United Utilities Water

# DRAFT Drainage and Wastewater Management Plan 2023

# Technical Appendix 6 – Resilience

Document Reference: TA6

June 2022

United Utilities

Water for the North West

# Executive Summary

We need to ensure that we are resilient to challenges such as population growth and climate change so that we are able to cope with, and recover from disruptions, and to anticipate trends and variability in order to maintain services for people and protect the natural environment. This is why we need to have robust plans to allow us to effectively adapt and mitigate. We acknowledge that some risks are outside of management control, so in order to effectively manage the risk we will need to work with stakeholders and communities across the North West to tackle issues together.

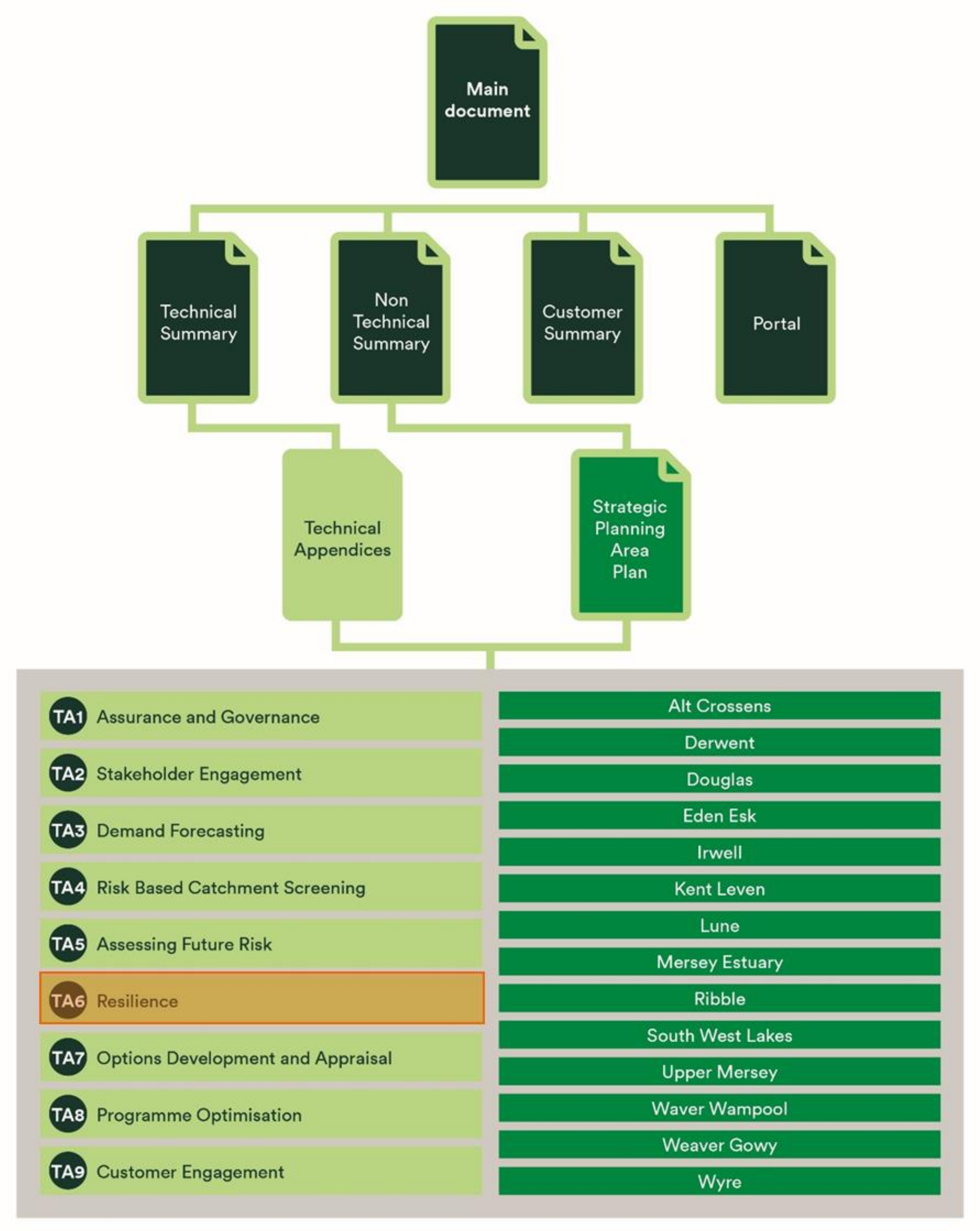
Through the Drainage and Wastewater Management Plan (DWMP), we have run a comprehensive suite of assessments across the whole of the North West to develop a robust understanding of wider catchment resilience issues that are not directly linked to systems characteristics. Our focus for this DWMP has been to assess what we believe to be the most significant risks:

- Fluvial and/or coastal flooding of wastewater treatment works and major pumping stations;
- Power outages;
- Outages to remote communications;
- Response Recovery Plans;
- First flush and low flows;
- Coastal/river erosion and land stability;
- Changes in the water quality of rivers as a result of climate change;
- Changes in catchment contributions as a result of climate change; and
- Outfall locking.

The whole of the North West was assessed, and the results showed that the region is least resilient to the risk posed from third-party power outage (60% of tactical planning units (TPUs) were deemed to be less resilient), and is most resilient to the risk of remote communications outages (76% of TPUs were deemed to be more resilient).

The results from the assessment have been incorporated into the options development and programme appraisal stage of the DWMP. A combination of approaches have been taken, from incorporating the assessments into generic high-level solutions, to bespoke optioneering, which will be used to inform the best solution for the particular issue across the region. These assessments will inform the next business plan for 2025–2030, and our long-term delivery strategies, to ensure that the North West is as best prepared for the future as possible.

***Figure 1 DWMP document structure***



## Acronyms

For a list of acronyms, refer to document C0003.

## Contents

## Tables



## Figures

# 1. Introduction

1.1. Across the North West, we rely on natural sources of water such as reservoirs, rivers and boreholes to provide water, which we abstract in a responsible and sustainable way to be treated and supplied to customers. We also rely on natural watercourses to receive treated wastewater back into the environment. The ability for us to do this sustainably and efficiently will be affected by future challenges such as climate change and population growth.

1.2. In recent years, we have already experienced how the climate is beginning to change and the sensitive balance is shifting as we are now experiencing more extreme shifts in weather patterns. Predictions forecast that the impacts of climate change are expected to accelerate over the next 25 years so the ability for the North West's ecosystem to cope with drier summers and wetter winters will be tested.

*Figure 2 Climate change statistics for the North West*

**The past 150 years in the North West**

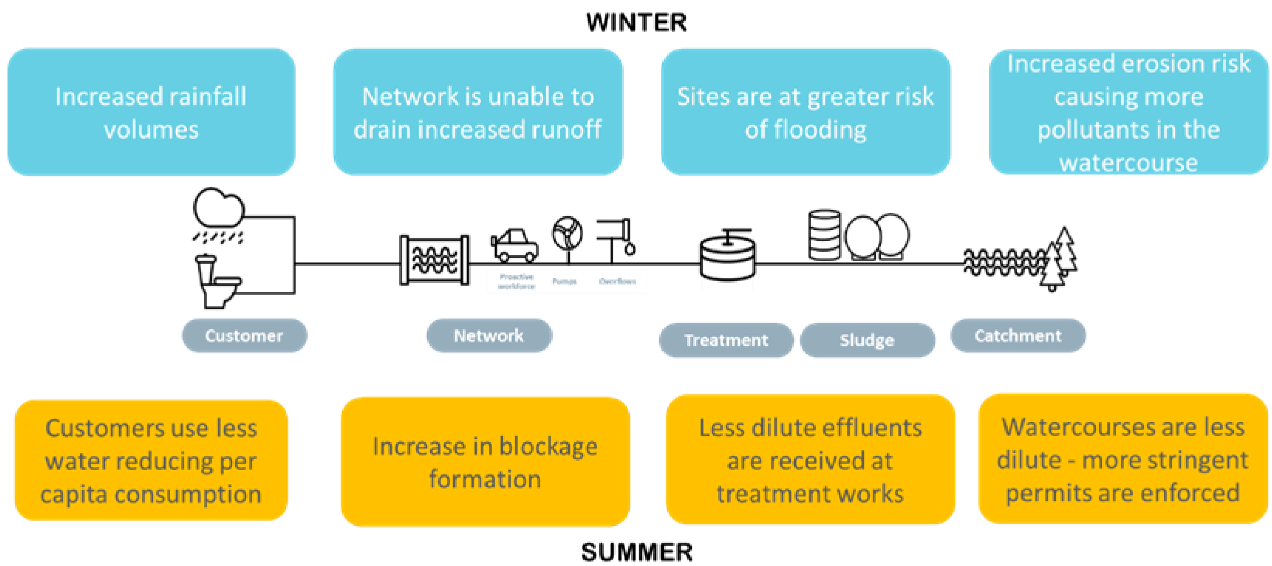
**100%** of the top 10 hottest years have occurred since 2002

**50%** of the top 10 wettest years have occurred since 2000

**0%** of the top 10 coldest years have been recorded since 1963

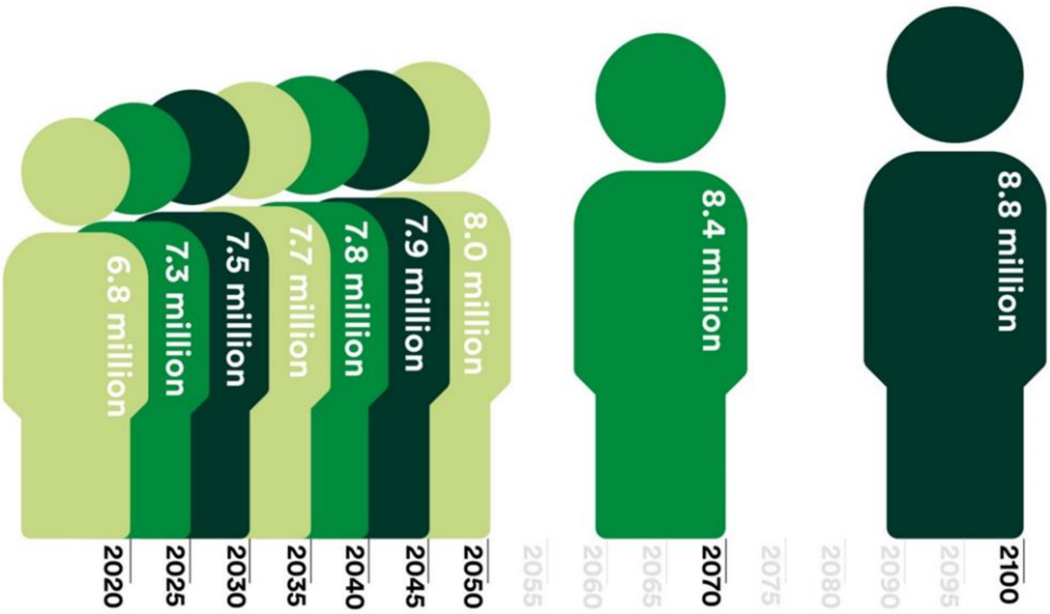
1.3. For example, during drier summers, drainage and wastewater systems will be under pressure as the likelihood for sewer blockages to form increases. Also, during wetter winters, there will be increased volumes of rainfall, which need to be drained and could lead to flooding.

*Figure 3 Examples of how winter and summer seasons can impact the wastewater production line*




1.4. As for the challenge that population growth presents, the population of the North West is predicted to increase by 14% by 2050 with growth expected across smaller towns through to major cities. The core of the sewerage system within most towns and cities is combined, which means that there is less capacity for sewage as combined sewers also convey rainwater. When compared with other regions in the UK, the North West has the highest portion of combined sewers at over 50%.

***Figure 4 Example of forecasted population growth across the North West***




1.5. To ensure that we are resilient to these challenges, so that we are able to cope with, and recover from disruptions, and to anticipate trends and variability in order to maintain services for people and protect the natural environment, we need to have robust plans in place. This will include working with stakeholders and communities across the region to tackle issues together.

1.6. As a business, we have already been doing this through the delivery of the Water Resource Management Plan (WRMP), which aims to allow for effective water resource planning to ensure the long-term balance between supply and demand. Our Climate Change Adaptation Report also explores the impacts of climate changes, the importance of being resilient to changing weather conditions and demonstrates the steps that we are taking to adapt to that change.

1.7. Embedded within our business are processes and models to allow us to objectively assess and prioritise the risk and consequences of disruptions to our systems and services. Our Systems Thinking approach, which aims to improve our asset reliability and resilience, reduces unplanned service interruptions and helps us to move away from the traditional reactive approach to address problems proactively before harm is caused. We are also finding new ways to deliver resilience through projects such as the Dynamic Network Management (DNM) programme. This will highlight opportunities and develop common understandings of how drainage systems perform across the region, and will allow us to further identify flood risk and water quality management partnership opportunities

1.8. As a company, we already take account of multiple scenarios of what the future might look like, but being resilient goes further than this, and this is where the Drainage and Wastewater Management Plan (DWMP) allows us to go above and beyond. The DWMP is an opportunity to:

- Strengthen partnership working with all stakeholders across the region to improve resilience of shared risks;
- To provide a basis for more collaborative and integrated planning to tackle shared and interrelated risks relating to drainage, flooding and protecting the environment; and
- Collectively explore innovative solutions such as Sustainable Drainage Systems (SuDS) and nature-based solutions to understand what is best for the North West.

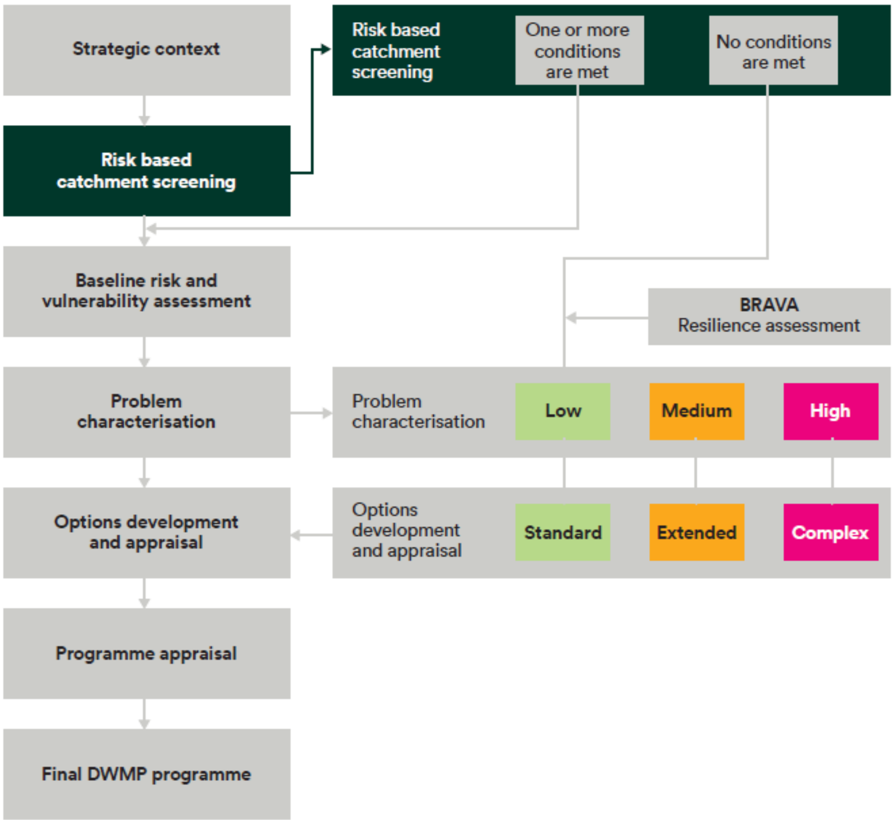
1.9. Woven throughout the DWMP are approaches, assessments and tools to understand potential future challenges and opportunities across drainage, flooding and environmental sectors. Resilience is a key part of this and we have undertaken a wide range of resilience assessments to gain a better understanding of how pressures such as climate change and population growth might impact the North West.

# 2. Understanding resilience risks

## 2.1 Overview

2.1.1. For the DWMP, we have completed a variety of assessments across the whole of the North West to develop an understanding of wider catchment resilience issues that are not directly linked to systems characteristics. The assessments have been run alongside the Baseline Risk and Vulnerability Assessment (BRAVA, Figure 5), for further information see Technical Appendix 5 – Assessing Future Risk (TA5) and have been incorporated throughout the plan to allow us to expand our understanding of core resilience risks.

*Figure 5 Flow chart demonstrating how the Resilience Assessment aligns with BRAVA*




2.1.2. We have undertaken a comprehensive range of resilience assessments covering our most significant risks from service outages to how climate change might impact the region. For this cycle of the DWMP, we have determined that these risks represent the great risk to service:

- Fluvial and/or coastal flooding of wastewater treatment works and major pumping stations;
- Power outages;
- Outages to remote communications;
- Response Recovery Plans;
- First flush and low flows;
- Coastal/river erosion and land stability;
- Changes in the water quality of rivers as a result of climate change;
- Changes in catchment contributions as a result of climate changes; and
- Outfall locking.

2.1.3. These assessments have been carried out at a tactical planning unit (TPU). A TPU is also known as wastewater treatment work drainage catchments. This is the drainage catchment area encompassing all the sewers and wastewater assets e.g. pumping stations, which drain into the associated wastewater treatment works.

2.1.4. We have completed the assessments across the whole of the region to build a richer picture of the resilience considerations. The sections below will provide more detail and the approaches taken for each resilience assessment. We have used the latest, best available data at the time of the analysis. In light of new information, we will look to review and update as necessary.

## 2.2 Assessing fluvial and coastal flooding of wastewater treatment works and major pumping stations

2.2.1. The ability for sewer networks and wastewater treatment works to operate effectively without harm to the environment or our customers can be affected due to flooding from surface waters, rivers and the coast. This is a significant risk as we have a large proportion of our assets within close proximity to watercourses and coasts as we rely on gravity, where possible, to allow us to safely return treated flows back into the natural environment.

2.2.2. To understand the risk to wastewater treatment and wastewater network assets, we have assessed their flood risk exposure. The approach considers all assets, not just those deemed to be a critical asset as the risk to flooding is a widespread risk given the close proximity of assets to watercourses and coasts. The approach uses the Environment Agency flood maps for surface water and river and coastal flooding at 1 in 30, 1 in a 100 and 1 in a 1000-year return periods. Their flood maps were used in the analysis and were accurate at the time this assessment was conducted. A digital terrain model was used to determine the elevation of the buildings and structures, which were compared against the Environment Agency flood maps for each of the return periods. Predicted flood depths were rounded to the nearest 100mm, removing any predicted depths less than 100mm from further analysis.

2.2.3. The predicted flood depths determined whether assets were at risk of flooding and a Net Present Value (NPV, £) was calculated. The NPV is the potential costs associated with flooding including the probability of the event over a fixed investment horizon. The assessment is a present-day view so is, therefore, a baseline (2020) scenario.

2.2.4. We summarised the assessment to a TPU. If the NPV was greater than £0, the TPU was deemed to be 'less resilient' to fluvial and/or coastal flooding. If the NPV was equal to £0, the TPU was deemed to be 'more resilient' to fluvial and/or coastal flooding.

## 2.3 Assessing risk caused by power outage

2.3.1. A key aspect of infrastructure resilience is the ability of a facility to continue to operate through shocks and stresses. This assessment is limited to the hazard associated with the loss of power to a site, rather than the failure of electrical equipment on site. The loss of power to a site can have a wide-reaching impact, as flooding or pollution incidents may occur if flows cannot be received or pumped due to power loss.

2.3.2. Some sites are provided with multiple power supplies, a fault tolerant ring main or a backup power supply. Sites have been identified as partially tolerant to the risk of loss of power through the following three mechanisms:

(1) A diesel generator has been registered against the asset inventory for the site.

In some cases a power generation capability is sized to insure that the operation of the site can be maintained during a loss of supply event.

(2) A dual supply is provided by the District Network Operator (DNO).

A well designed, dual supply provides some degree of fault tolerance to a site, as in theory, the loss of a single local substation would not lead to the loss of power to the site.

(3) The local DNO substation has dual supplies, however, there is a single feed to the site's ring main.

If a substation has a single feed to the site's ring main a failure on the single incomer can still lead to loss of service from the site.

2.3.3. Any site that is identified to have any of the above is typically expected to have a degree of resilience to a third-party asset failure or loss of power to the site.

2.3.4. We have assessed assets across both wastewater network and wastewater treatment. United Utilities Water (UUW) corporate data systems were used to determine whether assets have any of the above power supplies and whether the sites are unpowered. The assessment is a present-day view so is, therefore, a baseline (2020) scenario. This assessment determines whether there is any reliance on power and does not consider resilience to widespread outages due to events such as national outage or due to extreme weather.

2.3.5. We summarised the assessment to a TPU. If a TPU was determined to have at least one of the above power supplies or the treatment asset is unpowered, it is deemed to be 'more resilient' to power outages. If a TPU has no alternative method of backup power, it is deemed to be 'less resilient' to power outages.

## 2.4 Outages to remote communications

2.4.1. With the increasing degree of automation associated with the management of a sewerage system, it is important to consider the control, telemetry and automation requirements when assessing overall resilience. One of the key vulnerabilities is inter-site communications, where signals are required from remote sites for the continued normal operation of any specific site.

2.4.2. Many sites are provided with telemetry to enable remote monitoring of the health and performance of the facilities on the site. Relatively few sites require remote signals to provide local control; telemetry for these sites is more critical than those that can continue to operate with local control.

2.4.3. Sites are connected together through three primary routes:

(1) Fixed third-party telecoms lines;

(2) Fixed outstation to outstation lines; and

(3) Site to site radio links.

2.4.4. If any of the above are present, there is some form of remote monitoring and control between sites. This means that if a signal is lost at one of the locations, the asset may not perform as intended, for example if two pumping stations are linked, one may not pump and, therefore, poses a flooding risk. Any site that is identified to have any of the above is typically expected to have a degree of control dependent upon the function of a remote site.

2.4.5. This assessment considers assets across both wastewater network and wastewater treatment. UUW corporate data systems were used to determine whether assets have any of the above controls. The assessment is a present-day view so is, therefore, a baseline (2020) scenario. This assessment determines whether there is any reliance on communications and does not consider resilience to widespread outages due to events such as national outage or due to extreme weather.

2.4.6. We summarised the assessment to a TPU. If a TPU was determined to have at least one of the above controls, it is deemed to be 'less resilient' to power outages. If a TPU has no degree of control, it is deemed to be 'more resilient' to communications outages.

## 2.5 Response Recovery Plans

2.5.1. All sites are covered by some level of contingency planning to help us deal with incidents and events efficiently and effectively. Our contingency planning framework helps us to identify and prioritise the development of more complex or site-specific plans. The principle element of the prioritisation within the framework is site criticality rather than risk. This is because in responding to an event, the probability of the event is no longer relevant and the expected or credible impacts from the event take precedence.

2.5.2. This assessment considers wastewater treatment works assets only. UUW corporate data systems were used to determine whether assets have a site specific or generic response recovery plan. The assessment is a present-day view so is, therefore, a baseline (2020) scenario.

2.5.3. We summarised the assessment to a TPU. Each TPU was determined to have either a 'site specific plan' or a 'generic plan'.

## 2.6 First flush and low flow events

2.6.1. Climate change may present periods of prolonged low flows or intense rainfall increasing the risk of septicity and first flush effect. This has the potential to impact wastewater treatment works performance.

2.6.2. The approach considers information collated by UUW operational teams in 2018 and in 2020 to identify sites at risk of first flush and low flow events. This assessment considers wastewater treatment works assets only. A risk matrix was developed taking into account factors such as consent limits (biochemical oxygen demand (BOD), suspended solids and ammonia), dry weather flow (DWF) limits, sludge imports, process type and whether recirculation is present. To understand the risk further, we then applied expertise knowledge to determine to what degree the asset is at risk to allow for a form of prioritisation.

2.6.3. Each wastewater treatment works that has been identified by operational teams is determined to be vulnerable to the risk of first flush and/or low flow events, irrespective of the risk matrix/expert knowledge as the asset has a historical risk of first flush and/or low flow events. These plans need to be continually reviewed and so the data was accurate at the time the assessment was conducted. The assessment is a present-day view so is, therefore, a baseline (2020) scenario.

2.6.4. We summarised the assessment to a TPU. If a TPU has been identified to be at risk of first flush and/or low flow events, it is deemed to be 'less resilient'. If a TPU has not been identified by operational teams, it is, therefore, deemed to not be potentially vulnerable to first flush and/or low flows, and, therefore, has not been assessed.

## 2.7 Coastal and river erosion and land stability

2.7.1. More severe storms and potential changes in erosion rates pose a risk to our assets being able to function as designed. For example, an asset may collapse into the river due to undercutting. Land stability also poses a risk as assets could be affected due to landslips and access might be restricted. In recent years, we have experienced this as a result of severe storms such as Storm Desmond and Storm Eva, whereby access roads to assets were blocked.

2.7.2. We have undertaken an initial assessment to review all wastewater assets (wastewater treatment works buildings, network structures, discharge points and sewers) within a set proximity to an existing watercourse or coastal tidal zone. British Geological Survey (BGS) data was used to determine dominant soil and geology types. In order to understand the risk of failure to assets, an impact/consequence score was determined. For each asset, a likelihood scoring matrix and a preliminary probability red/amber/green (RAG) status was determined based on the susceptibility to erosion and land stability, with red being at the highest risk, and green being the lowest risk. For limitations of this assessment, refer to Table A.1 in Appendix A. The assessment is a present-day view so is, therefore, a baseline (2020) scenario.

2.7.3. We summarised the assessment to a TPU. Assets identified as a red RAG status (those at risk of erosion and/or land instability) were aggregated to a TPU. If a TPU has been identified to be at risk of erosion and/or land stability, it is deemed to be 'less resilient'. If a TPU has not been identified to be at risk of erosion and/or land stability, it is deemed to be 'more resilient.

***Figure 6 Examples of erosion risk and mitigation across the North West***

**Great Clifton Wastewater Treatment Works**

The River Derwent, adjacent to Great Clifton Wastewater Treatment Works, was severely affected by the floods of November 2009. During the flooding event, the course of the river changed in several locations, one of these being adjacent to Great Clifton Wastewater Treatment Works.

In addition to numerous of the treatment process units being threatened, two significant sections of the access roads were washed away, resulting in three to five metres high vertical faces across the access road. This resulted in a total loss of access to the wastewater treatment works.

To mitigate this risk, a Rock Armour solution was constructed in 2012.

**Allonby Foreshore Pumping Station**

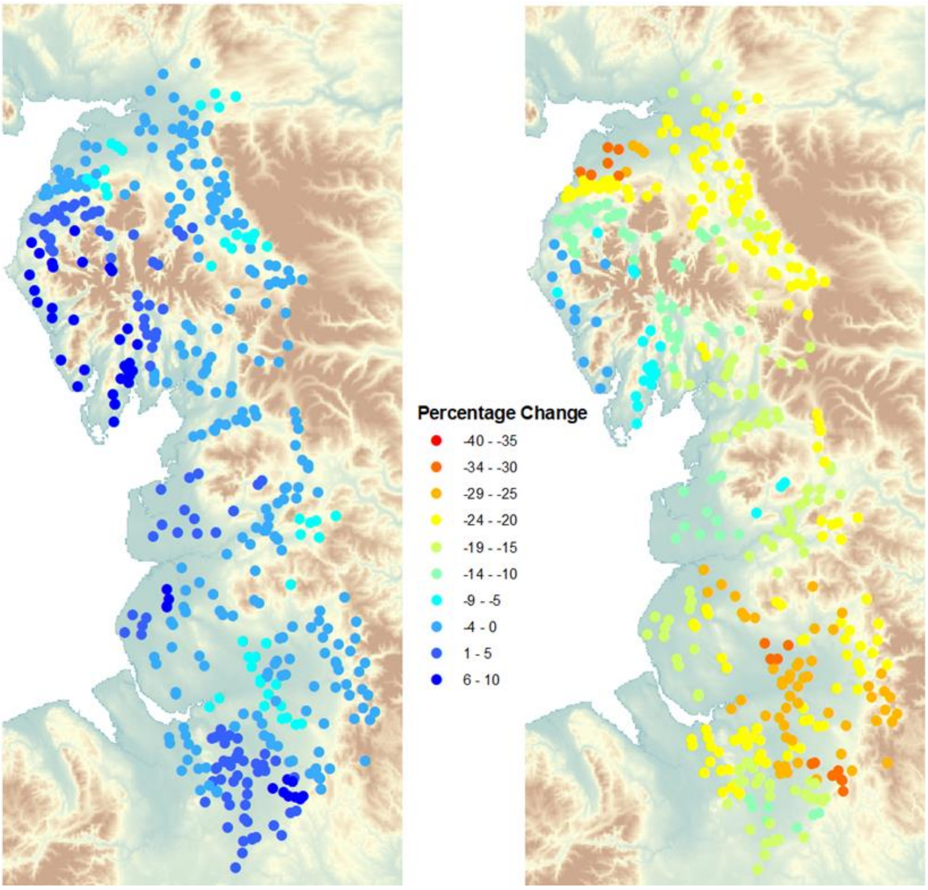
Allonby Foreshore Pumping Station is at risk of coastal erosion and is responsible for pumping all flows from Allonby village to Allonby Wastewater Treatment Works. If the pumping station is compromised, it poses a significant flooding and environmental risk. Discussions are ongoing and the rate of erosion is being closely monitored.

## 2.8 Potential for changes in the water quality of rivers as a result of climate change

2.8.1. Climate change is predicted to cause warmer, drier summers, which could have adverse impacts on water quality of watercourses across the North West. This could result in adverse impacts to the environment, water quality and biodiversity across the region.

2.8.2. The approach considers interactions between predictions of future river flows and temperature, water quality and the impact of wastewater treatment works discharges. The approach determined baseline (2020) and future river flows and water temperature (2030 and 2050) using hydrological modelling. Historical data was used to determine the baseline, and Figure 7 is an example of the change in baseline (1961–90) to 2050s mean and Q95 at wastewater treatment works locations across the North West. The large increases in the Lake District are related to characteristics of the climatic driving forces within the climate change scenarios (UKCP09) used in this assessment.

***Figure 7 Change in river flows and water temperature baseline (1961–90) to 2050s mean (left) and Q95 (right) at wastewater treatment works locations across the North West***




2.8.3. SIMCAT modelling was then used in combination with the future river flows and water temperature, and population growth forecasts to determine predicted concentrations of various parameters (phosphate, nitrate, ammonia, biochemical oxygen demand (BOD), dissolved oxygen (DO), perfluorooctane sulfonate (PFOS) and cypermethrin) for the 2020, 2030 and 2050 design horizons.

2.8.4. The predicted changes in concentration of the above parameters have been attributed against the current Water Framework Directive (WFD) classification status for chemical and biological indicators. The WFD is an EU Directive, which is a classification scheme for surface waters. The WFD classification categories are high, good, moderate, poor and bad status. For example, 'high status' means no or very low human pressures, so the waterbody is at near natural conditions. 'Good status' means a slight change from natural conditions due to human pressures. 'Bad status' means severe changes from natural conditions and there are significant impacts on wildlife, amenity and fisheries.

2.8.5. So, for each of the 2020, 2030 and 2050 design horizons, each of the parameters above have a predicted WFD classification status. These classification status' can be compared across the design horizons to determine any potential changes as shown in the example below (Table 1). For the purpose of this assessment, potential WFD status deterioration is defined as any decrease in WFD status throughout the WFD status classifications e.g. high to good, moderate to bad etc.

***Table 1: Example of potential deterioration in WFD at a wastewater treatment works across the design horizons***

| Parameter | Design horizon | | | Potential deterioration in WFD status |
|---|---|---|---|---|
| | 2020 | 2030 | 2050 | |
| **Phosphate** | Good | High | High | No |
| **Nitrate** | High | Moderate | Moderate | Yes |
| **Ammonia etc** | Good | Moderate | Poor | Yes |

2.8.6. This assessment considers wastewater treatment works assets only, and primarily considers riverine catchments, not transitional or coastal catchments. Bespoke assessments were carried out on key lakes within the Lake District and the tidal reach of the River Mersey (from Warrington downstream to Liverpool Docks).

2.8.7. We summarised the assessment to a TPU. If a TPU has potential predicted detriment in WFD status in either 2030 or 2050 design horizons for at least one parameter, is it deemed to be 'less resilient'. If a TPU does not have potential predicted detriment in WFD status in either 2030 or 2050 design horizons across any parameters, is it deemed to be 'more resilient'.

## 2.9 Potential for changes in catchment contributions as a result of climate change

2.9.1. Climate change and other factors such as population growth and urbanisation may affect land use. If the purpose of an area of land changes, for example from rural (e.g. cattle grazing) to urban (e.g. housing), the run-off rates, pollutant sources and loadings (source apportionment) into the waterbody may change. This could result in adverse impacts to the environment, water quality and biodiversity across the region.

2.9.2. A literature review was conducted to determine potential changes in land use and associated loadings for phosphate and nitrate.

2.9.3. This assessment was run in parallel with the 'changes in the water quality of rivers as a result of climate change' assessment and, therefore, uses the same base data for the future river flows and temperature, SIMCAT modelling approach, and associated concentrations to WFD classification status (refer to Section 2.8). The only variation to this assessment is that the potential changes in catchment contributions are also incorporated into SIMCAT.

2.9.4. We summarised the assessment to a TPU. If a TPU has potential predicted detriment in WFD status in either 2030 or 2050 design horizons for either phosphate or nitrate, is it deemed to be 'less resilient'. If a

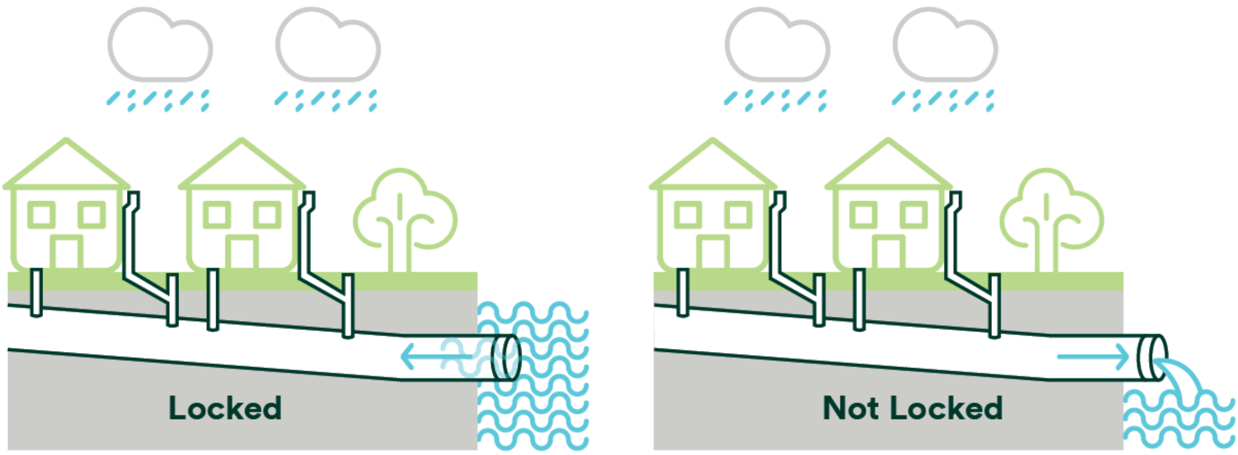
TPU does not have potential predicted detriment in WFD status in either 2030 or 2050 design horizons for either phosphate or nitrate, is it deemed to be 'more resilient'.

## 2.10 Outfall locking

2.10.1. The ability of sewer networks and wastewater treatment works' treatment process to operate as intended are highly reliant on freely discharging flows to the environment via storm overflows, and final effluent outlets and storm outlets at wastewater treatment works.

2.10.2. Outfall locking is when water levels from rivers and coasts increase, usually during storm conditions, and submerge the outfall and can cause hydraulic restrictions. A locked outfall can have wide reaching impacts on other areas of the sewer network as flow can back up and result in flooding.

***Figure 8 Example of a locked outfall versus a freely flowing outfall***




2.10.3. We have used river models supplied by the Environment Agency where available. The information provided contained river level and river flow data for a range of return periods (1 in 2 years, 1 in 5 years, 1 in 10 years, 1 in 20 years, 1 in 25 years, 1 in 30 years, 1 in 50 years, 1 in 75 years, 1 in 100 years, 1 in 200 years and 1 in 1000 years). The modelled river level data across the range of return periods was compared against outfall heights. An outfall was deemed to be locked when the outfall was fully submerged.

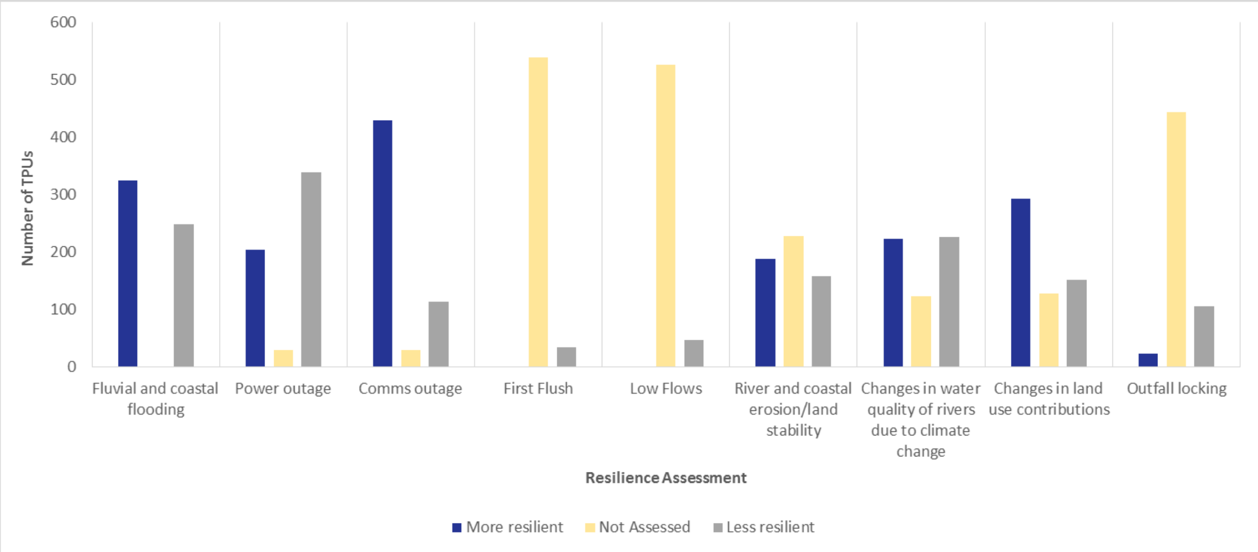
2.10.4. This assessment only considers outfalls discharging to rivers. No assessment has been undertaken for coastal discharges. It is also assumed that all outfalls are free discharges, for example there are no flap valves, and all discharges are gravity and not pumped.

2.10.5. We summarised the assessment to a TPU. If a TPU had at least one outfall at risk of locking in at least one return period, it was deemed to be 'less resilient' to outfall locking. If a TPU does not have any outfalls at risk of locking in any return period, it was deemed to be 'more resilient' to outfall locking.

# 3. Results of risk assessments

3.1. For each resilience assessment undertaken, the number of TPUs that are assessed vary significantly due to various limitations of each assessment. The North West is least resilient to power outages (339 TPUs are less resilient (60%), Figure 9), and most resilient to communications outage (429 TPUs are more resilient (76%), Figure 9).

***Figure 9 Summary each assessment and the associated number of TPUs, which are more or less resilient (excluding Response Recovery Plans)***



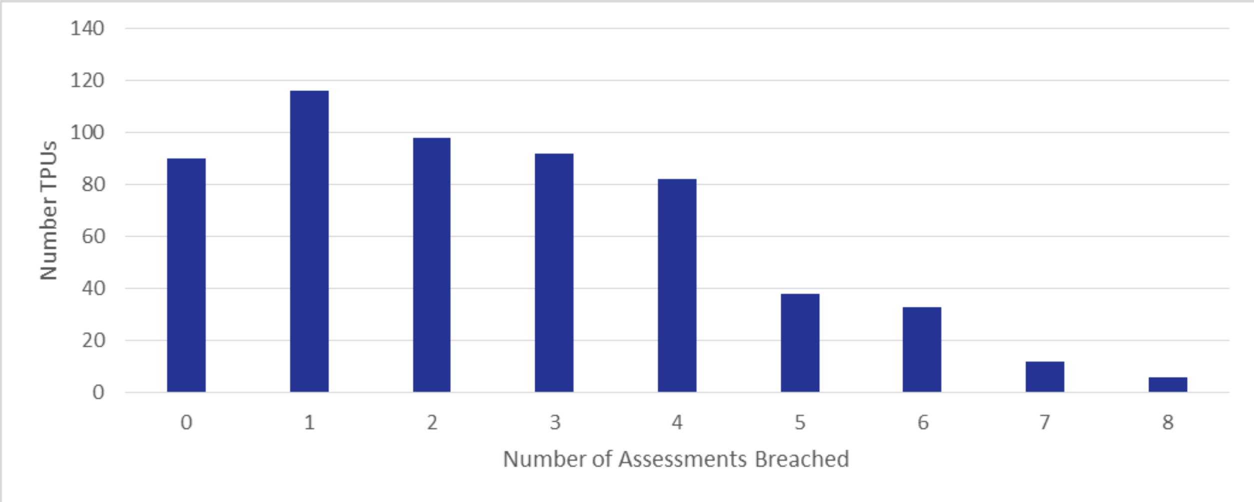

3.2. With the exclusion of Response Recovery Plans, across the North West, the majority of TPUs are less resilient to one assessment (Figure 10), which is attributed to the risk of power outage. There are 12 TPUs across the region, which are less resilient to seven assessments and there are six TPUs which are less resilient to eight assessments (Figure 10), the majority of which are attributed to the Upper Mersey Strategic Planning Area (SPA). The Upper Mersey SPA is one of our Place Based Planning pilots and the resilience assessments will feed into this process. There are zero TPUs which are less resilient to all nine assessments (Figure 10).

**Place Based Planning**

The Upper Mersey SPA is one of our Place Based Planning pilot areas, which is an opportunity to identify partnership solutions that offer better value and deliver wider benefits along with co-funding.

A key feature of the pilots will be to build the governance needed to ensure that the plan is co-owned.

***Figure 10 Number of TPUs that are deemed to be less resilient across the nine resilience assessments (excluding Response Recovery Plans)***



# 4. Consolidation to Strategic Planning Areas

## 4.1 Overview

4.1.1. There are 14 SPAs across the North West (Figure 11), which typically align to the Environment Agency optional management catchment level. Across the SPAs, the majority are least resilient to power outage.

*Figure 11 Map of the 14 SPAs across the North West*


4.1.2. Within each SPA, there are numerous TPUs. For example, the Alt Crossens SPA has 12 TPUs.

4.1.3. For each resilience assessment, the number of TPUs assessed vary due to the limitations of each assessment.

4.1.4. For the purpose of displaying the results, for each resilience assessment (excluding Response Recovery Plans), the number of TPUs that are 'more resilient', 'less resilient' or were not assessed within each SPA, have been calculated as a percentage (for an example see Table 2).

*Table 2 Example: Catchment X has 12 TPUs which are either more resilient, less resilient or not assessed*

| Resilience Assessment | Number of TPUs deemed to be more resilient | Number of TPUs deemed to be less resilient | Number of TPUs not assessed |
|---|---|---|---|
| **A** | 6 (50%) | 6 (50%) | 0 (0%) |
| **B** | 4 (33%) | 8 (67%) | 0 (0%) |
| **C** | 10 (83%) | 2 (17%) | 0 (0%) |
| **D etc.** | 3 (25%) | 5 (42%) | 4 (33%) |

4.1.5. For each SPA, each resilience assessment has an associated percentage of the TPUs that is deemed to be more resilient, less resilient or not assessed. A traffic light system has then been determined based on the less resilient and not assessed per cent using the thresholds shown in Table 3.

*Table 3 Thresholds used for the traffic light system based on the 'less resilient' and 'not assessed' percentages for Catchment X (SPA)*

| Threshold (per cent of TPUs that are deemed to be less resilient) | Traffic Light |
|---|---|
| **< 40%** | Green |
| **40–60 %**<br><br>**Or >25% not assessed** | Amber |
| **>60%** | Red |
| **Not Assessed** | Grey |

*Table 4 Example of the traffic light system applied to Catchment X (SPA)*

| Resilience Assessment | Less resilient | Not assessed | Traffic Light |
|---|---|---|---|
| **A** | 50% | 0% | Amber |
| **B** | 67% | 0% | Red |
| **C** | 2% | 0% | Green |
| **D etc.** | 42% | 33% | Amber (as >25% of the TPUs have not been assessed) |

## 4.2 Alt Crossens

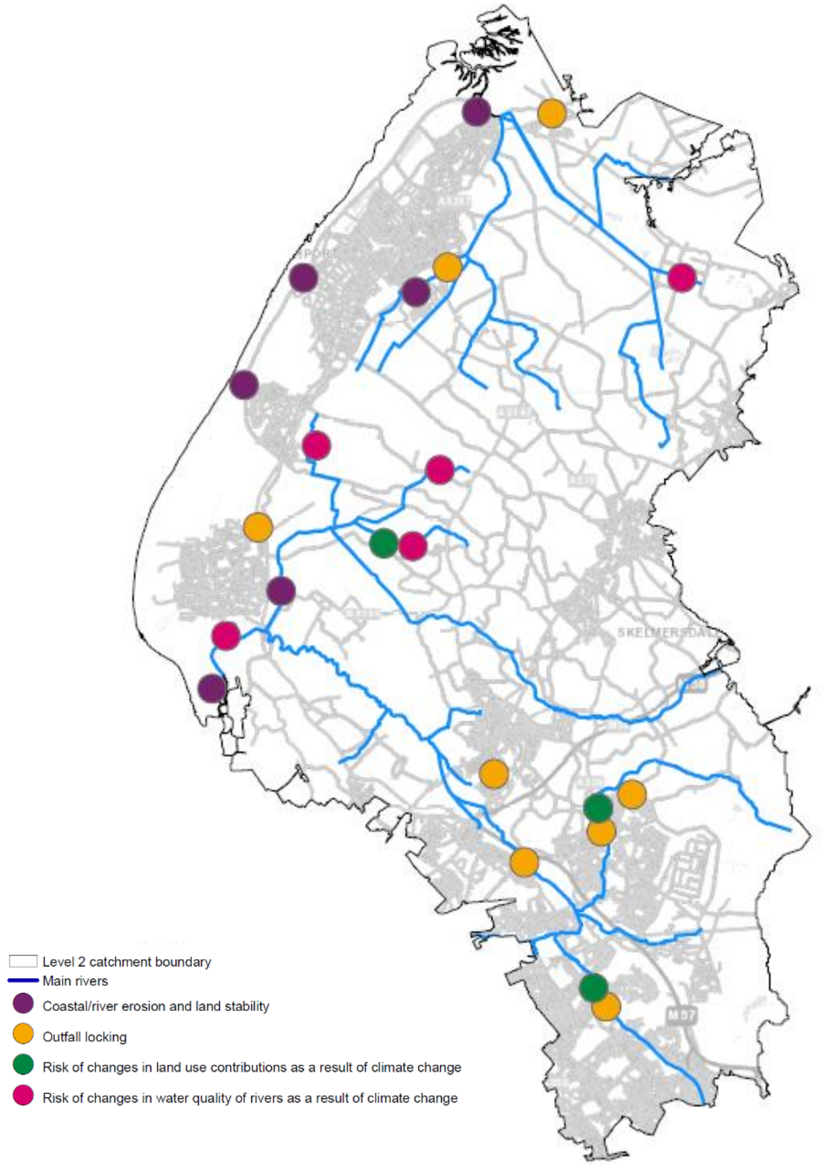
4.2.1. The Alt Crossens SPA is least resilient to power outage as it is the only assessment that scores red (Table 5). Three assessments score amber and three assessments score green (Table 5). No TPUs within the SPA were identified by operational teams as being potentially vulnerable to first flush or low flows.

4.2.2. There are several locations in the SPA where there may be shared risks which could be explored for partnership solutions, such as areas that are vulnerable to erosion. Some examples are shown in Figure 12.

*Table 5 Traffic light scoring for the Alt Crossens SPA (excluding Response Recovery Plans)*

| Resilience Assessment | Traffic light |
|---|---|
| Fluvial and coastal flooding of wastewater treatment works and major pumping station | |
| Power outages | |
| Communications outage | |
| First flush | |
| Low flows | |
| Coastal/river erosion and land stability | |
| Changes in the water quality of rivers as a result of climate change | |
| Changes in catchment contributions as a result of climate change | |
| Outfall locking | |

*Figure 12 Map of some of the potential shared risks in the SPA, which can be explored for partnership opportunities*



## 4.3 Derwent

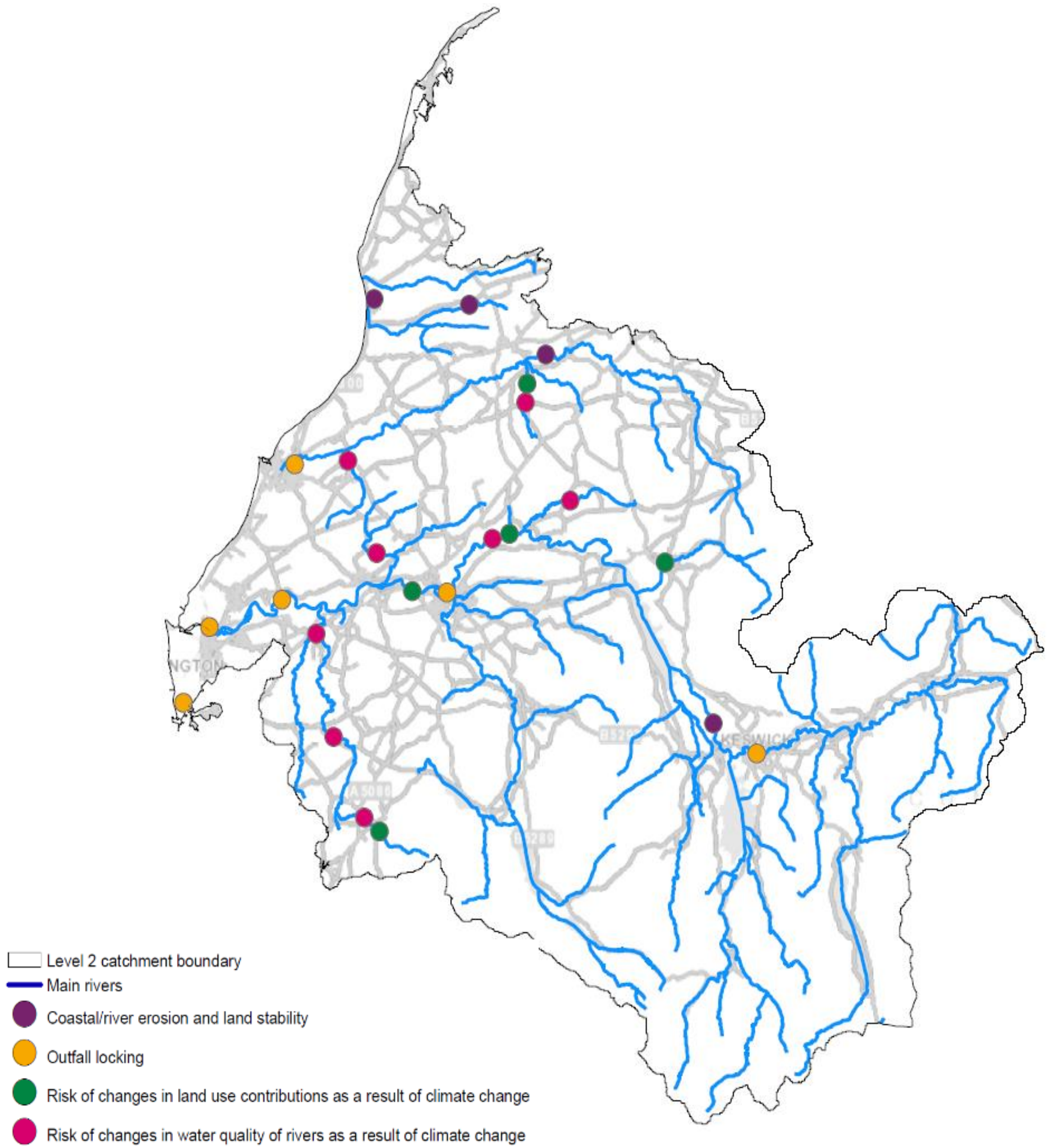
4.3.1. The Derwent SPA is least resilient to power outage as it is the only assessment that scores red (Table 6). There are four assessments that score both amber and green. (Table 6).

4.3.2. There are several locations in the SPA where there may be shared risks, which could be explored for partnership solutions, such as areas that are vulnerable to erosion. Some examples are shown in Figure 13.

***Table 6 Traffic light scoring for the Derwent SPA (excluding Response Recovery Plans)***

| Resilience Assessment | Traffic light |
|---|---|
| Fluvial and coastal flooding of wastewater treatment works and major pumping station | |
| Power outages | |
| Communications outage | |
| First flush | |
| Low flows | |
| Coastal/river erosion and land stability | |
| Changes in the water quality of rivers as a result of climate change | |
| Changes in catchment contributions as a result of climate change | |
| Outfall locking | |

***Figure 13 Map of some of the potential shared risks in the SPA, which can be explored for partnership opportunities***



## 4.4 Douglas

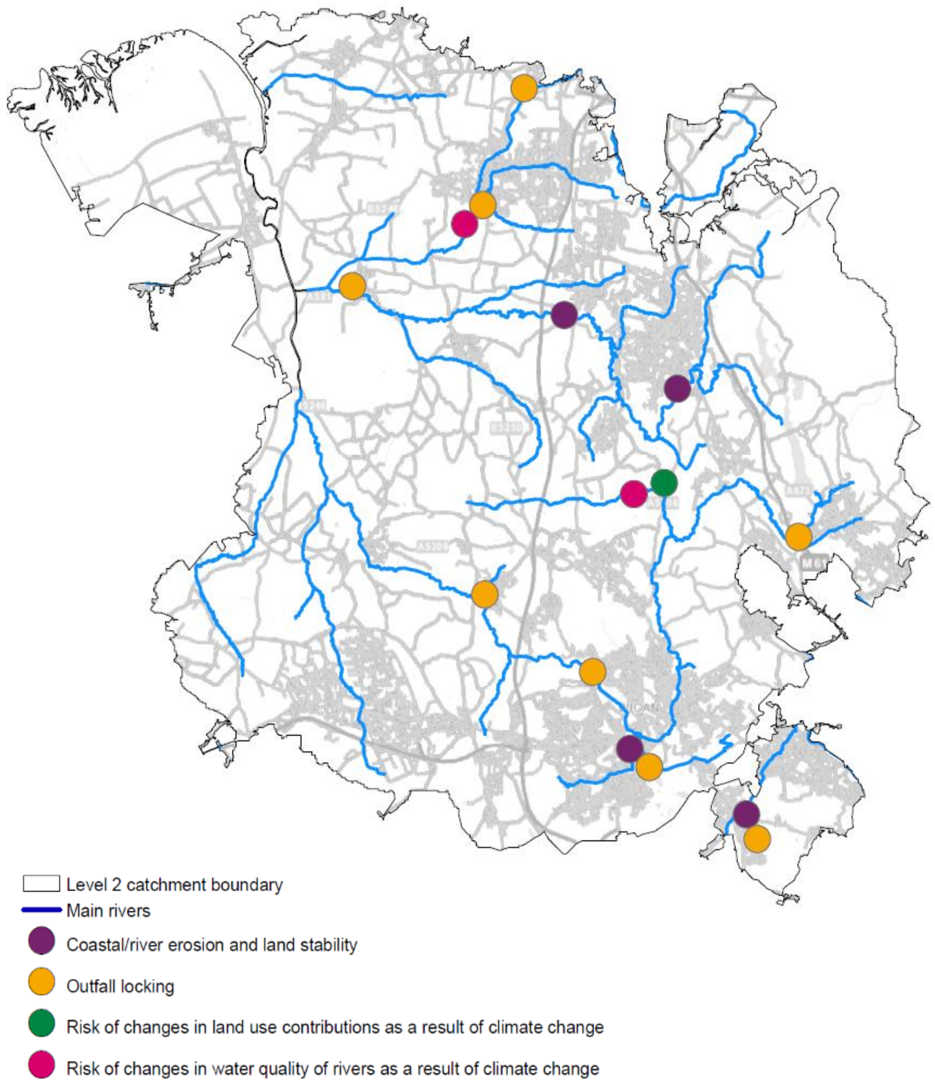
4.4.1. The Douglas SPA is least resilient to fluvial and coastal flooding of wastewater treatment works and major pumping stations as it is the only assessment that scores red (Table 7). Three assessments score amber and three assessments score green (Table 7). No TPUs within the SPA were identified by operational teams as being potentially vulnerable to first flush or low flows.

4.4.2. There are several locations in the SPA where there may be shared risks, which could be explored for partnership solutions, such as areas that are vulnerable to erosion. Some examples are shown in Figure 14.

*Table 7 Traffic light scoring for the Douglas SPA (excluding Response Recovery Plans)*

| Resilience Assessment | Traffic light |
|---|---|
| Fluvial and coastal flooding of wastewater treatment works and major pumping station | |
| Power outages | |
| Communications outage | |
| First flush | |
| Low flows | |
| Coastal/river erosion and land stability | |
| Changes in the water quality of rivers as a result of climate change | |
| Changes in catchment contributions as a result of climate change | |
| Outfall locking | |

*Figure 14 Map of some of the potential shared risks in the SPA, which can be explored for partnership opportunities*



## 4.5 Eden and Esk

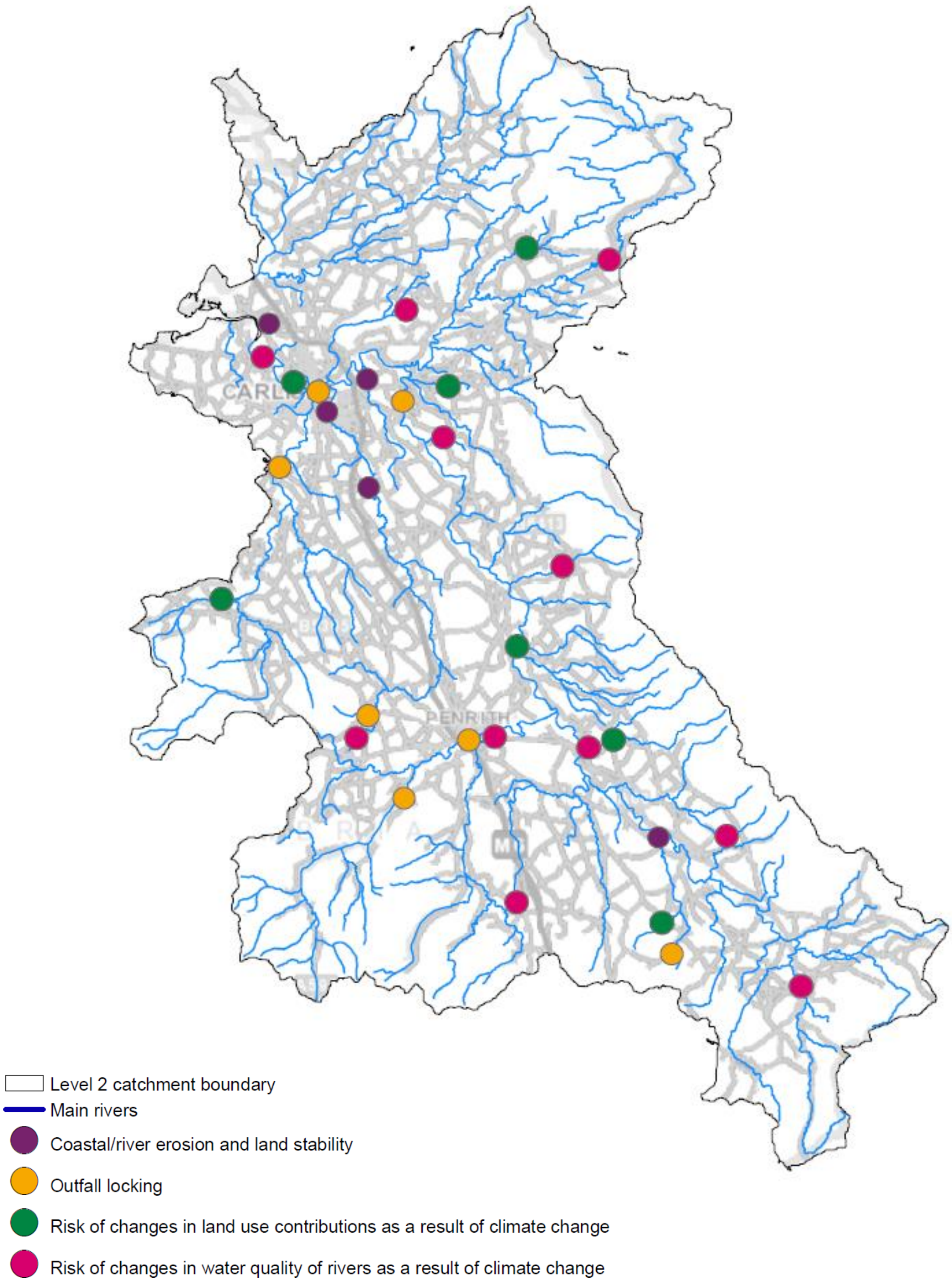
4.5.1. The Eden and Esk SPA is most resilient to communications outage, and fluvial and coastal flooding of wastewater treatment works and major pumping stations as the assessments score green (Table 8). However, we are aware that there are significant localised risks with regards to flooding, and that there have been areas which have been severely affected during periods of heavy rainfall. The SPA is least resilient to power outage by scoring red (Table 8). No TPUs within the SPA were identified by operational teams as being potentially vulnerable to low flows.

4.5.2. There are several locations in the SPA where there may be shared risks, which could be explored for partnership solutions, such as areas that are vulnerable to erosion. Some examples are shown in Figure 15.

***Table 8 Traffic light scoring for the Eden and Esk SPA (excluding Response Recovery Plans)***

| Resilience Assessment | Traffic light |
|---|---|
| Fluvial and coastal flooding of wastewater treatment works and major pumping station | Green |
| Power outages | Red |
| Communications outage | Green |
| First flush | Yellow |
| Low flows | Grey |
| Coastal/river erosion and land stability | Yellow |
| Changes in the water quality of rivers as a result of climate change | Yellow |
| Changes in catchment contributions as a result of climate change | Yellow |
| Outfall locking | Yellow |

***Figure 15 Map of some of the potential shared risks in the SPA, which can be explored for partnership opportunities***



## 4.6 Irwell

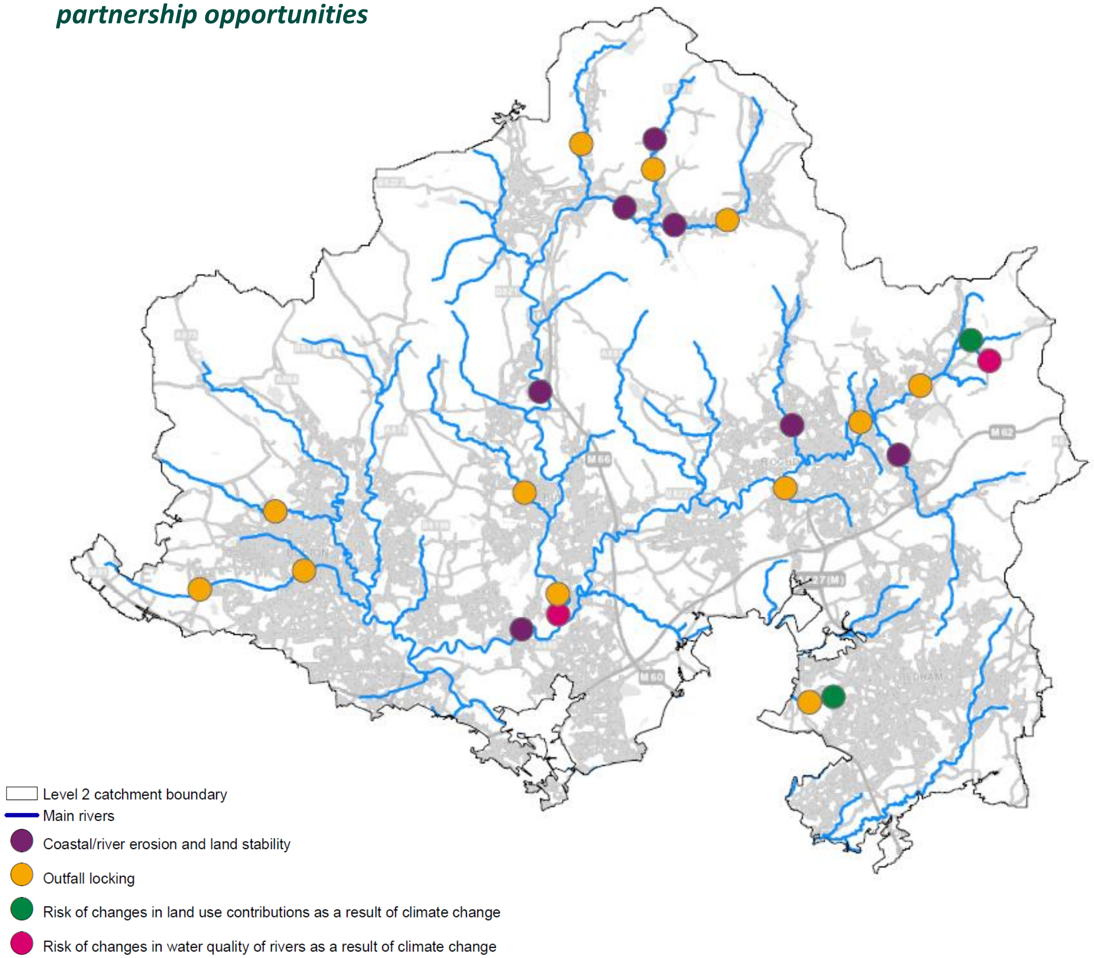
4.6.1. The Irwell SPA is least resilient to three assessments by scoring red (Table 9). There is a great number of assessments that score amber, which are communications outage, first flush, low flow and outfall locking (Table 9). Two assessments relating to the water quality of rivers due to climate change score green (Table 9).

4.6.2. There are several locations in the SPA where there may be shared risks, which could be explored for partnership solutions, such as areas that are vulnerable to erosion. Some examples are shown in Figure 16.

*Table 9 Traffic light scoring for the Irwell SPA (excluding Response Recovery Plans)*

| Resilience Assessment | Traffic light |
|---|---|
| Fluvial and coastal flooding of wastewater treatment works and major pumping station | |
| Power outages | |
| Communications outage | |
| First flush | |
| Low flows | |
| Coastal/river erosion and land stability | |
| Changes in the water quality of rivers as a result of climate change | |
| Changes in catchment contributions as a result of climate change | |
| Outfall locking | |

*Figure 16 Map of some of the potential shared risks in the SPA, which can be explored for partnership opportunities*



## 4.7 Kent Leven

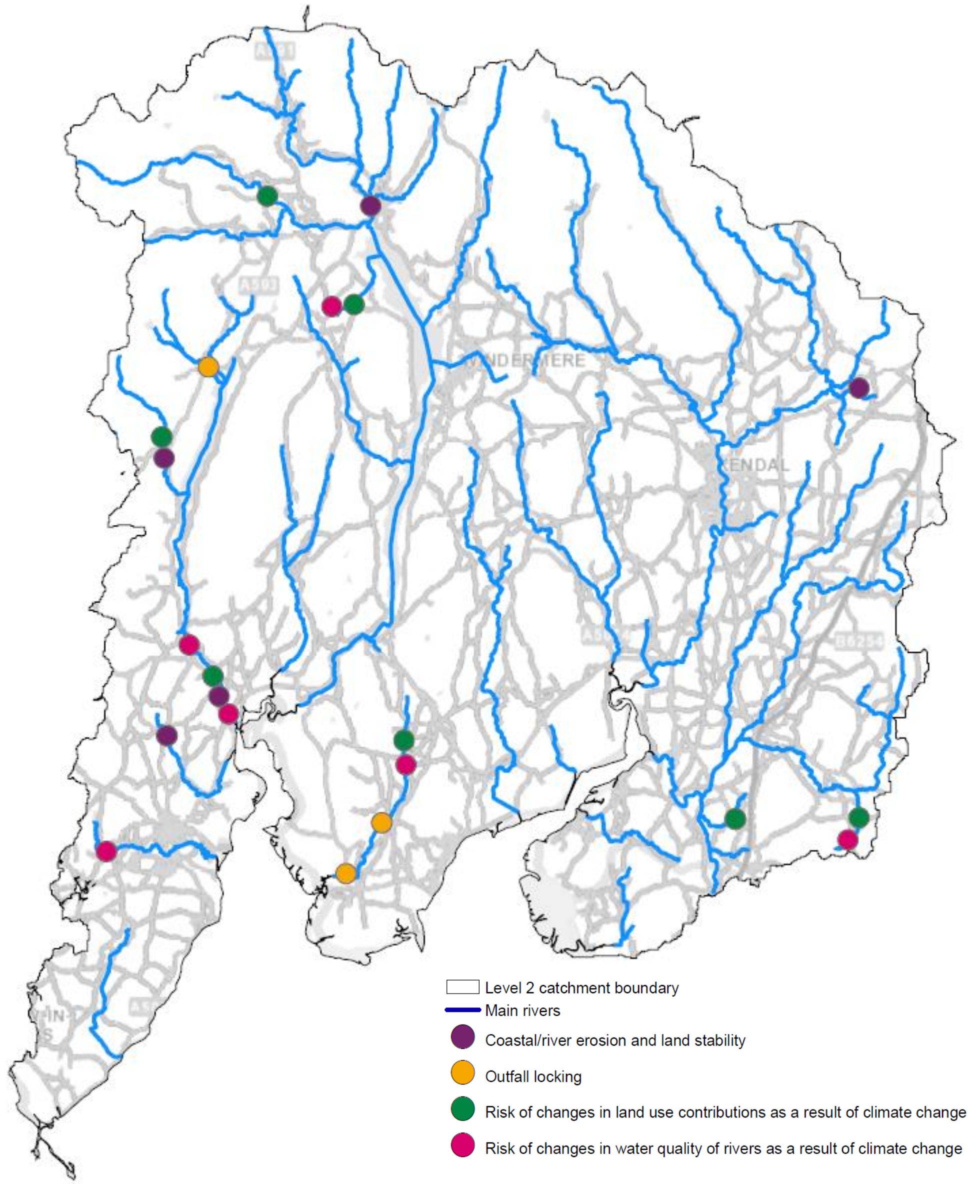
4.7.1. The Kent Leven SPA scores a mixture of red (five assessments) and green (four assessments, Table 10).

4.7.2. There are several locations in the SPA where there may be shared risks, which could be explored for partnership solutions, such as areas that are vulnerable to erosion. Some examples are shown in Figure 17.

***Table 10 Traffic light scoring for the Kent Leven SPA (excluding Response Recovery Plans)***

| Resilience Assessment | Traffic light |
|---|---|
| Fluvial and coastal flooding of wastewater treatment works and major pumping station | Green |
| Power outages | Red |
| Communications outage | Green |
| First flush | Red |
| Low flows | Red |
| Coastal/river erosion and land stability | Red |
| Changes in the water quality of rivers as a result of climate change | Green |
| Changes in catchment contributions as a result of climate change | Green |
| Outfall locking | Red |

***Figure 17 Map of some of the potential shared risks in the SPA, which can be explored for partnership opportunities***



## 4.8 Lune

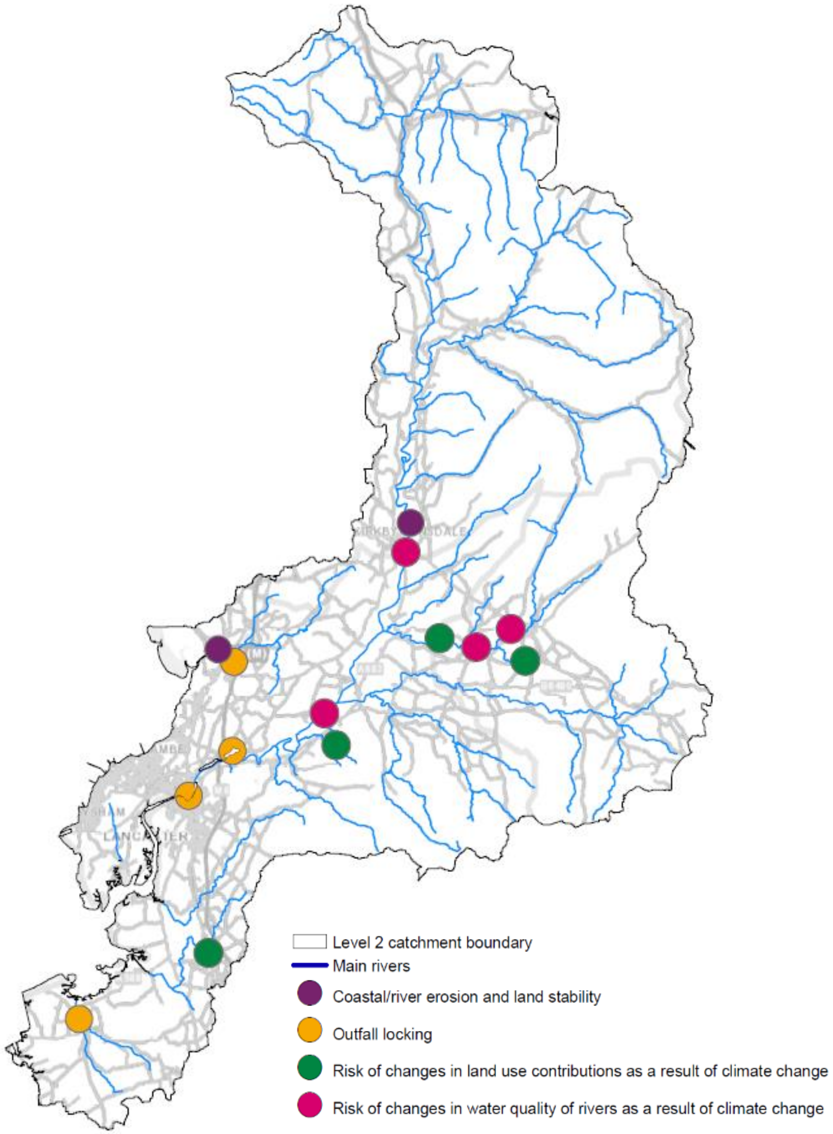
4.8.1. The Lune SPA is least resilient to the majority of resilience assessments by scoring red (Table 11). The SPA is most resilient to communications outage by scoring green (Table 11).

4.8.2. There are several locations in the SPA where there may be shared risks, which could be explored for partnership solutions, such as areas that are vulnerable to erosion. Some examples are shown in Figure 18.

***Table 11 Traffic light scoring for the Lune SPA (excluding Response Recovery Plans)***

| Resilience Assessment | Traffic light |
|---|---|
| Fluvial and coastal flooding of wastewater treatment works and major pumping station | Red |
| Power outages | Red |
| Communications outage | Green |
| First flush | Red |
| Low flows | Red |
| Coastal/river erosion and land stability | Red |
| Changes in the water quality of rivers as a result of climate change | Red |
| Changes in catchment contributions as a result of climate change | Red |
| Outfall locking | Red |

***Figure 18 Map of some of the potential shared risks in the SPA, which can be explored for partnership opportunities***



## 4.9 Mersey Estuary

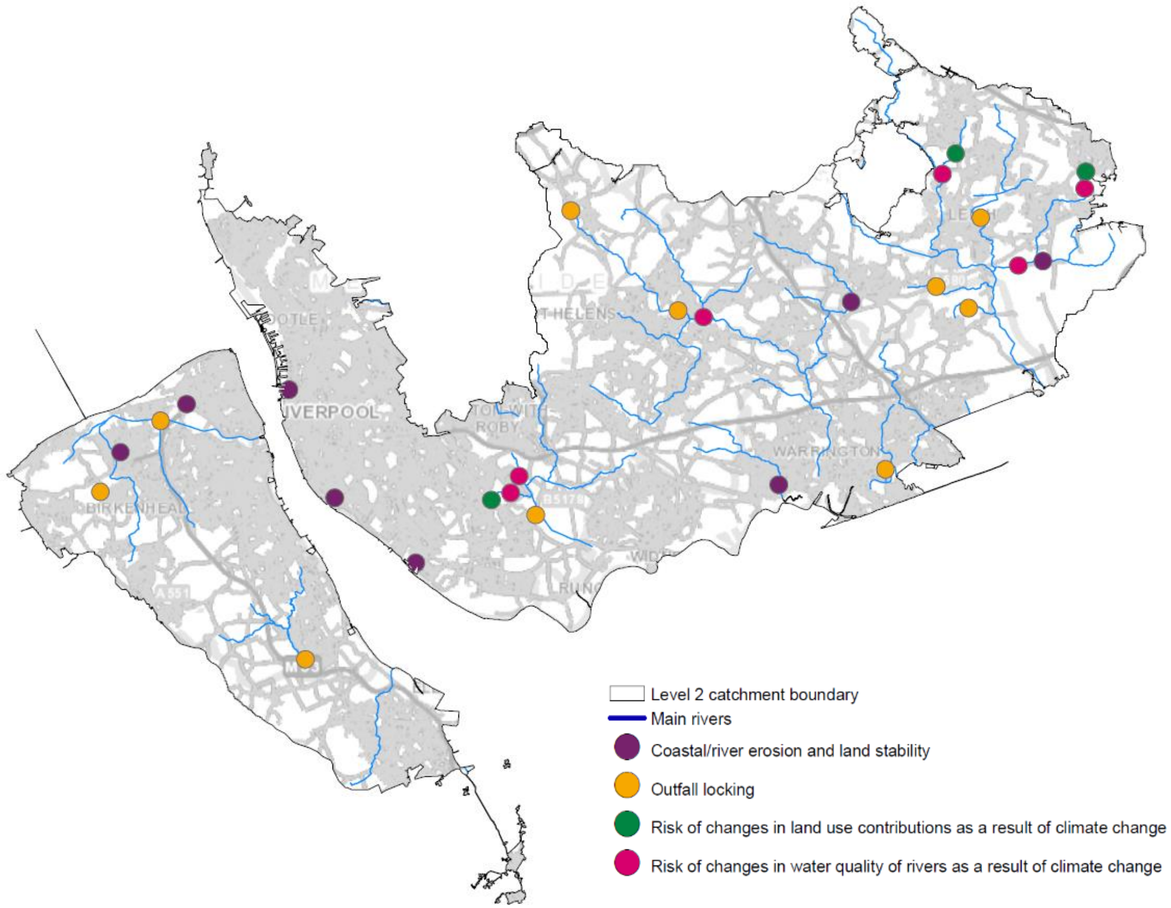
4.9.1. The Mersey Estuary SPA is least resilient to three of the resilience assessments by scoring red (Table 12). The SPA scores amber for the majority of assessments and scores green for power outages only (Table 12).

4.9.2. There are several locations in the SPA where there may be shared risks, which could be explored for partnership solutions, such as areas that are vulnerable to erosion. Some examples are shown in Figure 19.

*Table 12 Traffic light scoring for the Mersey Estuary SPA (excluding Response Recovery Plans)*

| Resilience Assessment | Traffic light |
|---|---|
| Fluvial and coastal flooding of wastewater treatment works and major pumping station | |
| Power outages | |
| Communications outage | |
| First flush | |
| Low flows | |
| Coastal/river erosion and land stability | |
| Changes in the water quality of rivers as a result of climate change | |
| Changes in catchment contributions as a result of climate change | |
| Outfall locking | |

*Figure 19 Map of some of the potential shared risks in the SPA, which can be explored for partnership opportunities*



## 4.10 Ribble

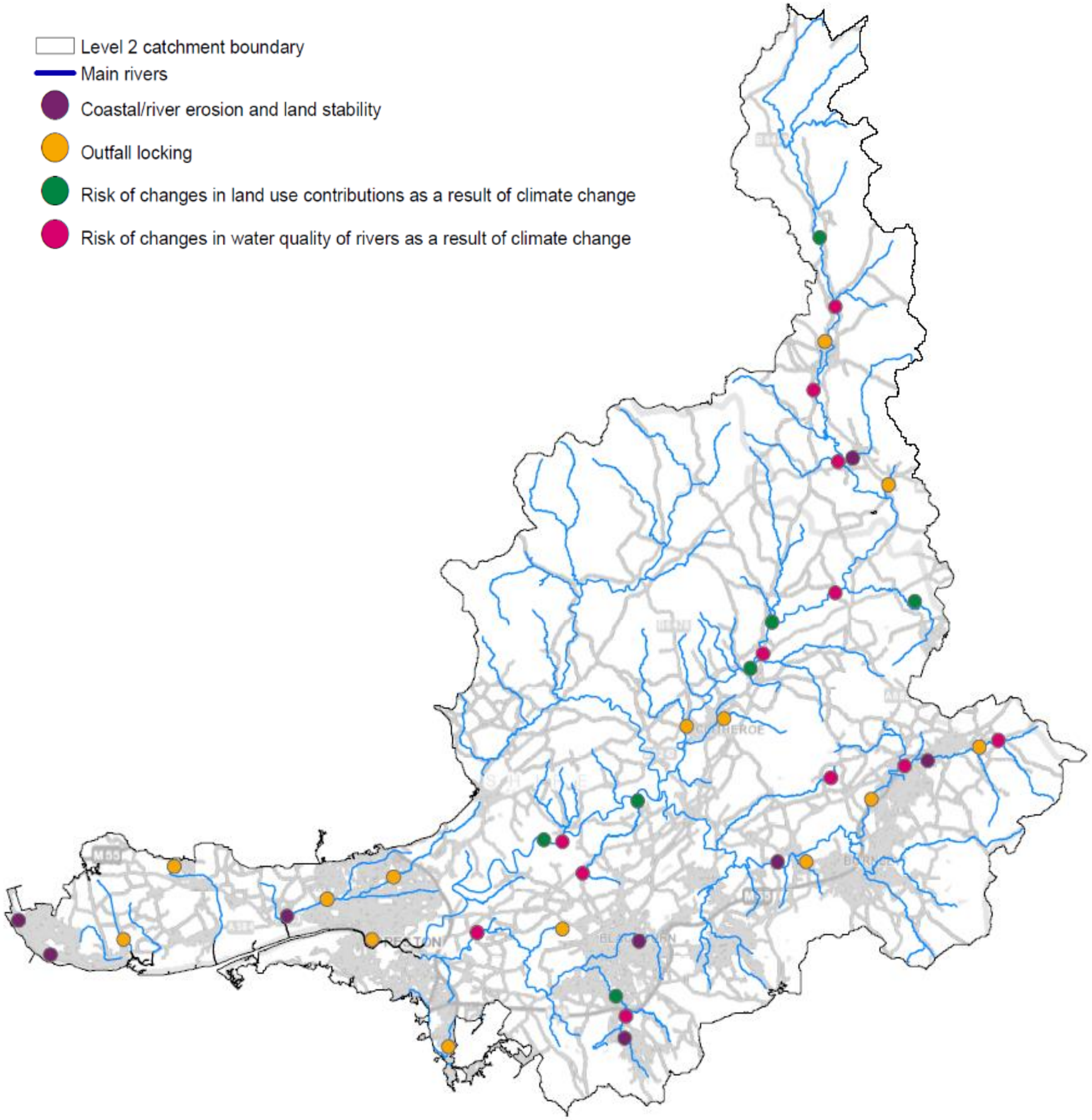
4.10.1. The Ribble SPA is least resilient to power outage as it is the only assessment that scores red (Table 13). The SPA scores amber for five assessments and green for three assessments (Table 13).

4.10.2. There are several locations in the SPA where there may be shared risks, which could be explored for partnership solutions, such as areas that are vulnerable to erosion. Some examples are shown in Figure 20.

***Table 13 Traffic light scoring for the Ribble SPA (excluding Response Recovery Plans)***

| Resilience Assessment | Traffic light |
|---|---|
| Fluvial and coastal flooding of wastewater treatment works and major pumping station | |
| Power outages | |
| Communications outage | |
| First flush | |
| Low flows | |
| Coastal/river erosion and land stability | |
| Changes in the water quality of rivers as a result of climate change | |
| Changes in catchment contributions as a result of climate change | |
| Outfall locking | |

***Figure 20 Map of some of the potential shared risks in the SPA, which can be explored for partnership opportunities***



## 4.11 South West Lakes

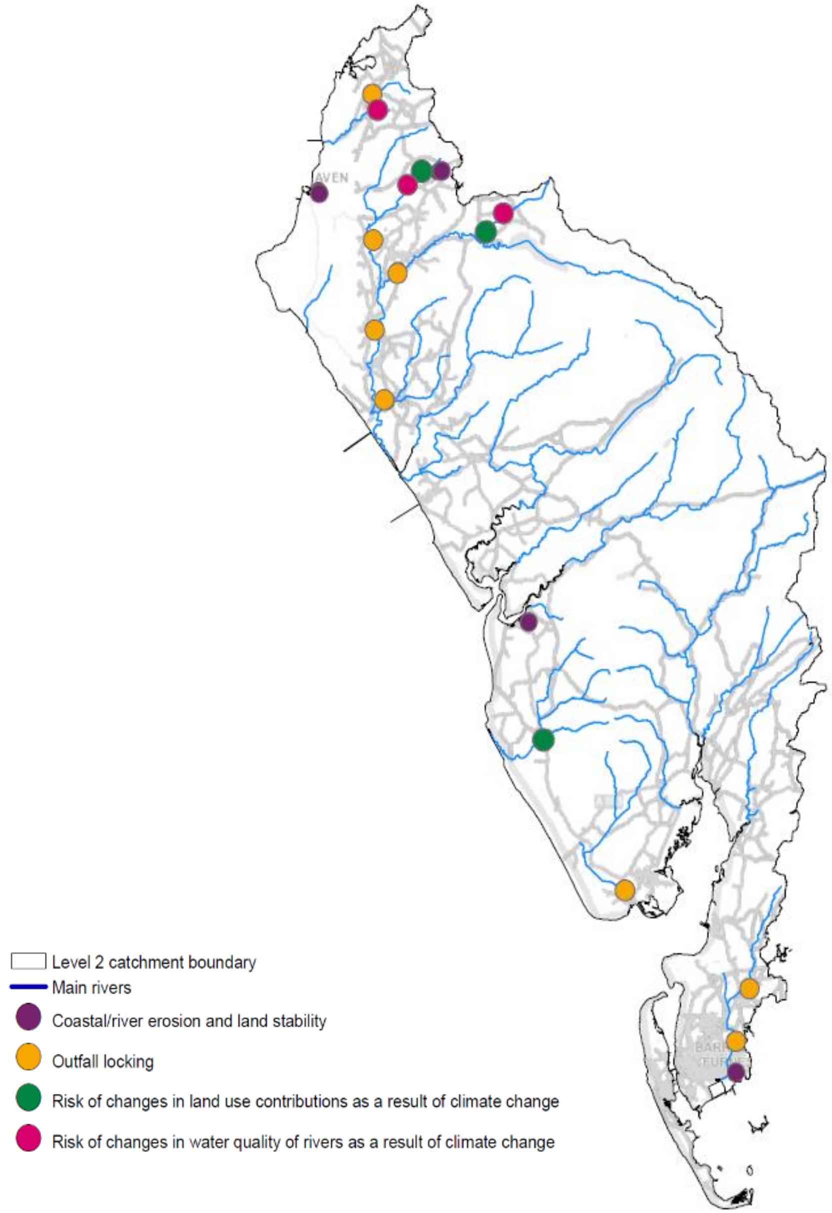
4.11.1. The South West Lakes SPA scores green for all assessments. No TPUs within the SPA were identified by operational teams as being potentially vulnerable to first flush or low flows (Table 14).

4.11.2. There are several locations in the SPA where there may be shared risks, which could be explored for partnership solutions, such as areas that are vulnerable to erosion. Some examples are shown in Figure 21.

***Table 14 Traffic light scoring for the South West Lakes SPA (excluding Response Recovery Plans)***

| Resilience Assessment | Traffic light |
|---|---|
| Fluvial and coastal flooding of wastewater treatment works and major pumping station | |
| Power outages | |
| Communications outage | |
| First flush | |
| Low flows | |
| Coastal/river erosion and land stability | |
| Changes in the water quality of rivers as a result of climate change | |
| Changes in catchment contributions as a result of climate change | |
| Outfall locking | |

***Figure 21 Map of some of the potential shared risks in the SPA, which can be explored for partnership opportunities***



## 4.12 Upper Mersey

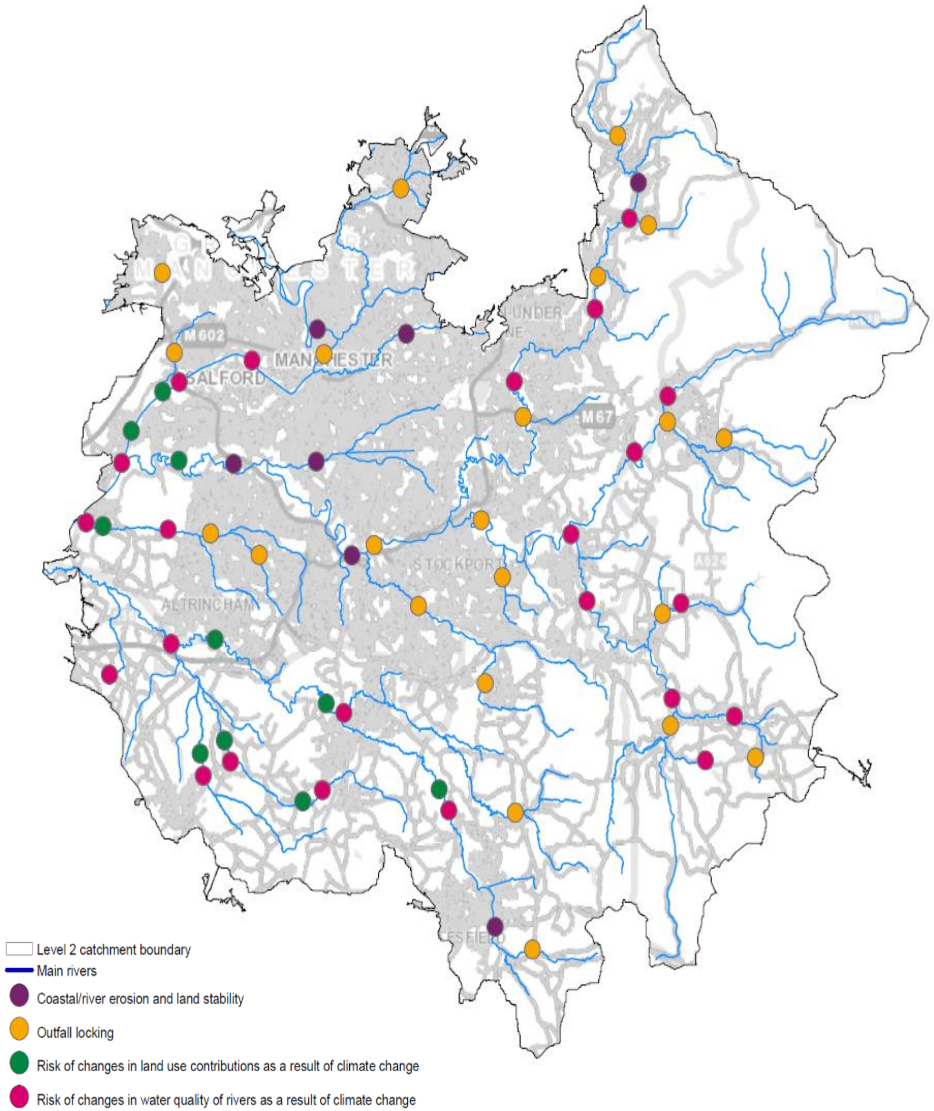
4.12.1. The Upper Mersey SPA is least resilient to power outage and the risk of fluvial and coastal flooding as they are the only assessments that scores red (Table 15). There are three assessments that scored amber, and three assessments which scored green (Table 15).

4.12.2. There are several locations in the SPA where there may be shared risks, which could be explored for partnership solutions, such as areas that are vulnerable to erosion. Some examples are shown in Figure 22.

***Table 15 Traffic light scoring for the Upper Mersey SPA (excluding Response Recovery Plans)***

| Resilience Assessment | Traffic light |
|---|---|
| Fluvial and coastal flooding of wastewater treatment works and major pumping station | |
| Power outages | |
| Communications outage | |
| First flush | |
| Low flows | |
| Coastal/river erosion and land stability | |
| Changes in the water quality of rivers as a result of climate change | |
| Changes in catchment contributions as a result of climate change | |
| Outfall locking | |

***Figure 22 Map of some of the potential shared risks in the SPA, which can be explored for partnership opportunities***



## 4.13 Waver Wampool

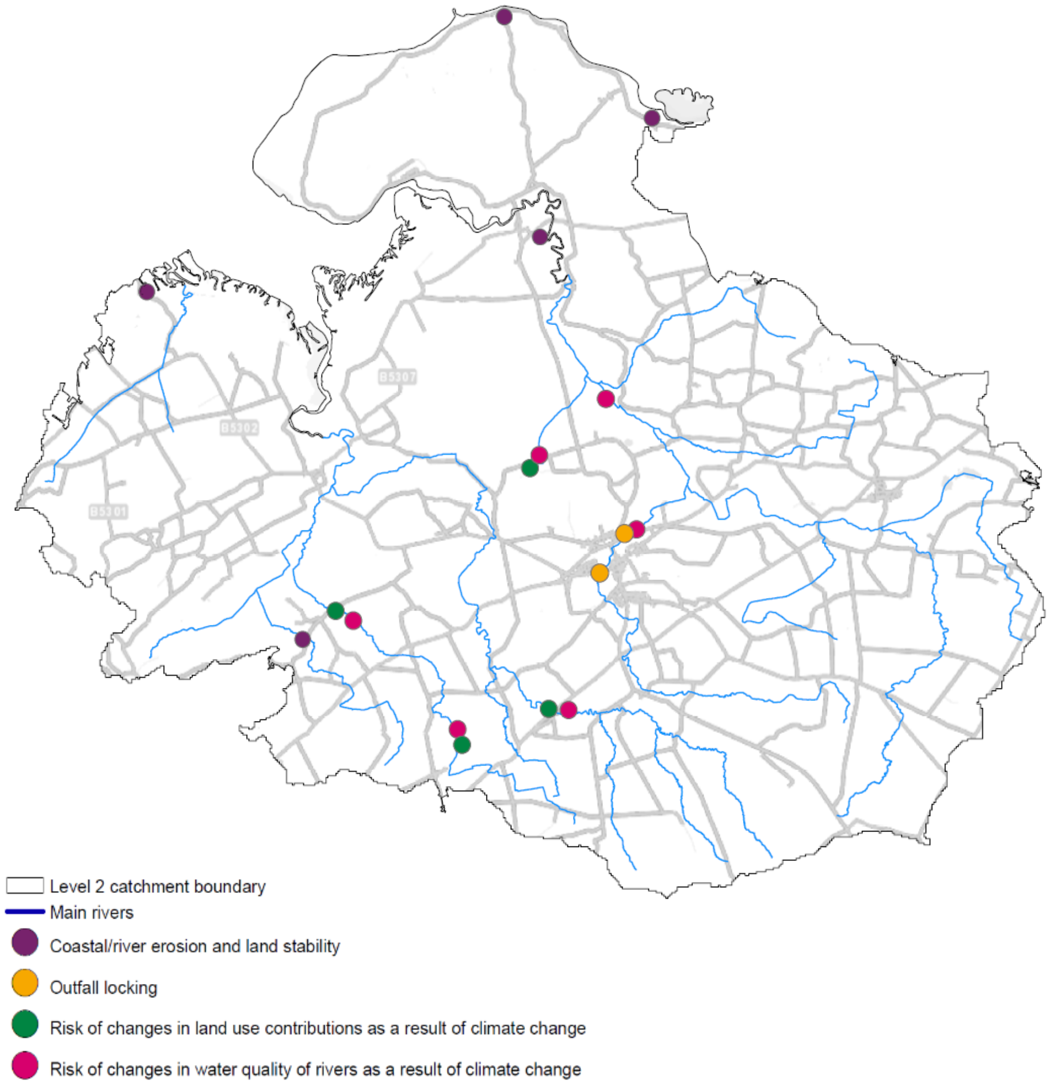
4.13.1. The Waver Wampool SPA is least resilient to two resilience assessments by scoring red (Table 16). Resilience to communications outages scored green, and the remaining assessments scored amber (Table 16).

4.13.2. There are several locations in the SPA where there may be shared risks, which could be explored for partnership solutions, such as areas that are vulnerable to erosion. Some examples are shown in Figure 23.

***Table 16 Traffic light scoring for the Waver Wampool SPA (excluding Response Recovery Plans)***

| Resilience Assessment | Traffic light |
|---|---|
| Fluvial and coastal flooding of wastewater treatment works and major pumping station | |
| Power outages | |
| Communications outage | |
| First flush | |
| Low flows | |
| Coastal/river erosion and land stability | |
| Changes in the water quality of rivers as a result of climate change | |
| Changes in catchment contributions as a result of climate change | |
| Outfall locking | |

***Figure 23 Map of some of the potential shared risks in the SPA, which can be explored for partnership opportunities***



## 4.14 Weaver Gowy

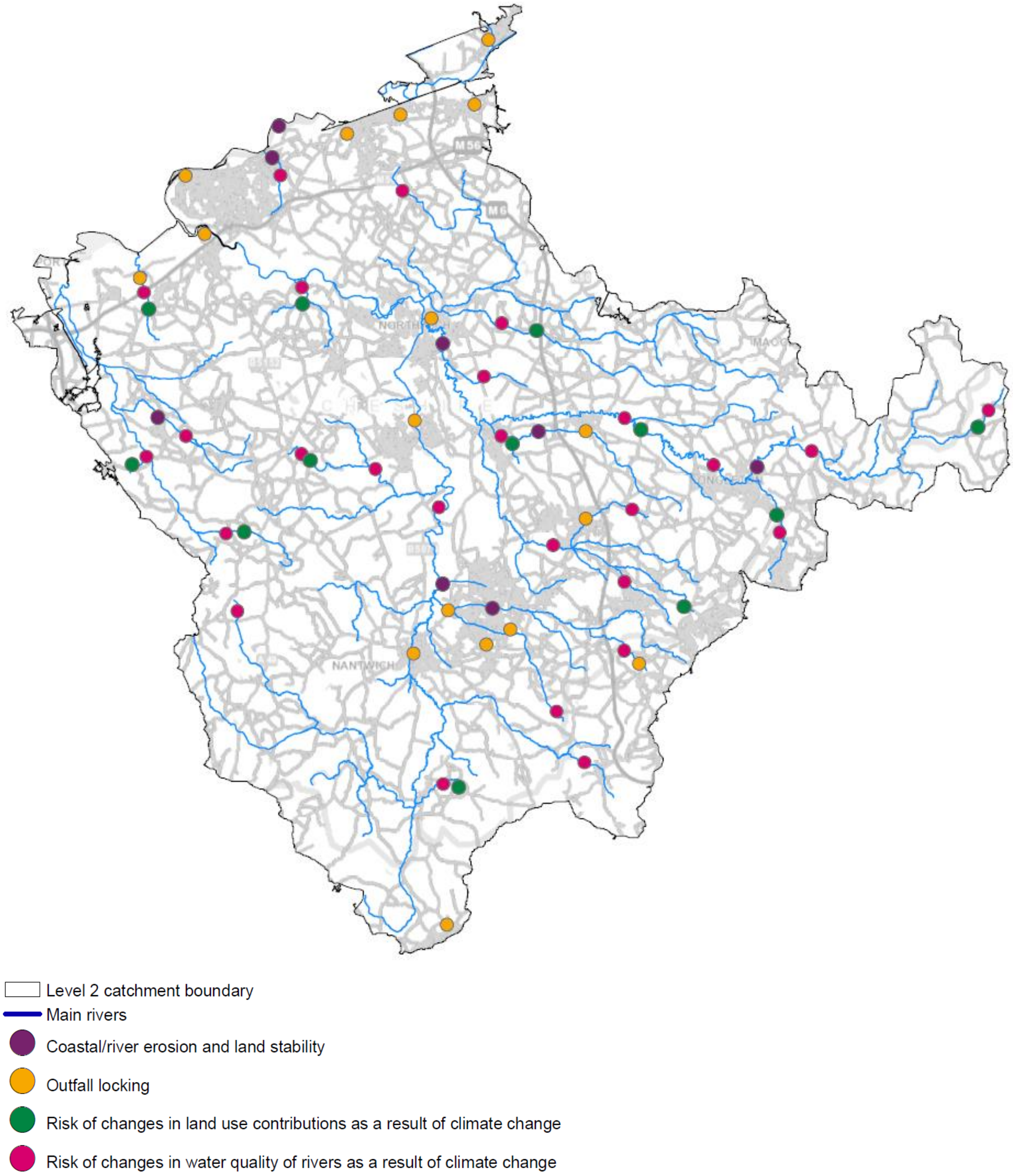
4.14.1. The Weaver Gowy SPA is least resilient to power outage as it is the only assessment that scores red (Table 17). There are four assessments that score amber, and four assessments that score green (Table 17).

4.14.2. There are several locations in the SPA where there may be shared risks, which could be explored for partnership solutions, such as areas that are vulnerable to erosion. Some examples are shown in Figure 24.

***Table 17 Traffic light scoring for the Weaver Gowy SPA (excluding Response Recovery Plans)***

| Resilience Assessment | Traffic light |
|---|---|
| Fluvial and coastal flooding of wastewater treatment works and major pumping station | |
| Power outages | |
| Communications outage | |
| First flush | |
| Low flows | |
| Coastal/river erosion and land stability | |
| Changes in the water quality of rivers as a result of climate change | |
| Changes in catchment contributions as a result of climate change | |
| Outfall locking | |

***Figure 24 Map of some of the potential shared risks in the SPA, which can be explored for partnership opportunities***



## 4.15 Wyre

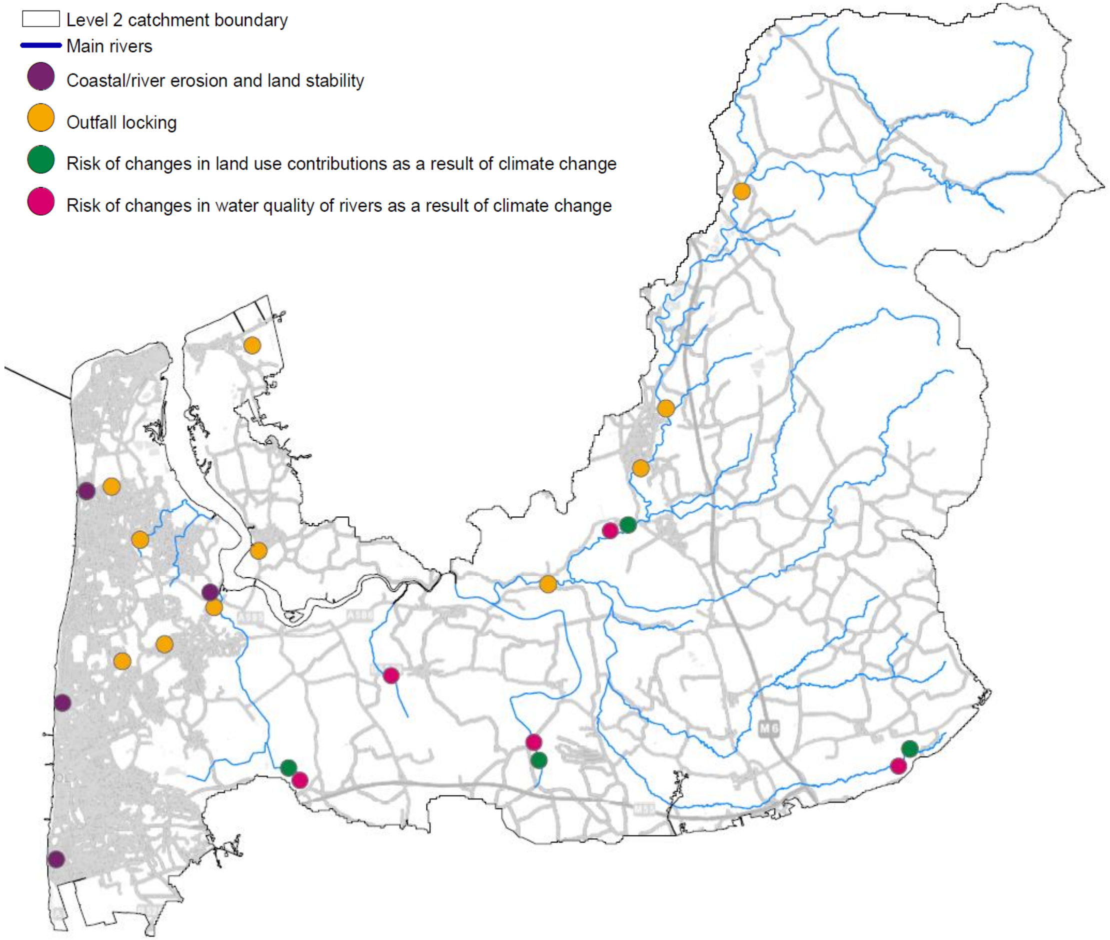
4.15.1. The Wyre SPA is least resilient to power outage as it is the only assessment that scores red (Table 18). There are three assessments that scored green, and the remaining assessments scored amber (Table 18).

4.15.2. There are several locations in the SPA where there may be shared risks, which could be explored for partnership solutions, such as areas that are vulnerable to erosion. Some examples are shown in Figure 25.

*Table 18 Traffic light scoring for the Wyre SPA (excluding Response Recovery Plans)*

| Resilience Assessment | Traffic light |
|---|---|
| Fluvial and coastal flooding of wastewater treatment works and major pumping station | |
| Power outages | |
| Communications outage | |
| First flush | |
| Low flows | |
| Coastal/river erosion and land stability | |
| Changes in the water quality of rivers as a result of climate change | |
| Changes in catchment contributions as a result of climate change | |
| Outfall locking | |

*Figure 25 Map of some of the potential shared risks in the SPA, which can be explored for partnership opportunities*



# 5. Consolidation to Tactical Planning Unit

5.1. A summary for each TPU across the resilience assessments can be found in [✂ ].

# 6. Next steps and options development

6.1. We have used the results from these assessments, along with the BRAVA outputs, to feed into the options development and programme optimisation elements of the DWMP. This is an iterative screening process, and the purpose of this stage is to identify all the solutions that we should consider. These solutions then get taken forward for a best value assessment, which will select the preferred option. The purpose of programme appraisal is to then identify the best combination of solutions and delivery strategy. Table 19 below summarises the optioneering approach taken for each resilience assessment. For further information, refer to Technical Appendix 7 – Options Development and Appraisal (TA7).

6.2. By conducting the resilience assessments, it has been shown that many of the TPUs within our region are more vulnerable to power outage than other risks. The potential vulnerability to power outage is a known risk within UUW and there are numerous activities that are ongoing in order to gain a better understanding and to improve our systems resilience. For example, through response recovery and contingency planning, an additional National Power Outage Plan is being developed. We have gathered information on which back-up power facilities are present across the region and what level of operational delivery they will provide e.g. 75% capacity compared to normal conditions. From this, a high-level plan is being developed and the purpose is to detail a framework approach that UUW can coordinate a cross-departmental response to, and recovery from, the impacts of widespread failure of electricity.

6.3. In addition to the development of the National Power Outage Plan, there are numerous strategies in development such as working with our Distribution Network Operators (DNOs) to understand the design standards for elements such as flood protection. We are also enhancing our data sources and beginning to explore performance monitoring, which will allow us to improve our maturity on the scale of risk. We can then build this into decision-making processes to allow for targeted investment.

6.4. Overall, for the DWMP we have focused on the resilience impacts relating to drainage and wastewater. However, we acknowledge that solutions such as natural flood management (NFM) can also benefit water resources through better water security, quality and availability. This is why we have worked closely with the WRMP to ensure that the solutions benefit drainage, wastewater and water resources. Further information can be found in TA7. These assessments will also inform the next business plan for 2025–2030 to ensure that the North West is as best prepared for the future as possible.

*Table 19 Summary of the options approach taken for each resilience assessment*

<table>
<tr><th>Resilience assessment</th><th>Options approach</th><th>Description</th></tr>
<tr><td>Fluvial and/or coastal flooding of wastewater treatment works and major pumping stations</td><td rowspan="4">Secondary screening</td><td rowspan="4">Takes into account cost, performance and the wider benefits/impacts. Each option is scored relative to the resilience risk identified for the TPU.<br><br>The score could be positive if there is no dependency between the options and resilience assessment (e.g. non-powered solutions in areas that are more resilient to third-party power outages).<br><br>The score could be negative if there is a dependency between the options and resilience assessment (e.g. powered solution in areas that are less resilient to third-party power outages).<br><br>Scoring contributes to a factor for each option, which is taken into account alongside cost benefit, allowing lower cost benefit options, which deliver wider resilience benefits to be considered further.</td></tr>
<tr><td>Power outages</td></tr>
<tr><td>Outages to remote communications</td></tr>
<tr><td>First flush and low flows</td></tr>
<tr><td>Response Recovery Plans</td><td>Bespoke optioneering</td><td>Review of the individual response recovery plans by form of various workshops across the region. The risks identified will inform the planning programme and will be addressed through updated generic and specific plans. Additionally, two bespoke contingency plans have been created for two higher risk sites. One of these supports a multiagency severe weather plan, the other supports operations to respond to potential damage from debris strikes during flooding incidents at a vulnerable, high consequence site.</td></tr>
<tr><td>Coastal/river erosion and land stability</td><td>Bespoke optioneering</td><td>For vulnerable assets identified through the assessment, a piece of work has been commissioned to assess zones of erosion and deposition to inform river migration direction. This will feed into our corporate risk register to be considered for potential future capital funding projects.</td></tr>
<tr><td>Outfall locking</td><td>Bespoke optioneering</td><td>For high-risk outfalls (modelled 1 in 30-year river level return periods or below) identified, a piece of work has been commissioned focusing on their proximity to modelled hydraulic sewer flooding and associated upstream natural flood management (NFM) opportunities. These areas will be prioritised as part of the holistic plan for rainwater management.</td></tr>
</table>

<table>
<tr><td>Changes in the water quality of rivers as a result of climate change</td><td rowspan="2">Adaptive planning</td><td rowspan="2">For locations that are predicted to deteriorate in WFD in either 2030 or 2050, will be incorporated into adaptive planning, which will allow for different scenarios and outcomes to be tested in combination with wider DWMP assessments and wider business risks.</td></tr>
<tr><td>Changes in catchment contributions as a result of climate change</td></tr>
</table>

# Appendix A

***Table A1 Summary of the limitations of the resilience assessments***

| Section | Resilience assessment | Limitation |
|---|---|---|
| **2.7** | Coastal and river erosion and land stability | All assessments have been undertaken using desk-based data and any site specific characteristics and the potential impact from future climatic changes have not been considered. The assessment considers the surface geology as indicated by the BGS data and does not take into account the associated geology depth. The land stability element does not take into account the effects of topography. When considering the erosion and land stability risks to gravity and pressurised sewers, only sewers greater than 600mm in diameter have been considered due to the risks of pollution. |

# Appendix B

[✄ ].

United Utilities Water Limited / United Utilities Group PLC

Haweswater House
Lingley Mere Business Park
Great Sankey
Warrington
WA5 3LP

unitedutilities.com

Water for the North West