United Utilities Water

Drainage and Wastewater Management Plan 2023

Technical Appendix 6 - Resilience

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United Utilities

Water for the North West

Executive Summary

We need to ensure that we are resilient to shocks and stresses, 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 identify, adapt to and mitigate risks. We acknowledge that some risks are outside of management control, so in order to effectively manage the risk we will need to work in partnership with stakeholders and communities across the North West to tackle issues together.

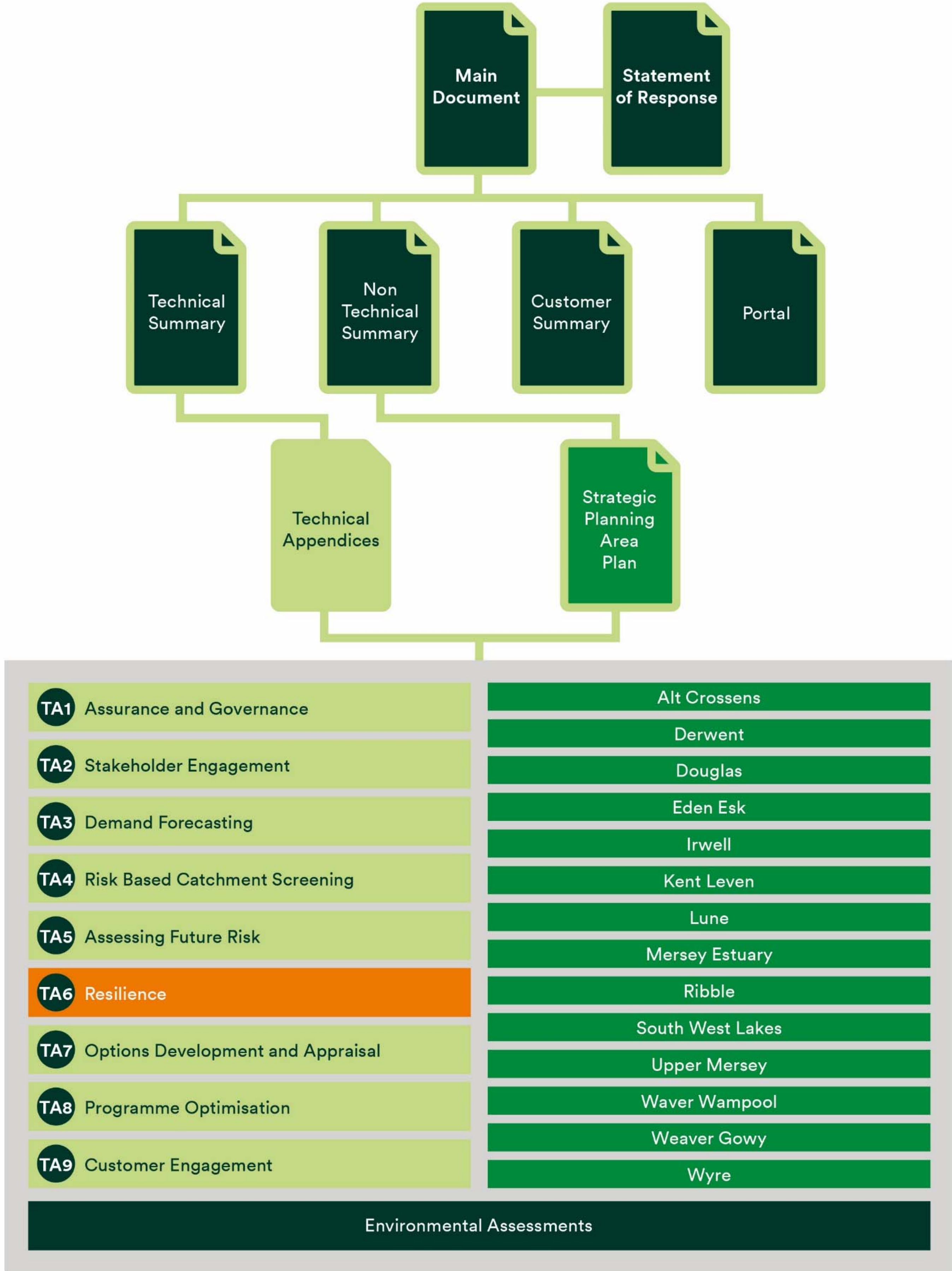
Through the Drainage and Wastewater Management Plan (DWMP), we have run a comprehensive suite of assessments across the whole of the North West to develop a robust understanding of wider catchment resilience issues that are not directly linked to systems characteristics. Our focus for this DWMP has been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

- Fluvial and/or coastal flooding of wastewater treatment works and major pumping stations;
- Power outages;
- Outages to remote communications;
- Response and 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.

We assessed all the drainage areas across the North West, 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 assessments 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 depending of the scale of risk, 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



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1. Introduction

1.1 Overview

1.1.1 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 population growth and both the acute and chronic impacts of climate change.

1.1.2 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.

1.1.3 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. Forecasts of future climate change indicate that the impacts are expected to accelerate over the next 25 years (Figure 2). Further challenging the ability for the North West's ecosystem to cope with drier summers and wetter winters.

Figure 2 Climate change statistics for the North West

The past 150 years in the North West

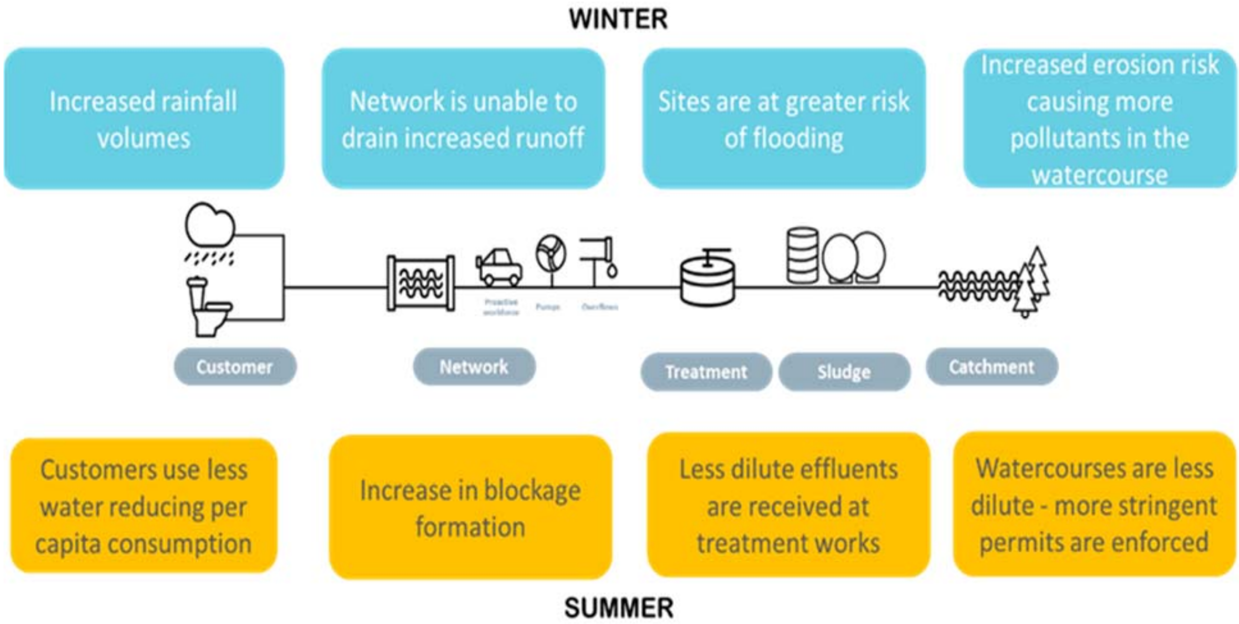
100% of the top 10 hottest years have occurred since 2002

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

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

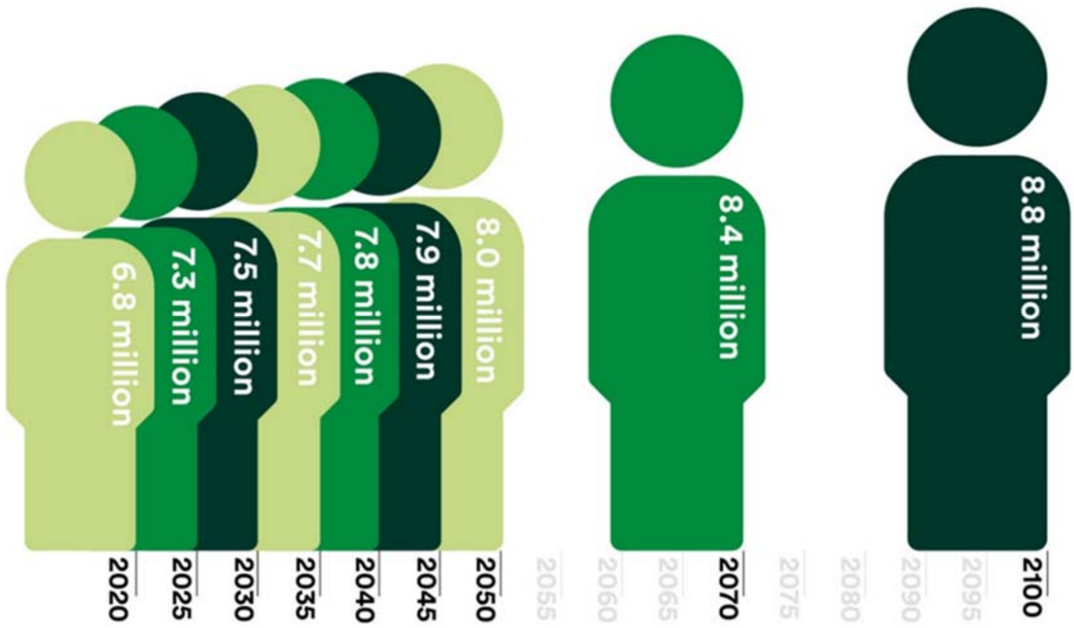
1.1.4 For example, during drier summers, drainage and wastewater systems could be under pressure as the likelihood for sewer blockages to form increases, for example, combined sewers may have less sewer flow than normal so the risk of sewer debris build up increases. Also, during wetter winters, there will be increased volumes of rainfall, which need to be drained and could lead to flooding (Figure 3).

Figure 3 Diagram shows how climate change could impact the wastewater production line



1.1.5 As for the challenge that population growth presents, the population of the North West is predicted to increase by 2050 (Figure 4) with growth expected across smaller towns through to major cities. The development required to accommodate these larger population places a greater demand on capacity of the sewerage system. A large proportion of the sewerage systems within towns and cities are combined, this provides further pressure on systems capacity as additional surface water also needs to be drained for the developed sites which pushes the sewers beyond the original design capacity. 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



1.1.6 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 that we maintain a long-term supply and demand balance over the short and long-term 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.

1.1.7 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 or service disruption is caused. We are also finding new ways to deliver resilience through projects such as the Dynamic Network Management (DNM) programme (Figure 5). 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.

Figure 5 Dynamic Network Management (DNM)

Dynamic Network Management

Dynamic Network Management (DNM) is an innovative monitoring approach which has been developed to enable us to deliver more proactive investment strategies. The aim of this was to reduce the risk of flooding and pollution incidents.

Sensors have been installed at key points in the system to allow us to monitor performance in real time. They are first used to determine the baseline performance of the system. Once this is understood, the sensors are then used to recognise when the drainage system is not operating as expected given the conditions being experienced. They then send an alert back to a central system called the 'DNM Platform'. An operational team risk assess the alerts and, where necessary, send out a proactive response team to further investigate. This allows us to be able to proactively manage any issues in the drainage system before it impacts customers or the environment.

1.1.8 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.

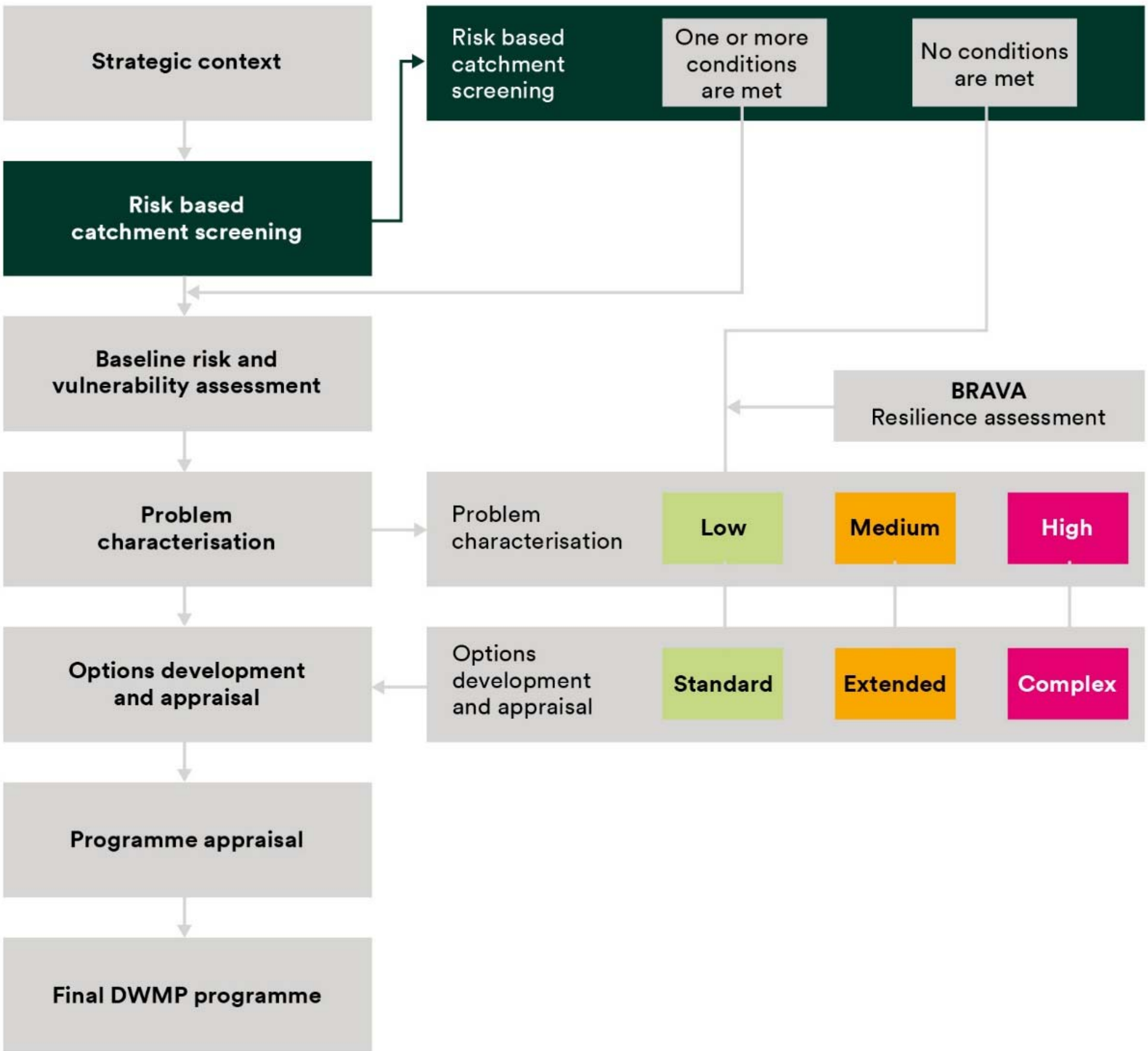
1.1.9 Woven throughout the DWMP are approaches, assessments and tools to understand potential future challenges and opportunities across drainage, flooding and environmental sectors. Resilience is a key part of this and we have undertaken a wide range of resilience assessments to gain a better understanding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

2. Understanding resilience risks

2.1 Overview

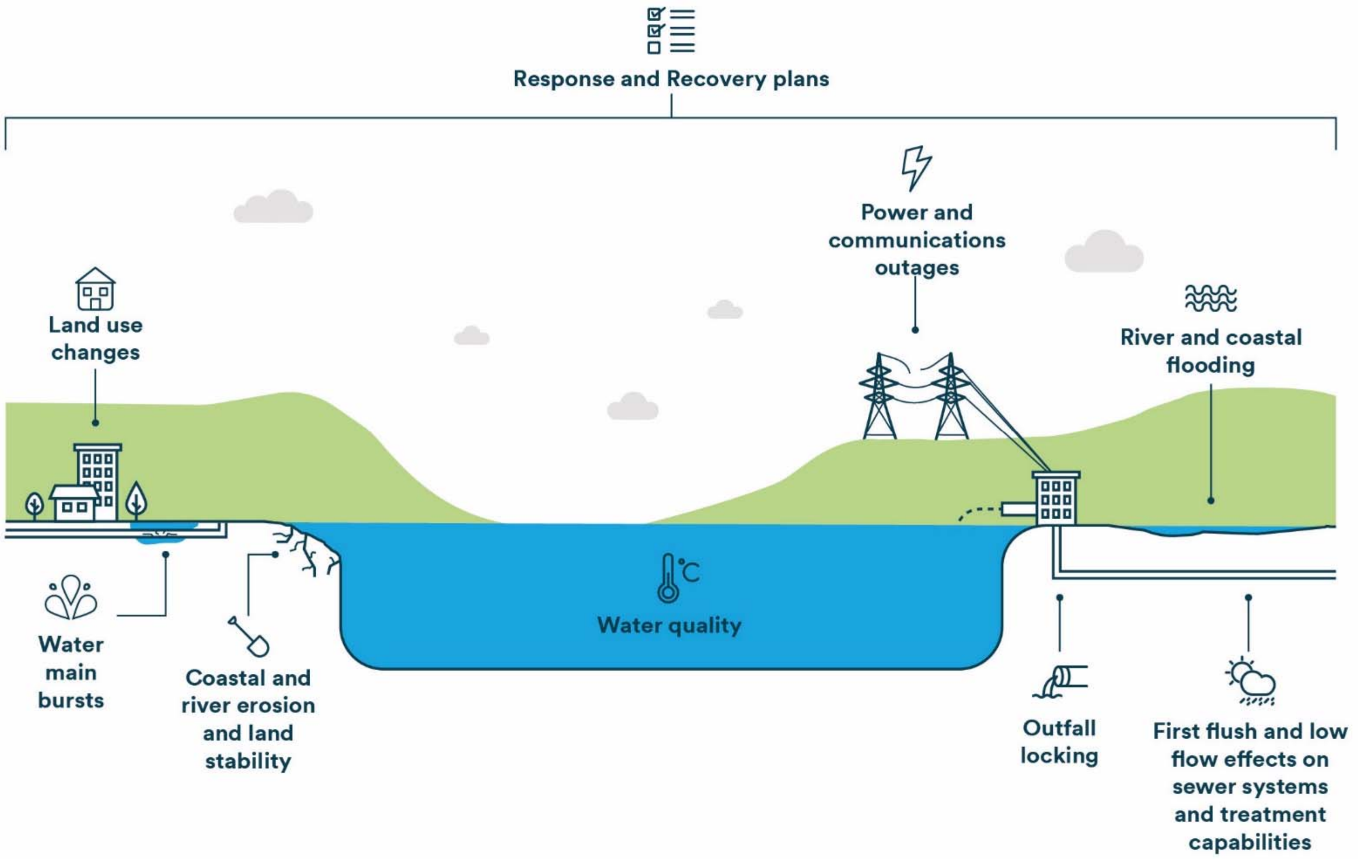
2.1.1 For the DWMP, we have completed a variety of assessments across the whole of the North West to develop an understanding of wider catchment resilience issues that are not directly linked to systems characteristics. The assessments have been run alongside the Baseline Risk and Vulnerability Assessment (BRAVA, Figure 6), which were undertaken to assess the baseline position of system performance and to understand the impact on maintaining compliance with planning objectives, such as internal or external sewer flooding, sewer collapses and blockages, 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 6 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, the following represent the greatest risks to service (Figure 7).

Figure 7 Diagram shows the assessments considered as part of resilience



2.1.3 These assessments have been carried out at a tactical planning unit (TPU) level. A TPU is the drainage area including all the sewers and wastewater assets e.g. pumping stations, which drain to the associated wastewater treatment works.

2.1.4 We have completed the assessments across the all of the TPU's in the region to build a richer picture of the resilience considerations. The sections below will provide more detail on 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 Background

2.2.1.1 The ability for sewer networks and wastewater treatment works to operate effectively without harm to the environment or 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 to be discharged into the natural environment.

2.2.2 Understanding the risk

2.2.2.1 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 as these were deemed low risk and low consequence.

2.2.2.2 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.

2.2.2.3 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.

2.2.2.4 A summary of the results for each assessment can be found in section 3 and a consolidation of the results for each of the 14 Strategic Planning Areas can be found in section 4.

2.2.3 Next steps for improving resilience

2.2.3.1 A number of our wastewater treatment work sites and major pumping stations are vulnerable to risks associated with fluvial and/or coastal flooding. UUW has already carried out work throughout the region to protect our sites from this risk, for example the [✂] Flood Partnership Scheme (Figure 8) and the Wyre Fluvial Flood Risk Alleviation Project (Figure 9).

Figure 8 Case study for the [✄] Flood Partnership Scheme

[✄ [redacted]]

Figure 9 Case study for the Wyre Fluvial Flood Risk Alleviation Project

Wyre Fluvial Flood Risk Alleviation Project

There are significant fluvial flood risks experienced by communities and that are also impacting our assets in the area.

What are we doing?

- Formed a partnership between United Utilities Water, Environment Agency, The Rivers Trust, FloodRE and Co-op Insurance;
- Exploring how a business case could be developed to attract investment from multiple sources into natural flood management;
- Commissioned an innovative flood modelling tool to identify the best locations to deliver natural flood management and quantify the benefits;
- Identifying other benefits that could also be delivered and monetised; and
- Funding was secured from Esmee Fairbairn Foundation, DEFRA and the Environment Agency to get the project investment ready.

Beneficiaries include United Utilities Water, FloodRE, Environment Agency, Regional Flood and Coastal Committee, organisations looking for carbon offsets, developers or people looking to deliver biodiversity net gain.

Benefits

- 600m^3 of water retained
- 25,600 tonnes of carbon sequestered
- 283 biodiversity units created
- 56 properties protected from flooding (1 in 50-year)
- Learning on how to deliver an investment approach

Activities completed:

- Business case developed to secure the funding;
- Contracts signed by 5 key flood beneficiaries
- Wider benefits identified in water resources, carbon, biodiversity net gain;
- Landowner contracts agreed and investment secured.

2.2.4 As part of the DWMP methodology, we have carried out a high-level assessment to identify potential high risk assets and high-level costs to provide mitigation. This investigation aims to act as a signpost to indicate where we may want to invest to provide resilience to ensure that we are able to operate effectively in a fluvial or coastal flooding event.

2.2.5 The Environment Agency Costing Tool Database[1] was used to provide an estimated cost to provide earth banking of sufficient height to project from forecast flood depths. All wastewater treatment works, last in line wastewater pumping stations, and high criticality pumping stations were included in the assessment.

2.2.6 The estimated costs have been developed as part of the DWMP and we are continuing to support and align with strategy development to support the business plan for the next investment cycle (2025 –

[1] https://www.gov.uk/flood-and-coastal-erosion-risk-management-research-reports/long-term-costing-tool-for-flood-and-coastal-risk-management

2030). Therefore, the potential estimated spend for future investment will be shared in autumn 2023 through the business plan submission for investment cycle 2020 - 2025.

2.3 Assessing risk caused by power outage

2.3.1 Background

2.3.1.1 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.

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

- 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.
- 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.
- 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.

2.3.1.3 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.

2.3.2 Understanding the risk

2.3.2.1 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.

2.3.2.2 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.

2.3.2.3 A summary of the results for each assessment can be found in section 3 and a consolidation of the results for each of the 14 Strategic Planning Areas can be found in section 4.

2.3.3 Next steps for improving resilience

2.3.3.1 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 resilience to interdependent threats.

2.3.3.2 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. This team are also investigating the use of an "Incident Contingency Planning Tool" which will be built into our Dynamic Network Monitoring (DNM, Figure 9) platform to improve how sites respond to a power loss event. The tool will provide a central location to store and view key site contingency information. The tool may be used prior to an incident to plan and prioritise mitigation to be installed or put in place by site or during an incident to prioritise the operational response to sites. The tool will also allow sites to easily report on mitigation installed on site during an incident. This centralisation and collation of information will allow us to prepare better for future events.

2.3.3.3 In addition to the development of the National Power Outage Plan, there are numerous strategies in development such as working with our 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 enable more targeted risk based investment.

2.3.3.4 Another example is our Better Rivers: Better North West Project which is a commitment that we have made to improve rivers and waterways across the North West. As part of our commitment to ensure our operations progressively reduce the impact to river health, there is an ongoing project investigating the role of power resilience in improving pollution incidents and aims to deliver a number of interventions to reduce pollution incidents where power has been a main cause or contributing factor. The Better Rivers: Better North West Power Resilience Project (Figure 10), includes interventions such as generator hook-up points, uninterruptible power supplies (UPS) and controlled power supply interruption (PSI). These will improve sites ability to endure short duration power "black-out" or momentary "brown-out" situations, and/or to recover automatically thereafter.

2.3.3.5 We have used this project to determine high-level costs for the North West. All wastewater treatment works were included in our assessment and the estimated cost based on AMP7 rollout. The estimated costs have been developed as part of the DWMP and we are continuing to support and align with strategy development to support the business plan for the next investment cycle (2025 – 2030). Therefore, the potential estimated spend for future investment will be shared in autumn 2023 through the business plan submission for investment cycle 2020 – 2025.

Figure 10 Better Rivers: Better North West Resilience Project

Better Rivers: Better North West Power Resilience Project

The power resilience project aims to deliver a number of interventions to reduce pollution incidents where power has been a main cause or contributing factor.

The interventions considered as part of the Power Resilience Project checks on key electrical components and installation of:

- generator hook-up points;
- "under-voltage" relays;
- "brown-out" relays;
- surge protection relays;
- uninterruptible power supplies (UPS);
- Harmonic Filters and Power Factor Correction checks; and
- Controlled power supply interruption (PSI).

A power outage (blackout) is the loss of the electrical power network supply to an end user. There are many causes of power failures in an electricity network. Examples of these causes include faults at power stations, damage to electric transmission lines, substations or other parts of the distribution system, a short circuit, cascading failure, fuse or circuit breaker operation.

The biggest distinction between brownouts and blackouts is that brownouts are partial outages while blackouts are a complete shutdown of electricity.

A brownout is a drop in voltage in an electrical power supply system. Unintentional brownouts can be caused by excessive electricity demand, severe weather events, or a malfunction or error affecting electrical grid control or monitoring systems. Intentional brownouts are used for load reduction in an emergency, or to prevent a total grid power outage due to high demand.

During a brownout, the system capacity is reduced and the voltage is typically reduced by at least 10 to 25 percent.

2.4 Outages to remote communications

2.4.1 Background

2.4.1.1 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.

2.4.1.2 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.

2.4.1.3 Sites are connected together through three primary routes:

- Fixed third-party telecoms lines;
- Fixed outstation to outstation lines; and
- Site to site radio links.

2.4.1.4 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 should have a degree of control dependent upon the function of a remote site.

2.4.2 Understanding the risk

2.4.2.1 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.

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

2.4.2.3 A summary of the results for each assessment can be found in section 3 and a consolidation of the results for each of the 14 Strategic Planning Areas can be found in section 4.

2.4.3 Next steps for improving resilience

2.4.3.1 Over the years, the management of our sewer systems is becoming increasingly automated and improving our sites resilience to the risks associated with any communications loss is crucial to ensuring sites continue to operate effectively. We recognise the potential vulnerability to loss of communications across some of our sites and are taking steps to protect them accordingly.

2.4.3.2 There are a number of activities that are ongoing in order to gain a better understanding and to improve our systems resilience. For example, we are working to upgrade and replace all of our business critical communications as part of the Public Switched Telephone Network (PSTN) Replacement Programme. Approximately 80% of our telemetry will move away from copper PSTN line on to 4G, wireless, roaming sims, with the remaining 20% on fibre connections. In addition to the resilience provided by the supplier, the routers on our assets will also have battery back-up capable of sustaining communications during a short duration power outage.

2.4.3.3 By upgrading our telemetry network in this way, we have improved our situational awareness. Having telemetry systems that operate independent of grid power provides us with the ability to determine if an asset has failed due to power loss or due to other causes. This will assist with coordinating our response plans and continuity plans.

2.5 Response and Recovery Plans

2.5.1 Background

2.5.1.1 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 Understanding the risk

2.5.2.1 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.

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

2.5.2.3 A summary of the results for each assessment can be found in section 3 and a consolidation of the results for each of the 14 Strategic Planning Areas can be found in section 4.

2.5.3 Next steps for improving resilience

2.5.3.1 All of our sites have contingency procedures and plans in place to help manage incidents as and when they occur. We are continuously updating and improving our approach to emergency planning. For example, the Emergency Planning Team are working to monitor, review and improve current contingency plans in place for sites across the region. An integral part of these improvements in the work that is ongoing to standardise the non-infrastructure wastewater network site contingency plans so that the way information is presented is consistent. We also have generic incident management procedures and structure in place to support the implementation of contingency plans. We aim to continue to improve our emergency planning procedures building on new technologies and information throughout as and when they emerge.

2.6 First flush and low flow events

2.6.1 Background

2.6.1.1 Climate change may present periods of prolonged low flows which will increase septicity of the load or intense rainfall which results in a first flush effect. This has the potential to impact wastewater treatment works performance.

2.6.2 Understanding the risk

2.6.2.1 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.

2.6.2.2 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.

2.6.2.3 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.

2.6.2.4 A summary of the results for each assessment can be found in section 3 and a consolidation of the results for each of the 14 Strategic Planning Areas can be found in section 4.

2.6.2.5 In addition to assessing the potential risks from first flush and low flow events, we have also investigated the potential impacts of dry weather flow and higher temperatures on treatment efficiency, utilising the findings as part of two Water Research UK (UKWIR) studies[23]. The UKWIR studies state that under dry weather and warmer conditions Primary Settlement Tank (PST) performance is likely to improve due to longer hydraulic residence time, and Activated Sludge Plant (ASP) performance is also improved due to reduced load from PSTs, increased hydraulic residence time, and higher rates of biological activity and higher temperature impact on aeration efficiency resulting in increased OPEX.

2.6.2.6 The UKWIR studies concluded that under first flush events:

- Extreme summer rainfall events may be become less intense whereas winter rain fall intensity increases, however there is uncertainty of the changes intensity and number of events;
- First flush events are unlikely to impact of primary settlement, due to the use multiple tanks however small works (which will include Treat all flows (TAF) sites) operating on single tanks are more likely to have increased risk of carry over to secondary treatment processes;
- There is minimal impact on suspended growth secondary treatment is foreseen with the exception of the potential for foaming under prolonged storm flow/low load conditions;
- There are a number of impacts to fixed film (i.e. mineral/plastic media filter) processes. These include the need to maintain minimum wetting rates which could impact on performance and nuisance risks associated with filter flies and odour; and
- There are no regulatory risks associated with primary or secondary treatment systems arising from first flush events.

2.6.2.7 As part of our responsibilities to protect the environment, we continually monitor the performance and compliance of our wastewater treatment assets. This is also a key consideration when developing our longer term strategies in addition to wider factors such as current and future capacity demands.

2.6.3 Next steps for improving resilience

2.6.3.1 We recognise our potential vulnerability to first flush and low flow events. In order to reduce the impacts of first flush and low flow events on our wastewater treatment works, it is important that we continue monitoring and reviewing what is happening within the network to reduce and manage the likelihood of any risk associated.

2.6.3.2 Within the wider business we are continuously using new technologies and information to improve our ability to respond and react to incidents. One of the key areas of interest for the business is to improve Dynamic Network Management (DNM) coverage (Figure 11). DNM is already being used at a number of sites across the region to identify leakages and vulnerable sites. It is based on real-time data which helps us to understand trends in the sewer network. The monitors identify when the level in the sewer rises above or below what is expected and sends out an alert. Based on trends identified though monitoring we can pick up first flush and low flow as these events will cause the level to go outside the anomaly trend of what is expected. If the level falls above or below the learned anomaly trend an alert is generated. The response will depend upon the alert logic criteria built within the platform, for example for a gradual change it may generate an alert for a desktop study, however if the change is more sudden and we believe we are going to flood / pollute within a given period (set in the logic), a work order would be raised for a site visit.

2.6.3.3 For all the DNM alerts we have a prescribed workflow which documents the logic, the criteria for action under each specific circumstance, the service level agreement (SLA) and the response. Our ambition is to build on this DNM coverage to continue to improve monitoring meaning operational teams can respond to incidents quickly therefore preventing further impacts.

2.6.3.4 Based on the success we have seen from DNM across the network, we are now exploring how to take the DNM concept and apply it to the Wastewater Treatment (Dynamic Treatment Management, DTM). This may then allow us to link the network, treatment and receiving environment together intelligently through Dynamic Catchment Management (DCM), delivering upon Catchment Systems Thinking (CaST) across our entire asset base.

[2] Climate Change Implication for Wastewater Treatment (Report Ref 12/CL/12/1)

[3] Planning for and responding to the mean and extremes of weather (Report Ref 15/CL/01/23)

Figure 11 Dynamic Network Management

Dynamic Network Management

Dynamic Network Management (DNM) is an innovative monitoring approach which has been developed to enable us to deliver more proactive investment strategies. The aim of this was to reduce the risk of flooding and pollution incidents.

Sensors have been installed at key points in the system to allow us to monitor performance in real time. They are first used to determine the baseline performance of the system. Once this is understood, the sensors are then used to recognise when the drainage system is not operating as expected given the conditions being experienced. They then send an alert back to a central system called the ‘DNM Platform’. An operational team risk assess the alerts and, where necessary, send out a proactive response team to further investigate. This allows us to be able to proactively manage any issues in the drainage system before it impacts customers or the environment.

2.7 Coastal and river erosion and land stability

2.7.1 Background

2.7.1.1 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 (Figure 12).

Figure 12 Examples of erosion risk and mitigation across the North West

2.7.2 Understanding the risk

2.7.2.1 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 which can provide insight into ground vulnerability to erosion. 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 further details 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.

2.7.2.2 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.

2.7.2.3 A summary of the results for each assessment can be found in section 3 and a consolidation of the results for each of the 14 Strategic Planning Areas can be found in section 4.

2.7.3 Next steps for improving resilience

2.7.3.1 UUW recognise the risk that river erosion poses to both our network assets and treatment facilities. As part of the DWMP we carried out a high-level assessment to identify where these high risk sites are and how much it may cost to protect them. This investigation aims to act as a signpost to indicate where the business may want to improve our resilience to ensure that we are able to continue to operate effectively at these sites.

2.7.3.2 The next step would be to carry out investigations at these sites to determine characteristics that influence erosion rate such as geology, soil, migration rates and further prioritise sites based on these risks. The estimated costs have been developed as part of the DWMP and we are continuing to support and align with strategy development to support the business plan for the next investment cycle (2025 – 2030). Therefore, the potential estimated spend for future investment will be shared in autumn 2023 through the business plan submission for investment cycle 2020 – 2025.

2.7.3.3 The DWMP assessment has only accounted for point assets, however, our ambition over the next investment cycle (2025 – 2030) is to further investigate potential mitigation measures across known risks (both linear and point assets) through targeted investment.

2.7.3.4 The results from these assessments are helping to inform our long-term approach to managing river and coastal erosion within the context of a changing climate. As part of our business plan for investment cycle 2025 - 2030, we will be seeking to conduct more detailed investigations for those highest risk assets and implement mitigation measures where necessary. More information will be provided in our business plan submission for investment cycle 2020 – 2025 in autumn 2023.

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

2.8.1 Background

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

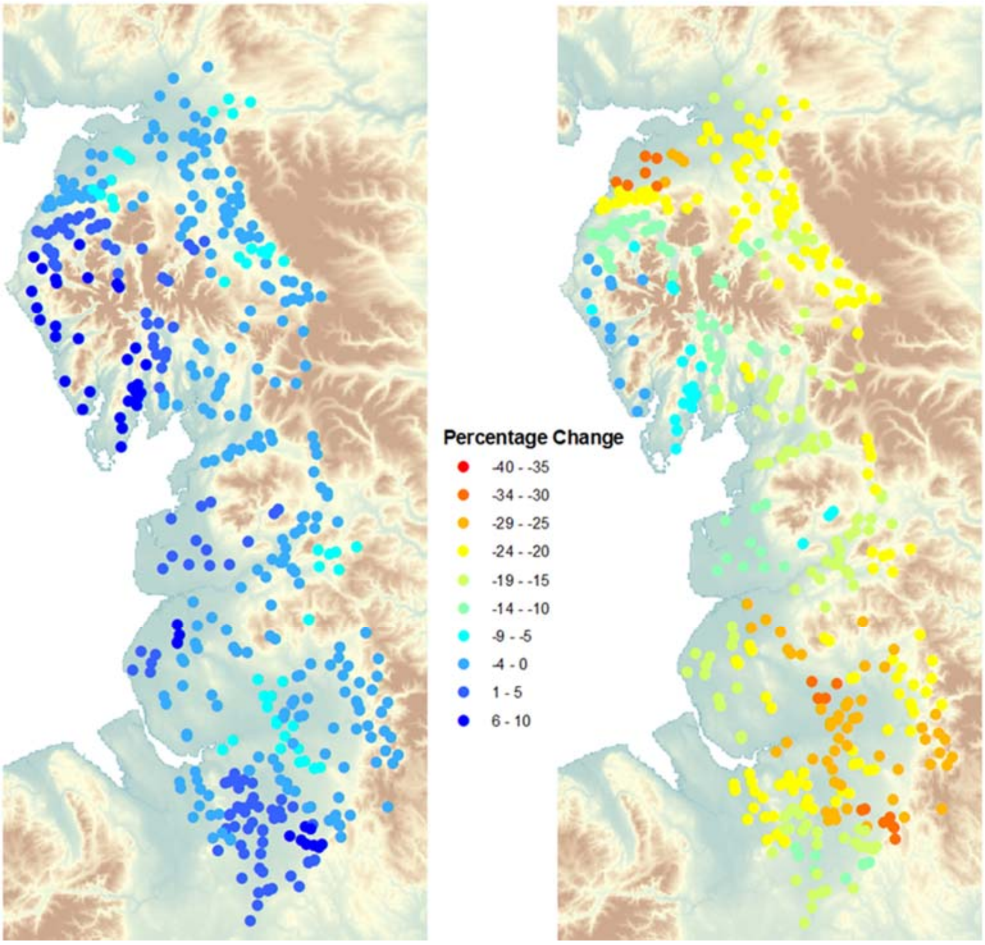
2.8.2 Understanding the risk

2.8.2.1 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 (2030 and 2050) river flows and water temperature hydrological modelling, inclusive of climate change scenario UKCP09. Baseline data was determined through the use of historical data.

2.8.2.2 Figure 13 (left) is an example of the change in river flows and water temperature from baseline (1961-90) to projected (2050 mean).

2.8.2.3 Figure 13 (right) shows the Q95 at wastewater treatment works 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. The Lake District coast highlights notable larger increases in the changes from baseline to projected flow and temperature. These are related to characteristics of the climatic driving forces within the UKCP09 scenarios.

Figure 13 Change in river flows and water temperature from baseline (1961-90) to 2050s mean (left) and Q95 (right) at wastewater treatment works locations across the North West



2.8.2.4 SIMCAT (SIMulation of CATchments) modelling, which is the Environment Agency's water quality river model, 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.

2.8.2.5 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.

2.8.2.6 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

2.8.2.7 Due to the natural limitations of SIMCAT modelling, 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).

2.8.2.8 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'.

2.8.2.9 A summary of the results for each assessment can be found in section 3 and a consolidation of the results for each of the 14 Strategic Planning Areas can be found in section 4.

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

2.9.1 Background

2.9.1.1 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 Understanding the risk

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

2.9.2.2 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.

2.9.2.3 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'.

2.9.2.4 A summary of the results for each assessment can be found in section 3 and a consolidation of the results for each of the 14 Strategic Planning Areas can be found in section 4.

2.9.3 Next steps for improving resilience

2.9.3.1 The impacts of climate change on river characteristics and catchment contributions are interrelated and both present adverse impacts to the environment, water quality and biodiversity across the region. We recognise the importance of playing our part towards improving water quality across the North West which is why we have made a number of commitments to set out how we plan to make our contribution to improving river health over the next three years and beyond as part of our Better Rivers: Better North West project[4] (Figure 14). This includes improving wastewater treatment processes, reducing the number of activation events from our storm overflows, enhancing data monitoring and sharing and greater innovation and more use of nature-based solutions.

Figure 14 Better Rivers: Better North West commitments

Better Rivers: Better North West Project

The Better Rivers: Better North West commitment aims to build trust and confidence that we are addressing concerns and making our contribution to improving river health.

The steps UUW are making towards these commitments include:

- Actively engaging and listening to all our stakeholders to demonstrate we are taking action;
- Seeking engagement and support in the creation of our future plans;
- Providing greater transparency of our performance and the issues to be tackled; and
- Engaging with community groups who value access to water for recreational purposes to identify priority locations.

The commitments set out by the Better Rivers Better North West include:

1. Ensuring our operations progressively reduce impact to river health;
2. Being open and transparent about our performance and our plans;
3. Making rivers beautiful and supporting other to improve and care for them; and
4. Creating more opportunities for everyone to enjoy rivers and waterways.

2.9.3.2 Additionally, due to the interconnected nature of our systems, there is a shared responsibility of all those who are impacting the river to work collaboratively to tackle the issues that we face together. Our Catchment Systems Thinking (CaST) approach supports catchment management in a holistic manner. As part of this we consider all the inputs into the river and the influence they will have on the water quality to ensure we are considering all the pollutant sources. This approach encourages us to think about our activities in the wider environment to deliver multiple benefits which includes, but also goes beyond water quality alone.

2.9.3.3 We are working in partnership with other land owners and stakeholders to promote the principles of catchment systems thinking. We work with more than 1,600 farmers across the region to look at the wider environment and the water course through the use of farm interventions. For example, buffer zones to prevent surface runoff, the implementation of fences to limit direct animal access to watercourses, and much more. We encourage changes in behaviours and practices by engaging with farmers and land owners through workshops, seminars, and one to one site visits. Through this collaboration and engagement we are understanding how good farming practices can benefit water quality including, for example, avoiding the application of manure and fertilisers prior to periods of

[4] https://unitedutilities.annualreport2022.com/case-studies/better-rivers-better-north-west/

particularly heavy rainfall, using innovative soil analysis to only apply the right amount of nutrients the crop needs at that time, and utilising herbicide application techniques such as weed wipers that almost eliminate any risk to water. An example of where we promoted these farming practices is the Wyre (Figure 15).

Figure 15 Water Friendly Farming in the Wyre

Water Friendly Farming

Working in partnership, the Mersey Rivers Trust, Severn Rivers Trust and United Utilities Water used funding from the Water Environment Grant to help protect and improve the water quality in the Upper Weaver, Cheshire. Six sub catchments in this area were chosen due to their moderate to poor Water Framework Directive status.

Farms in the catchments were provided with free advice, water quality management plans and small grants to implement the water quality improvement measures identified in the plans. These measures included:

- Yard works - to separate clean and dirty water and reduce foul drainage runoff and the risk of water pollution;
- Gateway/crossing point resurfacing - to prevent erosion and reduce the risk of water pollution from surface runoff;
- Fencing - to prevent livestock entering water courses, reducing erosion of banks and soil runoff;
- Livestock - interventions to provide livestock with drinking sources alternative to the watercourse in order to reduce bank erosion, runoff and water pollution from faecal contamination and mobilised sediments;
- Tree and hedge planting - to reduce soil erosion and runoff and extend or link existing hedgerow to create wildlife corridors; and
- Soil management - aeration, sward lifting, arable subsoiling and the provision of winter cover crops and undersown cereal crops to ensure that the more productive topsoil remains in fields and reduce runoff, soil erosion and water pollution.

Key outcomes

80 water management plans written

40 farms committed to works with funded interventions

Over £150k of funding provided to farms

The project was completed March 2022.

2.9.3.4 An example of where using different techniques has worked in practice is in Cumbria, where it was observed that high levels of phosphorus were entering the rivers. By working in partnership with the farmers, and by implementing new techniques, we were able to reduce the levels of phosphorus entering the rivers, allowing the wildlife to thrive. These techniques include putting fences along a riverbank to prevent cattle manure from entering the river or putting roofs on slurry stores to prevent the slurry being washed into the river by the rain. Working with farmers has meant that the catchment water quality can be improved without the need for intensive processes at wastewater treatment works, giving a more holistic, environmentally friendly approach (Figure 16).

Figure 16 Improving water quality in the River Petteril

Improving water quality in the River Petteril

In 2015 United Utilities set out to improve water quality in the River Petteril after a review of the ecosystem's resilience found that the local ecology was impacted by significant nutrient inputs, particularly phosphorus which exceeded levels set out in the Water Framework Directive.

Phosphorus inputs were partly due to wastewater discharges from a small number of rural wastewater treatment works which were identified for upgrades to chemical treatment; however, this was disproportionately expensive compared with the number of customers served and not very sustainable. This also did not consider wider flood risk in the catchment. Agricultural run off to the river was also considered a major contributor to the high phosphorus levels. The traditional approach to improving river quality by treatment work did not factor in these issues, and did not allow for holistic, systems-based solution to the problem.

We worked with a variety of organisations such as the Environment Agency, local Rivers Trust and farmers to understand management of phosphorus in the area, agree targets for reduction and develop and deliver innovative solutions. The solutions identified included:

- Improvements to data collection and monitoring;
- Working with farmers to improve agricultural practices and land management;
- Upgrades to the treatment works.

The Petteril project achieved and exceeded its target reduction in phosphorus levels in the river through a powerful collaborative approach with farmers and other stakeholders. The improvements made were achieved cost-efficiently, representing value for customers—more than £7 million was saved in comparison to the traditional engineering-based solution.

The partnerships created have also laid down the roots for further collaborative working and an integrated approach to managing pollution in the catchment into the future. United Utilities is now actively engaged in aligning interests with other partners to create a catchment market for nutrient reduction and deliver further reductions to phosphorus levels.

2.10 Outfall locking

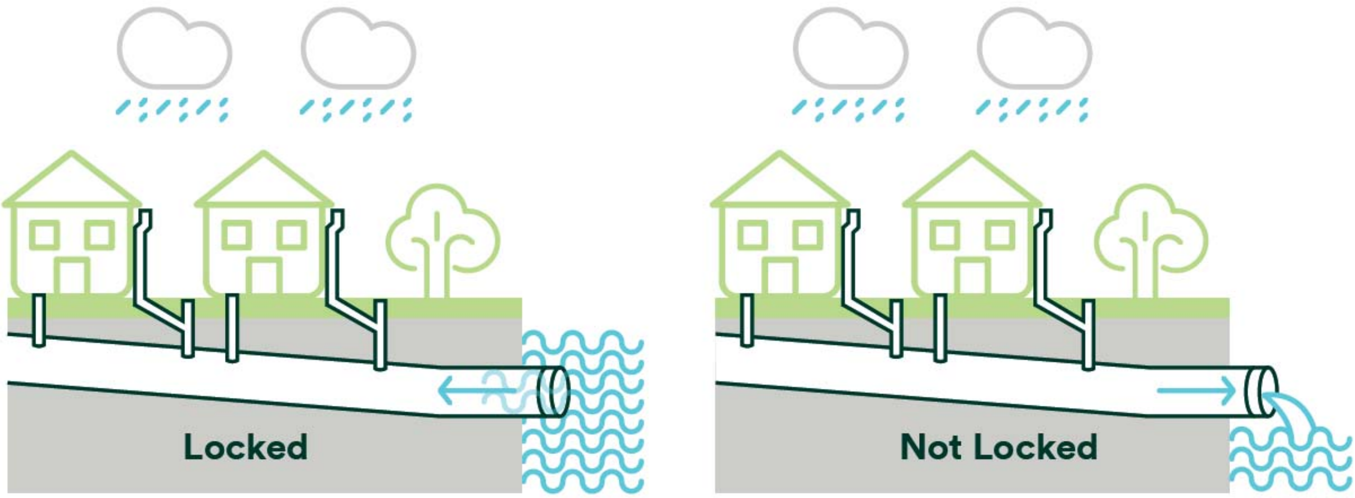
2.10.1 Background

2.10.1.1 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[5], and treated final effluent outlets and storm outlets at wastewater treatment works.

2.10.1.2 Outfall locking is when water levels from rivers and coasts rise, usually during storm conditions, and submerge the outfall and can cause hydraulic restrictions as the discharge cannot overcome the pressure to allow water to flow out freely. A locked outfall can have wide reaching impacts on other areas of the sewer network as flow can back up and result in surcharging to the environment and into private property (Figure 17).

[5] Storm overflows are designed to provide relief on the sewer network under storm conditions

Figure 17 Example of a locked outfall versus a freely flowing outfall



2.10.2 Understanding the risk

2.10.2.1 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.

2.10.2.2 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.

2.10.2.3 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.

2.10.2.4 A summary of the results for each assessment can be found in section 3 and a consolidation of the results for each of the 14 Strategic Planning Areas can be found in section 4.

2.10.3 Next steps for improving resilience

2.10.3.1 We have carried out a high-level assessment to identify high priority assets and where we may want to invest to provide resilience during storm conditions.

2.10.3.2 The installation of flap valves can prevent river water flowing backwards up the pipes and entering into the sewer network. For this assessment, we have included any outfalls that are at risk of locking in a 1 in 50-year return periods and below. The estimated costs have been developed as part of the DWMP and we are continuing to support and align with strategy development to support the business plan for the next investment cycle (2025 – 2030). Therefore, the potential estimated spend for future investment will be shared in autumn 2023 through the business plan submission for investment cycle 2020 – 2025.

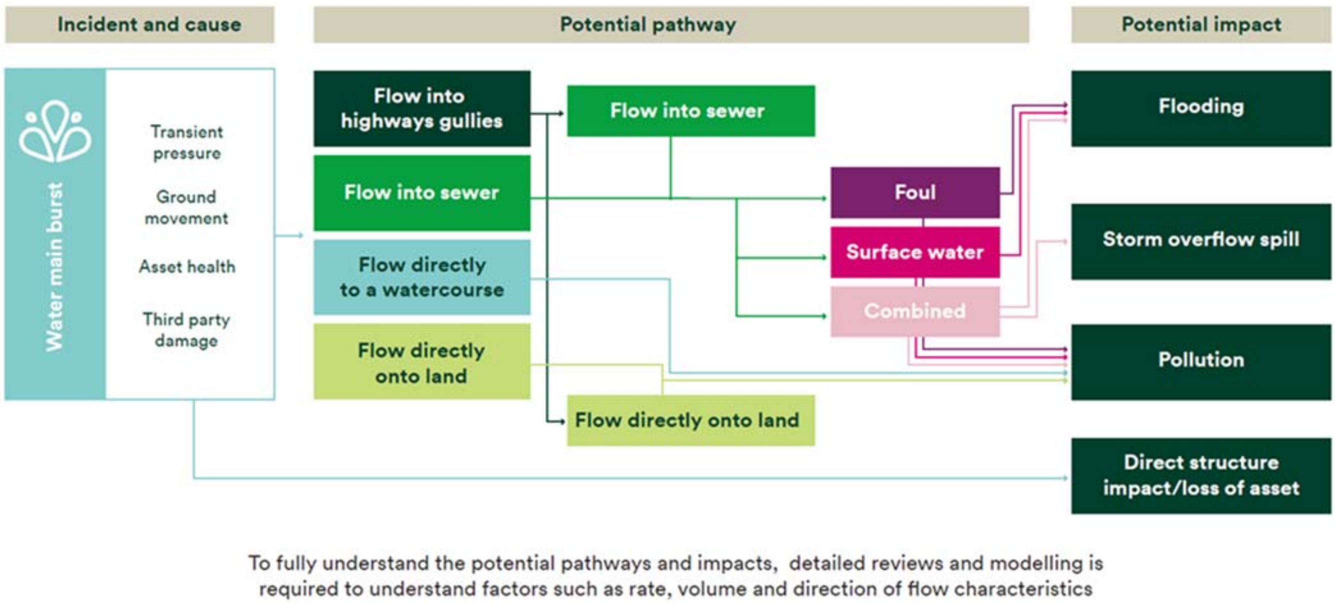
2.11 Water main bursts impact on wastewater

2.11.1 Background and understanding the risk

2.11.1.1 We strive to provide great service to our customers and communities whilst protecting the environment. However, sometimes accidents and incidents occur such as damage to or bursts on water mains. In addition to causing service interruptions to water supply, there is also a risk to wastewater assets and services due to the interconnected nature of our systems.

2.11.1.2 For example, a water main could burst due to causes such as ground movement, changes in transient pressure and also third party damage. This can result in flows into sewers which can cause storm overflow activation events, flooding and even pollution incidents. There can also be direct flow onto land or watercourses also resulting in potential pollution incidents (Figure 18).

Figure 18 Diagram shows the potential pathways that water main bursts may impact wastewater



2.11.2 Next step for improving resilience

2.11.2.1 We recognise our potential vulnerability to the risks associated with water main bursts. It is important that we continue to monitor and review what is happening within the systems to reduce and manage the risk. Water assets do not exist in isolation so it is therefore important for us to consider them alongside wastewater and look at the systems holistically. We are continuously using new technologies and information to improve our ability to respond and react to incidents.

2.11.2.2 Our Systems Thinking approach enables us to better manage our end-to-end water and wastewater systems, optimising our decision-making and helping us move away from the traditional reactive approach to address problems proactively before they affect customers. This creates long-term value, improving our asset reliability and resilience, reducing unplanned service interruptions, and delivering cost savings.

2.11.2.3 Systems Thinking involves looking at the entire system and all of its linkages, rather than individual assets or sites in isolation, to find the best all-round solutions. Our digital backbone sends vast amounts of real-time data to our Integrated Control Centre (ICC), from which we plan, monitor and control our operations. We also factor in other source data such as weather forecasts and customer demand, and at the higher capability maturity levels we use artificial intelligence and machine learning to identify trends and anomalies that could signal potential issues. This helps us to identify hot spots and parts of the systems which may be vulnerable to water main leakages or burst so that we can proactively repair issues before they become major incidents.

2.11.2.4 There are lots of sensors being used throughout the water network that would help us to identify leaks/ network events which feed into the real-time data collected and response coordinated through the ICC. These include:

- Flow meters in district metering areas (DMA) are monitored daily to allow leaks to be identified and actioned, and try to pick up leaks before they turn into bursts that could impact on environment;
- Acoustic sensors are deployed (listening for leaks) to identify leaks on the network;
- Pressure monitors that show loss of pressure/problems with control which could be used to identify a problem on the network that could lead to a burst;
- Service reservoir level monitoring to pick-up changes that could indicate a major burst on the network; and
- Calm networks approach to network operation to minimise sudden flow changes that could cause discolouration or sudden pressure/ flow changes.

2.12 Strategic tunnels

2.12.1 Background and understanding the risk

2.12.1.1 Within the North West there are strategic tunnels and interceptor sewers, which have been constructed to convey storm flows to wastewater treatment works in order to protect the water quality of the receiving waters. An example of this is the [✄].

2.12.1.2 The purpose of the tunnel is to:

- Prevent the discharge of solids to the River Mersey by discharging all dry weather flows into treatment; and
- To minimise the number and volume of overspills to the River Mersey by storing storm water without increasing the flood risk and having regard to the topography of the catchment area.

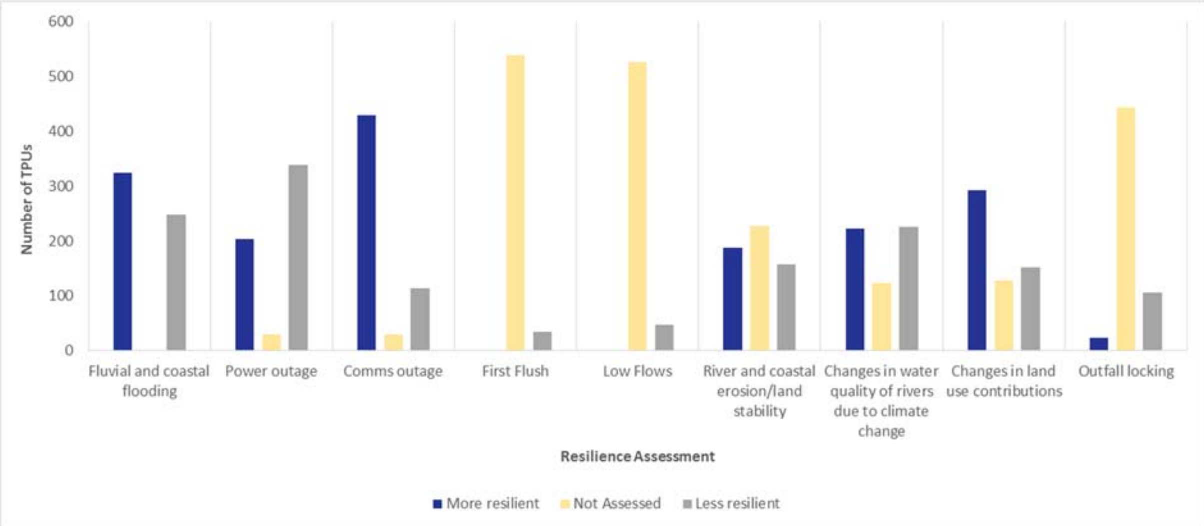
2.12.1.3 The MEPAS east-bank interceptor sewer and other large tunnels, which are located along the coast of the North West, are experiencing accelerated erosion rates and increased silting and degradation of the tunnels potentially as a result of salt water ingress. In order to understand what intervention needs to take place, assessments need to be carried out in order to understand a more detailed condition of the asset. This is currently underway and we will be able to develop a plan to address the risks upon completion.

3. Results of risk assessments

3.1.1 Overview

3.1.1.1 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 19), and most resilient to communications outage (429 TPUs are more resilient (76%), Figure 19).

Figure 19 Summary each assessment and the associated number of TPUs, which are more or less resilient (excluding Response Recovery Plans)



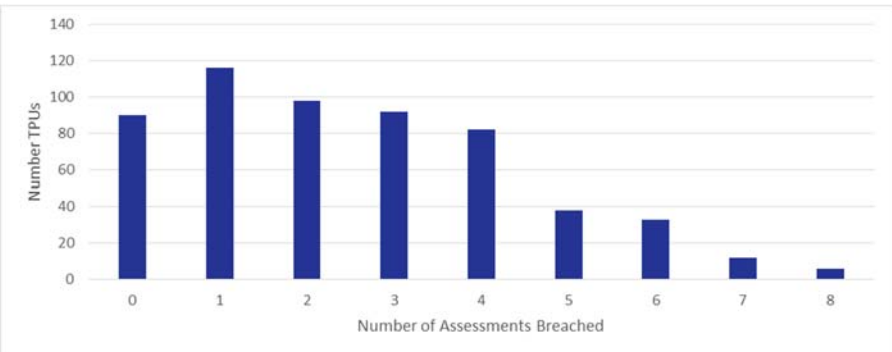
3.1.1.2 With the exclusion of Response and Recovery Plans, across the North West, the majority of TPUs are less resilient to one assessment (Figure 20), which is attributed to the risk of power outage. There are 12 TPUs across the region, which are less resilient to seven assessments and there are six TPUs which are less resilient to eight assessments (Figure 20), 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 20).

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.

3.1.1.3 A summary for each TPU across the resilience assessments can be found in Appendix B.

Figure 20 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 21), which typically align to the Environment Agency optional management catchment level. Across the SPAs, the majority are least resilient to power outage.

Figure 21 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 and 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 Example of the traffic light system applied to Catchment X (SPA)

Threshold (per cent of TPUs that are deemed to be less resilient)	Traffic Light
< 40%	Green
40–60 % 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

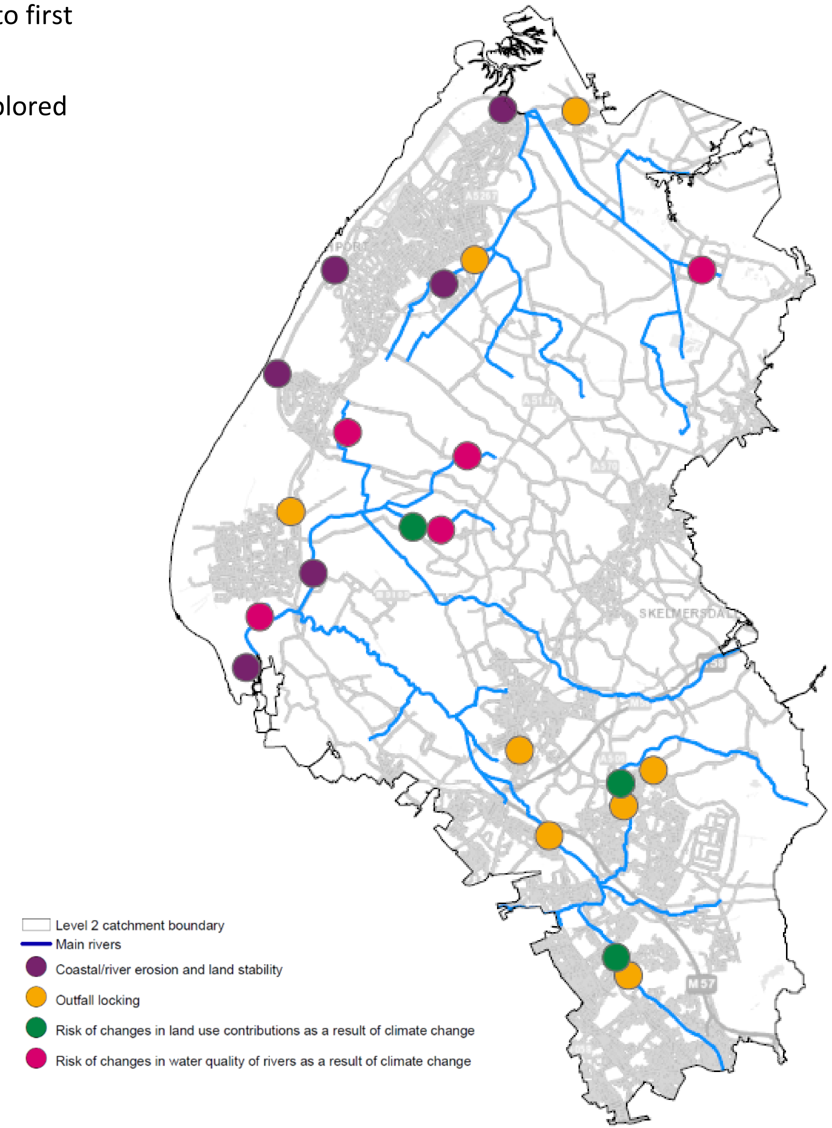
4.2.1 The Alt Crossens SPA is least resilient to power outage as it is the only assessment that scores red (Table 5). Three assessments score amber and three assessments score green (Table 5). No TPUs within the SPA were identified by operational teams as being potentially vulnerable to first flush or 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 22.

Table 5 Traffic light scoring for the Alt Crossens SPA (excluding Response and 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



4.3 Derwent

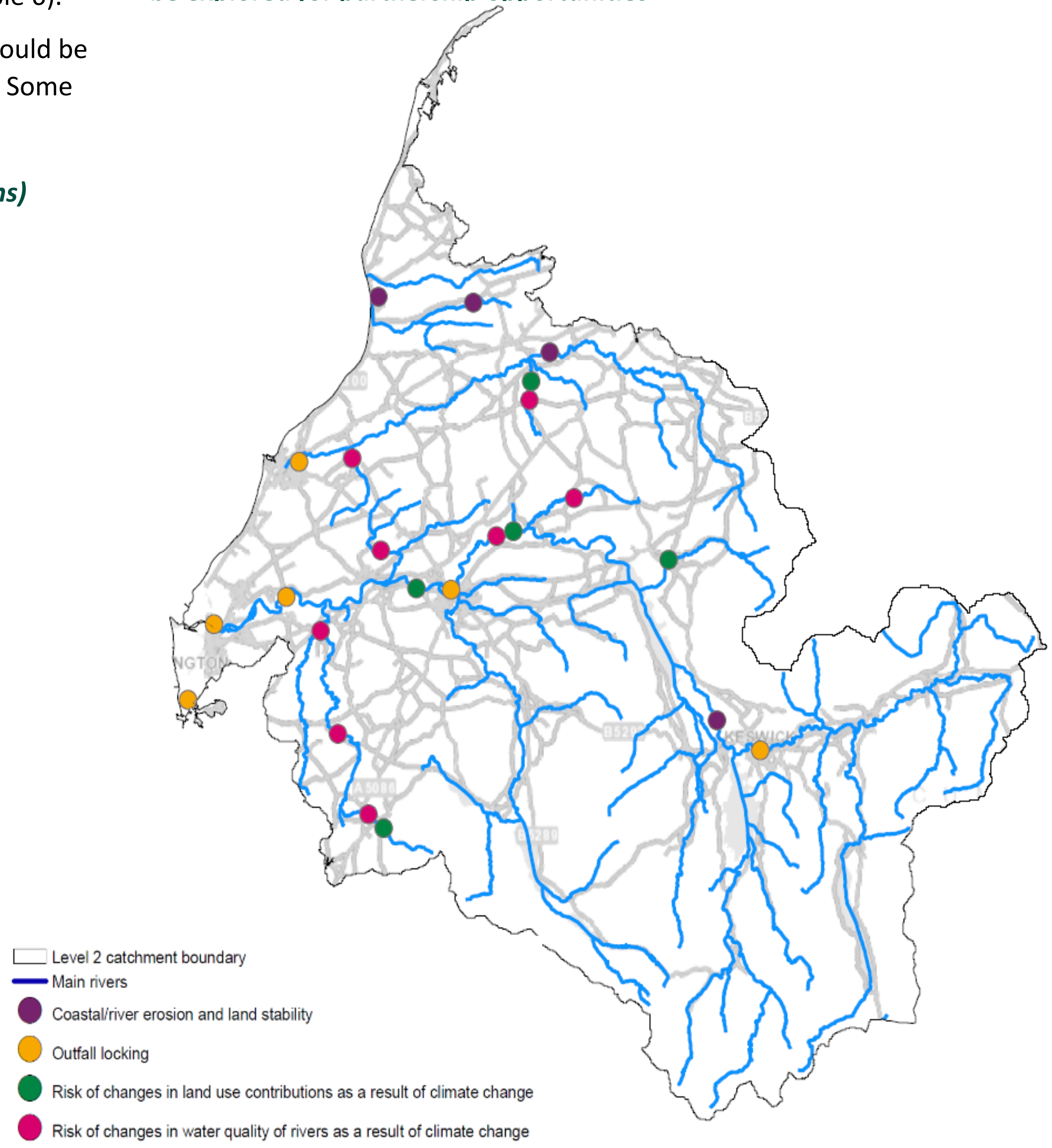
4.3.1 The Derwent SPA is least resilient to power outage as it is the only assessment that scores red (Table 6). There are four assessments that score both amber and green (Table 6).

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 23.

Table 6 Traffic light scoring for the Derwent SPA (excluding Response and 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	Amber
Low flows	Amber
Coastal/river erosion and land stability	Amber
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	Amber

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



4.4 Douglas

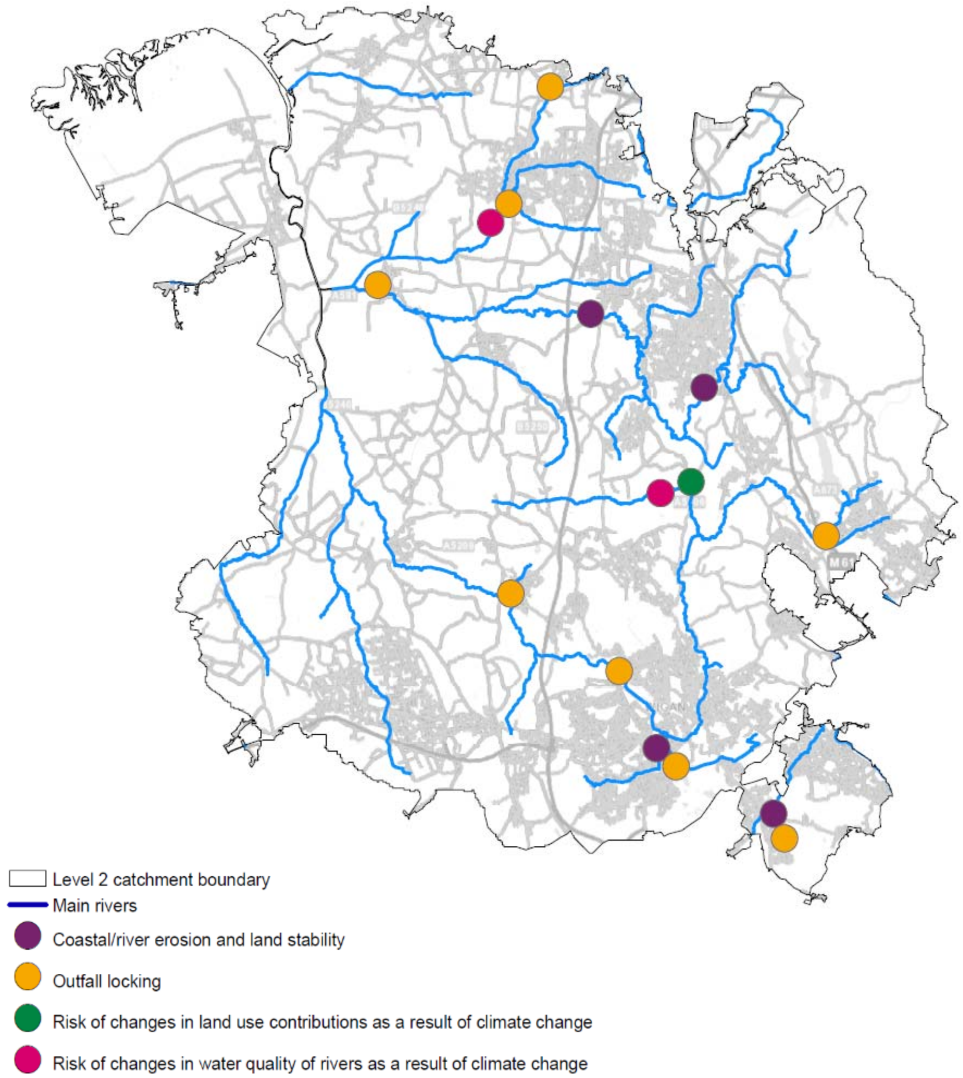
4.4.1 The Douglas SPA is least resilient to fluvial and coastal flooding of wastewater treatment works and major pumping stations as it is the only assessment that scores red (Table 7). Three assessments score amber and three assessments score green (Table 7). No TPUs within the SPA were identified by 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 24.

Table 7 Traffic light scoring for the Upper Mersey SPA (excluding Response and 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



4.5 Eden and Esk

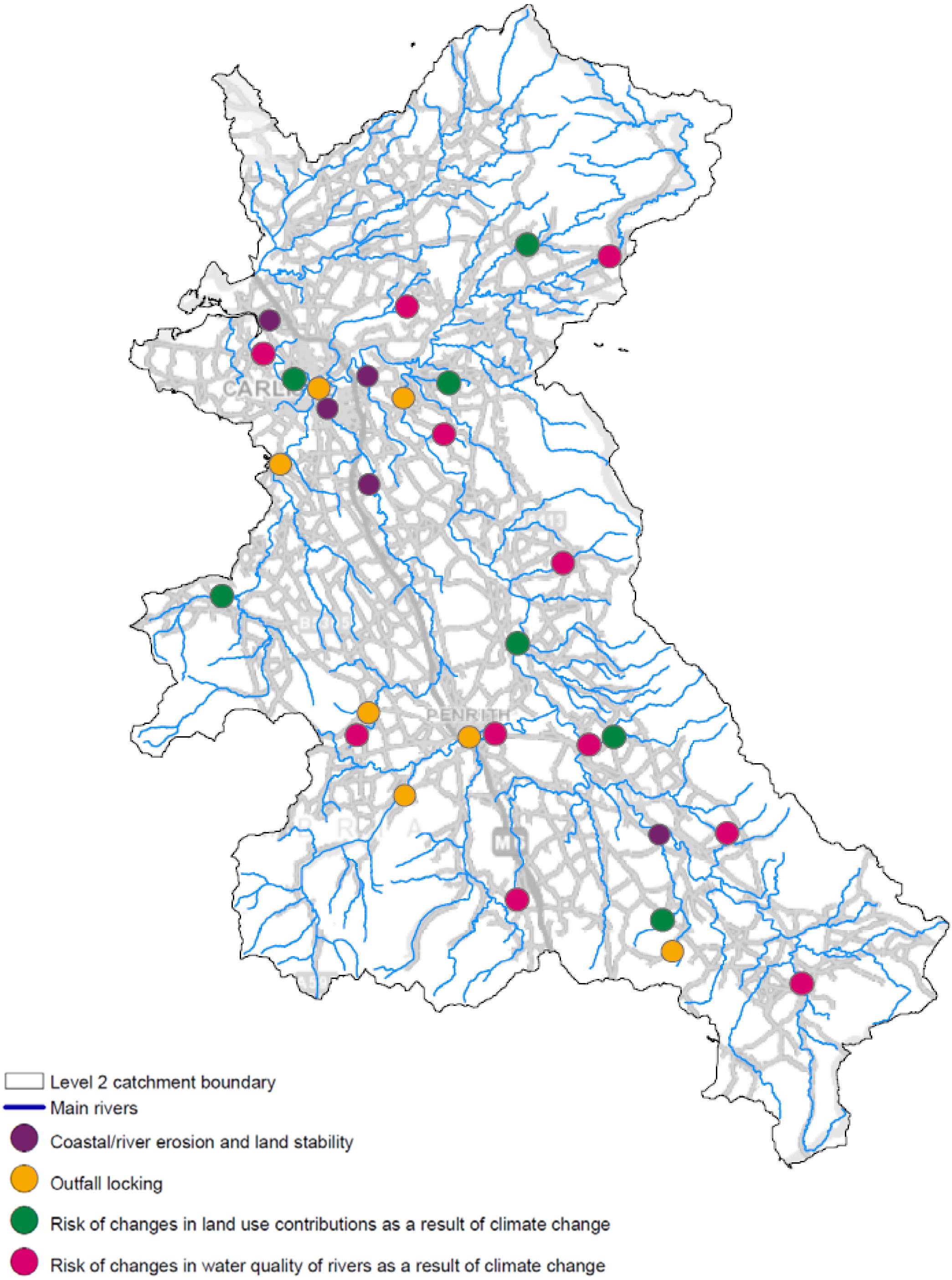
4.5.1 The Eden and Esk SPA is most resilient to communications outage, and fluvial and coastal flooding of wastewater treatment works and major pumping stations as the assessments score green (Table 8). However, we are aware that there are significant localised risks with regards to flooding, and that 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 25.

Table 8 Traffic light scoring for the Eden and Esk SPA (excluding Response and 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



4.6 Irwell

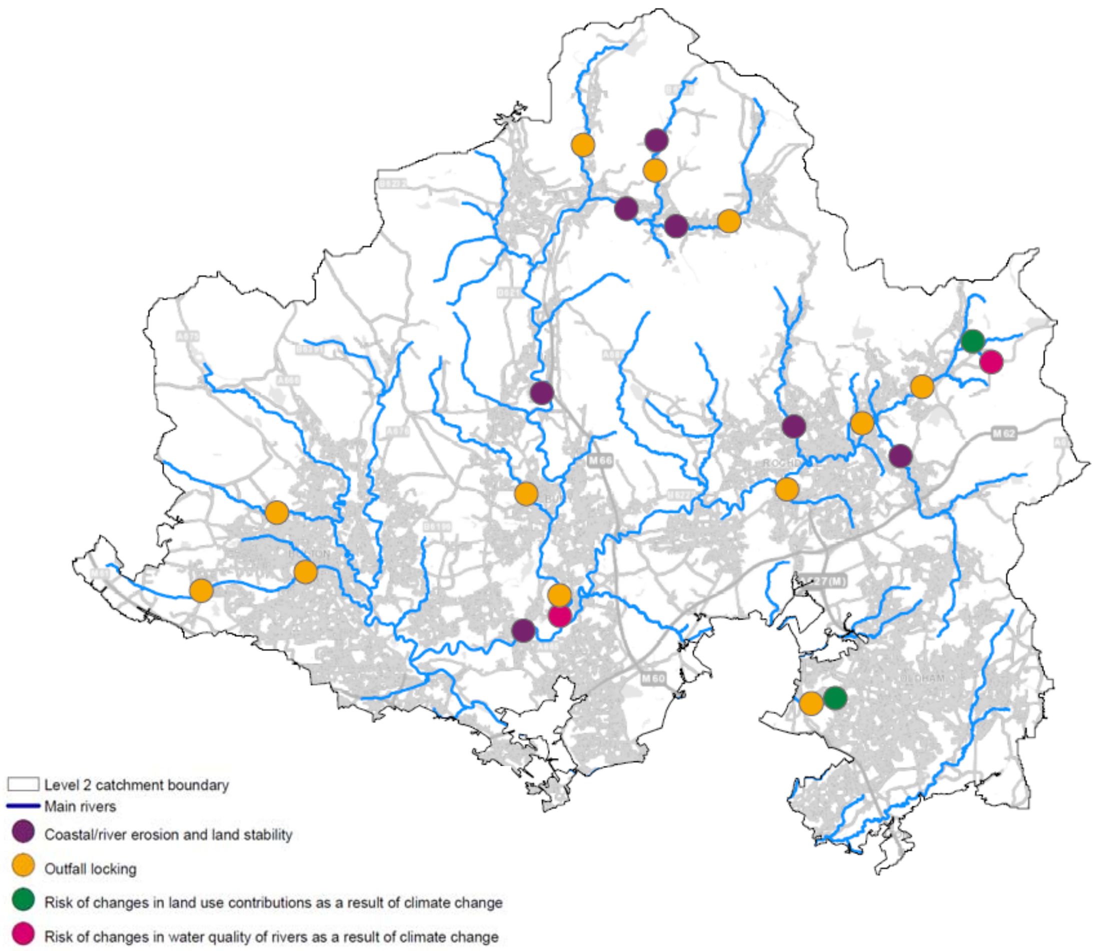
4.6.1 The Irwell SPA is least resilient to three assessments by scoring red (Table 9). There is a great number of assessments that score amber, which are communications outage, first flush, low flow and outfall locking (Table 9). Two assessments relating to the water quality of rivers due to climate 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 26.

Table 9 Traffic light scoring for the Irwell SPA (excluding Response and 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 26 Map of some of the potential shared risks in the SPA, which can be explored for partnership opportunities



4.7 Kent Leven

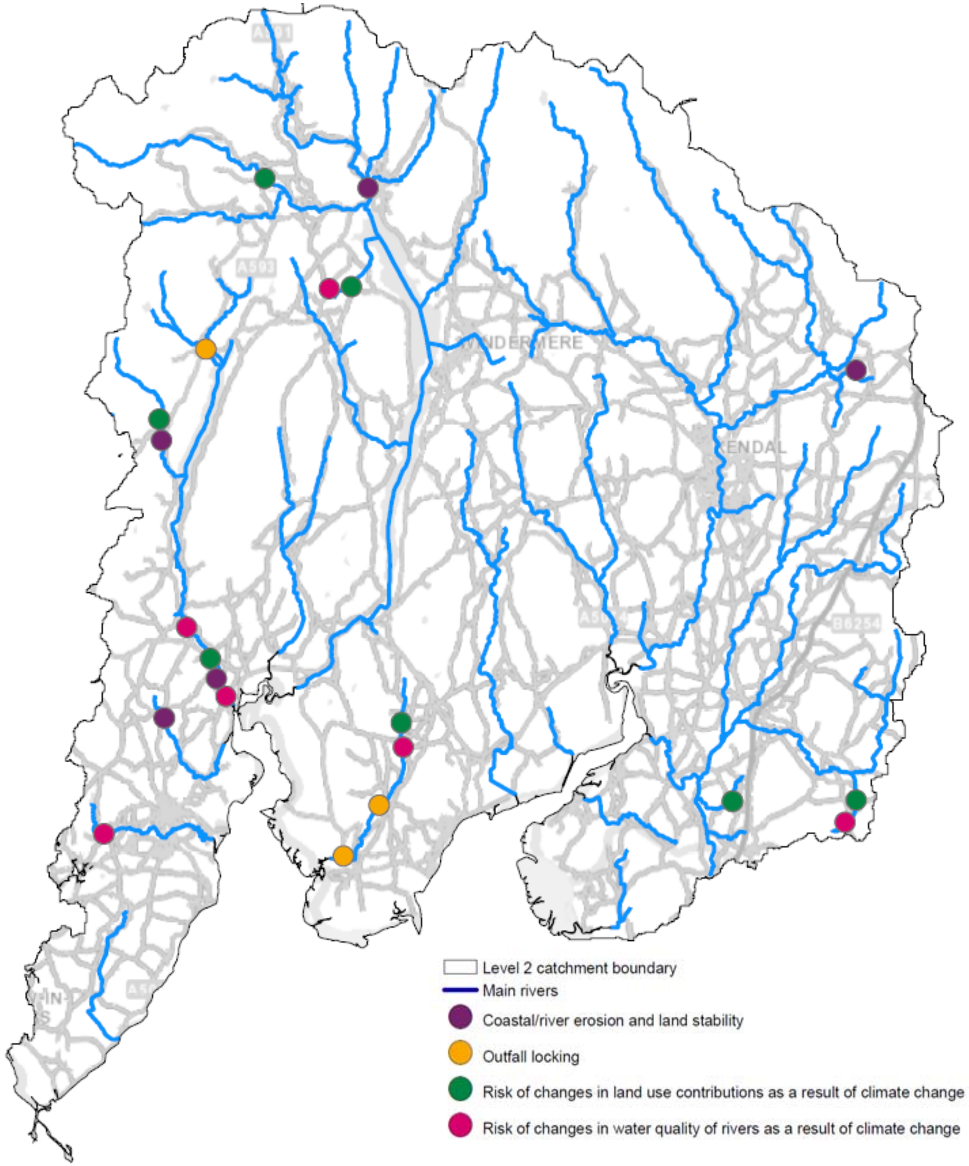
4.7.1 The Kent Leven SPA scores a mixture of red (five assessments) and green (four assessments, Table 10).

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 27.

Table 10 Traffic light scoring for the Kent Leven SPA (excluding Response and 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 27 Map of some of the potential shared risks in the SPA, which can be explored for partnership opportunities



4.8 Lune

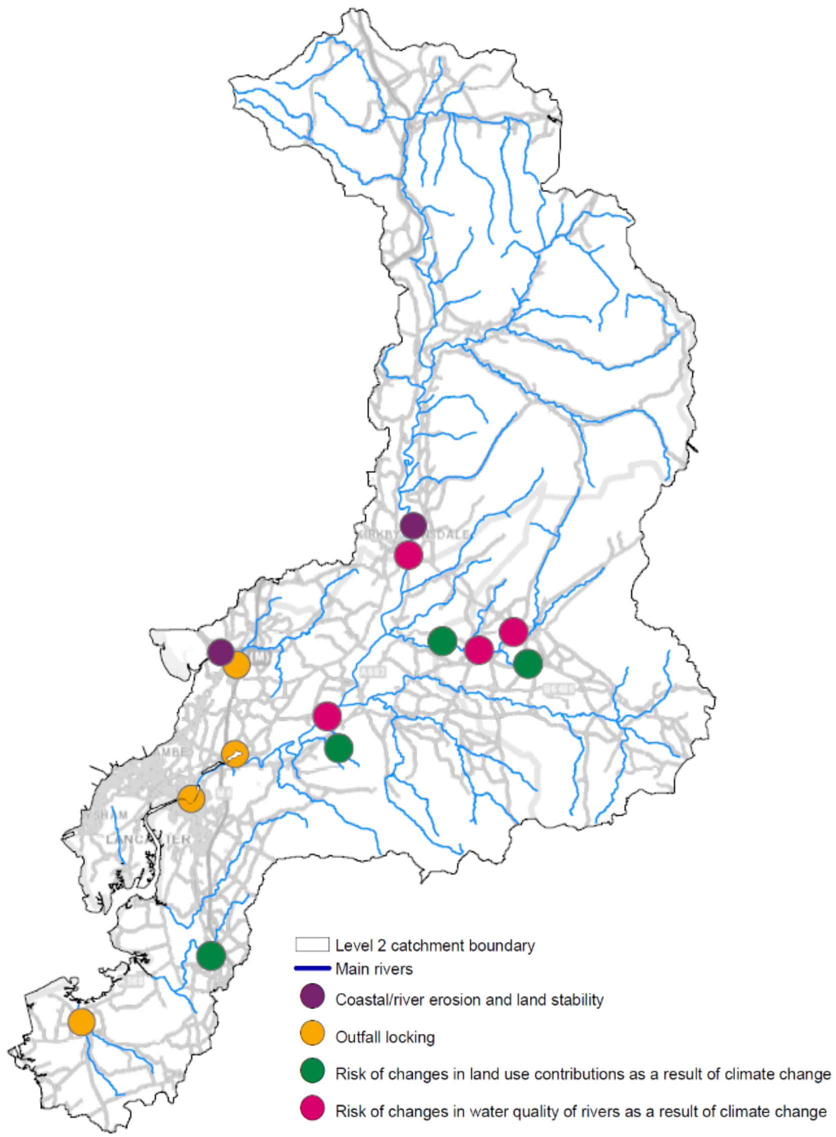
4.8.1 The Lune SPA is least resilient to the majority of resilience assessments by scoring red (Table 11). The SPA is most resilient to communications outage by scoring green (Table 11).

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 28.

Table 11 Traffic light scoring for the Lune SPA (excluding Response and 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 28 Map of some of the potential shared risks in the SPA, which can be explored for partnership opportunities



4.9 Mersey Estuary

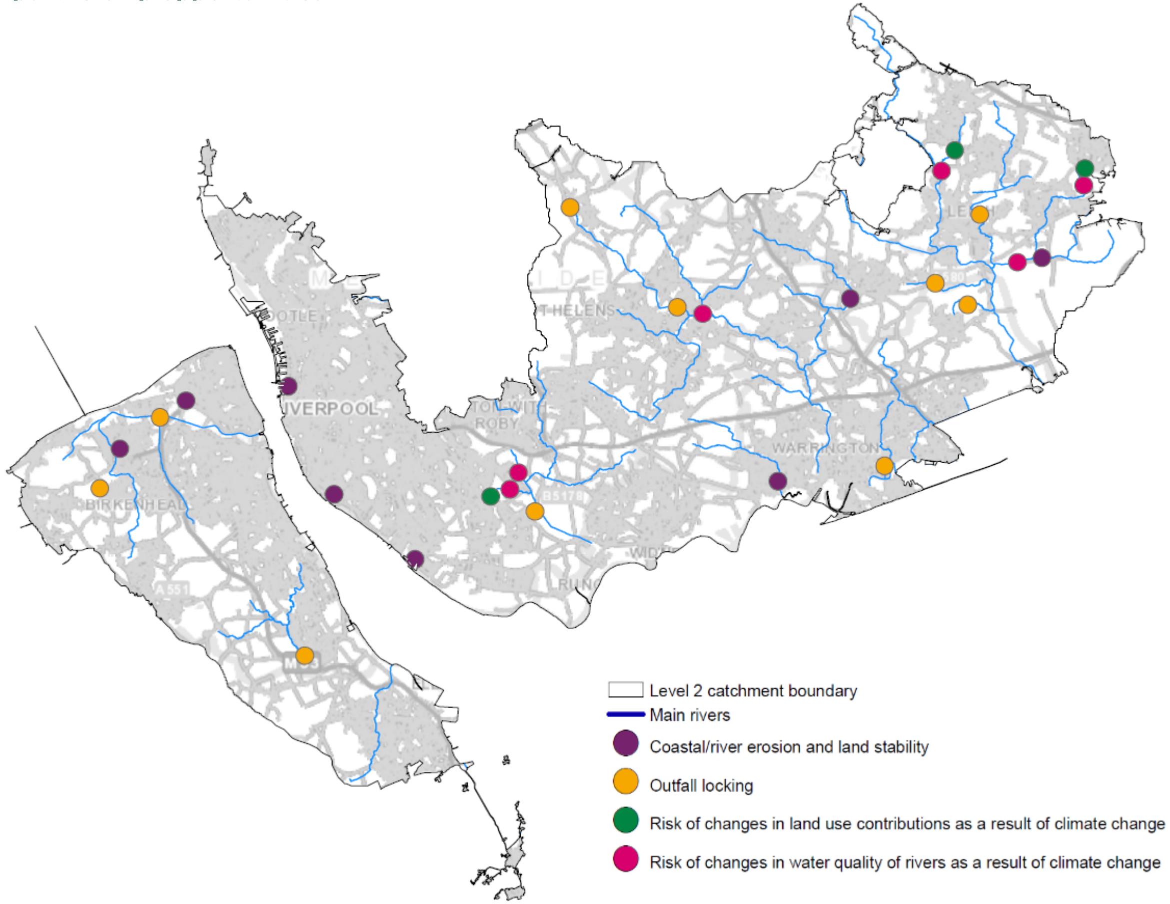
4.9.1 The Mersey Estuary SPA is least resilient to three of the resilience assessments by scoring red (Table 12). The SPA scores amber for the majority of assessments and scores green for power outages only (Table 12).

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 29.

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

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

Figure 29 Map of some of the potential shared risks in the SPA, which can be explored for partnership opportunities



4.10 Ribble

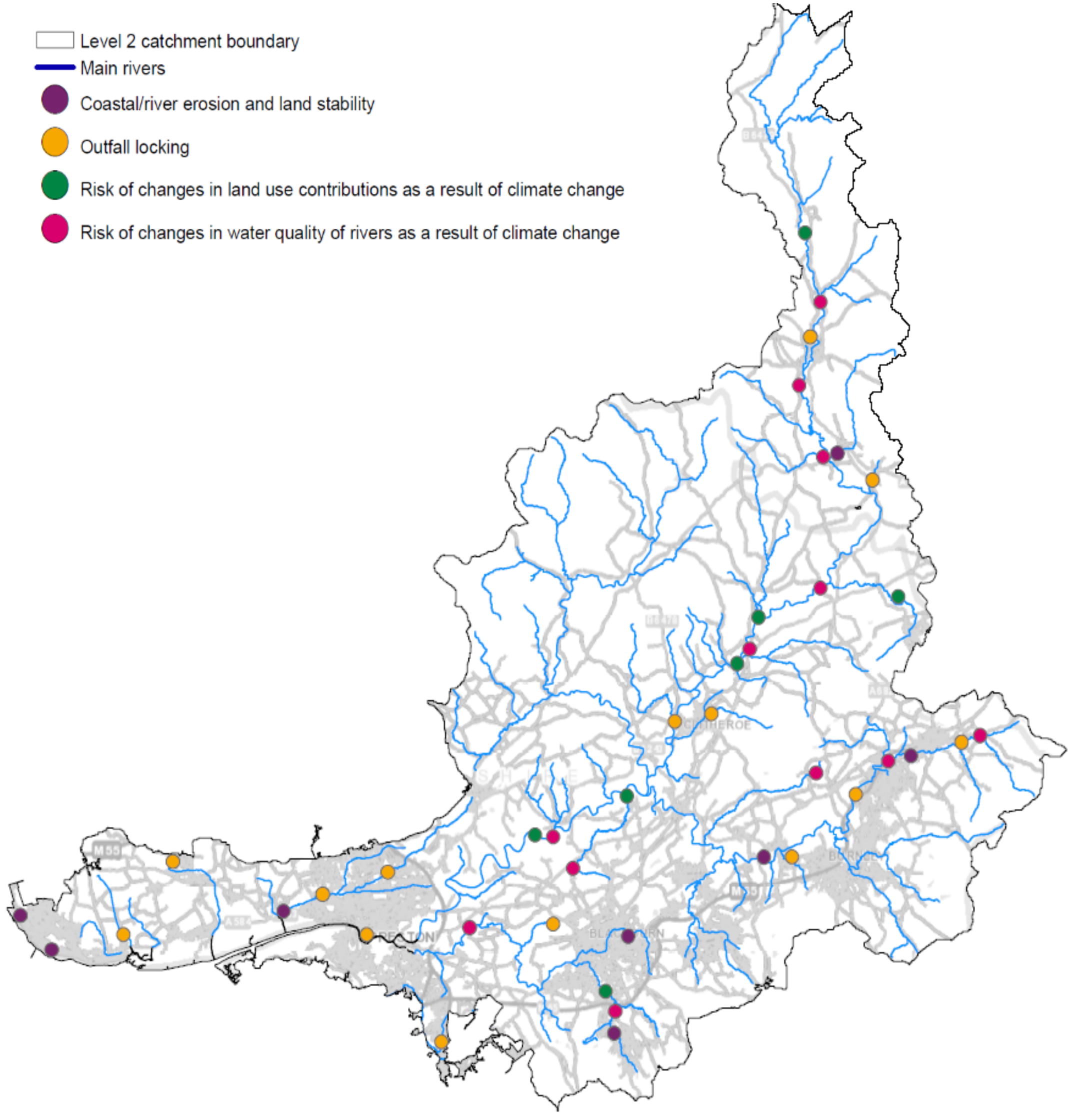
4.10.1 The Ribble SPA is least resilient to power outage as it is the only assessment that scores red (Table 13). The SPA scores amber for five assessments and green for three assessments (Table 13).

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 30.

Table 13 Traffic light scoring for the Ribble SPA (excluding Response and 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 30 Map of some of the potential shared risks in the SPA, which can be explored for partnership opportunities



4.11 South West Lakes

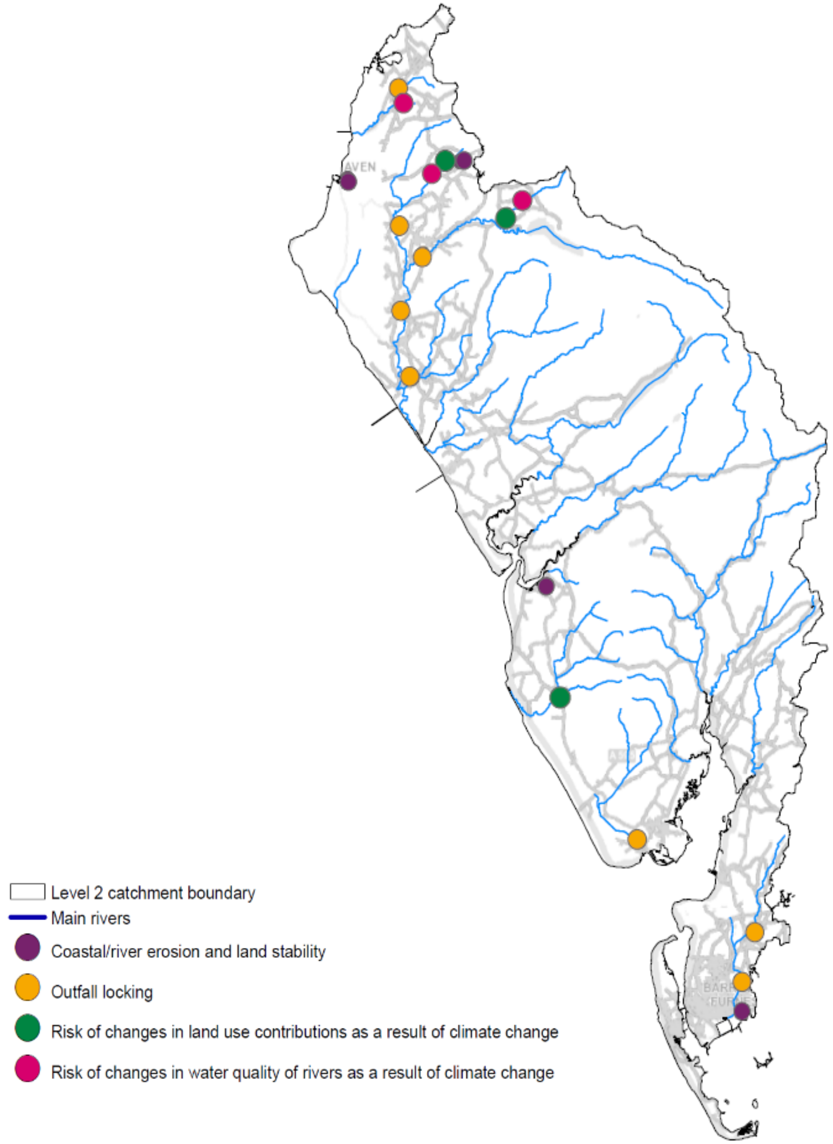
4.11.1 The South West Lakes SPA scores green for all assessments. No TPUs within the SPA were identified by operational teams as being potentially vulnerable to first flush or low flows (Table 14).

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 31.

Table 14 Traffic light scoring for the South West Lakes SPA (excluding Response and 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 31 Map of some of the potential shared risks in the SPA, which can be explored for partnership opportunities



4.12 Upper Mersey

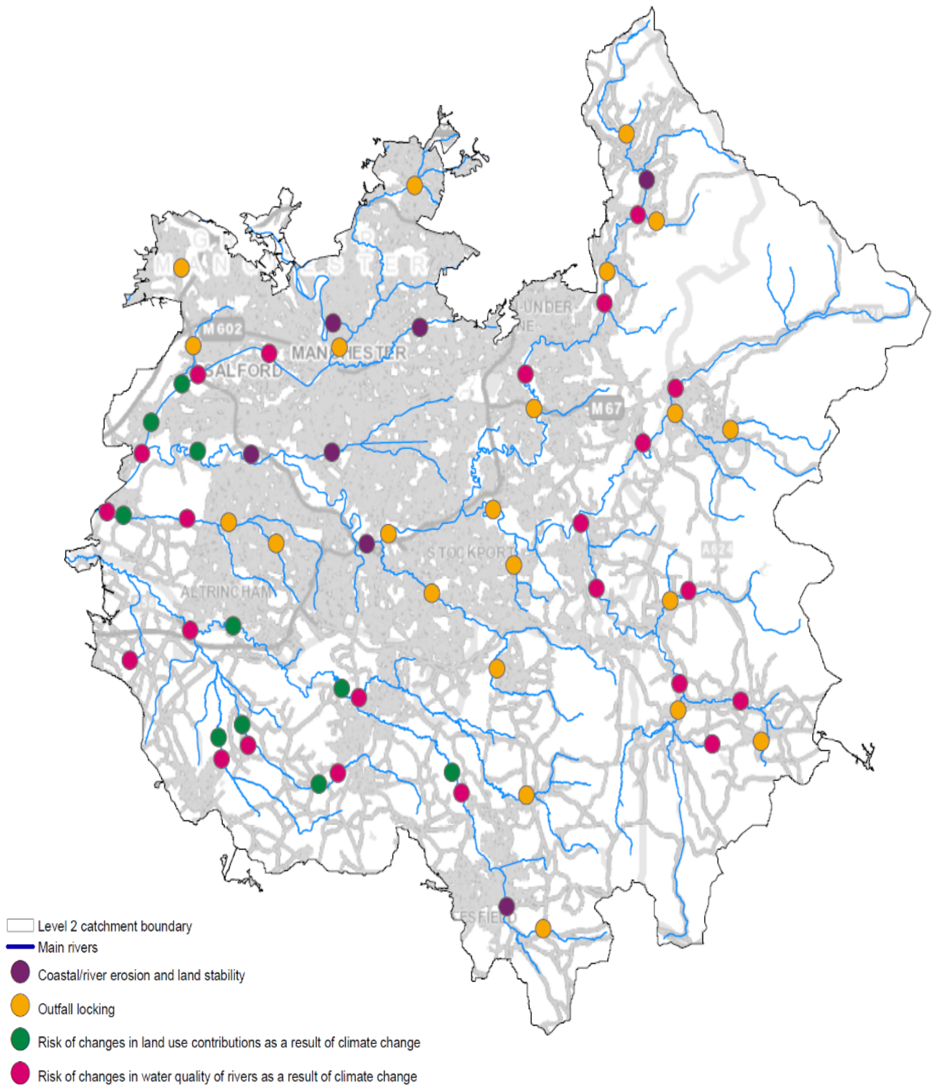
4.12.1 The Upper Mersey SPA is least resilient to power outage and the risk of fluvial and coastal flooding as they are the only assessments that scores red (Table 15). There are three assessments that scored amber, and three assessments which scored green (Table 15).

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 32.

Table 15 Traffic light scoring for the Upper Mersey SPA (excluding Response and 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 32 Map of some of the potential shared risks in the SPA, which can be explored for partnership opportunities



4.13 Waver Wampool

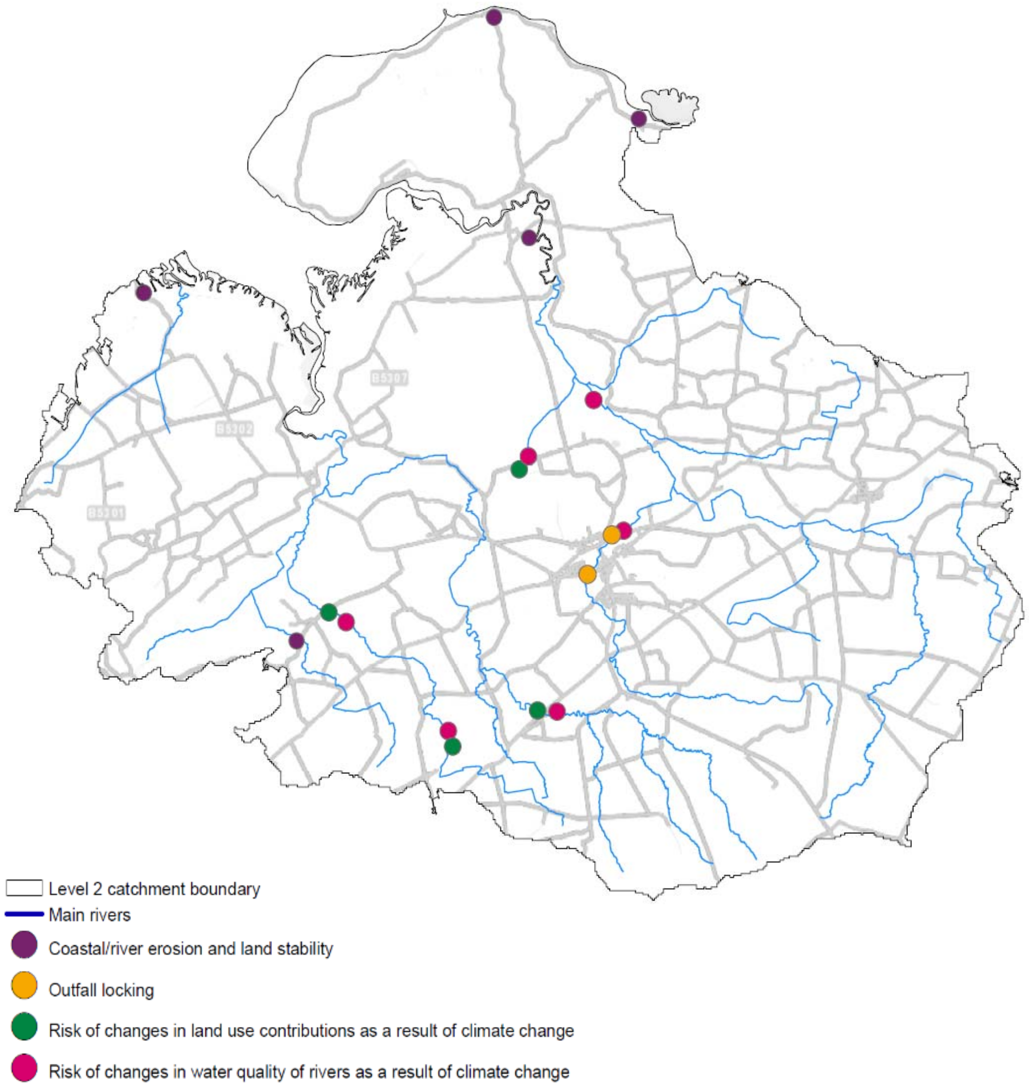
4.13.1 The Waver Wampool SPA is least resilient to two resilience assessments by scoring red (Table 16). Resilience to communications outages scored green, and the remaining assessments scored amber (Table 16).

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 33.

Table 16 Traffic light scoring for the Waver Wampool SPA (excluding Response and 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 33 Map of some of the potential shared risks in the SPA, which can be explored for partnership opportunities



4.14 Weaver Gowy

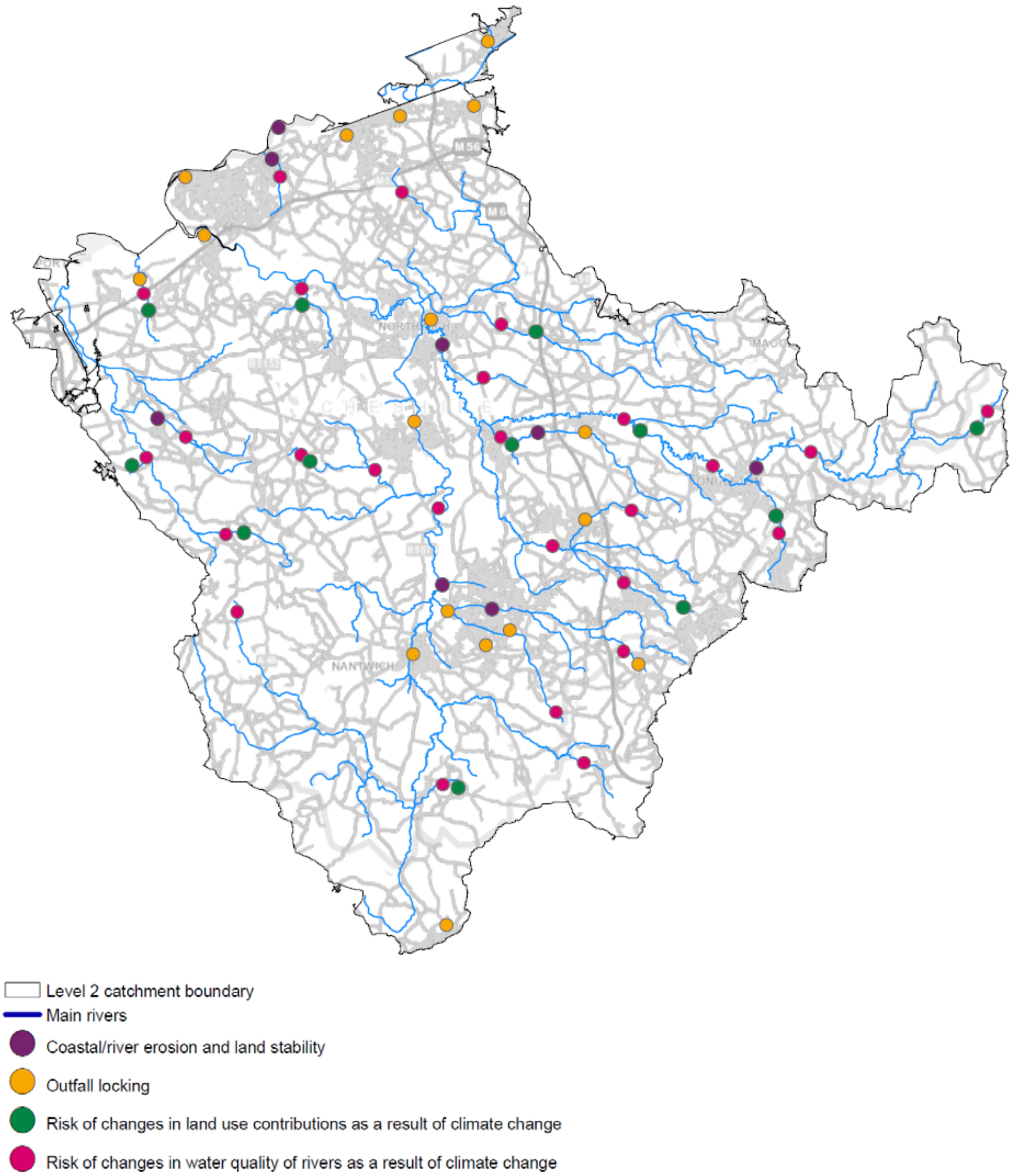
4.14.1 The Weaver Gowy SPA is least resilient to power outage as it is the only assessment that scores red (Table 17). There are four assessments that score amber, and four assessments that score green (Table 17).

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 34.

Table 17 Traffic light scoring for the Weaver Gowy SPA (excluding Response and 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 34 Map of some of the potential shared risks in the SPA, which can be explored for partnership opportunities



4.15 Wyre

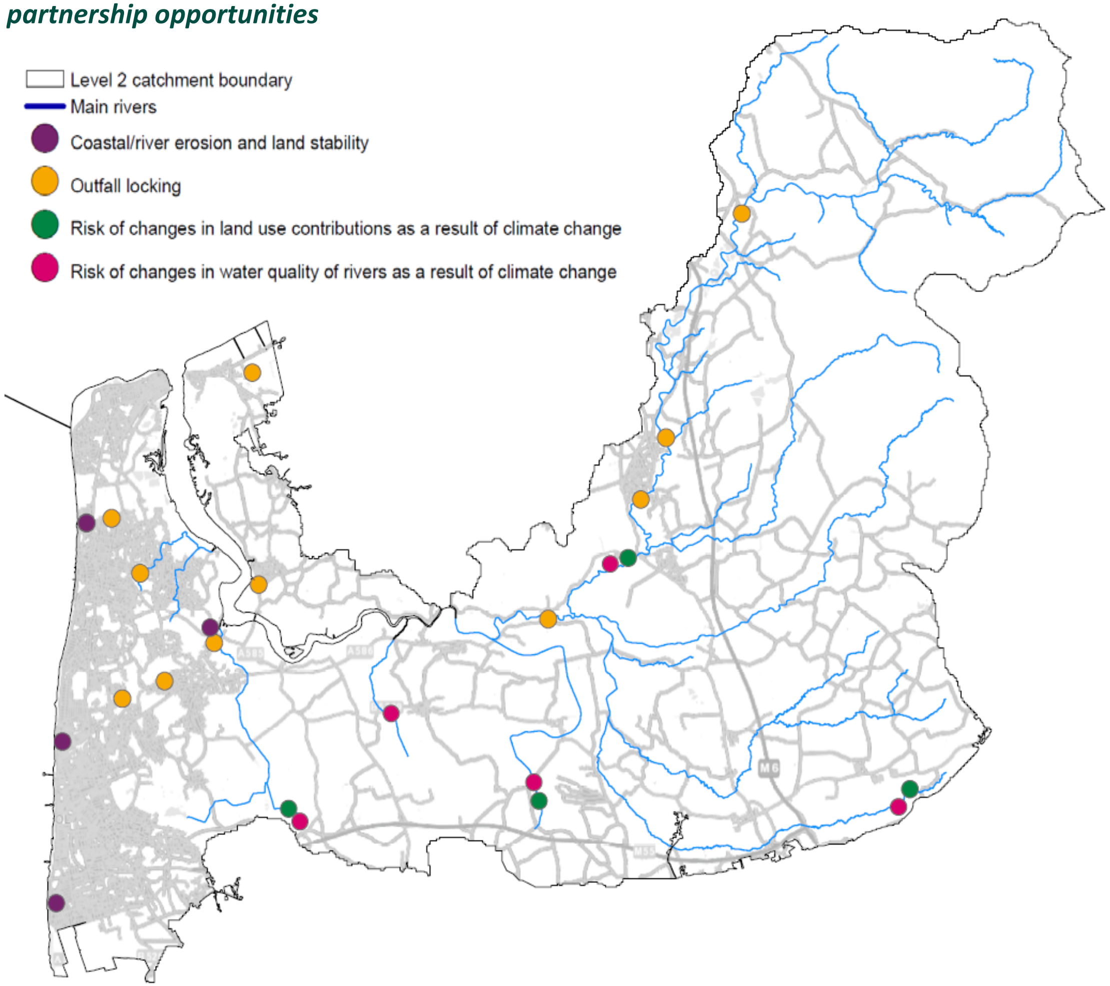
4.15.1 The Wyre SPA is least resilient to power outage as it is the only assessment that scores red (Table 18). There are three assessments that scored green, and the remaining assessments scored amber (Table 18).

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 35.

Table 18 Traffic light scoring for the Wyre SPA (excluding Response and 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 35 Map of some of the potential shared risks in the SPA, which can be explored for partnership opportunities



5. The consideration of resilience within the DWMP and the wider business

5.1 Overview

5.1.1 The DWMP is a high-level, strategic planning process that aims to provide a consistent assessment framework to identify potential interventions that may be required, for a range of future scenarios, to maintain robust and resilient wastewater services now and in the future.

5.1.2 The DWMP has a 25 year time horizon and will be revisited and every 5 years, taking account of the latest information, customer preferences and statutory requirements. The information presented throughout the DWMP will be used in conjunction with other long-term planning tools being developed and refreshed across the business to provide a strategic framework to support the development of both long-term and shorter-term investment strategies.

5.1.3 Securing resilient services is rightly a priority for us, we recognise the importance of ensuring that we as a business are resilient and are able to anticipate, cope with and recover from disruption to our services. The DWMP has provided a high-level overview of the main challenges and opportunities that we anticipate we may face and provides a framework for where we may want to consider investment to improve our resilience now and in the future.

5.1.4 Further to our DWMP resilience assessments resilience is a key area of focus in the development of our wastewater strategies and in the development of our Price Review submission in 2024 (also known as PR24) to support investment cycle 2025 – 2030 (also known as AMP8). The DWMP resilience assessments have provided long-term strategic direction into the development of our immediate investment plans, and will continue to do so as we develop our holistic Long-term Delivery Strategies (LTDS).

5.1.5 Working with partners is key to managing risks identified throughout our resilience assessments and the wider DWMP. Where we have shared risk, we also have a shared responsibility to manage these risks in collaboration with wider organisations and landowners. UUW are prepared to co-create and co-fund schemes, where appropriate, in order to protect its assets and continue to maintain robust and resilient service for our customers through these assets in with expectations from both our customers and regulators. One of the key focus' of the DWMP is to co-develop our long-term strategy in partnership with our stakeholders which is an ambition echoed throughout our wastewater strategies and in the development of our business plan for investment cycle 2025 - 2030.

Appendix A

Table 19 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

Refer to the spreadsheet ‘TA6 Resilience – SA001 Appendix B’.

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United Utilities

Water for the North West