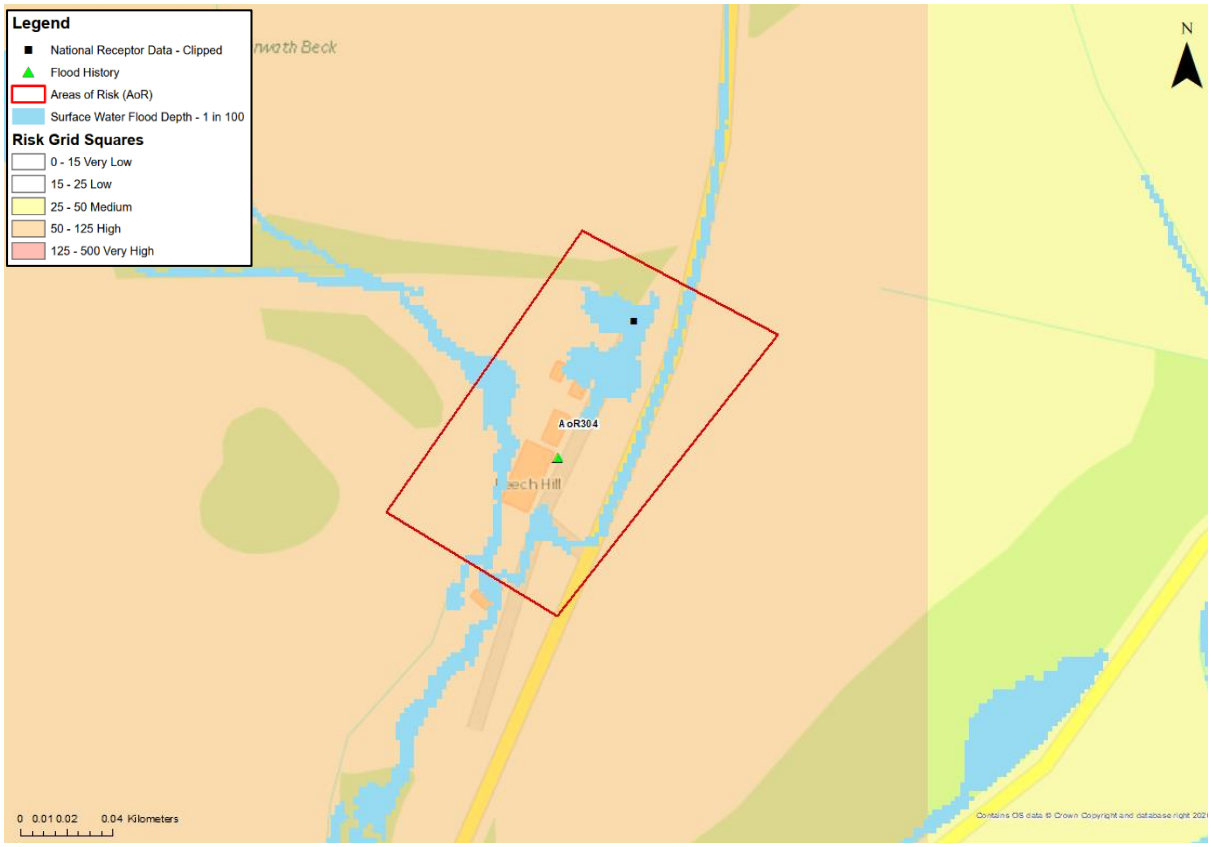


Figure 4-36 AoR's Maryport (5 of 6)

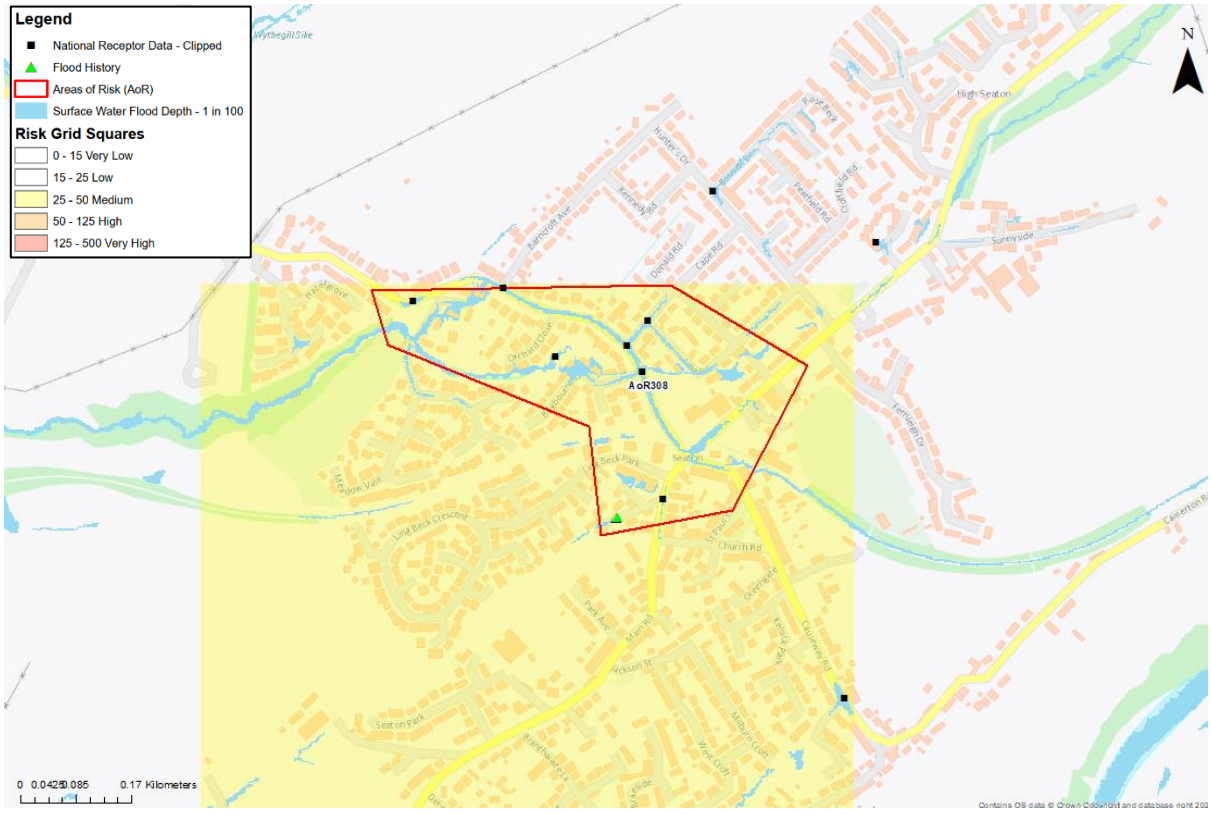


Figure 4-37 AoR's Maryport (6 of 6)

Action Plan

Table 4-25 Maryport PVA Stage 2b Action Plan

Type of Action	Location	AoR s	Delivery lead	Action
SWMP - ICM	Seaton	AoR308	CCC	• Review UU model • Carry out as individual SWMP/ICM model
SWMP - ICM	Gill Beck	AoR309	CCC	• Review UU model • Fully integrated (costal, fluvial & pluvial) study • Potential to link with HS006 after UU model review
SWMP - ICM	Maryport, Main Road	AoR306	CCC	• 1D/2D study assessing interaction between surface water, sewer and river flooding.
SWMP	Ewanrigg	AoR307	CCC	• 2D pluvial study • Potential to link with HS008 after UU model review
SWMP	Hindrigg	AoR304	CCC	• 2D pluvial study

4.9 PVA-011 Carlisle

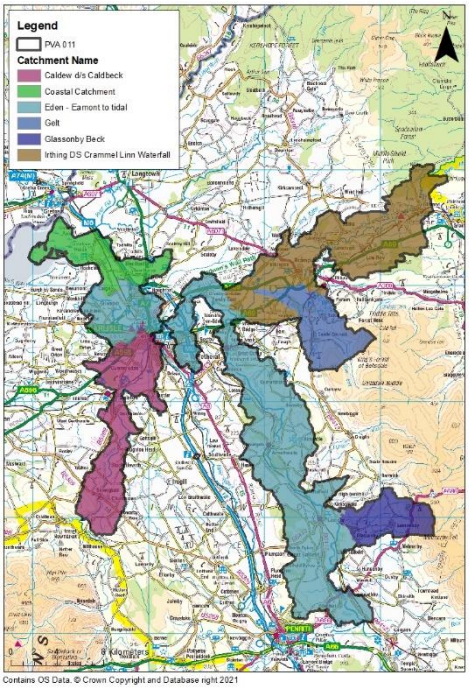
Carlisle (Potentially Vulnerable Area 011)

Total risk classification: Very High.

River basin district name:	Management catchment:	Operational catchment:	Waterbody name:
Solway Tweed	Eden and Esk	Caldew, Esk and Irthing, and Eden Lower	Caldew d/s Caldbeck, Irthing DS Crammel Linn Waterfall and Eden - Eamont to tidal

Background

This Potentially Vulnerable Area is centred around Carlisle and is formed of the Eden and Esk catchments which are located in the north of Cumbria. It has an area of approximately 315km².



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The catchment within this PVA is extensive and consists of a number of large subcatchment units.

To the north west of the PVA, the River Irthing forms part of the PVA. The source of the River Irthing is in the Northumberland National Park within the conifer plantations and blanket bog around Butterburn. It flows south-west to meet the Eden just north of Warwick Bridge. Bolton Fell and Walton Moss (a part-restored lowland raised moss) drains into the Irthing near Brampton. The King Water and Gelt are important tributaries with the Upper Gelt and Old and New Water tributaries feeding the drinking water reservoir at Castle Carrock. The uplands are managed for sheep, cattle and grouse and the lowlands for intensive beef, dairy, sheep and arable.

To the west, the River Caldew forms part of the PVA. The River Caldew originates from the Skiddaw massif to the north of Keswick. The river flows north through Caldbeck, Dalston and Cummersdale villages, before joining the River Eden at Carlisle. Its main tributaries are Pow and Roe Beck, the River Ive and Gillcambon Beck. Land use is mixed, with upland sheep farming in the headwaters and dairy and beef farming in the lower reaches. It is urban through Carlisle. The impact of mining can still be seen in the Mosedale valley near Carrock Fell and near High Pike.

To the south, The River Petteril is not currently included in the PVA but will contribute to flows in the Eden. The River Petteril begins close to the villages of Penruddock and Greystoke and flows north towards Carlisle, where it joins the River Eden. It runs alongside the M6 motorway and West Coast Mainline railway for much of its length. The River Petteril's main tributary, Blackrack Beck, joins the Petteril north of Calthwaite. Land use in the Petteril catchment is mainly dairy and beef farming until the river reaches the city.

The Lower Eden in the north of the PVA, starts at Watersmeet where the Eamont meets the Eden downstream of Penrith. It flows north over red sandstone through the villages of Langwathby, Lazonby, Armathwaite and Wetheral; it is joined by the Esk and Irthing to the north east of the Carlisle, before flowing through the city and out into

the Solway Firth in the west. Water drains from the west side of the central North Pennines directly into the lower Eden via number of tributaries. The predominant land use outside the city is dairy and arable farming.

Carlisle lies upstream of any tidal influence on the River Eden so flood risk is not impacted by tides.

Summary of flooding impacts

The risk of flooding to people and property are summarised in Table 4-26.

The Carlisle PVA has a significant number of properties, infrastructure and assets at risk from surface water flooding based on the strategic assessment. With 100s of residential properties at risk as well and key infrastructure including the M6 and A69 in multiple locations. This is a large complex PVA with significant flood risk. The location of the impacts of flooding is shown in Figure 4-38.

Table 4-26 Risk of flooding PVA 011 (1% AEP Scenario)

Category	Caldew d/s Caldbeck	Irthing DS Crammel Linn Waterfall	Gelt	Glassonby Beck	Eden - Eamont to tidal	Coastal Catchment
Social - People	130	39	3	1	156	2
Social - Community	4	0	1	1	7	0
Economic - Businesses	12	5	1	0	24	0
Economic - Transport	A6, A595, B5299, B5305, Railway, Minor roads at multiple locations	A689, A69(T), A6071, B6413, B6318, Railway, Minor roads at multiple locations,	A69(T), B6413, Railway, Minor roads at multiple locations	A686,	M6, A69, A689, A7, A686, A595, B6413, B5307, B6412, B6263, Railway at multiple locations, Minor roads at multiple locations	M6, A7, A689, Railway, Minor roads at multiple locations,
Environment - Agriculture	None of note	None of note	None of note	None of note	None of note	None of note
Environment – Cultural and Natural Heritage	Lake District National Park, 4 scheduled monuments, River Eden SSSI, 4 listed bridges, Dalston Road Cemetery, Hadrians Wall	Scheduled monuments at 12 locations, 2 SAC's, Northumberland National Park, 3 SSSI's, 5 listed buildings, 2 world heritage sites,	4 SSSI's, 2 SAC's, North Pennines Moors, 1 listed bridge, 1 scheduled monument, 1 world heritage sites (roman ruin),	1 SAC's, North Pennines Moors, 1 SSSI,	Corby Castle and Rickerby Park, 2 LNR's, Scheduled monuments at 16 locations, 6 SSSI's, 5 listed bridges, the Solway coast, River Eden, 2 world heritage sites,	1 SSSI, Solway Firth (SAC, SPA and Ramsar), 1 world heritage sites, Solway Coast (AONB),
Verification – Number of recorded flood events	8	3	1	2	15	2

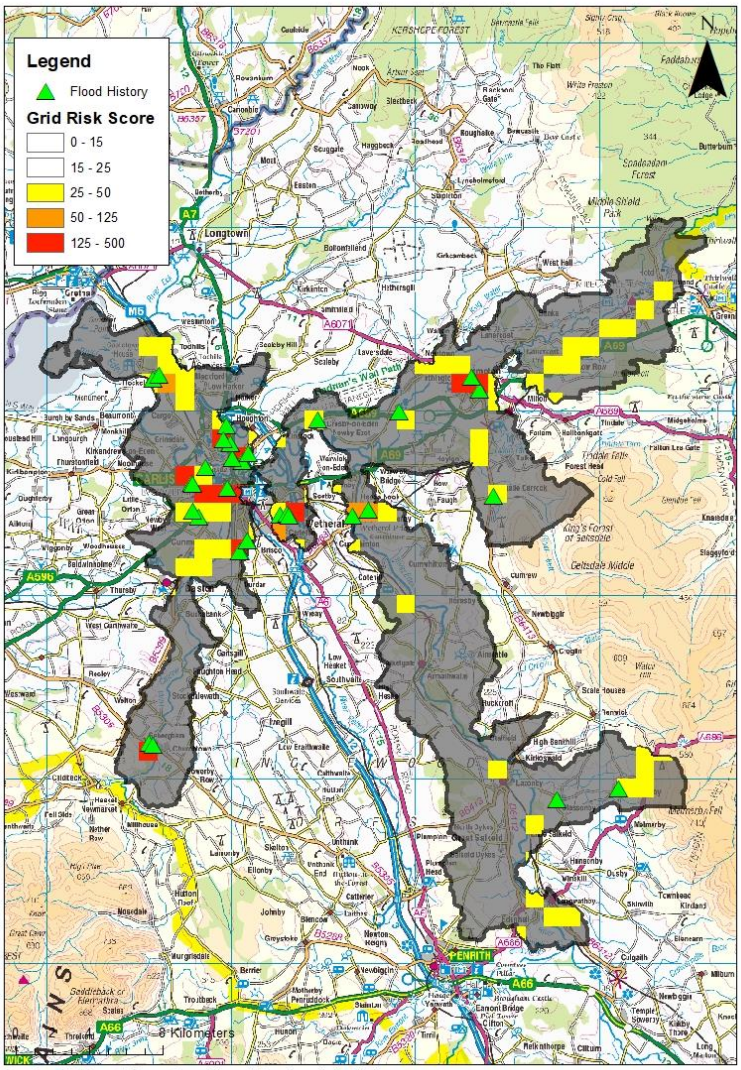

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Figure 4-38 Risk and flood history PVA-011

Sensitivity to Climate Change

Based on peak flow climate change uplifts the catchment is deemed to be **very sensitive** to climate change. This indicates potential greater frequency and magnitude of potential flooding in the future at a scale which could significantly reduce any mitigation measures designed to present day data. This may require a high allowance to be used as a design scenario for scheme development.

It should also be noted given the prevalence of urban areas in this catchment flooding from overwhelmed drainage networks is likely to increase in frequency and magnitude.

History of flooding

Carlisle has a history of flooding with flood events recorded as far back as the 1700s. In recent years there have been significant floods in 1963, 1968, 1979, 1980, 1984, 2005 and recently in 2015.

Across the catchment, the January 2005 flooding affected 2,700 homes. In Carlisle three people died, 1,844 properties were flooded and there was significant disruption to residents, businesses and visitors. The cost of the flooding was estimated at over £400 million. The flooding followed prolonged heavy rain,and was caused by a combination of floodwater from the Rivers Eden, Pettereril and Caldew and localised flooding from sewers and road drainage.

On 5th and 6th December 2015, approximately 2,100 properties suffered flooding. This flooding can be attributed to a record-breaking rainfall event from Storm Desmond. This led to extensive flooding from the Rivers Eden, Petteril, and Caldew, plus flooding from other watercourses, surface water and drainage systems. The river levels experienced in December 2015

exceeded the design level of the existing defences, resulting in the extensive flooding of the City. Overwhelmed drainage also contributed to flooding and occurred prior to watercourses reaching peak flows. This occurred at Warwick Road West, Adelaide Street and Tilbury Road. Additionally integrated flooding between rivers and drainage systems was reported at Etterby Terrace from Gosling Syke and the Hardwick Circus area.

Surface water flooding was also reported in Viaduct Estate due to gravity locking of the local drainage system. This has been noted as a recurrent problem every 6 – 10 years affecting businesses. The Brampton area has also been subject to frequent surface water flooding (2 - 5 years) in the past (2012, 2013) most notably around Vallum Close and Brampton Road affecting a small number of properties. Surface water flooding at Oaklands Drive is also noted due to culvert blockage affecting 4 properties at 6 – 10 year intervals.

Sewer flooding is also known to be an issue around Westrigg Road, Stainton Road and Wigton Road affecting up to 20 properties every 2 – 5 years. California Road is a high priority location affected by integrated flooding from ordinary watercourse, sewer and surface water flooding frequently flooding 5 residential properties.

Area of Risk Identification

AoR's identified in the Carlisle PVA are shown in the figures below. Analysis of flood history, predicted flood extents, receptors affected, topography, review of CCC flood reports, likely flood mechanism and consultation with CCC staff has been used to identify priority AoR's to be taken forward for this PVA (**Table 4-27**) and relevant actions to reduce surface water flood risk (Table 4-28).

Table 4-27 Stage 2a Carlisle AoR Identification Summary

No of AoR s	AoR s not taken forward	AoR s taken forward for consultation	AoR s taken forward for detailed assessment
37	AoR119 AoR115 AoR121	AoR104 AoR105 AoR106 AoR107 AoR108 AoR109 AoR124 AoR125 AoR126 AoR127 AoR110 AoR116 AoR118 AoR120 AoR128 AoR129 AoR130 AoR131 AoR134 AoR135 AoR136 AoR137 AoR138 AoR139 AoR112 AoR111 AoR123 AoR117 AoR132 AoR133 AoR203 AoR113 AoR114 AoR122	AoR104 AoR105 AoR106 AoR107 AoR108 AoR109 AoR124 AoR125 AoR126 AoR127 AoR110 AoR116 AoR118 AoR120 AoR128 AoR129 AoR130 AoR131 AoR134 AoR135 AoR136 AoR137 AoR138 AoR139 AoR112 AoR111 AoR123 AoR117 AoR132 AoR133 AoR203 AoR113 AoR114 AoR122

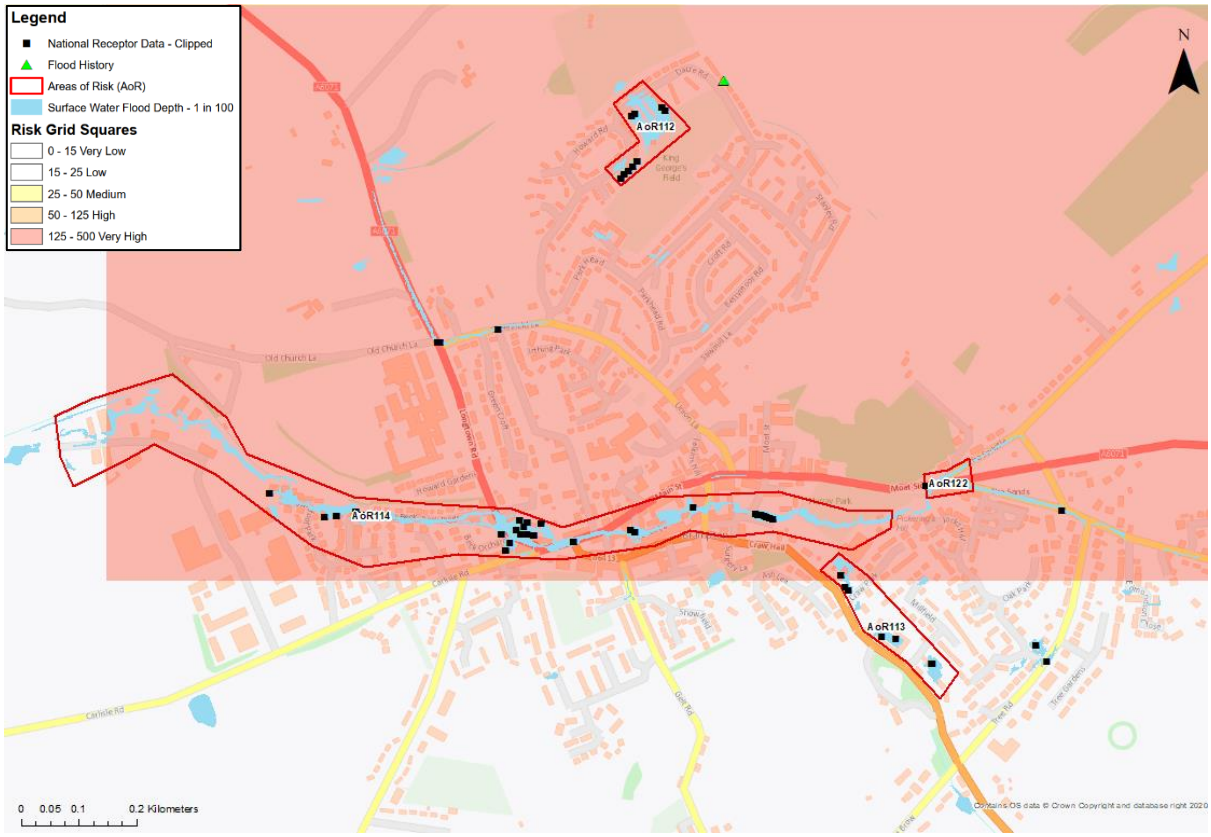


Figure 4-39 AoR's Carlisle (1 of 9)

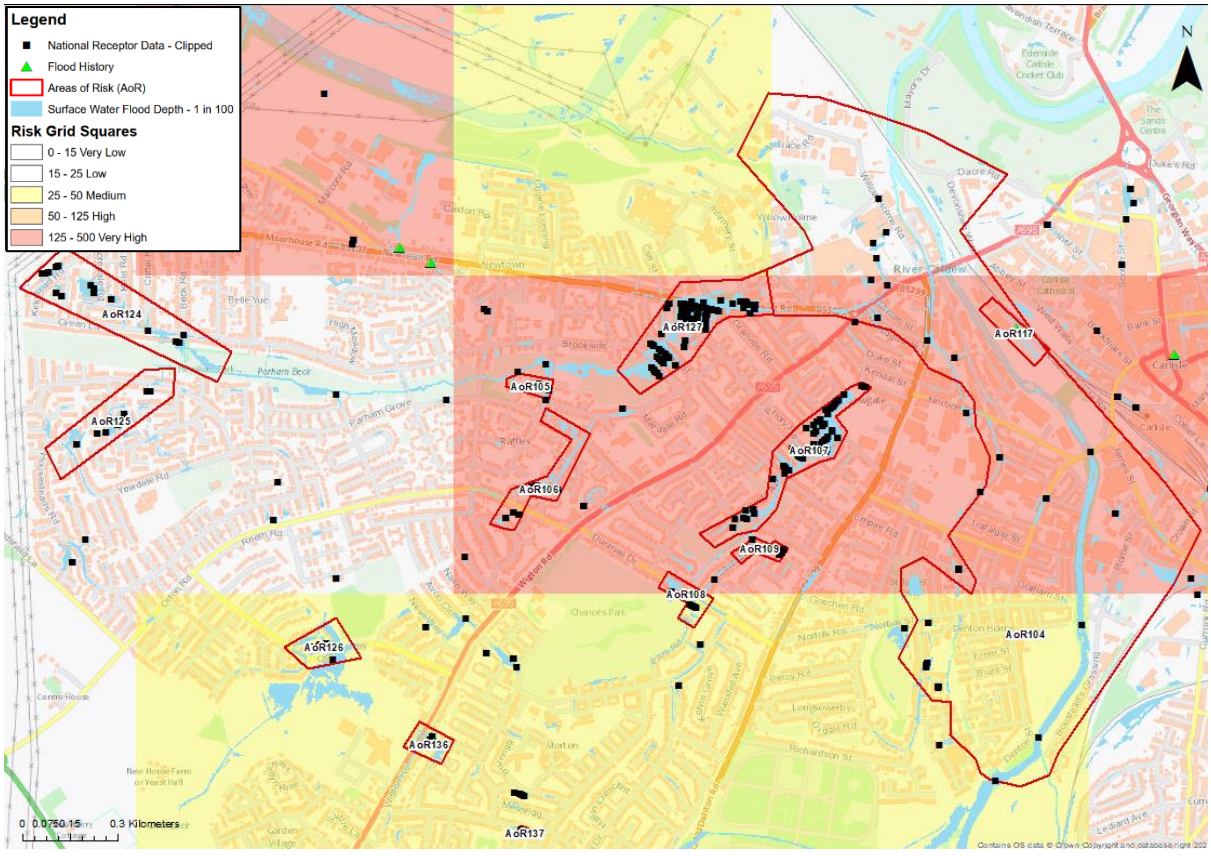


Figure 4-40 AoR's Carlisle (2 of 9)

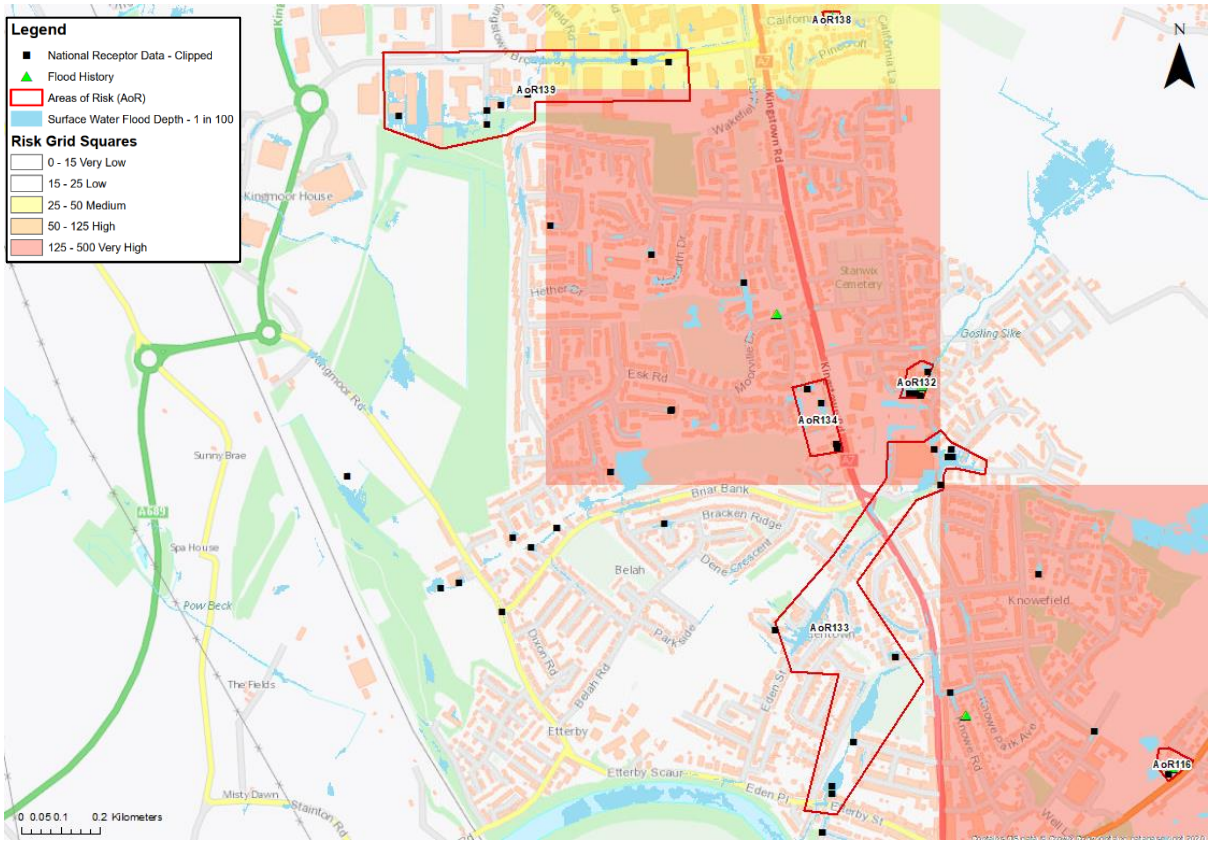


Figure 4-41 AoR's Carlisle (3 of 9)

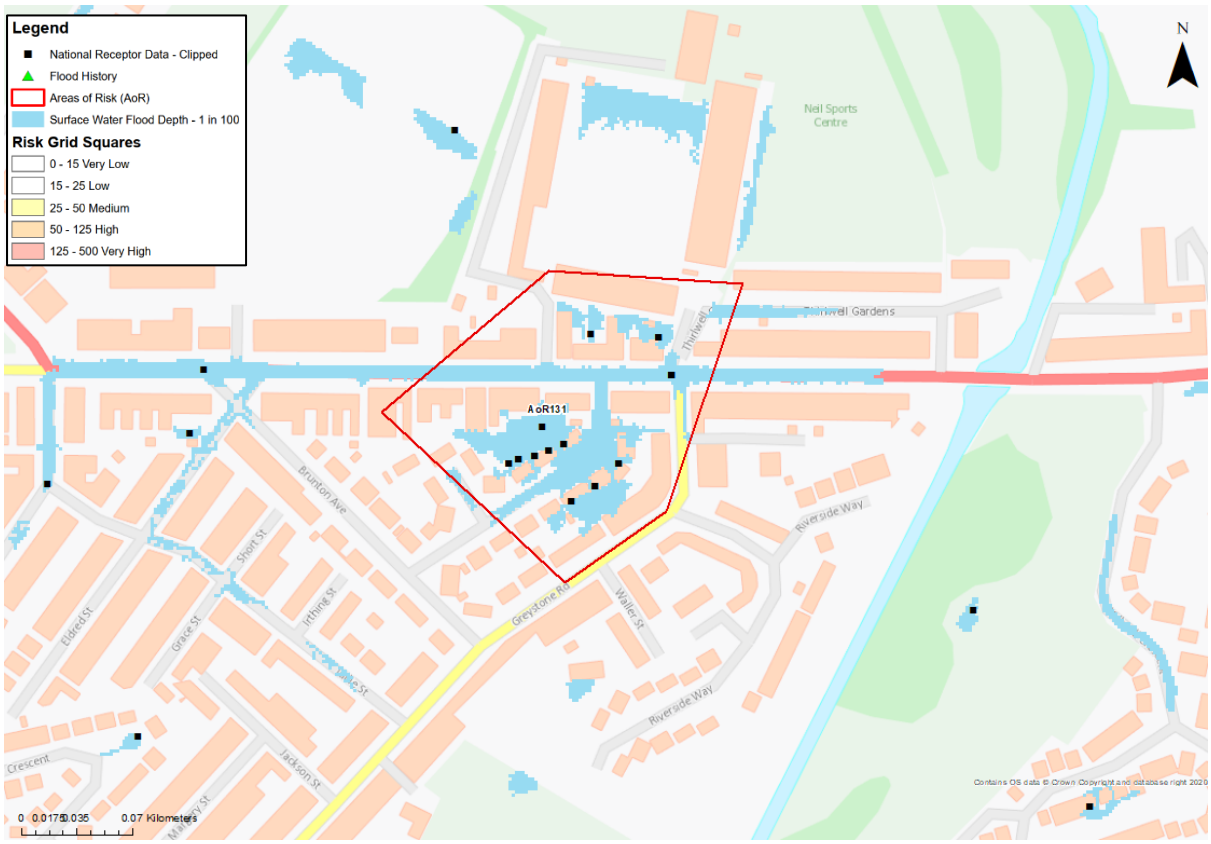


Figure 4-42 AoR's Carlisle (4 of 9)

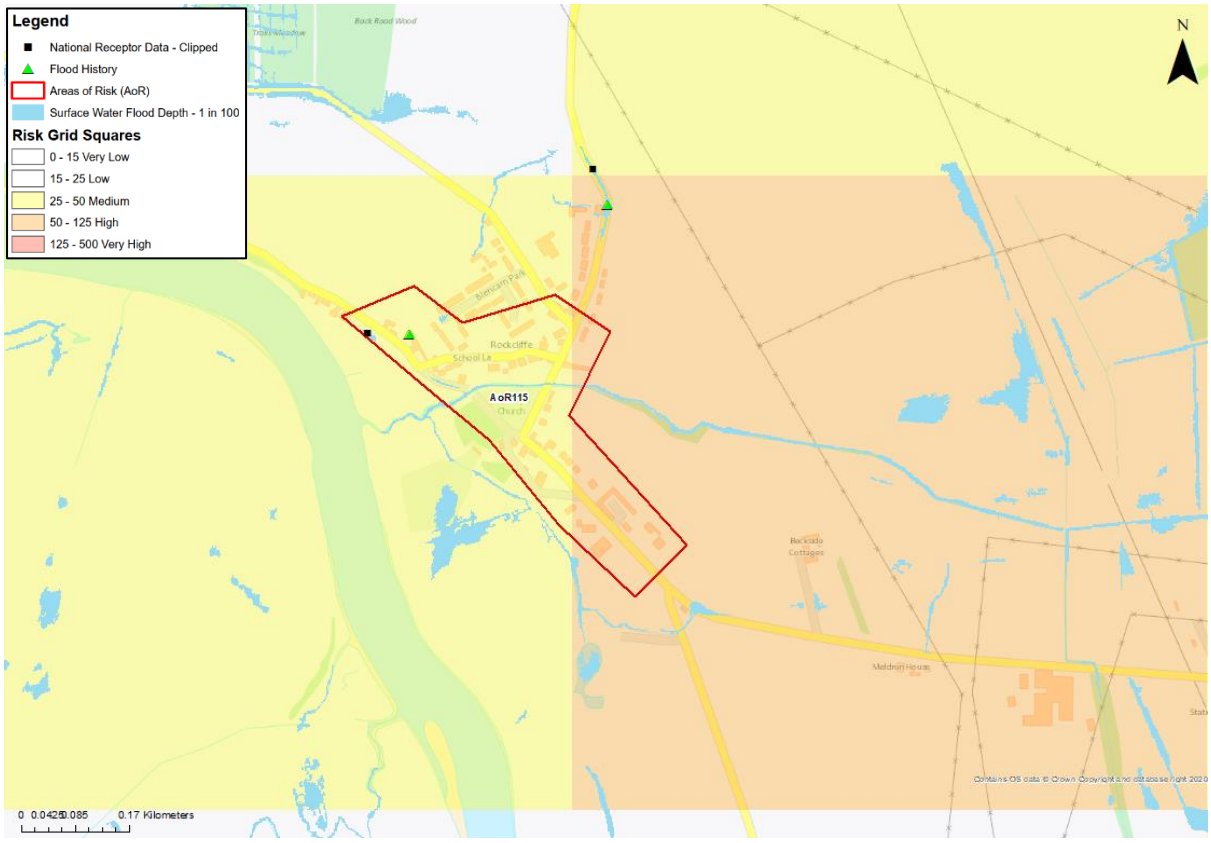


Figure 4-43 AoR's Carlisle (5 of 9)

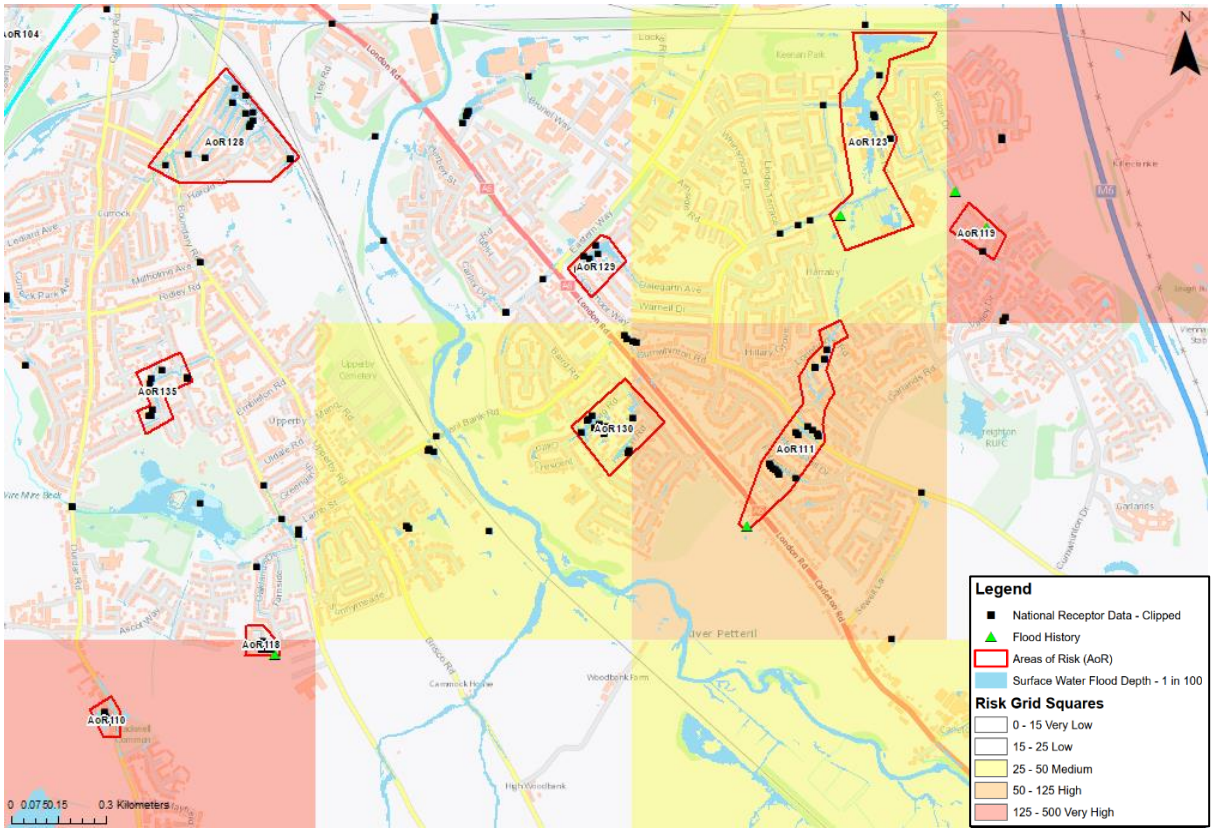


Figure 4-44 AoR's Carlisle (6 of 9)

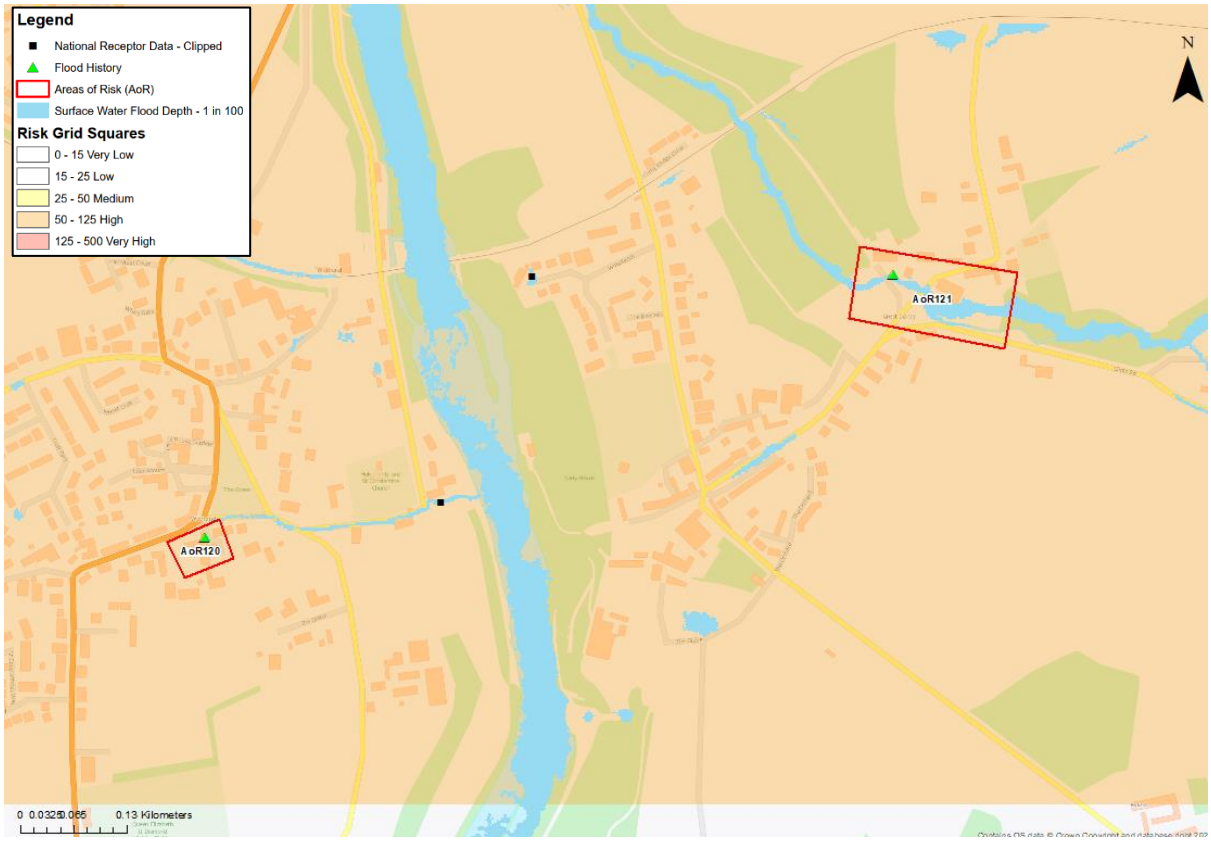


Figure 4-45 AoR's Carlisle (7 of 9)

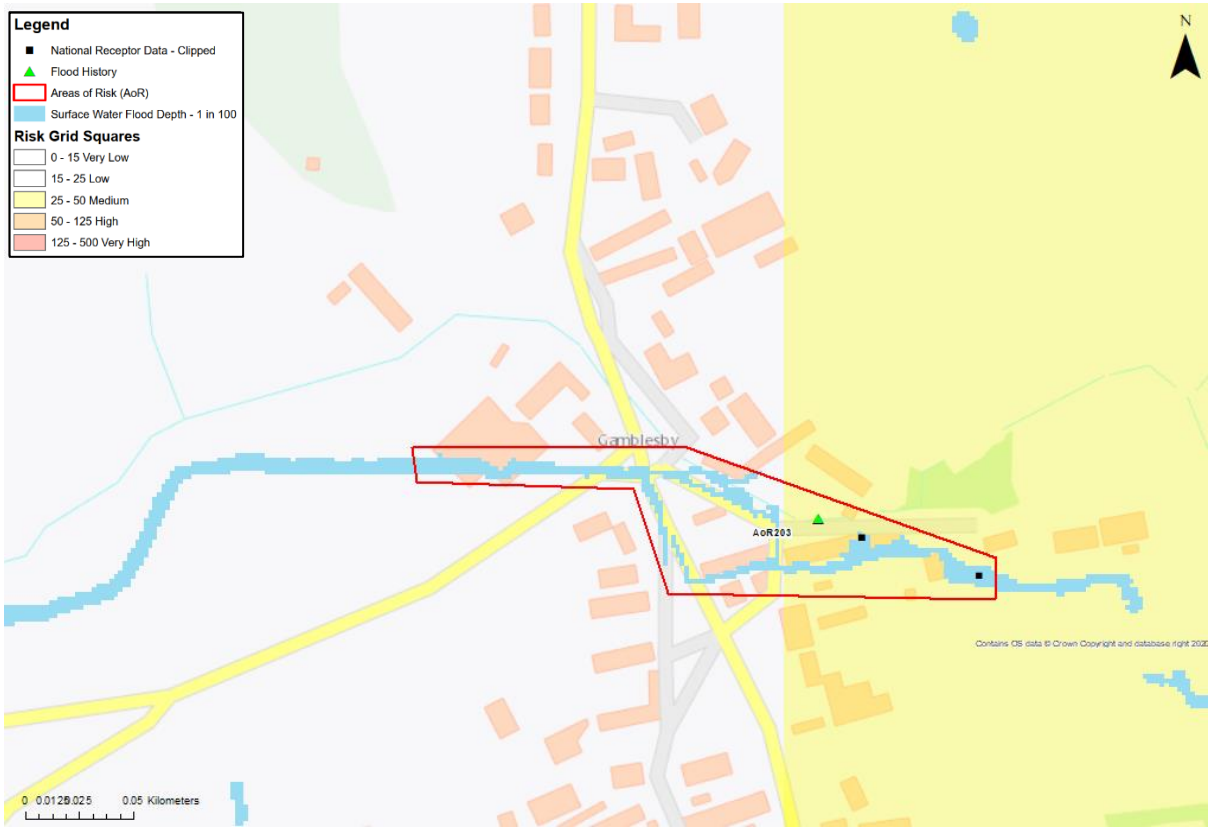


Figure 4-46 AoR's Carlisle (8 of 9)

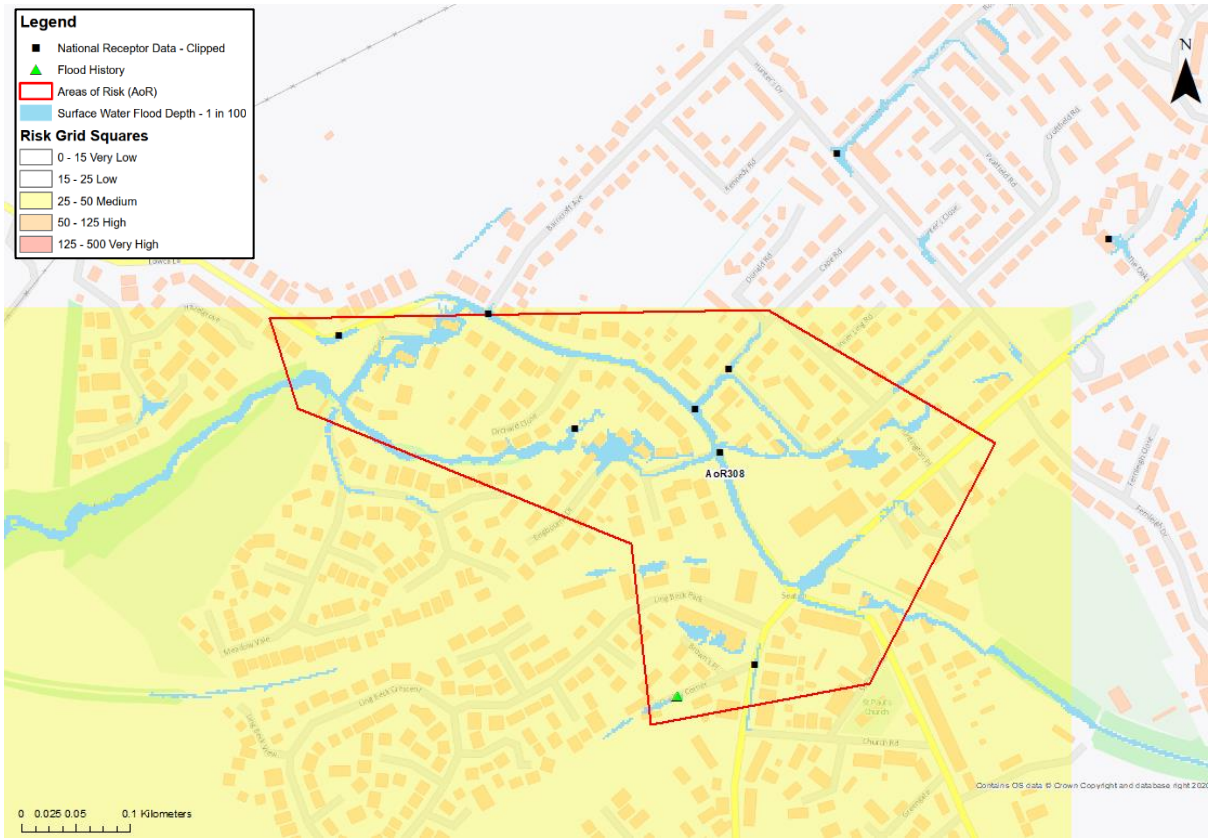


Figure 4-47 AoR's Carlisle (9 of 9)

Action Plan

Table 4-28 Carlisle PVA Stage 2b Action Plan

Type of Action	Location	AoR s	Delivery lead	Action
Consultation SWMP - ICM	Carlisle	AoR104 AoR105 AoR106 AoR107 AoR108 AoR109 AoR124 AoR125 AoR126 AoR127 AoR110 AoR116 AoR118 AoR120 AoR128 AoR129 AoR130 AoR131 AoR134 AoR135 AoR136 AoR137 AoR138 AoR139	CCC/ UU / EA	• Review Jacobs modelling and UU outputs for Carlisle to scope study areas for modelling • Workshop with CCC, EA and UU to understand breadth of work to be undertaken and discuss breaking down of study areas • CCC to raise at Making Space for Water Carlisle. CCC to invite AECOM to attend and present on Carlisle. • Individual 2D Pluvial studies – where possible to simplify modelling requirements

		AoR112 AoR111 AoR123 AoR117 AoR132 AoR133 AoR203		
Consultation	Brampton	AoR112 AoR113 AoR114 AoR122	EA / CCC	• Consult EA works in the area
Fluvial Study/ICM	Brampton	AoR112 AoR113 AoR114 AoR122	EA / CCC	• 1D/2D linked river model in Brampton • Include pluvial elements if necessary

4.10 PVA-012 Nent

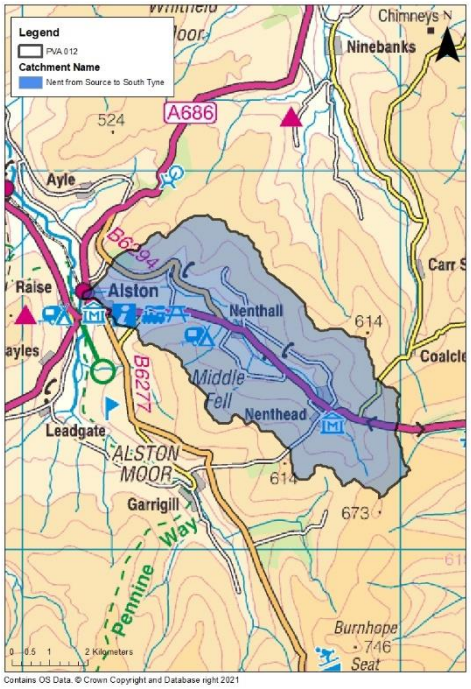
Nent (Potentially Vulnerable Area 012)

Total risk classification: High

River basin district name:	Management catchment:	Operational catchment:	Waterbody name:
Northumbria	Tyne	South Tyne Upper	Nent from Source to South Tyne

Background

This Potentially Vulnerable Area is centred around Alston and is formed of the Nent catchment which is located in the east of Cumbria. It has an area of approximately 29km².



The River Nent runs through this PVA and originates in fells of eastern Cumberland. The Nent rises on the marsh covering the summit of Knoutberry Hill. From here it runs north-westwards to Nenthead, from where the A689 follows the dale down, to Nenthall, after which is broadens and turns westward to Alston, where it joins the South Tyne. A number of small streams feed the River Nent as it flows towards Alston such as the Hudgill Burn and Galligill Burn.

The geology of the basin consists of sedimentary rocks, principally sandstone, shale, and limestone that have undergone extensive base metal mineralisation. The river is a relatively stable multi-channel gravel bed river.

Summary of flooding impacts

The risk of flooding to people and property are summarised in **Table 4-29**

The strategic assessment shows limited flooding of properties and assets within the catchment however the road network is impacted to some extent throughout the catchment. Historic flood records have shown significantly more properties to be at flood risk than the strategic assessment indicates.

The location of the impacts of flooding is shown in Figure 4-48.

Table 4-29 Risk of flooding PVA 012

Category	1% AEP Scenario
Social - People	3 residential properties
Social - Community	1

Economic - Businesses	7 non-residential properties
Economic - Transport	A686, A689, B6294, minor roads at multiple locations
Environment - Agriculture	None
Environment – Cultural and Natural Heritage	3 SSSI's, Tyne & Nent (SAC), North Pennines, 2 Scheduled Monuments, 2 listed buildings
Verification – Number of recorded flood events	4

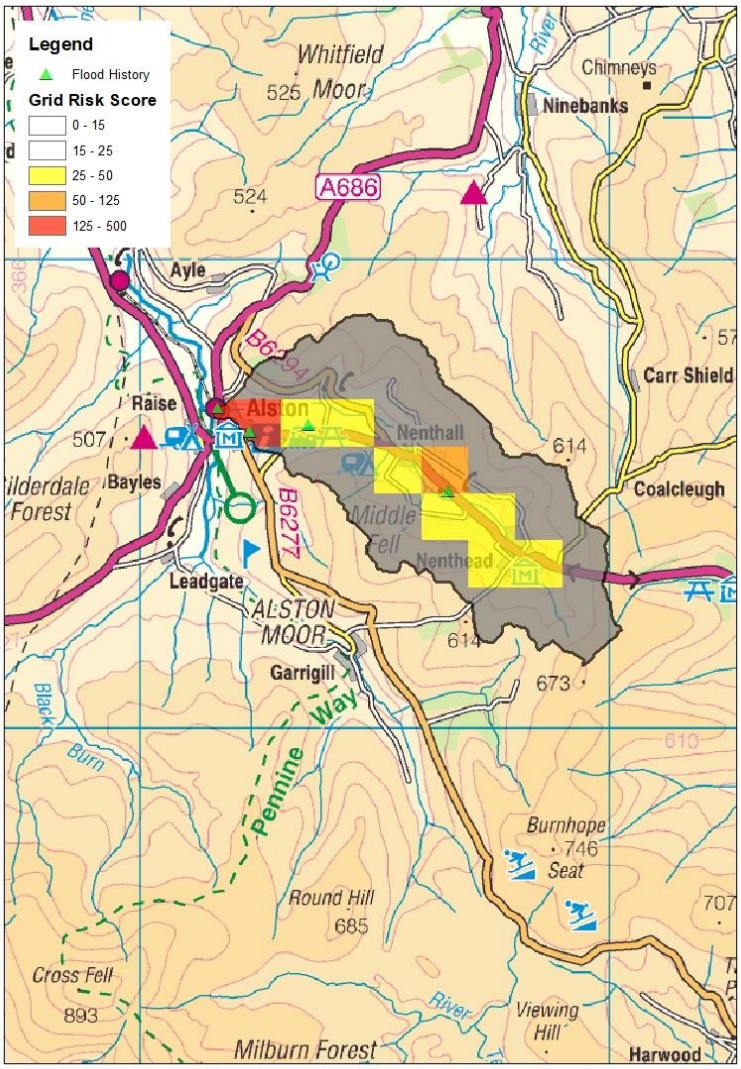


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Figure 4-48 Risk and flood history PVA-012

Sensitivity to Climate Change

Based on peak flow climate change uplifts the catchment is deemed to be **sensitive** to climate change. This indicates potential greater frequency and magnitude of potential flooding in the future at a scale which could significantly reduce any mitigation measures designed to present day data. This may require a medium allowance to be used as a design scenario for scheme development.

History of flooding

Regular flooding is reported from Alston Millrace affecting 1 property annually. This is likely to be an integrated issue between drainage and the historic millrace.

Clitheroe/Potter's Lane has been frequently (2 – 5 years) affected by surface water flooding impacting up to 14 properties. This has been linked to highway drainage issues. High Skelgill / Lambsgate areas are also noted to be affected by surface flooding from drainage but at less frequent intervals (6 -10 years) with 5 properties impacted. Low Byer and Station Yard is also a priority surface water flood risk location with 4 commercial and 5 residential properties impacted recurrently.

To the south of Alston, a combination of surface water flood and fluvial overtopping has impacted properties at Nentsberry / Hagg Mine frequently, most recently in 2016.

Area of Risk Identification

AoR's identified in the Nent PVA are shown in the figures below. Analysis of flood history, predicted flood extents, receptors affected, topography, review of CCC flood reports, likely flood mechanism and consultation with CCC staff has been used to identify priority AoR's .

Table 4-30 Stage 2a Nent AoR Identification Summary

No of AoR s	AoR s not taken forward	AoR s taken forward for consultation	AoR s taken forward for detailed assessment
6	AoR211 AoR212 AoR207 AoR208 AoR209 AoR210	N/A	

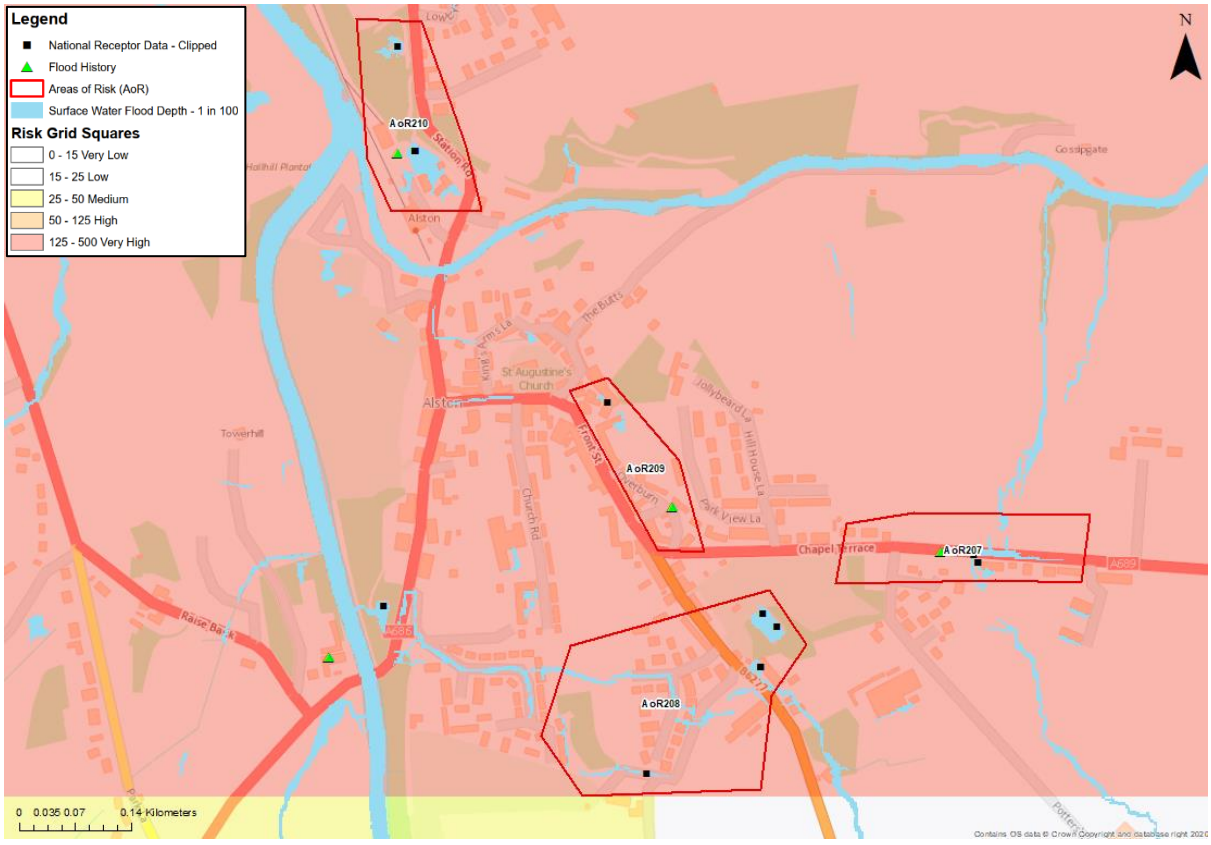


Figure 4-49 AoR's Nent (1 of 2)

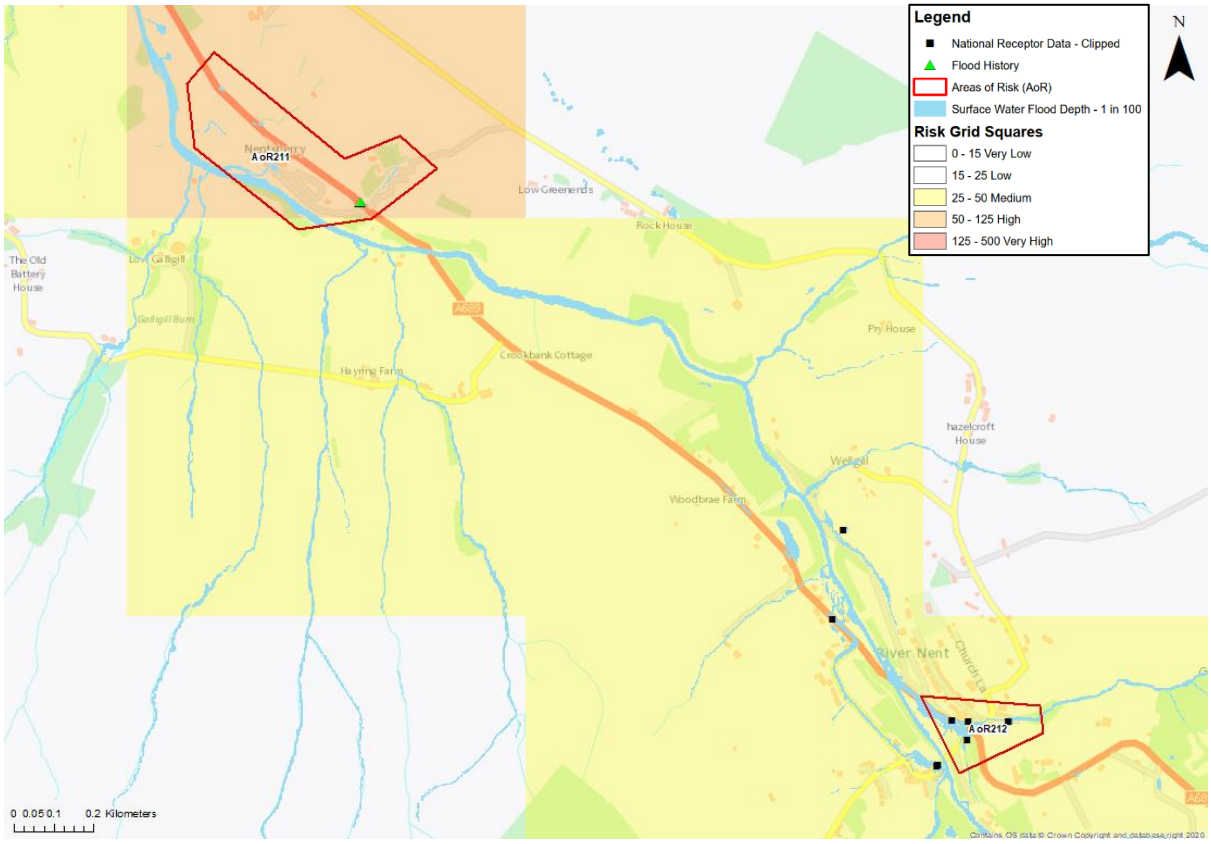


Figure 4-50 AoR's Nent (2 of 2)

Action Plan

No actions are proposed to be taken forwards for the Nent PVA. After consultation with CCC it is clear that a significant amount of work has been carried out in the catchment to understand options to reduce flood risk. None of these recent studies found an economically viable solution(s) and hence no actions are proposed as part of this study. The Nent PVA will remain and should be re assessed as part of the next cycle.

4.11 PVA-015 Bootle

Bootle (Potentially Vulnerable Area 015)

Total risk classification: Medium

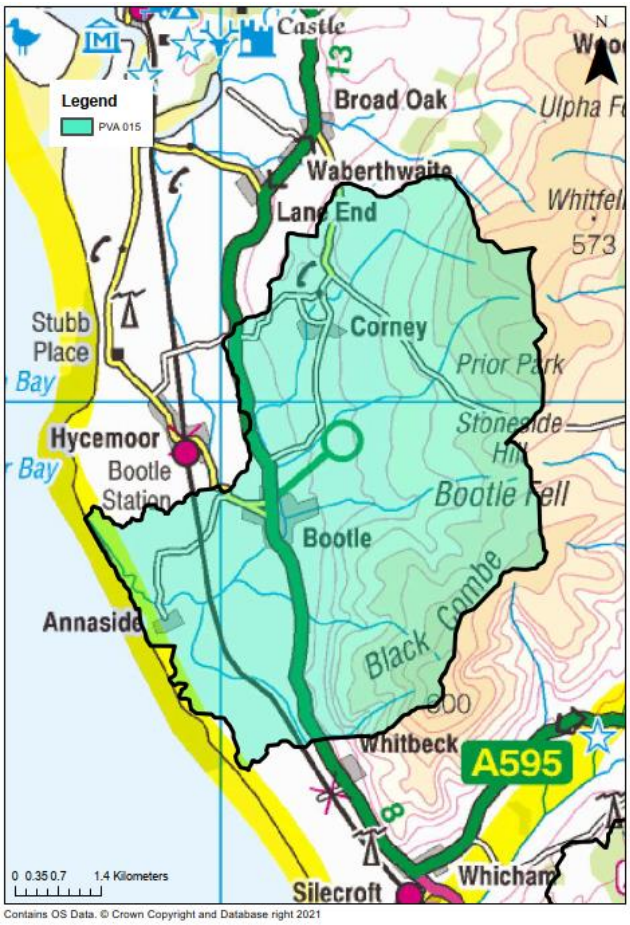
River basin district name:	Management catchment:	Operational catchment:	Waterbody name:
North West	South West Lakes	Irt-Mite-Esk-Annas	River Annas

Background

This Potentially Vulnerable Area is centred around the village of Bootle. The PVA is formed of the River Annas catchment which is located in south west Cumbria. It has an area of approximately 42km².

The Kinmont Beck and Crookley Beck drain the southwestern fells of the Lake District,and join at the eastern edge of the village of Bootle to form the River Annas. The River then flows southwest towards Annaside on the Irish Sea coast. The rivers path has moved as a result of longshore drift forcing it to flow parallel to the shore and discharge to the sea at Selker. The river is crossed by the A595 road and the Cumbrian coast railway line. The downstream end of the catchment is coastal.

The land use in the Annas catchment is chiefly moorland with only minor patches of woodland. This becomes intensive agricultural grazing at the coastal section.



Summary of flooding impacts

The risk of flooding to people and property are summarised in **Table 4-31**.

The strategic assessment using the 1 in 100 year pluvial flood extents have shown no properties and limited infrastructure to be at risk from flooding. One high risk grid cell is located to the south of the PVA which is where the A595 and railway network are potentially impacted. However historic flood events have shown more properties to be at risk.

The location of the impacts of flooding is shown in Figure 4-51.

Table 4-31 Risk of flooding PVA 015

Category	1% AEP Scenario
Social - People	0 residential properties
Social - Community	0 community assets
Economic - Businesses	0 non-residential properties
Economic - Transport	A595, minor roads at multiple locations, Railway,
Environment - Agriculture	None
Environment – Cultural and Natural Heritage	Lake District National Park, 2 SSSI's, 4 scheduled monuments,
Verification – Number of recorded flood events	3

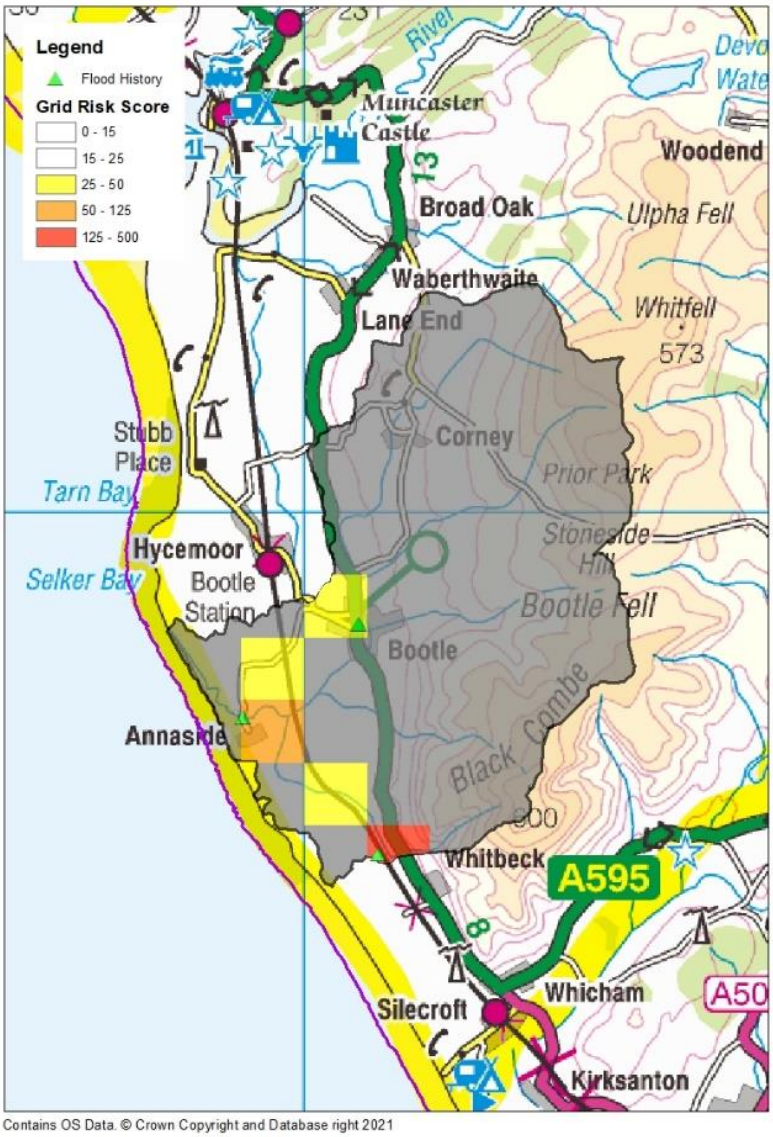


Figure 4-51 Risk and flood history PVA-015

Sensitivity to Climate Change

Based on peak flow climate change uplifts the catchment is deemed to be **moderately sensitive** to climate change. This indicates potential greater frequency and magnitude of potential flooding in the future at a scale which could reduce the benefits any mitigation measures designed to present day data. This may require a low to medium to be used as a design scenario for scheme development. The downstream section of this catchment is likely to be more sensitive to climate change due to coastal influence.

History of flooding

Surface water flood risk has largely affected the Mill Street area in the past. 12 properties have been flooded frequently in this location as a result of surface water runoff from Lake District hill entering the watercourse in significant rainfall events. This has caused the river to overtop at Hinninghouse Bridge flooding farmland and properties.

Overland flow has also regularly flooded the A595 which has been exacerbated by collapse of road drainage infrastructure in places. Insufficient/blocked drainage has resulted in past flooding of the carriageway near Bootle Station. The station itself has been affected once in 2013.

Area of Risk Identification

AoR's identified in the Bootle PVA are shown in the figures below. Analysis of flood history, predicted flood extents, receptors affected, topography, review of CCC flood reports, likely flood mechanism and consultation with CCC staff has been used to identify priority AoR's to be taken forward for this PVA (**Table 4-32**) and relevant actions to reduce surface water flood risk (Table 4-33).

Table 4-32 Stage 2a Bootle AoR Identification Summary

No of AoR s	AoR s not taken forward	AoR s taken forward for consultation	AoR s taken forward for detailed assessment
5	AoR423 AoR425	AoR421	AoR422 AoR424

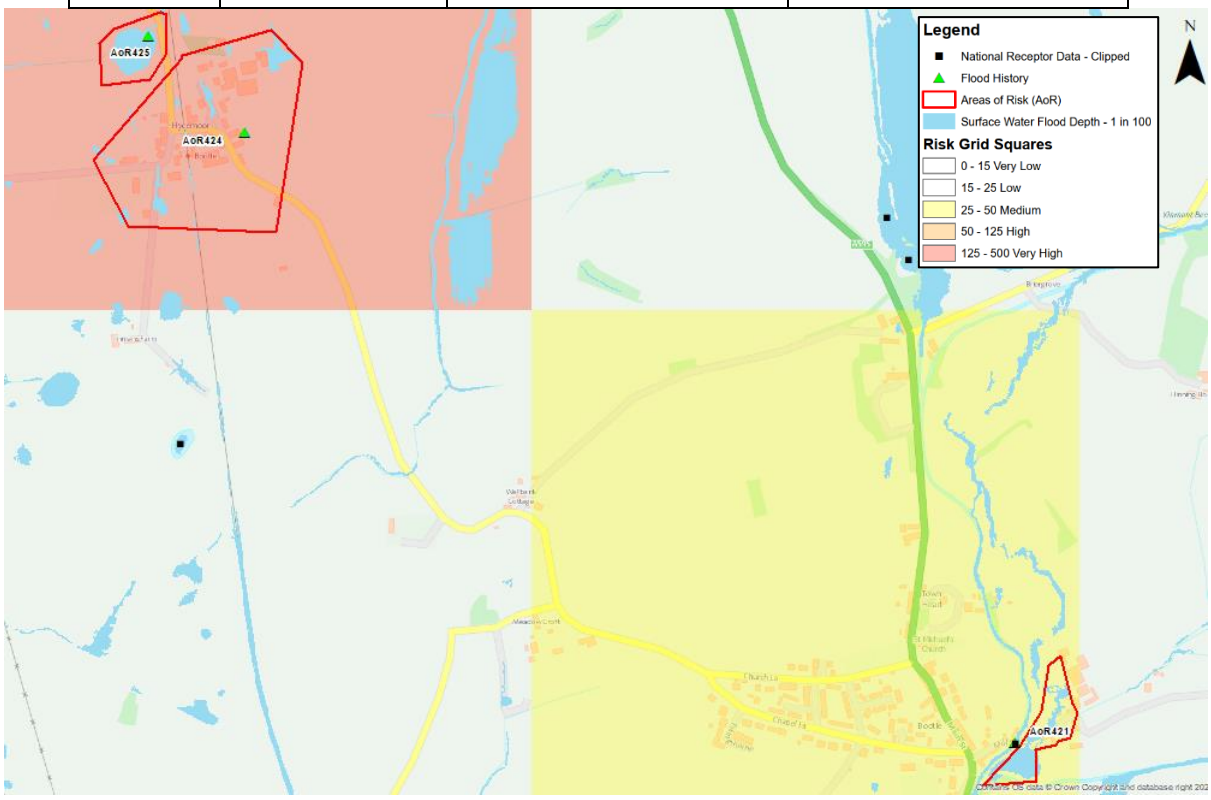


Figure 4-52 AoR's Bootle (1 of 3)

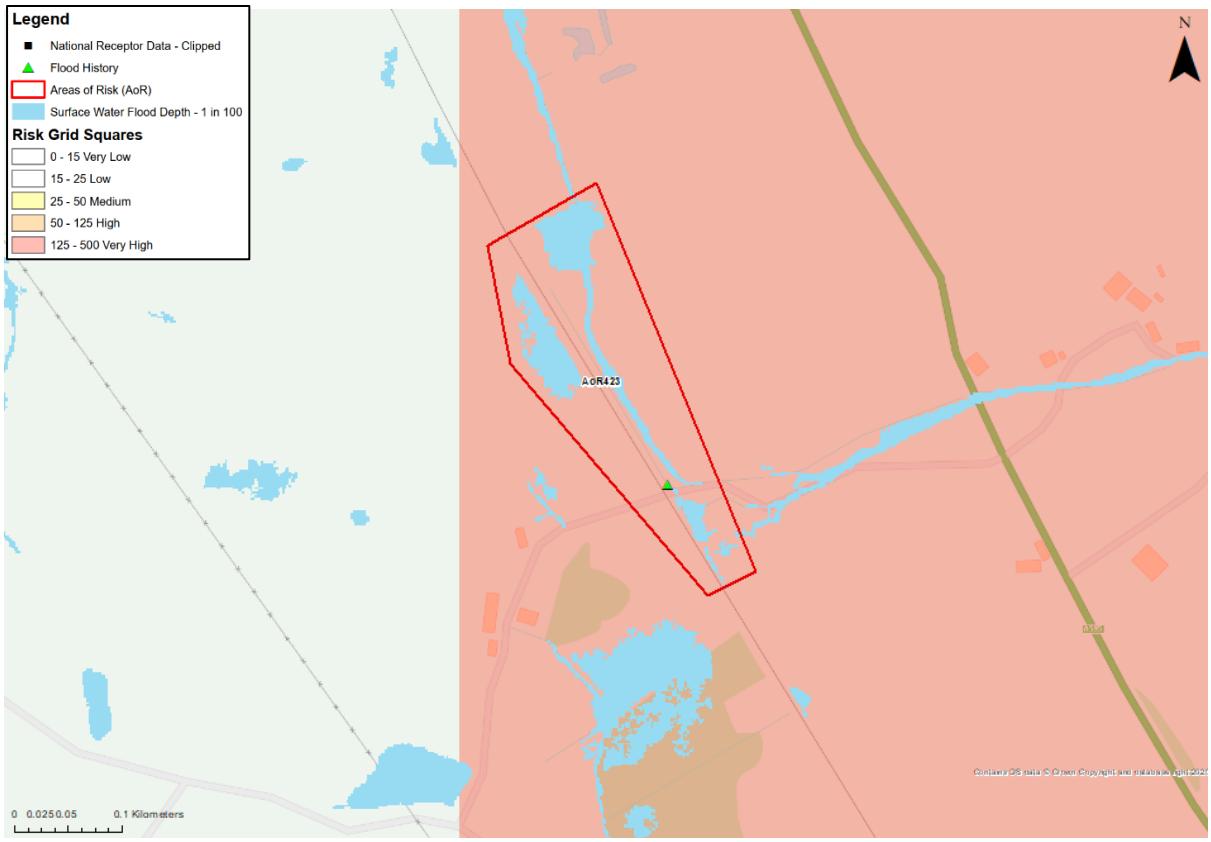


Figure 4-53 AoR's Bootle (2 of 3)

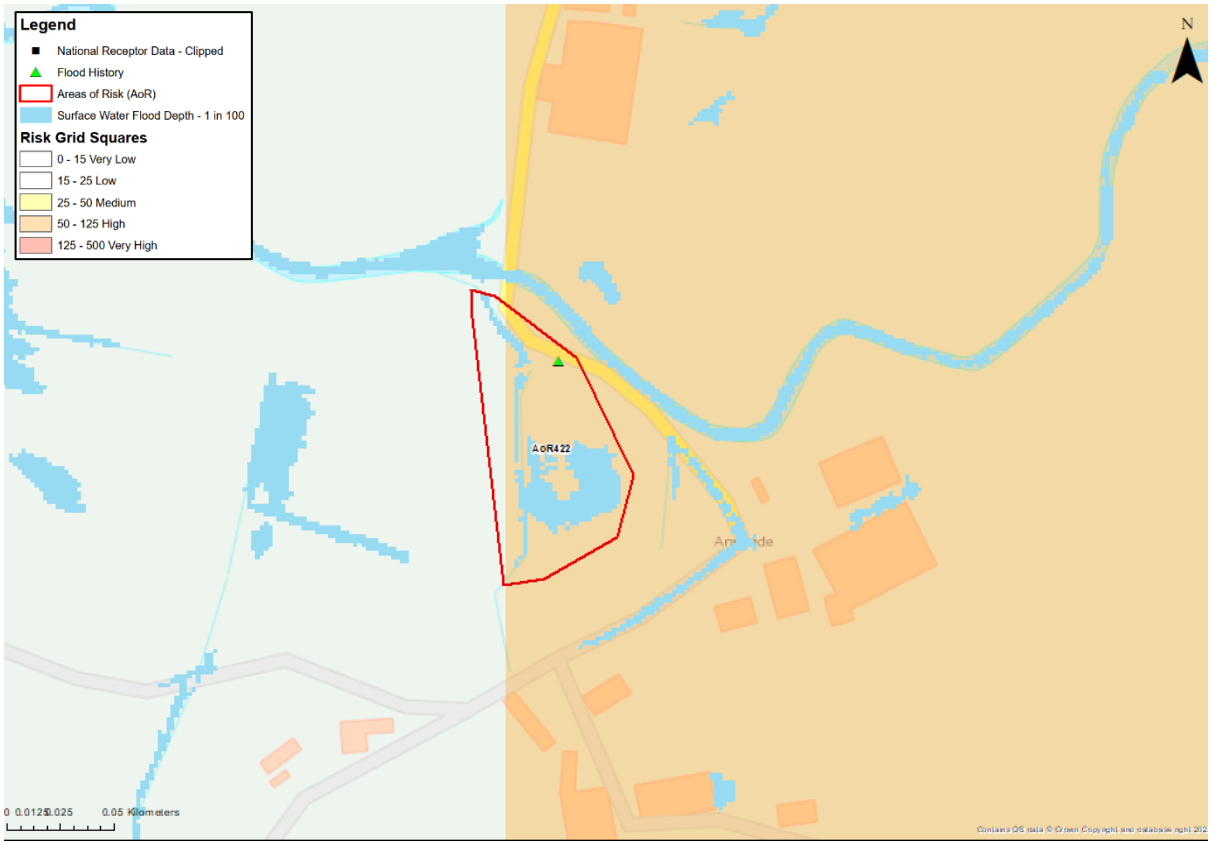


Figure 4-54 AoR's Bootle (3 of 3)

Action Plan

Table 4-33 Bootle PVA Stage 2b Action Plan

Type of Action	Location	AoR s	Delivery lead	Action
Consultation	River Annas Catchment	AoR421	CCC / EA	Consultation with EA and WCRT on NFM works to date
SWS	Annaside	AoR422	CCC	Review existing drainage and opportunities for improvement
SWMP	Bootle	AoR424	CCC	2D Pluvial study

4.12 PVA-017 Burton in Kendal

Burton in Kendal (Potentially Vulnerable Area 017)

Total risk classification: Low

River basin district name:	Management catchment:	Operational catchment:	Waterbody name:
North West	Kent and Leven	Bela	Holme Beck

Background

This Potentially Vulnerable Area is centred around the village of Burton in Kendal. The PVA is formed of the Holme Beck catchment which is located in south east Cumbria. It has an area of approximately 30km².

The Holme Beck flows south to north originating in the Yealand Radmayne area. It is a small, largely unmodified watercourse which joins the River Bela downstream of Pye's Bridge Lane. The main land use of the catchment is pastoral farming with small pockets of woodland. The M6 also runs through this catchment. The Holme Beck appears to cross the Lancaster Canal and there is potential for interaction between these waterbodies. The natural catchment of the Burn has potentially been modified to feed the canal.

Summary of flooding impacts

The risk of flooding to people and property are summarised in **Table 4-34**

The majority of risk from surface water flooding is within the Holme Beck catchment with 8 residential properties and 3 non-residential properties at risk. In addition, a significant amount of transportation links are likely to be affected from surface water within the Holme Beck catchment. Historic flood events are aligned with the strategic assessment.

The location of the impacts of flooding is shown in Figure 4-55.

Table 4-34 Risk of flooding PVA 017 (1% AEP Scenario)

Category	Keer	Holme Beck
Social - People	0 residential properties	8 residential properties
Social - Community	0 community assests	0 community assets
Economic - Businesses	0 non-residential properties	3 non-residential properties
Economic - Transport	A6070, minor roads at 2 locations	M6, A6, A6070, B6384, Railway at 3 locations, minor roads at multiple locations,
Environment - Agriculture	None	None
Environment – Cultural and Natural Heritage	Dalton medieval village, Morecambe Bay Pavements (SAC), Hutton Roof Crags (SSSI),	Farleton Knott and Hutton Roof Crags (SSSI's), Arnside & Silverdale (AONB), Holme Park Quarry (LNR), Morecambe Bay Pavements (SAC), 2 listed bridges,
Verification – Number of recorded flood events	0	1

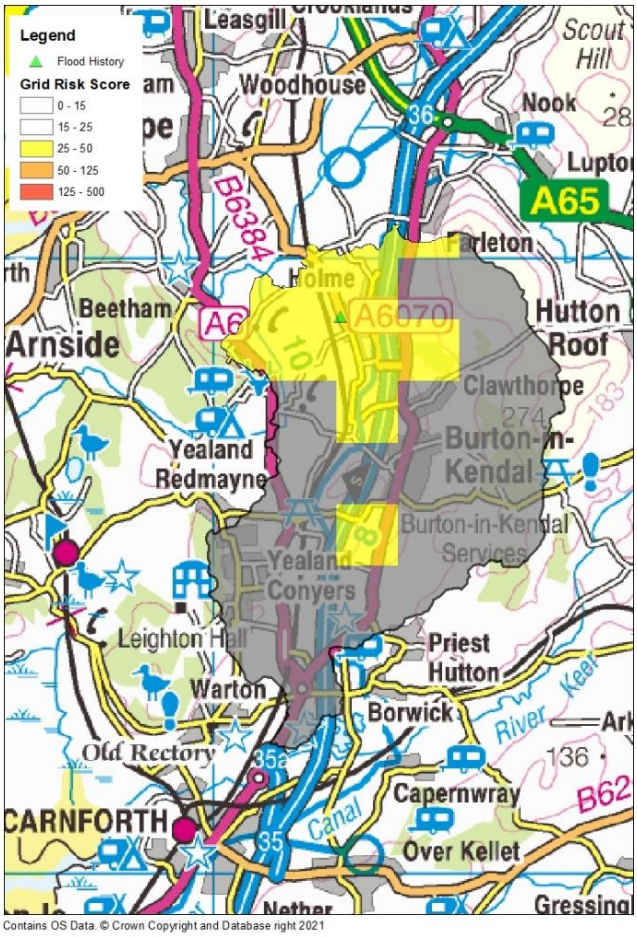


Figure 4-55 Risk and flood history PVA-017

Sensitivity to Climate Change

Based on peak flow climate change uplifts the catchment is deemed to be **highly sensitive** to climate change. This indicates potential greater frequency and magnitude of flooding in the future at a scale which could reduce impact any mitigation measures designed to present day data. This may require a higher allowance to be used as a design scenario for scheme development. The limited capacity of existing infrastructure is likely to be put under more pressure due to increased rainfall frequency and intensities.

History of flooding

Flooding has been reported in Holme Village affecting 11 properties including 5 gardens multiple times per year since 2011. This is believed to be a result of insufficient capacity in a culverted watercourse under the highway.

Area of Risk Identification

AoR's identified in the Burton in Kendal PVA are shown in the figures below. Analysis of flood history, predicted flood extents, receptors affected, topography, review of CCC flood reports, likely flood mechanism and consultation with CCC staff has been used to identify priority AoR's to be taken forward for this PVA (**Table 4-35**) and relevant actions to reduce surface water flood risk (Table 4-36).

Table 4-35 Stage 2a Burton in Kendal AoR Identification Summary

No of AoR s	AoR s not taken forward	AoR s taken forward for consultation	AoR s taken forward for detailed assessment
3	AoR544 AoR545	N/A	AoR509

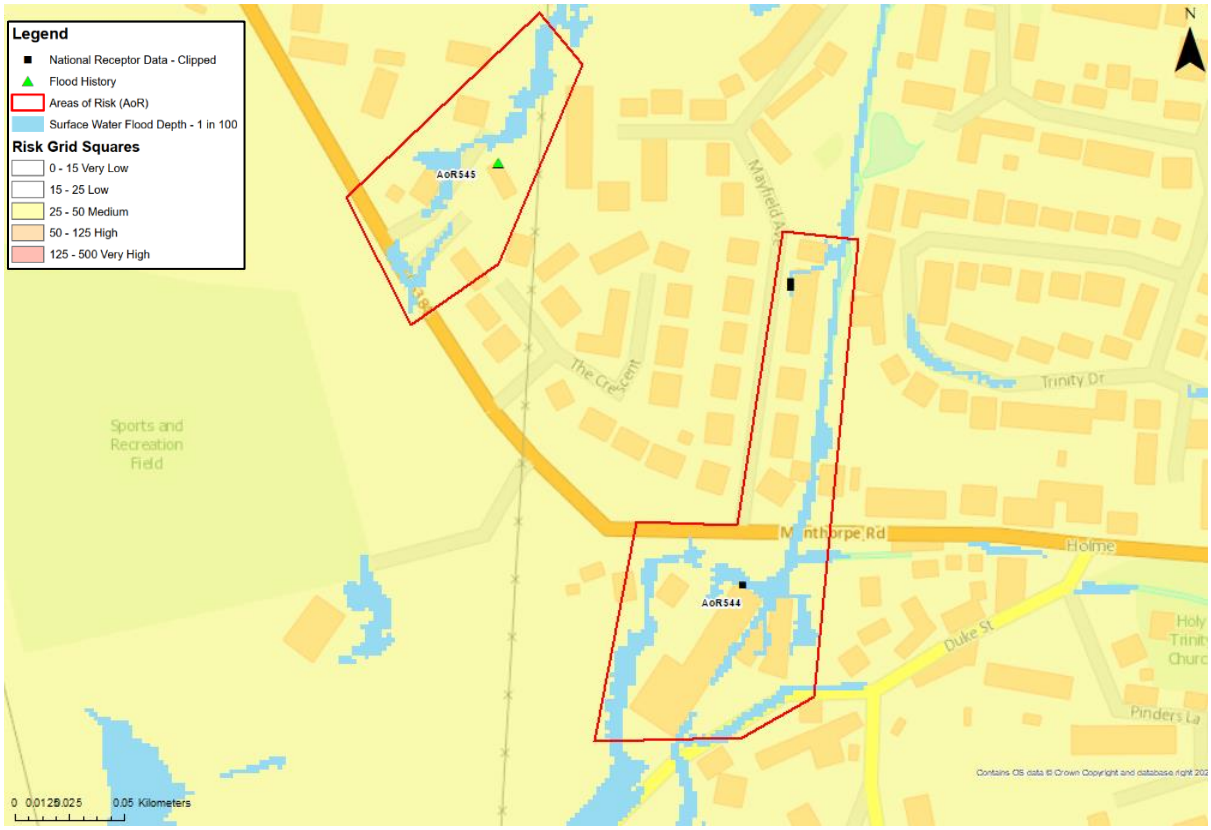


Figure 4-56 AoR's Burton in Kendal (1 of 2)

Figure 4-57 AoR's Burton in Kendal (2 of 2)

Action Plan

Table 4-36 Burton in Kendal PVA Stage 2b Action Plan

Type of Action	Location	AoR s	Delivery lead	Action
SWMP	Boon Town	AoR509	CCC	2D pluvial study to determine flood mechanisms to the south of Burton in Kendal

4.13 PVA-019 Kirkby Stephen

Kirkby Stephen (Potentially Vulnerable Area 019)

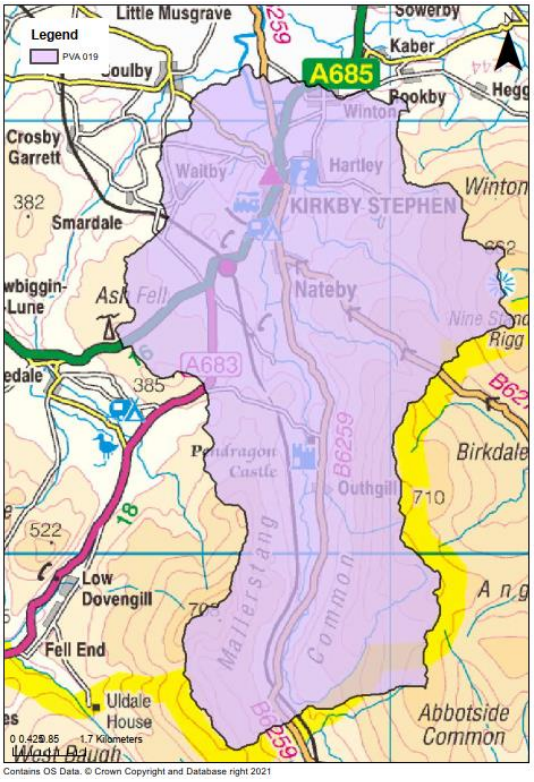
Total risk classification: Medium

River basin district name:	Management catchment:	Operational catchment:	Waterbody name:
Solway Tweed	Eden and Esk	Eden Upper	Eden – headwaters at Scandal Beck

Background

This Potentially Vulnerable Area is centred around Kirkby Stephen. The PVA is formed of the Eden Upper catchment which is located in South East Cumbria. It has an area of approximately 8km².

The River Eden generally flows south to north through the Eden Upper catchment. It begins in the high limestone fells above Mallerstang and then flows through the towns of Kirkby Stephen and Appleby. The river then widens as it passes through the village of Temple Sowerby and joins the Lower Eden at Langwathby. The catchment is mainly rural with dairy and beef farming as the primary landuse.



Summary of flooding impacts

The risk of flooding to people and property are summarised in Table 4-37.

Based on the strategic assessment there is limited surface water flooding with the Kirkby Stephen PVA with 8 residential properties at risk from the 1 in 100 year flood extent. However, during storm Desmond more extreme flooding was experienced (this is detailed below) and as such the PVA is thought to be at high risk than the strategic assessment indicates.

The location of the impacts of flooding is shown in Figure 4-58.

Table 4-37 Risk of flooding PVA 019

Category	1% AEP Scenario
Social - People	8 residential properties
Social - Community	0 Community Assets
Economic - Businesses	1 non-residential properties
Economic - Transport	A685, B6259, B6270, Railway, Minor roads at multiple locations.
Environment - Agriculture	None
Environment – Cultural and Natural Heritage	Yorkshire Dales, River Eden and North Pennine Moors (SAC's), North Pennines (AONB), 4 listed buildings, 10 SSSI's, North Pennine Moors (SPA), 2 scheduled monuments.
Verification – Number of recorded flood events	1

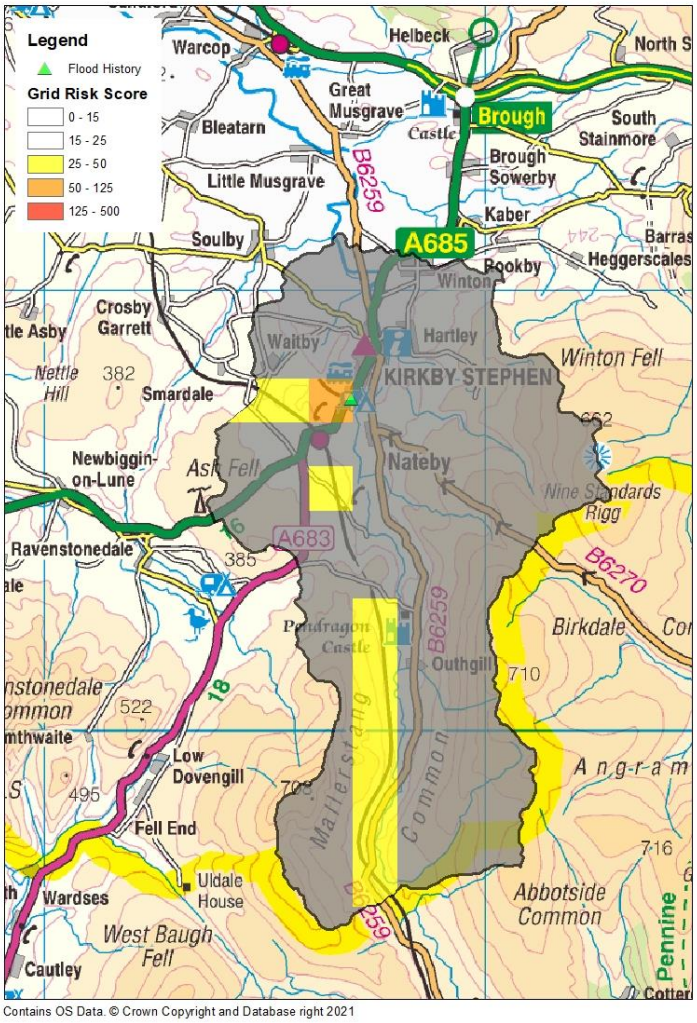


Figure 4-58 Risk and flood history PVA-019

Sensitivity to Climate Change

Based on peak flow climate change uplifts the catchment is deemed to be **highly sensitive** to climate change. This indicates potential greater frequency and magnitude of l flooding in the future at a scale which could reduce impact any mitigation measures designed to present day data. This may require a higher allowance to be used as a design scenario for scheme development. The limited capacity of existing infrastructure is likely to be put under more pressure due to increased rainfall frequency and intensities.

History of flooding

Following the weather event of Storm Desmond on 4-6th December 2015, CCC received information that 37 properties in 5 different locations in Kirkby Stephen had been affected by flooding from various sources including Main River, ordinary watercourses, surface water, surcharging drainage systems and groundwater.

Area of Risk Identification

AoR's identified in the Kirkby Stephen PVA are shown in the figures below. Analysis of flood history, predicted flood extents, receptors affected, topography, review of CCC flood reports, likely flood mechanism and consultation with CCC staff has been used to identify priority AoR's to be taken forward for this PVA (**Table 4-38**) and relevant actions to reduce surface water flood risk (Table 4-39).

Table 4-38 Stage 2a Kirkby Stephen AoR Identification Summary

No of AoR s	AoR s not taken forward	AoR s taken forward for consultation	AoR s taken forward for detailed assessment
5	AoR217 AoR219	AoR216 AoR220 AoR218	AoR216 AoR220 AoR218

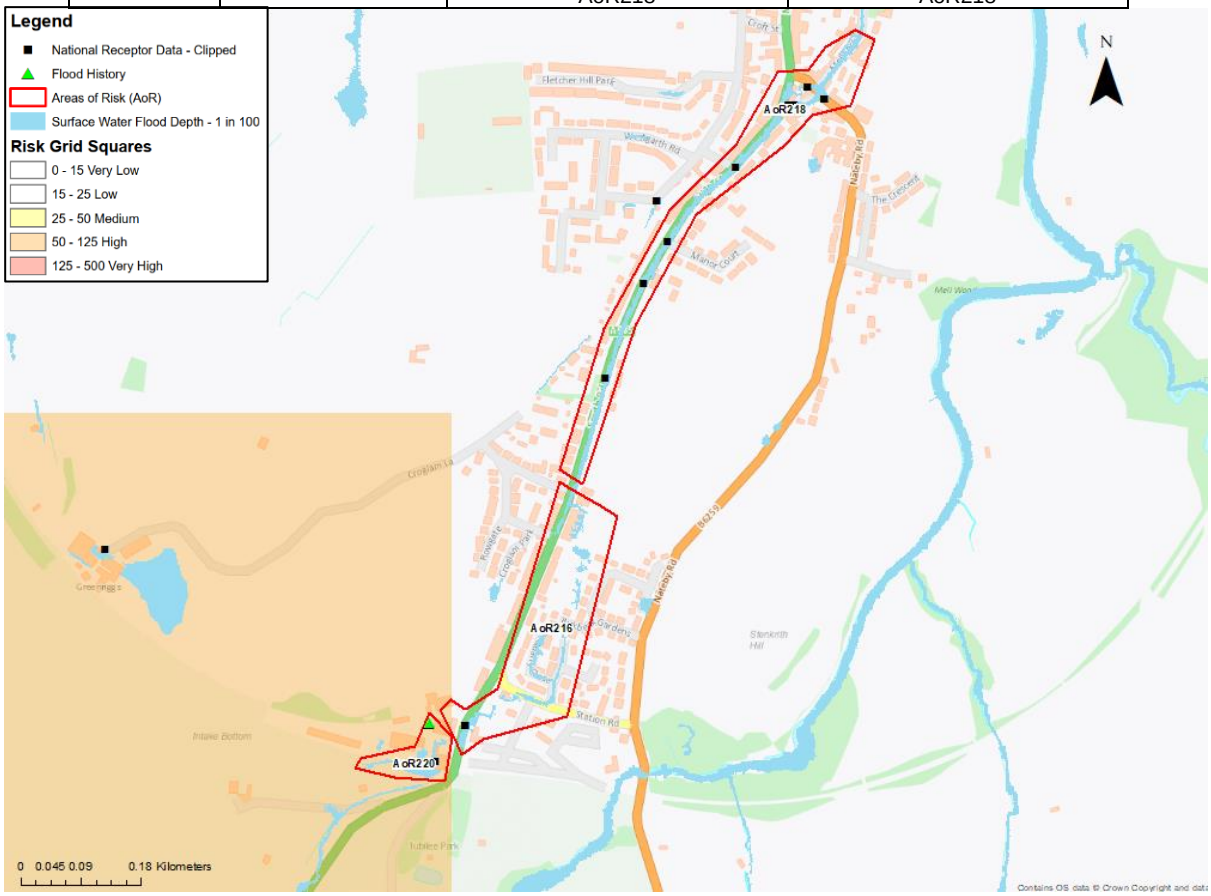


Figure 4-59 AoR's Kirkby Stephen (1 of 2)

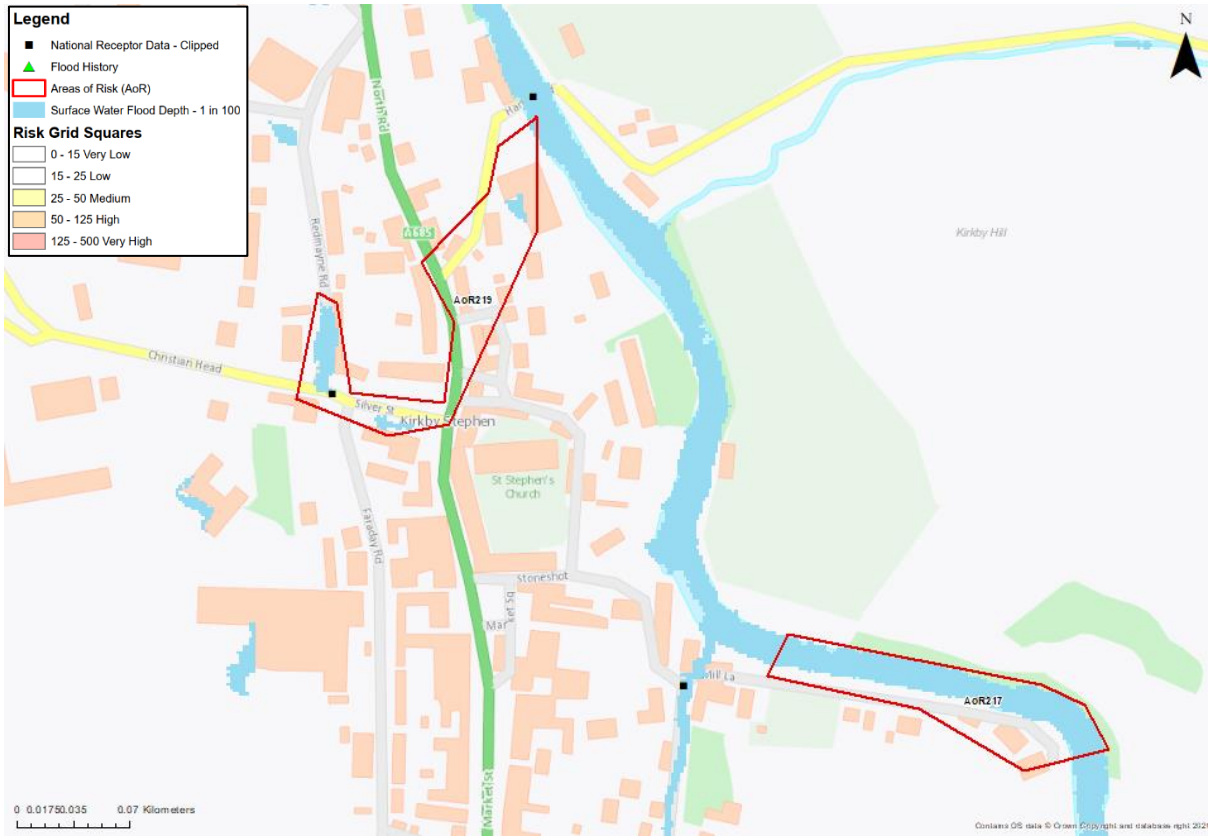


Figure 4-60 AoR's Kirkby Stephen (2 of 2)

Action Plan

Table 4-39 Kirkby Stephen PVA Stage 2b Action Plan

Type of Action	Location	AoR s	Delivery lead	Action
Consultation	Birbeck Gardens, Station Yard & High Street, Kirkby Stephen	AoR216 AoR220 AoR218	CCC/EA	• Consult with EA on work to date on Croglam Beck
SWMP	Birbeck Gardens, Station Yard & High Street, Kirkby Stephen	AoR216 AoR220 AoR218	CCC	• Culvert capacity assessment Croglam Beck Culvert (CIRIA Calcs) • 2D model including watercourse representation • Property Flood Resilience Assessment

5. PVA 020 - Coastal

5.1 Introduction

The areas within this PVA were identified by CCC and have not been identified through the process described in stage 1 and 2 of this report. Although this document focuses on areas at risk from surface water flooding, Cumbria will also be impacted from coastal flooding due to the future increase in sea level caused by climate change.

The latest available guidance on sea level rise is found within the United Kingdom Climate Projections 2018 (UKCP18)[4] which was published in December 2018. The dataset provides an indication of the possible increase in sea level due to the impact of climate change. The dataset details a range of allowances for each river basin district for different epochs up to 2125. These allowances are based on percentiles, which are used to describe the proportion of all possible scenarios that fall below an allowance. UKCP18 uses the both the 70th percentile (higher central allowance) and 95th percentile (upper end allowance).

The coast of Cumbria is split between two river basins, Northwest, and Solway Tweed. However, guidance has suggested that northwest allowance should be used for coastal areas within the Solway Tweed basin. These allowances have been provided within the table below.

Table 5-1 UKCP18 sea level rise

River Basin	Allowance	2000-2035	2036-2065	2066-2095	2096-2125
Northwest	Higher central	158mm	219mm	300mm	336mm
Northwest	Upper end	200mm	297mm	426mm	489mm

As shown within the table above, the sea level along the Cumbria coast could increase by 489mm by 2125.

[4] United Kingdom Climate Projections 2018, December 2018, Met Office

Figure 5-1 PVA-020

5.2 Coastal AoR's

Historic Coastal Issues

There are a number of different historic coastal issues within Cumbria. Most of these issues are focused around flood risk and erosion. Given the impact of climate change these issues are likely to worsen over time. Therefore, coastal AoR's highlights areas at risk of flooding, areas requiring coastal protection and also coastal areas requiring repair work.

Area of Risk Identification

Coastal AoR's identified in Cumbria are shown in the figures below. Unlike the surface water AoR's, these coastal areas have been identified by CCC and have not been identified through the process described in stage 1 and 2 of the report.

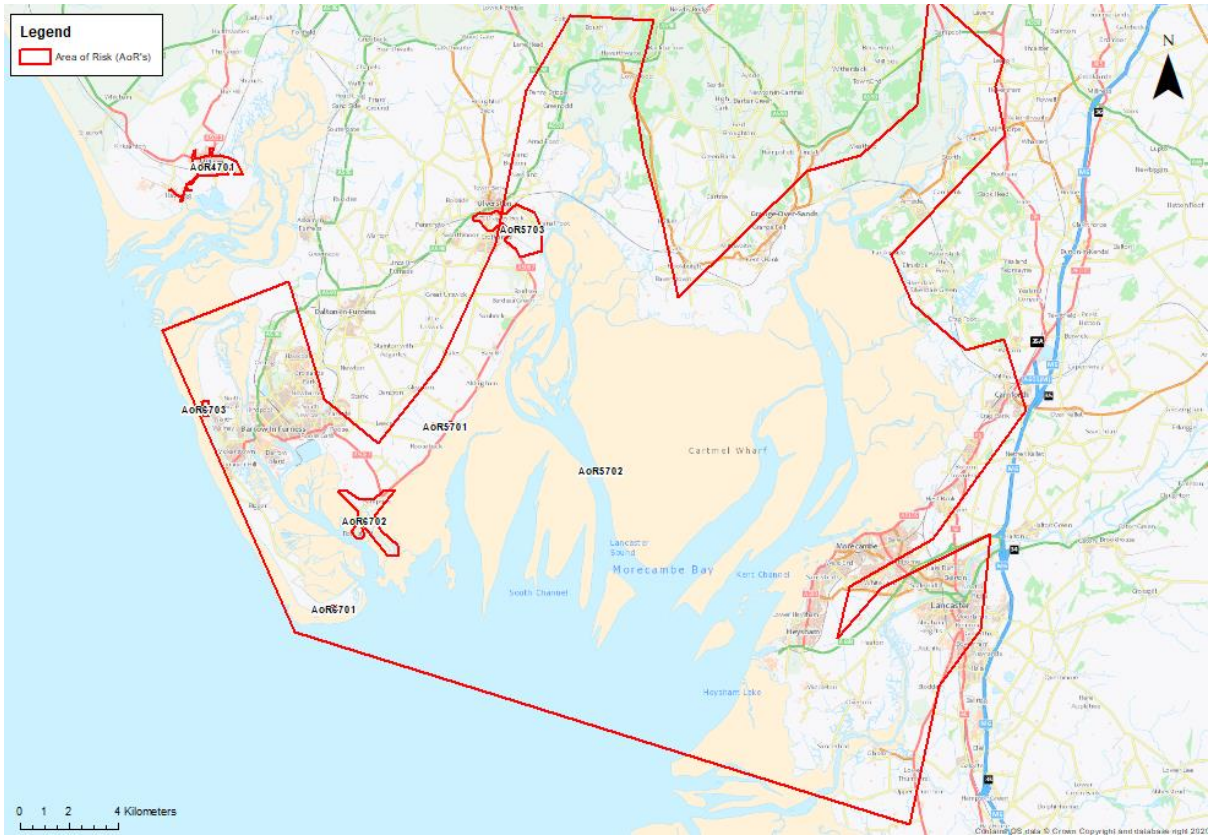


Figure 5-2 AoR's – Coastal (1 of 5)

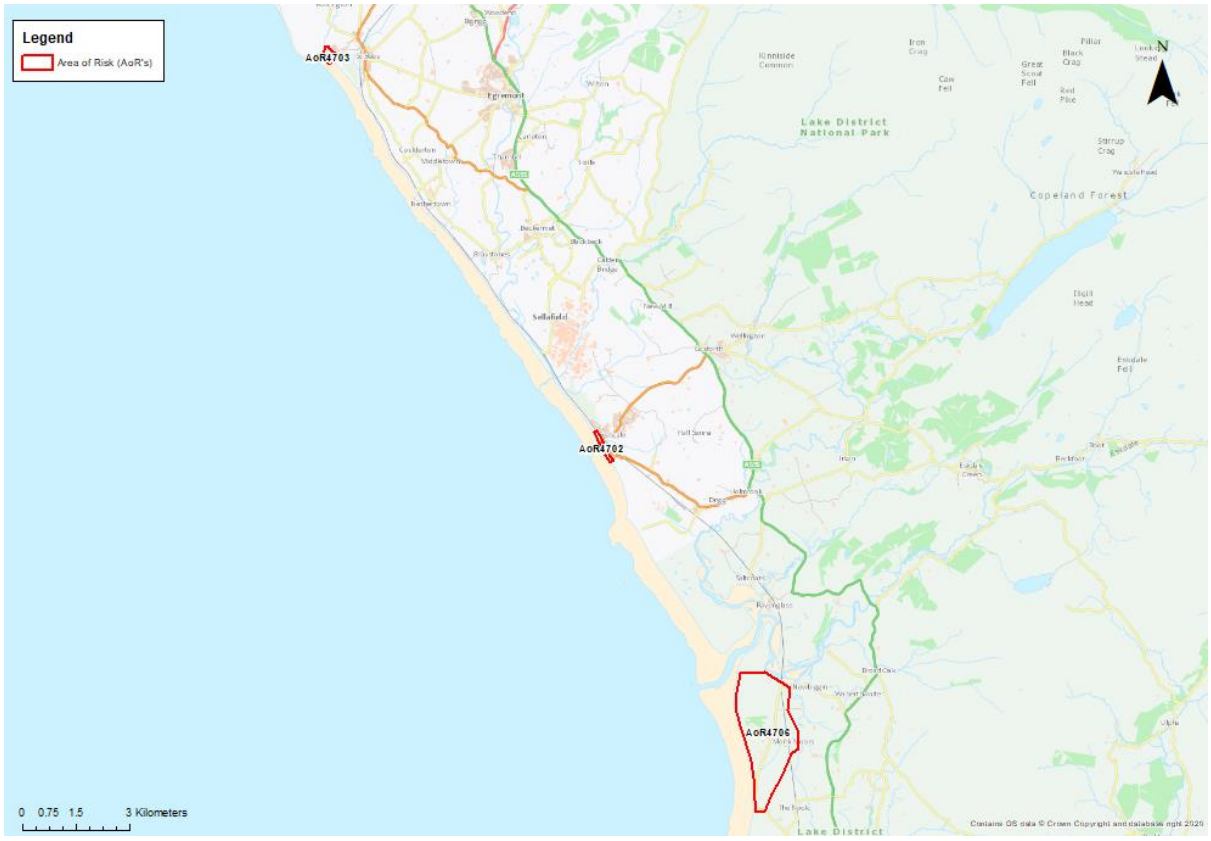


Figure 5-3 AoR's – Coastal (2 of 5)

Figure 5-4 AoR's – Coastal (3 of 5)

Figure 5-5 AoR's – Coastal (4 of 5)

Figure 5-6 AoR's – Coastal (5 of 5)

Action Plan

Table 5-2 Coastal Action Plan

Type of Action	Location	AoR s	Delivery lead	Action
CSR2	A5087 Newbiggin Protection, Silloth Groyne Replacement, Solway Firth Erosion Study, Morecambe Bay Erosion Study, Millom & Haverigg Flood Alleviation, Harrington North Shore Coastal Erosion Protection, South Walney Landfill Site Protection, Workington Former Steel Works Site Coastal Erosion Scheme, Oldside Landfill Workington, Dubmill Point Coastal Erosion, Allonby to Seacroft Farm Erosion Protection, Siddick to Risehow (Flimby), Siddick to Risehow (Siddick), Bowness on Solway Erosion Reduction, Anthorn to Cardurnock Coastal Erosion,	AoR5701 AoR3701 AoR3702 AoR5702 AoR4701 AoR3703 AoR6701 AoR3704 AoR3705 AoR3706 AoR3707 AoR3708 AoR3709 AoR3710 AoR3711 AoR3712 AoR4707	CCC	• Ongoing work progressing options as part of the CSR2 coastal programme.
	Seascale Coastal Erosion Protection, St Bees Coastal Erosion Protection, Parton Combined Flood and Coastal Erosion Risk Study, Stubb Place and Eskmeals Coastal Erosion Protection,	AoR4702 AoR4703 AoR4705 AoR4706 AoR4704	CBC	

	Whitehaven Rock Armour Capital Maintenance Whitehaven Harbour Flood Defence Capital Replacement Works,			
	Roa Island, West Shore Park Walney,	AoR6702 AoR6703	BBC	
	South Ulverston Integrated Flood Risk Management Scheme,	AoR5703	EA	

6. Glossary

Term	Definition
AEP	An annual exceedance probability (AEP) is the probability of an event occurring in any given year. i.e. A 1% AEP means there is a 1% chance in any given year of the event occurring. This means that on average 1 event of this size will occur every 100 years.
Appraisal	The process of defining objectives, examining options, and weighing up the costs, benefits, risks, and uncertainties before a decision is made. The FRM Strategy appraisal method is designed to set objectives and identify the most sustainable combination of actions to tackle flooding from rivers, sea, and surface water
Catchment	An area of land where rainwater drains into a single watercourse.
Coastal Flooding	Flooding that results from high sea levels or a combination of high sea levels and stormy conditions. The term coastal flooding is used under the Flood Risk Management (Scotland) Act 2009, but in some areas, it is also referred to as tidal flooding and covers areas such as estuaries and river channels that are influenced by tidal flows.
Combined Drainage System	A single pipe drainage system where both foul and storm runoff are conveyed in the same pipe.
Combined Sewer Overflow (CSO)	A relief structure allowing the discharge of diluted untreated wastewater from a combined sewer during a rainfall event, when the flow exceeds the wastewater network capacity.
Confluence	Where two or more rivers meet.
Conveyance	Conveyance is a measure of the carrying capacity of a watercourse. Increasing conveyance enables flow to pass more rapidly and reducing conveyance slows flow down. Both actions can be effective in managing flood risk depending on local conditions.
Culvert	A pipe or tunnel used for the conveyance of a watercourse or surface drainage water under a road, railway, canal, or other obstacle.
Environment Agency (EA)	An executive non departmental public body tasked to protect and improve the environment, and to promote sustainable development. The EA plays a central role in delivering and implementing the environmental policies of central government in England.
Flood Risk	Likelihood of flooding occurring and the consequences of it happening.
Fluvial or river Flooding	Occurs when river flow exceeds the channel capacity due to rainfall, covering the adjacent floodplain with water.
Geographical Information System (GIS	A mapping system to analyse and display geographically referenced information
Groundwater flooding	Flooding caused by increases in the water table to above ground level, due to rainfall
Highways Authority	Local authority responsibility for managing, maintaining, and improving England's roads that are not under the responsibility of the Highways Agency.
Hydraulic Model	A mathematical model developed to represent the physical characteristics of a drainage system, including assets, topography, and hydrology.
Hydrology	The scientific study and practical implications of the movement, distribution, and quality of freshwater in the environment.
Integrated Catchment Model	Approach to planning or managing an urban drainage system that leads to an understanding of how different physical components interact.
Joint Probability	Sometimes referred to as 'Combined Probability'. This is the probability of two or more events occurring simultaneously (for example, peak river flow and peak discharge from a surface water sewer).
Lead Local Flood Authority (LLFA)	Upper tier Local Authority responsible for reducing the risk of flooding from surface water, groundwater and ordinary watercourses under the Flood and Water Management Act 2010.
Likelihood of flooding	The chance of flooding occurring. High likelihood: A flood is likely to occur in the defined area on average once in every ten years (1:10). Or a 10% chance of happening in any one year. Medium likelihood: A flood is likely to occur in the defined area on average once in every two hundred years (1:200). Or a 0.5% chance of happening in any one year. Low likelihood: A flood is likely to occur in the defined area on average once in every thousand years (1:1000). Or a 0.1% chance of happening in any one year
Local Flood Risk Management Strategy (LFRMS)	The local strategy provides a framework for delivering local flood risk management in Cumbria.
Main River	Main rivers are usually larger streams and rivers, but also include smaller watercourses of strategic drainage importance. The Environmental Regulator has responsibility for main rivers, and these are designated by Defra.

Making Space for Water	Making Space for Water is the cross government programme taking forward the developing strategy for flood and coastal erosion risk management in England.
Ordinary Watercourse	An ordinary watercourse is any other river, stream, ditch, cut, sluice, dike, or non-public sewer that is not a Main River. The local authority or Internal Drainage Board has powers for such watercourses.
Overland Flow Path	The path that runoff follows as it flows over a surface until it reaches a collection channel or drain.
Pluvial or surface water Flooding	Flooding that results from rainfall-generated overland flow before the runoff enters any watercourse or sewer.
Receptor	Refers to the entity that may be impacted by flooding (a person, property, infrastructure, or habitat). The vulnerability of a receptor can be reduced by increasing its resilience to flooding.
Return Period	The expected average time between the exceedance of a particular extreme threshold. Frequently used to express the frequency of occurrence of an event, for example, rainfall or flooding
Residual risk the risk that	The risk that remains after risk management and mitigation. This may include risk due to very severe (above design standard) storms or risks from unforeseen hazards.
Riparian	The riparian area is the interface between land and a river or stream. For the purposes of FRM this commonly refers to the riparian owner, which denotes ownership of the land area beside a river or stream.
Runoff	Rain and surface water that does not percolate into the ground and flows over the surface to a sink, such as a drainage system inlet, watercourse or surface water body.
Sewer flooding (and other artificial drainage system flooding)	Flooding as a result of the sewer or other artificial drainage system (e.g. road drainage) capacity being exceeded by rainfall runoff or when the drainage system cannot discharge water at the outfall due to high water levels (river and sea levels) in receiving waters.
SuDS	Sustainable drainage systems: a sequence of management practices and control measures designed to mimic natural drainage processes by allowing rainfall to infiltrate, and by attenuating and conveying surface water runoff slowly compared to conventional drainage.
Surface flooding	Flooding from sewers, drains, small watercourses and ditches that occurs as a result of heavy rainfall and exceedance of the local drainage capacity. May occur from any component of the urban drainage system.
Surface Water Management Plans (SWMPs)	Vehicle through which urban flood risk will be assessed, managed and resolved in the future within England and Wales.
Natural flood management (NFM)	A set of flood management techniques that aim to work with natural processes (or nature) to manage flood risk.
Non-residential properties	Properties that are not used for people to live in, such as shops or other public, commercial or industrial buildings.
Potentially Vulnerable Areas (PVA)	Catchments identified as being at risk of flooding and where the impact of flooding is sufficient to justify further assessment and appraisal.
Property level protection	Property level protection includes flood gates, sandbags and other temporary barriers that can be used to prevent water from entering individual properties during a flood.
UU United Utilities	United Utilities is responsible for water and wastewater services in the North West of England.
Vulnerability	A measure of how likely someone or something is to suffer long-term damage as a result of flooding. It is a combination of the likelihood of suffering harm or damage during a flood (susceptibility) and the ability to recover following a flood (resilience)
WCRT West Cumbria Rivers Trust	West Cumbria Rivers Trust (WCRT) is part of the national network of river trusts which have played an ever increasing role in delivering environmental improvements throughout the country. West Cumbria Rivers Trust has a crucial role to play in raising awareness and increasing understanding of West Cumbria's rivers and lakes. This is done by connecting with people locally to make a positive difference to the health of rivers, lakes, people and wildlife.

7. Acknowledgements

The information described in this section relates to the data and maps that have been generated by the Environment Agency and have been reproduced in Annex B.

The Cumbria County Local Flood Risk Management Partners gratefully acknowledge the cooperation and input that various parties have provided, including inter alia, the following organisations:

7.1 EA

Maps generated which reproduce data generated by EA including 1 in 100 year surface water flood extents and National Receptor Database 2014 data with authorisation from EA under Licence number XXXXXXXXXX (2021).

7.2 Ordnance Survey

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7.3 CCC

The LLFA acknowledges the provision of flood models and other supporting data and information from departments within CCC and their collaboration in the production of flood risk management information.

7.4 UU

The LLFA acknowledge the inclusion of surface water flooding data generated by United Utilities in preparation of flood risk information.