Canal & River Trust

Our Climate Adaptation Report

Developed in response to the Adaptation Reporting Power Fourth Round (ARP4)

December 2024

canalrivertrust.org.uk

Foreword

We are pleased to publish our first Climate Change Adaptation Report and join the group of nationally important infrastructure providers who regularly report their progress in adapting to climate change.

Credit © ABC Boat Hire

Our canal network extends for 2,000 miles across England and Wales, supporting navigation for more boats than ever, providing blue-green corridors for people and nature through towns and cities, and hosting a range of important utilities and services running under towpaths or buried in canal structures. We also care for 71 large raised reservoirs, docks in Liverpool, London and Sharpness and the Tees Barrage, each of which presents its own challenges.

Canals are now at the heart of many communities, providing a range of economic, social and environmental benefits on the doorstep of around 10 million people. But with most of the canal network built more than 200 years ago, using the traditional methods and materials of the day, it is vulnerable to the more extreme weather events of the 21st century. The places around our canals have also changed beyond recognition and continue to be a focus for development and regeneration, making the canal network an enabler for growth. This, in turn, shapes the impact on it and the risks to public safety that the Canal & River Trust, as custodians of this historic fragile infrastructure with open access, has to manage to protect it and the communities around it.

The movement of water is fundamental to the operation of canals and, as such, they are also critical to society's adaptation to climate change. We deliver water to areas that will experience significant water deficit in the years to come, can move flash floods away to reduce risk to neighbouring properties and can mitigate urban heat effects in built-up cities. Our canal network – built for trade at the height of the Industrial Revolution – fulfils a range of uses far beyond what was anticipated when first dug by hand.

However, climate change, through greater rainfall, intensifying storms, heatwaves and droughts, increasingly threatens our complex and ageing infrastructure. Like other infrastructure providers, the challenge of keeping our canal network resilient and safe in the face of rising climate impact will require significant investment to safeguard what we have and the benefits we enjoy and to unlock the wider opportunities that the canals can offer society as we face this unprecedented challenge.

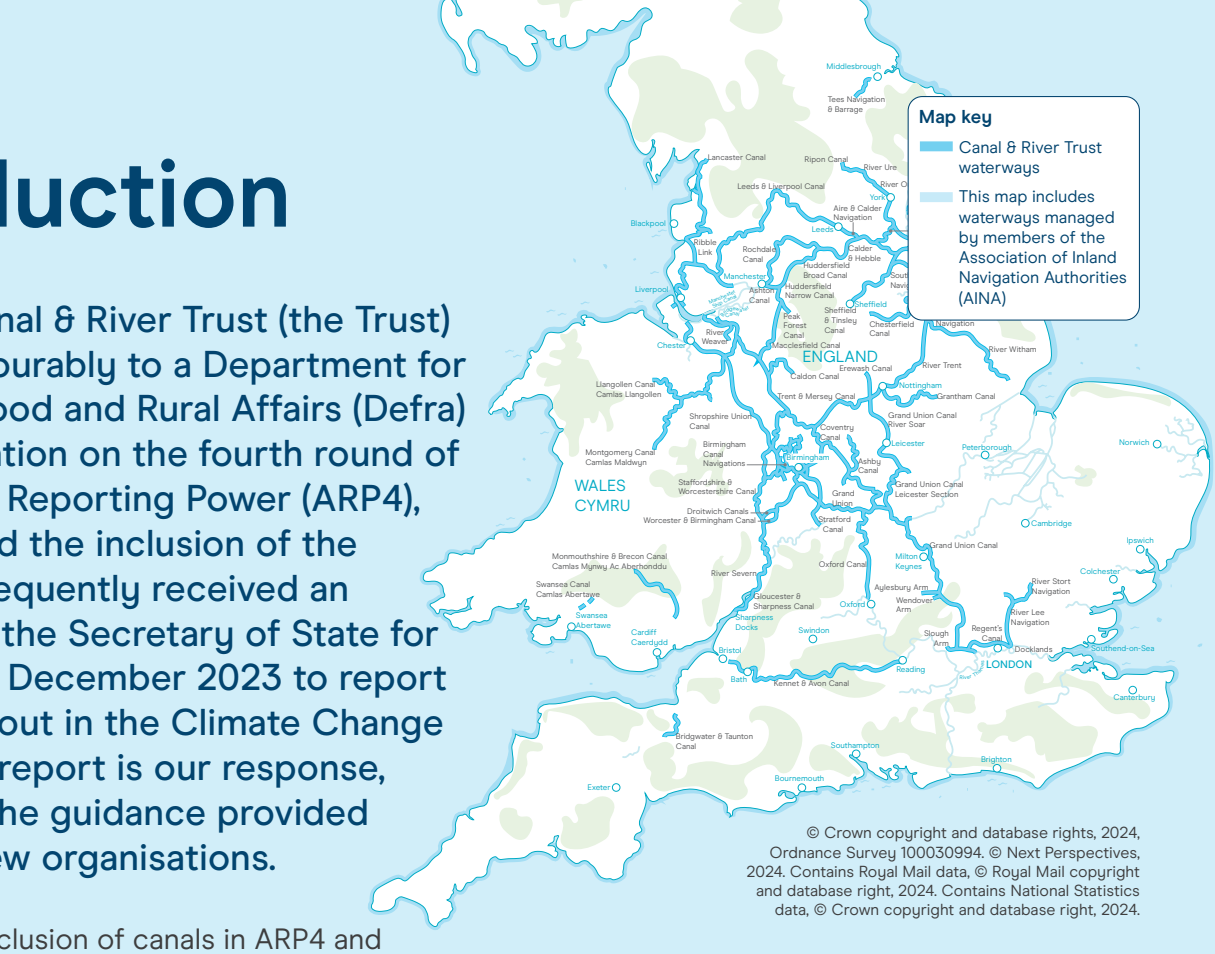
This report sets out some of the work we are doing to adapt to the threat of climate change to secure the canal network for future generations.

David Orr CBE
Chair

Richard Parry
Chief Executive

Introduction

In 2023 the Canal & River Trust (the Trust) responded favourably to a Department for Environment Food and Rural Affairs (Defra) public consultation on the fourth round of the Adaptation Reporting Power (ARP4), which proposed the inclusion of the Trust. We subsequently received an invitation from the Secretary of State for Environment in December 2023 to report in ARP4 as set out in the Climate Change Act 2008. This report is our response, which follows the guidance provided by Defra for new organisations.



We welcome the inclusion of canals in ARP4 and recognise the importance of our contribution to the UK's adaptation reporting framework and the national climate change adaptation plan. We have already experienced and understand how climate change is impacting the functions, assets and services the Trust provides as custodian of our 200+ year old network of historic and nationally important infrastructure.

In this report, we present our understanding of how climate change affects our canal network and its associated structures and habitats, the steps we are currently taking to manage those impacts and what we could do in the future, linked to the challenges and opportunities we face. We are at the start of our climate adaptation reporting journey, and we expect to use the process to grow our knowledge and understanding, refine our approach, and embed climate adaptation into our delivery and collaboration with other infrastructure providers.

In this report, we cover:

- **Details about the Trust & our canal network**
- **How climate change affects our canal network**
- **How we respond to climate change**
- **Understanding risks & challenges**
- **Climate adaption action plan**
- **Challenges & opportunities for adaptation**

Who we are

Canal & River Trust is a registered charity formed in 2012 to care for 3,219 kilometres (2,000 miles) of working canals, river navigations, docks and reservoirs across England and Wales ('the canal network').

Our canals, towpaths, docks and reservoirs are all man-made and our river navigations are routes that have been engineered to enable vessels to pass safely up or down them.

Our network includes 82 reservoirs (of which 71 are large raised reservoirs subject to the Reservoirs Act 1975), four inland ports and over 10,000 principal assets, made up of bridges, aqueducts, tunnels, embankments, a tidal barrage and nationally and internationally designated wildlife sites.

In addition, we have hidden assets, such as culverts, which are essential for the operation of the canal system. We also host infrastructure, including pipes and cables, for other providers. Our network includes what is believed to be the third-largest collection of listed buildings and structures (over 2,700) in England and Wales and 46 scheduled monuments.

What we do

Our core activities are to protect, operate and manage the canal network in England and Wales for navigation, access along our towpaths and to provide recreation and other leisure activities. Our main objectives include conserving and enhancing heritage, protecting biodiversity and supporting nature recovery as well as delivering wellbeing opportunities.
Our operational duties intersect with many aspects of daily life and are shaped by the places and landscapes around us.

Supporting partners & services

Beyond our core activities, we also provide essential services for others:

1. **Water transfer & supply:** Our canal network delivers sustainable water transfers through partnerships with water companies, securing drinking water needs and other water dependent services, while reducing the UK's need for new reservoirs to be constructed.
2. **Agricultural support:** Our canal network provides surplus water to farmers. This aids drought resilience, securing water supplies that are essential for sustaining agriculture.
3. **Flood mitigation & relief:** Our canal network serves as an adaptable resource to mitigate extreme weather impacts and can be used to divert water away from heavily-affected areas.
4. **Heating & cooling:** Our canal network provides opportunities for low-carbon heating and cooling of buildings and other infrastructure, such as data centres.
5. **Firefighting:** The emergency services use water from our canal network through agreed abstraction licences or direct use in emergency situations.
6. **Growth & regeneration:** Our canal network delivers attractive settings for sustainable urban living and provides beneficial services, such as active travel and urban cooling in our cities.

Evidence of what we do and the benefits it brings to the people and places in England and Wales can be found in our latest Impact Report.

www.canalrivertrust.org.uk/our-impact

Water supply – United Utilities & Bristol Water

We have a crucial role in helping water companies provide drinking water and cooling for power stations. In the example of United Utilities, raw water is abstracted from the River Dee and transported through the Llangollen Canal to Hurleston Water Treatment Works, outside Nantwich in Cheshire, supplying approximately 330,000 people.

Similarly, for Bristol Water, water is pumped from the River Severn to flow along the Gloucester & Sharpness Canal to serve around 600,000 people. Both systems offer sustainable water transfer solutions that eliminate the need for new pipelines.

These arrangements support regional water security and provide us with income, although both systems carry risks which need to be shared. In our current 10-year contract cycle with Bristol Water, the Trust incurs annual maintenance costs of around £4.4 million for the Gloucester & Sharpness Canal alone,

highlighting the need for sustainable funding to maintain these essential water transfer routes, with the likely risk that future costs will increase due to climate change.

Mytholmroyd flood alleviation scheme

In collaboration with the Environment Agency and Calderdale Council, we helped develop a flood alleviation scheme for a large village in West Yorkshire, which has historically been affected by flooding. The £35 million scheme included raising flood walls and creating an overflow system through the Rochdale Canal, directing excess floodwater to a designated floodplain. This approach reduces flood risk for the village while providing biodiversity benefits. The scheme highlights the canal's dual role in flood management and community wellbeing.

These partnerships highlight our proactive role in water management, economic support and climate adaptation, using canals to support wider public and environmental needs.

Water for agriculture

We provide surplus water from the network to local farmers, helping to support agriculture during droughts. A large agricultural customer grows root vegetables near the Aire & Calder Navigation and Selby Canal, abstracting water under agreements dating back to 1993, helping to safeguard food production. We collaborate closely with the Environment Agency to ensure water availability, underscoring the network's essential role in regional agriculture and food security.

Statutory consultee for planning applications & prescribed consultee for NSIPs

We are a statutory consultee for planning applications, and we are a prescribed consultee for Nationally Significant Infrastructure Projects (NSIPs). Approximately 96% of the land adjacent to our canal network is in third-party ownership.

Since 1997, our statutory consultee status acknowledges the risks posed to the structural integrity of our assets by development on land beyond our control. Damage to these assets can create significant public safety and financial risks, not only for the Trust but also for communities, businesses and infrastructure providers.

Protection against unsafe development

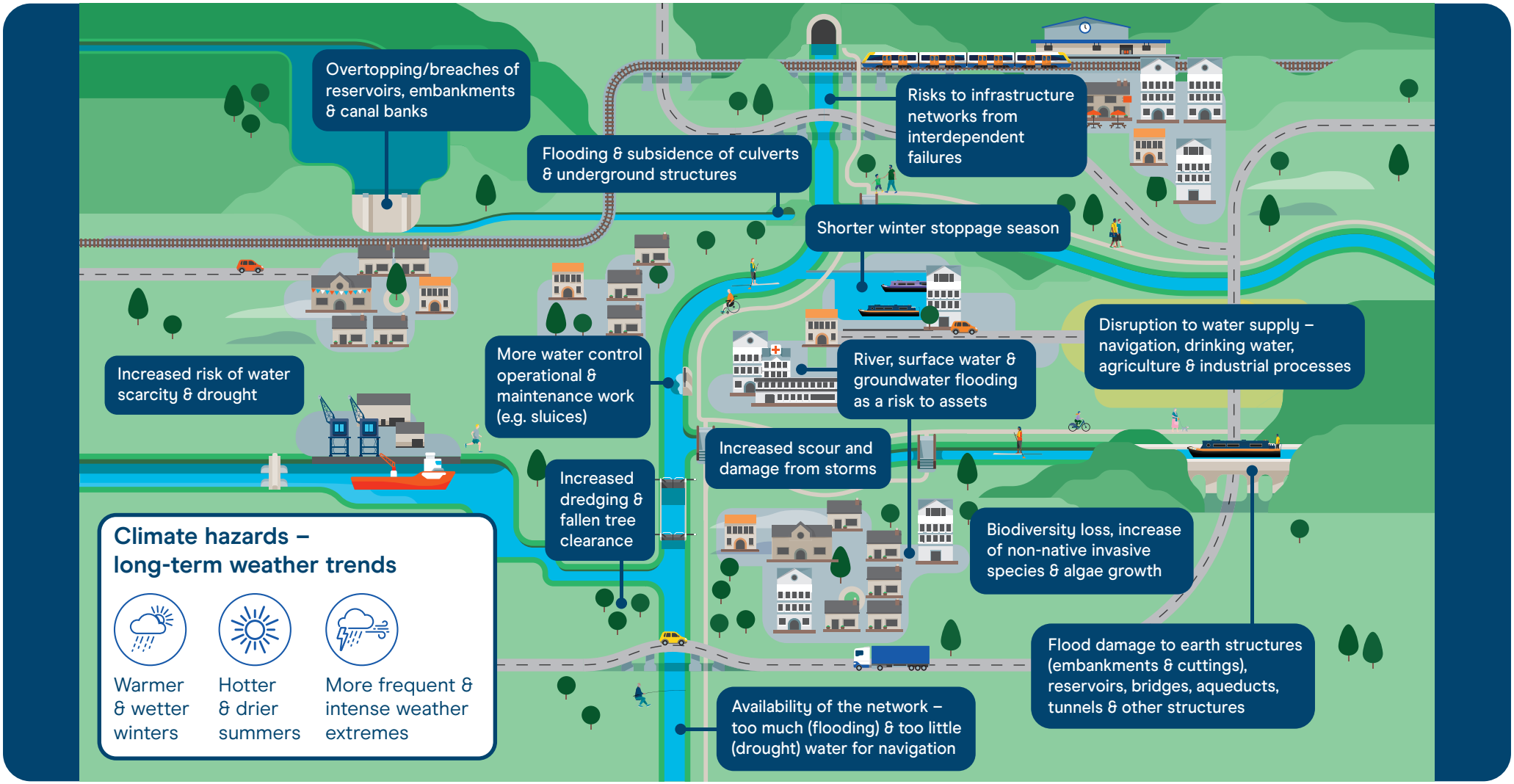
In autumn 2010, a planning application was submitted to construct apartments and associated ancillary works on an area of former industrial land.

The application was approved for the site, but the Local Planning Authority (LPA) failed to consult or take into account the concerns raised by the Trust's statutory predecessor, British Waterways, on a previously withdrawn application. Shortly after planning permission was granted, work began which, because these concerns had not been addressed, resulted in the collapse of the site's boundary retaining wall supporting a canal. This, in turn, caused damage to the construction site, the canal and its towpath and the adjoining land.

Urgent action was taken, including drainage and closure of the canal and towpath, to ensure public safety, to prevent further damage to the wider environment and mitigate the risk of flooding to nearby homes, businesses and transport infrastructure. Had corrective action not been taken, significant damage at an estimated cost of over £2.5 million could have occurred from evacuating homes and businesses, closure or restrictions to services on a major national railway line and a potential risk of injury or loss of life.

How climate change affects our canal network

Climate change is likely to significantly impact the functions, assets and services we provide. Temporal and spatial changes in rainfall frequency and intensity, increasing temperatures and rising sea levels pose risks, including flooding, drought, subsidence, structural damage and ecological degradation.



1 **Drought:** Prolonged dry spells, such as the 2022 drought which affected 15% of our network including important TransPennine routes like the Leeds & Liverpool Canal, have underscored the need for water resilience in the canal network. The drought reduced water levels, which in turn, impacted waterway dependent businesses, boating and tourism, as well as affecting agricultural water supply, habitats and wildlife. This highlights the importance of collaborative sustainable water management in the face of climate variability, particularly as these resources serve multiple community needs.

2 **Flooding**: Increasing extreme weather events are a major concern. During Storm Ciara (February 2020), intense rainfall led to widespread flooding and substantial damage to structures like the Figure of Three Locks on the Calder & Hebble Navigation, necessitating a costly rebuild of around £3 million. This event illustrates the heightened vulnerability of canal infrastructure in extreme weather.

3 **Landslips:** At Easenhall Cutting on the Oxford Canal, after a period of intense rainfall in early February 2024, approximately 4,000 tonnes of material from the 18-metre-high cutting slipped into the canal. Our team worked through difficult conditions, with continued wet weather saturating the site, to deliver a solution that involved installing a 300 metre access road across neighbouring fields and digging down the bank to remove the material from the canal, costing an estimated £2 million.

4 Towpath repairs:

Large scale damage was caused to the towpath at Blue Bank Lock on the Grand Union Canal in Leicester following Storm Babet in 2023 and further damaged by storms Gerrit and Henk in early 2024. The nearby River Soar overtopped, completely washing the bank and towpath away. With the support of the City Council, we rebuilt the walls, added sheet piling and built a new towpath. The cost of repairs to this section of towpath exceeded £315,000.

5 Subsidence:

Marple Lock Flight is a beautiful historic flight of 16 locks on the Peak Forest Canal. During 2023/24, sustained heavy rain washed away the fine soil behind the wall of Lock 7, leaving voids and causing the ground above to subside, which put the walls in danger of collapse. Emergency intervention saved the asset, but at a cost exceeding £1.4 million.

7 Invasive aquatic weeds:

Warmer water and nutrient-rich surface water run-off allows unwanted aquatic invasive weeds such as duckweed, floating pennywort, azolla and blue-green algae to flourish. The prolific growth has knock-on impacts for canal ecology, including in our 68 Sites of Special Scientific Interest, by reducing essential oxygen levels.

In 2023, we worked with Paddle UK, the Environment Agency, Yorkshire Water and Angling Trust to remove Floating Pennywort from the River Lee and Calder and Don Navigations. This partnership expanded its efforts into the East Midlands in 2024. This work wouldn't have been possible without the help of dedicated volunteers. Now these waters are flourishing with native species and healthy fish and people are back enjoying time on these stretches of water.

6 Canal culvert collapses:

There are hundreds of culverts located underground, allowing water to pass from one place to another. We have an inspection regime for our culverts, but during heavy rain and flooding, these old structures need to withstand increased pressure from the excess water passing through, sometimes causing erosion and structural damage. In early January 2024, in the wake of storms Gerrit and Henk, a sink hole appeared next to Deptmore Lock 42 on the Staffordshire & Worcester Canal adjacent to a residential property. Our teams responded quickly to make the site safe and identify the cause. The persistent and heavy rainfall had resulted in the collapse of a culvert, and a project was quickly mobilised to repair the damage, costing close to £200,000.

How we respond to climate change

Climate change is managed across multiple levels, ensuring it is fully integrated into our operations, planning, and decision-making. We have a governance structure that coordinates climate adaptation and mitigation efforts across national and regional teams, supporting our mission to protect and secure a sustainable future for our canal network in England and Wales.

Strategic oversight

Our Board of Trustees oversee our strategic direction and ensure that climate change is embedded in long-term planning and decision-making.

Executive directors

Our directors translate the strategic objectives into action, overseeing the integration of climate resilience and adaptation into the Trust's operational plans across all relevant activities. A key area is ensuring its integration into our operations and asset management plans.

Environment & climate action team

This team, within our Strategy & Impact directorate, provides the knowledge to develop detailed climate and sustainability strategies, promoting climate resilience in strategic and operational initiatives, and reporting progress to the executive directors.

Corporate risk management

Climate risks are part of the corporate risk framework, monitored alongside other operational risks. Corporate risks are overseen by a separate audit and risk committee.

Operations, asset management & delivery teams

Our 24/7 on-call team assesses climate change impacts, repairs damage and plans and delivers climate resilience projects and reacts to emergency events.

Our commitment

The Trust recognises the importance of climate adaptation and has supported actions to address it. Our purpose is to **"To achieve a sustainable future for our canal network, keeping it open and alive, making it resilient and safe and maximising its value for people, nature and the economy."**

Our next 10-year strategy has four societal goals, including: **"Our network protects and sustains neighbouring communities, services and water supply. It's a critical and interconnected part of the nation's infrastructure and is resilient to the changes in climate."** The revised strategy will be published in 2025.

How we currently manage climate risks

We have undertaken a range of resilience initiatives as part of a broader strategy to adapt to and mitigate the impacts of climate change. These initiatives focus on protecting our canal network, managing water resources, reducing flood risk and enhancing biodiversity.

Asset inspection & management

We have a mature approach to the management of our portfolio of over 40 types of assets, underpinned by our "Mandatory Standard: Asset Inspection Procedures (AIP 2024)".

Under AIP 2024, assets are inspected according to a hierarchy and assigned a score based on condition, Consequence of Failure (CoF) and serviceability. The following table outlines the condition Grade A to E specifying the condition of an asset, assessed at general inspection and principal inspection stages.

In considering asset failure potential, inspectors must consider the location, use and construction of the affected property, topography of adjacent land, natural/ constructed barriers to flow, geotechnical characteristics of embankment and of underlying and adjacent soils and ability of vegetation to mitigate scour effects.

For CoF, each asset is scored from Grade 1 to 5 as outlined below. Criteria are arranged in order of importance (e.g. potential loss of life or injury is of primary importance in assessing CoF).

Condition grade	Rating	Generic description
A	Very good	Sound construction. Cosmetic defects that will have no effect on stability.
B	Good	Minor defects but structurally sound.
C	Fair	Minor defects may develop into structurally significant defects in long-term (generally >10 years).
D	Poor	Structurally significant defects leading to loss of stability in medium term (generally 5 to 10 years).
E	Bad	Failed or in an incipient state of failure or about to collapse in the short term (generally <5 years).

Figure 2. Condition grading at inspection – Mandatory Standard: Asset Inspection Procedures (AIP – 2024).

CoF grade	Life	Flooding
5	Multiple deaths	Widespread flooding (>0.5 sq. km). Large urban area / commercial operations affected.
4	Multiple serious injuries / single death	Flooding of small community. Groups of >4 houses or >1 commercial operation affected. Flow across A class roads.
3	Serious injury (<3 No)	Disruption of a major transport link. Widespread flooding of agricultural land (>0.5 sq. km). Significant crop loss or inability to plant. Flow across B class roads.
2	Minor injuries	Limited flooding to gardens or agricultural land (<0.5 sq. km). Minor transport link disrupted. Minor roads may become icy.
1	Single minor injury	Seepage to gardens / agricultural land. Flows <0.5 l/s causing localised wet areas.

Figure 3. Consequence of failure grading – Mandatory Standard: Asset Inspection Procedures (AIP – 2024).

Asset Management Policy

Our Asset Management Policy integrates climate adaptation by emphasising:

- Continuous evaluation of climate impact and risk mitigation strategies.
- Sustainable asset and risk management of systems and waterways, accounting for financial, social, cultural and environmental factors.
- Mitigating our activities' effects on the natural and historic environment, aligned with our Natural Environment and Heritage Policies.

Strategic Asset Management Plan (SAMP)

Our SAMP aligns with the current international standard on asset management, ISO 55001, and supports strategic investment and operational decisions to enhance asset resilience in the face of climate change. We strive to adapt our network to withstand future climate impacts and mitigate adverse effects on asset performance where resources and finances allow.

Water Resources Strategy

Our Water Resources Strategy outlines our actions to ensure long-term water security. Drought planning is an integral part of this, detailing our approach to managing water resources during periods of reduced rainfall, from early warnings through to recovery phases. This strategy will be updated in 2025 and will build on previous water resource modelling that we have undertaken in the intervening period since our last Water Resources Strategy was published.

As part of our strategy and associated actions, we are continuing to assess the most up-to-date information available to identify pressures on our water resources, including climate change impacts.

Water efficiency & drought management

Our water management practices include:

- Water-saving initiatives across the canal network to improve water efficiency.
- Enhancements in reservoir management to adapt to changing precipitation patterns, ensuring a sustainable water supply for both navigation and local communities.
- Drought contingency planning, including water abstraction and flow regulation, to maintain navigability and ecosystem stability during dry periods.

We are advancing our hydrological modelling capabilities using Aquator software, replacing legacy water resource models. Progress is significant for the Birmingham Canal Navigations, Gloucester & Sharpness, Huddersfield Narrow, Kennet & Avon, Leeds & Liverpool and Oxford & Grand Union Canals. These models, now updated to include data up to 2019, allow us to assess a century of historical rainfall patterns, vital for understanding our water resources.

Flood Risk Management

We have an evidence-led Flood Risk Management approach. When there is too much water, we try to remove the excess as soon as possible, or close flood gates along river navigations where it is safe and appropriate to do so, to ensure the safety of the canal network. We have real-time monitoring across the network, which enables us to see and proactively respond to water level rises. Our approach also considers:

- Operations and emergency procedures.
- Post-event recovery processes.
- Resilience planning and strategic investment in flood mitigation.

Where risks are identified, we do what is possible with our resources to 'climate-proof' vulnerable assets, such as embankments, and help culverts to withstand extreme weather events where there is a high consequence of failure. While we dedicate resources to climate adaptation, more structured, long-term funding could enable disciplines within the Trust, such as asset management, to better address climate risks.

Reservoir Blue Asset Standard

Our Reservoir Blue Asset Standard defines our objectives for climate resilience in flood management with regard to reservoirs and their safety. All flood studies incorporate climate projections, considering intensified storms and increased flood flows. This reflects all statutory measures legally required for reservoir safety. Specific guidelines include:

- Designing and constructing new spillways to accommodate 10% increases in inflows associated with a Probable Maximum Flood.
- Allowing additional freeboard in spillways to accommodate higher water levels. This proactively addresses potential future impacts from both increased rainfall and prolonged drought conditions.

Supporting biodiversity & ecosystem functioning

Recognising the role of waterways in biodiversity and climate resilience, the Trust is committed to safeguarding and enhancing habitats.

Since 2021, we have been working with experts to develop and implement an innovative methodology to systematically catalogue habitat types and their conditions across our network. The mapped ecological footprint of our network is stored in our GIS-based Ecological Data Hub. The key reasons for undertaking this work were to provide a baseline against which the Trust could assess the impacts of climate change on biodiversity, along with supporting our emerging work on Natural Capital Accounting, our efforts to identify Biodiversity Net Gain (BNG) opportunities and developing our fundraising, communications and volunteering offers. The data will underpin ongoing monitoring and adaptive management practices.

Our Unlocking Biodiversity initiative, supported by Severn Trent Water, exemplifies the dedication to enhancing habitats across 335 kilometres of canal, particularly in the West Midlands. This project focuses on restoring habitats to support priority species like water voles and rare butterflies, which face threats from habitat fragmentation and climate change. Additionally, strategic habitat improvements, such as installing fish passes and planting native hedgerows, create blue-green corridors that facilitate safer movement and foraging for various species, effectively linking otherwise isolated habitats.

Invasive non-native species (INNS) present significant challenges to the health of native biodiversity along the Trust's canal network. We have regional programmes to tackle terrestrial and aquatic weeds conducted by volunteers, colleagues and contractors. With the growing impact of climate change and the resulting volume of invasive species, we run specific fundraising drives for this problem.

Capacity building

The Trust undertakes a breadth of activities to build knowledge and understanding of climate change across our charity.

Formalised partnerships for climate expertise: We collaborate with national and regional engineering and environmental organisations. We draw upon technical expertise from the likes of the UK Centre for Ecology & Hydrology (UKCEH), the British Dam Society, the British Hydrological Society and CIWEM, among others. We are committed to strengthening our existing partnerships with national and regional climate bodies and experts, ensuring our colleagues are well-informed about climate risks and are prepared for emerging challenges.

Embedding climate adaptation through cross-departmental action: We identify and address climate risks specific to each function in the Trust and manage this through our corporate risk processes. For example, our reservoir management and water resources teams focus on drought and flood impacts, while our heritage advisors work to conserve, adapt and enhance our assets susceptible to extreme weather. Our Environment & Climate Action Team delivers a central role in coordinating these efforts, ensuring a cohesive adaptation strategy across the charity.

Engaging actively with external stakeholders for broader resilience: We actively engage with partners and stakeholders such as the Environment Agency, Internal Drainage Boards, Network Rail and National Grid. These collaborations enable the Trust to access additional expertise and bolster resilience across the regions in which it operates. We work with external stakeholders to conduct specific climate assessments, develop guidance and contribute to research currently being undertaken on Probable Maximum Precipitation (PMP) and Probable Maximum Flood (PMF) estimation for reservoir safety.

Internal capacity

We have a wealth of experience and skills, and our people are engaged with professional memberships and networks, which encourages and enables continuous professional development (CPD) in the discipline of climate risk and adaptation.

Our ambition is to develop a stronger focus on climate adaptation through cross-departmental training and capacity-building, developing specific climate adaptation knowledge in technical teams through professional bodies, and have/include more regular stakeholder engagement. These measures will help the us develop the capability needed to address climate challenges across all areas of operation.

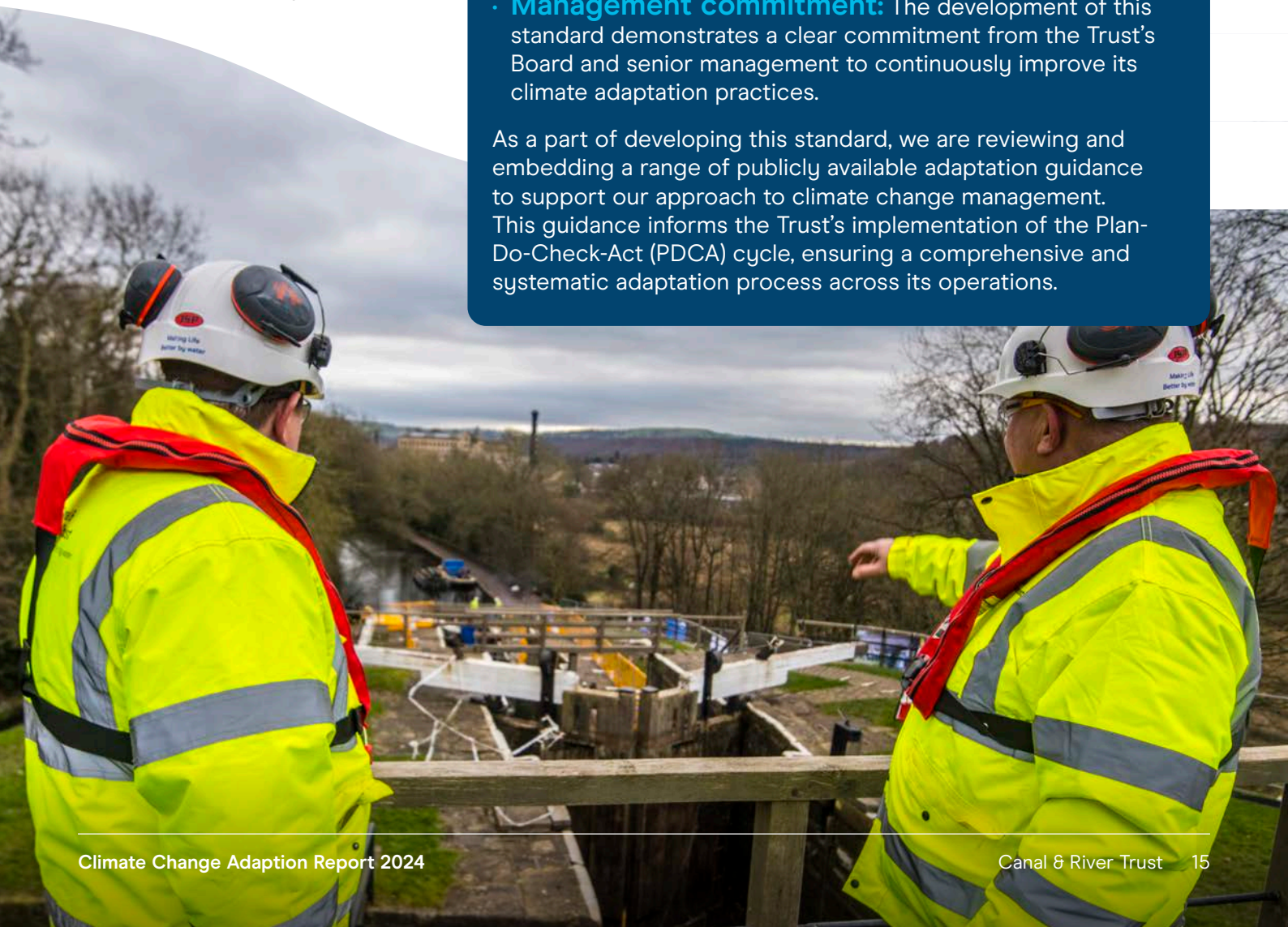
Commitment to adaptation standards, guidance & best practices

As part of our engagement with ARP4, we are concurrently developing an adaptation standard aligned with ISO 14090/14091 (Adaptation to Climate Change). This initiative reflects our commitment to embedding best practices into its management systems to enhance climate resilience across its operations.

The adoption of this internal standard will support several key areas:

- **Continued risk assessment:** This will provide a structured approach for identifying and assessing climate-related risks across our assets and services on an ongoing basis, enabling more informed decision-making and prioritisation of adaptation actions.
- **Adaptation planning and monitoring:** By aligning with these internationally recognised standards, we will improve its capacity to develop and implement robust adaptation plans. This includes setting clear adaptation objectives, pathways and metrics to ensure the effectiveness of climate resilience measures.
- **Management commitment:** The development of this standard demonstrates a clear commitment from the Trust's Board and senior management to continuously improve its climate adaptation practices.

As a part of developing this standard, we are reviewing and embedding a range of publicly available adaptation guidance to support our approach to climate change management. This guidance informs the Trust's implementation of the Plan-Do-Check-Act (PDCA) cycle, ensuring a comprehensive and systematic adaptation process across its operations.



Understanding risks & challenges

Part of the Middlewich Branch of the Shropshire Union Canal collapsed in March 2018, causing water to rapidly drain from the canal.

For the purposes of our risk assessment, we consider our main functions relating to our network of canals and towpaths, river navigations, reservoirs and docks to include:

- **Operating and managing our canal network:** Enabling navigation and supplying and transferring water for drinking water, agriculture, industrial processes and commercial purposes.
- **Protecting waterway infrastructure and associated functions:** Preventing and mitigating any adverse impacts arising from proposed third-party developments upon the structural integrity of the waterway, safety of our customers, users and neighbours, as well as water resourcing and management, land drainage and flood alleviation.
- **Protecting the character and quality of the waterway corridors:** Preserving and enhancing the unique canal heritage, amenity value, landscape character and biodiversity.
- **Promoting public enjoyment:** Providing public access to, from and along the waterways and enabling boating, water and land-based recreation and leisure activities.
- **Supporting sustainability:** Through water stewardship and security, building resilience to climate change, transition to net zero, biodiversity and nature recovery, as well as sustainable resource use.
- **Enhancing wellbeing:** Utilising waterways in helping to tackle physical inactivity, addressing health inequalities, promoting active lifestyles, supporting children and young people, encouraging time in nature and fostering social connections.
- **Ensuring financial stability:** Securing necessary resources required to deliver the ongoing and long-term management, repair and maintenance of the network.

We use a climate risk assessment approach to identify how climate change may directly disrupt operations (e.g., extreme weather) and indirectly impact key functions through interconnected systems such as infrastructure and supply chains.

Risk assessment scenarios, hazard identification & risk screening

We produced a Climate Change Risk Assessment (CCRA) as part of our formal Government Grant Review work in 2021. This CCRA was conducted in line with Defra's supplementary Green Book guidance – Accounting for the Effects of Climate Change (2020) and the Environment Agency's Climate Impacts Tool.

The CCRA involved the following key elements:

1. A climate impact profile was undertaken, identifying key climate events that have impacted the Trust within the last five years.
2. The Trust's policies, strategies and risk register were reviewed to ascertain how they address climate risk.
3. The key physical climate risks that will affect the Trust were identified using the Met Office's UKCP18 climate projections.

Climate risks to the Trust's staff, volunteers, operations, strategies and financial performance were identified and scored for a current (baseline) and two future (mid and end century) time periods. Two Representative Concentration Pathways (RCPs) were looked at to account for future uncertainty in greenhouse gas emissions. Risks were identified and scored based on a combination of quantitative (e.g., asset condition) and qualitative information (e.g., expert judgement).

The two RCPs used were:

- **RCP 2.6:** representing a 2°C temperature increase by 2100 – a lower-emissions future.
- **RCP 8.5:** representing a 4°C temperature increase by 2100 – a high-emissions future.

Table 1 presents the definitions used in the CCRA to score the risks for likelihood and impact by multiplying both figures. Table 2 is the risk matrix from Defra, provided as guidance for ARP4, which was used as a framework for scoring.

Table 1: Definitions of likelihood & impact scoring used in the CCRA. The risk score was a function of likelihood x impact.

Likelihood	Impact	Definition
Low (1)	Low (1)	Either the likelihood or impact is classed as low risk. This may be because of existing processes or procedures put in place by the Trust.
Low-medium (2)	Low-medium (2)	The risk is low-medium, meaning that while processes or procedures exist, they will need to be reviewed regularly to ensure the risk does not escalate.
Medium (3)	Medium (3)	Medium risk indicates that the risk poses some material threat to the Trust, but which can be managed to reduce to the lower levels of risk. These will require some level of management.
Medium-high (4)	Medium-high (4)	Medium-high risk indicates that there is some level of material impact on the Trust which requires urgent review and action by responsible officers.
High (5)	High (5)	High risk indicates that there is a significant potential for a material impact on the Trust's operations. These risks must be tackled immediately or a comprehensive response developed to bring the risk down over time. These will require proactive management.

Risk analysis & evaluation

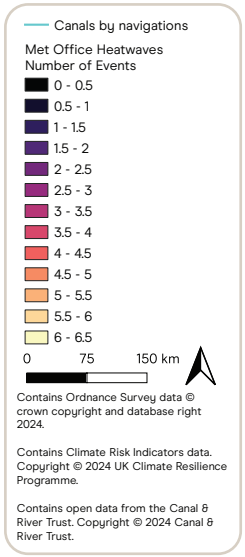
In 2021, a total of 33 risks were identified. Table 3, on page 20, details the top 12 highest risks, ranked in order of magnitude to inform and help prioritise subsequent adaptation action planning. To emphasise links to wider UK climate risks, they have also been categorised by the national risks identified in the Third UK Climate Change Risk Assessment (UKCCRA3). Based on the outcome, a series of actions to address climate risks and opportunities were developed to enable the Trust to increase its resilience, and adapt to climate change.

Table 2: Risk matrix showing level of risk (minor to severe) relating to scores (as per Defra guidance).

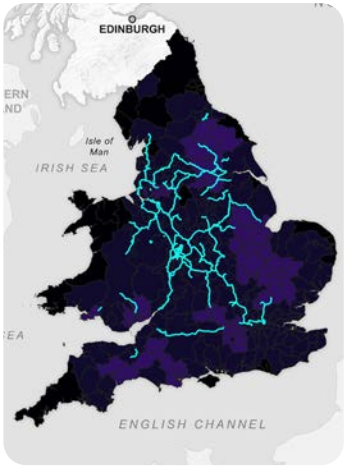
Impact					
	5 / Moderate	10 / Major	15 / Major	20 / Severe	25 / Severe
	4 / Moderate	8 / Moderate	12 / Major	16 / Major	20 / Severe
	3 / Minor	6 / Moderate	9 / Moderate	12 / Major	15 / Major
	2 / Minor	4 / Moderate	6 / Moderate	8 / Moderate	10 / Major
	1 / Minor)	2 / Minor	3 / Minor	4 / Moderate	5 / Moderate
			Likelihood		

As part of our future climate modelling, linked to RCP2.6 and RCP8.5, we have looked at how the predicted changes for various climate variables could affect our network, using the UKCP18 Global HadGEM Models from the Met Office. The series of maps overleaf on page 19 shows how changes in heatwaves and winter rainfall could affect our network over time. The median (50th percentile) and 2nd highest model number (95th percentile) values are shown to represent the midpoint of a range of scenarios (the median, the 50th percentile) and the upper end of a range of possible scenarios.

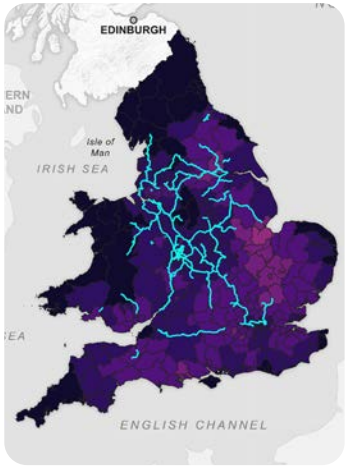
Heatwaves – number of events expected per year



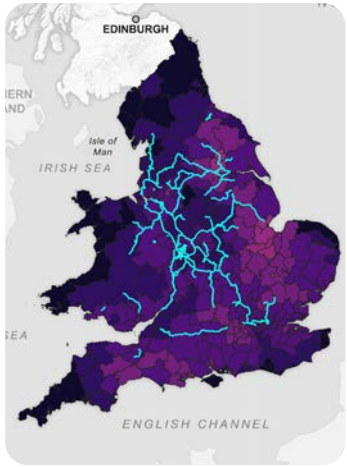
2°C warming in 2100
1991 – 2020 values
Median Model



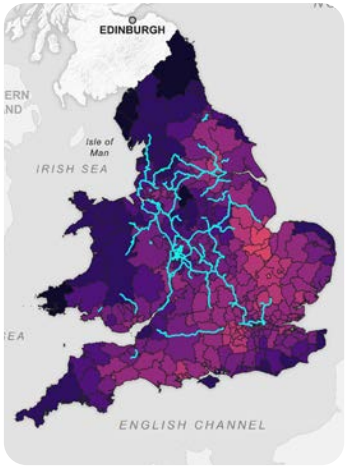
2°C warming in 2100
2031 – 2060 values
Median Model



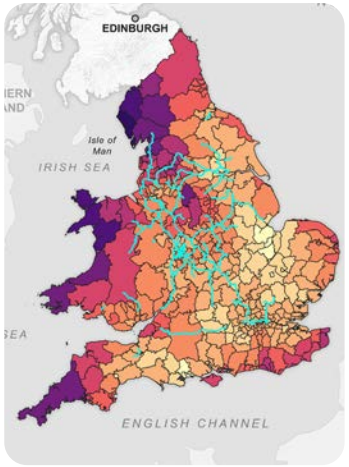
2°C warming in 2100
2071 – 2100 values
Median Model



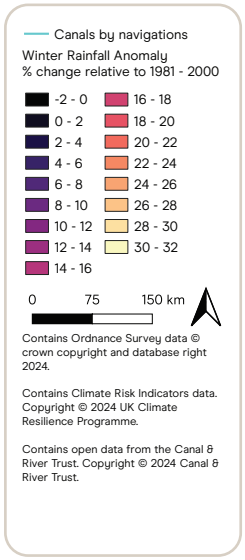
4°C warming in 2100
2031 – 2060 values
Second Highest Model



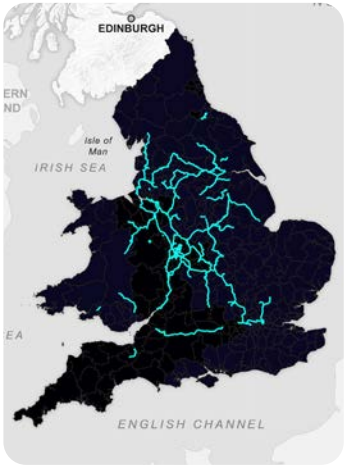
4°C warming in 2100
2071 – 2100 values
Second Highest Model



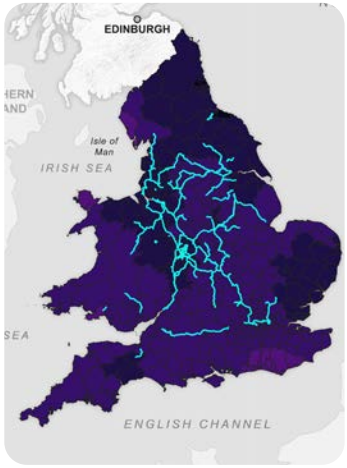
Winter rainfall anomaly



2°C warming in 2100
1990 – 2021 values
Median Model



2°C warming in 2100
2031 – 2060 values
Median Model



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2071 – 2100 values
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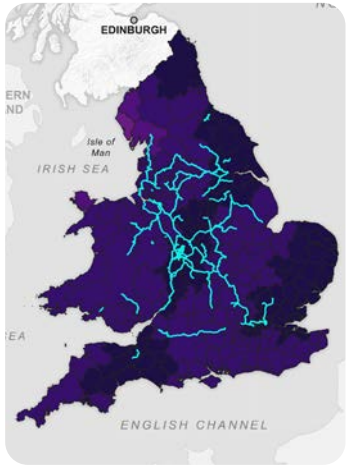
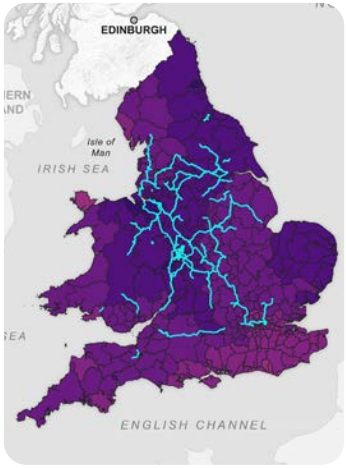


4°C warming in 2100
2031 – 2060 values
Second Highest Model



4°C warming in 2100
2071 – 2100 values
Second Highest Model

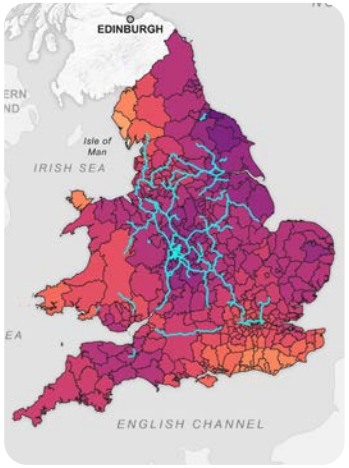


Table 3: Top 12 risks as identified in the CCRA (risk narratives have been updated since 2021 as part of the adaptation planning process).

Identified risk area	Description of impact	UKCCRA3[1] risk code	2°C scenario (RCP2.6) Overall score		4°C scenario (RCP8.5) Overall score	
			Mid-century	End of century	Mid-century	End of century
Increase risk of failure of earth structures due to extreme wet and dry periods.	Increases in periods of extreme wetness followed by dry spells (and vice versa), present a risk of increased failure of embankments. This may also be caused or exacerbated by changes in vegetation cover.	I1 I7	Severe	Severe	Severe	Severe
Flooding of, and potential structural damage to, culverts, tunnels and other underground structures due to increased frequency and intensity of river flows (and other run-off channels).	Increased frequency and intensity of river flows where culverts, tunnels and other underground structures are present, leading to inundation and overtopping risk.	I2	Major	Severe	Severe	Severe
Damage to infrastructure services from coastal flooding and erosion.	Rising sea levels leading to increased risk of erosion or inundation.	I3	Major	Severe	Severe	Severe
Drought / low seasonal rainfall effects on water control and maintenance.	More water control operational and maintenance work due to increased risk and incidence of drought. Drought orders or local water restrictions could impact on the ability of the Trust to deliver operational work.	I12	Major	Severe	Severe	Severe
Increased risk of water scarcity and drought affecting navigability.	Decreased flow rates and water availability could affect the navigability of the canal network, impacting upon boating and waterway-dependent businesses. Canals become unnavigable / inaccessible as they are reliant on water abstraction from sources that will be at risk (and surface water runoff will reduce).	I12	Major	Severe	Severe	Severe
Overtopping of canal banks affecting asset integrity (for towpaths, embankments, etc).	Increased run off due to surface water or other hydrological events leading to damage to assets or an increase in third-party claims.	I2	Major	Severe	Major	Severe
General damage to assets from flooding-related degradation (scour and erosion).	Increased scour of structures, such as bridges, due to increased flows arising from more intense rainfall may cause short-term catastrophic failure or the increased speed of degradation of an asset over the longer term.	I2	Major	Severe	Severe	Severe
Reservoir failure due to intensive, prolonged rainfall.	Intensive rainfall leading to failure exacerbated by factors, such as design, maintenance and age.	I2	Major	Severe	Severe	Severe
River, surface water and groundwater flooding as a risk to assets.	Assets become damaged from flood events and/or the rate of damage increases over time. Surface water flooding presents a risk in more urbanised settings due to its more unpredictable nature.	I2	Major	Major	Major	Severe
Increased dredging requirement due to low flow conditions.	Low flow conditions can reduce the natural transport of sediment through the system, potentially threatening safety of navigation and requiring dredging.	I2	Major	Major	Major	Severe
Risks to health and wellbeing of staff, volunteers and contractors on hot days – and risks to the public using our network.	Staff, volunteers and contractors working externally in temperatures above 28°C for prolonged periods over consecutive days are more at risk from a range of health impacts. All may face reductions in productivity due to overheating.	H1	Major	Major	Major	Major
Warming of canal water resulting in more algal blooms and other invasive plant species.	Increased risk of algal blooms and growth of invasive species.	N11	Moderate	Major	Major	Major

[1] UKCCRA3 is the UK Government's third climate change risk assessment, published in 2022. This risk assessment introduced standard codes for climate risks.

Interdependencies

The canal network was developed at the time of the Industrial Revolution and, as a result, pre-dates much of the modern infrastructure found in our towns and cities. Interdependencies with other infrastructure is an important consideration in our ability to deliver key functions, especially in a changing climate.

How other infrastructure impacts canals

Canals are subject to impacts from other landowners and infrastructure providers, such as:

- **Third-party asset failure:** This can include embankment failures or damage to key assets, such as locks or aqueducts.
- **River and surface water flooding:** Increased runoff and flows into canal network from other watercourses can cause overtopping and damage to canal assets. High flows from other sources can also cause scour and culvert damage.
- **Energy outages:** Power cuts related to extreme weather events can impact our ability to pump water across our canal network and affect key control systems.
- **Trees from adjacent land:** Trees can be blown across canals, blocking navigation and use of the towpath, as well as potentially damaging Trust assets.
- **Water availability:** In periods of extreme drought, there can be conflicting resource demands from other users that affect the amount of water available to fill our canal network with subsequent impacts on biodiversity.

Whilst the Trust owns the canal network, it has limited land holdings adjacent, with approximately 96% of the land adjacent to our canal network being in the ownership and control of third parties. Our emphasis lies in influencing them to plan, design, construct and operate property adjacent to our canal network in order to mitigate adverse impacts upon its structural integrity and public safety.

How canals support other infrastructure

The canal network is a key provider and host of important national infrastructure, including electricity and telecommunications cables, water and sewage pipes and gas mains. Our assets also provide protection to properties and other critical national infrastructure. We have undertaken an extensive assessment to catalogue all these assets across our network to understand the risks associated with our role as host and protector.

HOSTING

Public Road bridges		Towpaths
1,136 electricity cables		**1,576km** electricity cables
422 water mains and **106** sewers		
374 gas mains		**1,302km** gas mains
1,806 telecom cables		**659km** telecom cables

PROTECTING

Embankment		Reservoir
840 sub stations protected		**387** sub stations protected
128 schools protected		**34** schools protected
Railways protected at **570** locations		Railways protected at **55** locations
Motorways protected at **114** locations		Motorways protected at **18** locations
370,294 people protected		**193,663** people protected
31,881 businesses protected		
122,428 properties protected		**80,693** properties protected

How we manage interdependent risks

The structural integrity of the Trust's network can be adversely affected by the actions of third parties on land adjacent to the Trust's network, as demonstrated in the case study presented on page 6. These fortunately rare incidents pose risks to the safety of surrounding communities, businesses and infrastructure providers. Our role as a statutory consultee is key to our efforts in ensuring that the risks posed by third-party developments to the structural integrity and public safety of our assets, as well as our ability to inspect and maintain them, are assessed and mitigated through the planning process. Our third-party works team is dedicated to working with developers to ensure that our infrastructure is protected.

Where new connections for surface water drainage are identified, we work with the applicants to ensure that there is sufficient capacity in the canal for the connection and that the flows are managed through sustainable urban drainage systems. Likewise, where infrastructure providers are working on our network, they must meet our Code of Practice for works to ensure that work is carried out to a required standard on the network, mitigating future risk.

Many of our interdependent risks are spread out across the network and are location and context specific. These are managed at a regional or individual asset level, depending on the nature of the risk and criticality of the asset.

As part of our continued progress in ARP reporting, we will seek to engage further with other infrastructure operators at a strategic level to share best practice and identify opportunities to effectively manage our interdependent risks.

Climate adaptation action plan

Prioritising risks and identifying adaptation actions

Our priorities for adaptation are in response to the highest scoring risks as determined by the CCRA detailed earlier. The risks and associated actions are detailed in table 4 on the following pages. Adaptation actions are split into:

1. **'What we're doing now'**, which are ongoing actions and,
2. **'what will be needed, subject to funding'**, which are future actions required to address the risks.

'What will be needed, subject to funding' actions were identified through an internal workshop with senior Trust colleagues, discipline leads and functional heads. To aid understanding, risks have been grouped in line with the IPCC climatic-impact drivers for sectors.

Maintaining functional delivery in response to climate impacts

To maintain the Trust's operational capacity under changing climate conditions, our action plan focuses on safeguarding functional delivery. These measures address potential disruptions to the operation and management of waterways, recreational access, and ensuring the long-term viability of our canal network.

Approach to monitoring & evaluation

Adaptation actions are delegated to relevant disciplines and individuals. Monitoring and evaluation of adaptation actions will be provided by the Trust's Environment & Climate Action Team, who will be responsible for reporting progress as part of our existing governance arrangements.

Table 4

IPCC climate impact-driver category	Risk	What we're doing now	What will be needed, subject to funding
Heat and cold	Risks to health and wellbeing of colleagues, volunteers and contractors on hot days – and risks to the public using our network.	Where temperatures regularly exceed 25°C, alter working patterns of colleagues and volunteers to mitigate health impacts. Issue warnings to customers where possible.	Increase campaigns around heat stress management.
	Warming of canal water, resulting in more algal blooms and other invasive plant species.	Continue algal bloom monitoring under asset inspection procedures. Continue to identify partnerships for managing the growth of invasive aquatic weeds.	Increased frequency of communication and campaigns activity around algal blooms and invasive aquatic weeds.
Wet and dry	Increased risk of failure of earth structures due to extreme wet and dry periods.	Continue our critical asset investment programme to address those earth structures presenting the greatest risk. Continue with earth structure risk assessment processes to improve our understanding of risk and options for mitigation.	Undertake research to understand critical climate thresholds and modes of failure for earth structures.
	Flooding of, and potential structural damage to, culverts, tunnels and other underground structures, due to increased frequency and intensity of river flows (and other run-off channels) through our culverts.	Continue to maintain, improve and upgrade culverts, tunnels and other underground structures in line with our asset strategies.	Incorporate a range of climate change scenarios based on higher flow rates into modelling.
	Drought / low seasonal rainfall effects on water control and maintenance.	Continue to follow drought plans, appoint water resource commanders and drought coordinators during periods of sustained dry weather and, participate in joint stakeholder discussions and collaborative working with partners during times of drought. Monitor water levels and apply early warning forecasts to inform water management decisions.	Review approach to applying oversight and control of the network during drought and other extreme weather events. Consider future climate scenarios and role of canal network in water supply, and adopt reactive response plans where appropriate. Update Water Resources Strategy, reviewing opportunities for optimising storage capacity in reservoirs and other measures to address resilience of supply.

Table continues on next page.

IPCC climate impact-driver category	Risk	What we're doing now	What will be needed, subject to funding
Wet and dry	Overtopping of canal banks affecting asset integrity (for towpaths, embankments, etc).	Reviewing if any lower freeboard sections should have banks raised as a priority.	Reappraise design standards, where possible, to take account of an uplift factor for climate change.
	General damage to assets from flooding related degradation (scour and erosion).	Continue with asset health / degradation and criticality modelling. Target investment to address resilience from flooding where possible.	Reappraise design standards, where possible, to take account of an improvement factor for climate change.
	Reservoir failure due to intensive, prolonged rainfall.	Continuing our RARS programme and prioritise the investment required to address all 'unacceptable' reservoirs.	Increase asset resilience such as slope stability improvements to accommodate less stable surfaces caused by intense rainfall.
	River, surface water and groundwater flooding as a risk to assets.	Continue to use the Trust's role as a statutory consultee for planning applications to identify any proposed third-party changes which might create additional risk of flooding and influence designs as required. Be an active advocate for sustainable drainage systems.	Incorporate a range of climate change scenarios based on higher flow rates into modelling.
	Increased dredging requirement due to low flow conditions and increased deposits of silt and debris following storms.	Monitor water levels and apply early warning forecasts to inform water management decisions and future dredging programme to target key pinch points.	Assess the resource implications of reduced river flows and increased sedimentation on the need for dredging to facilitate navigation.
Coastal and oceanic	Damage to infrastructure services from coastal flooding and erosion.	Where any Trust assets are affected by coastal or tidal flooding, identify any interventions that should be incorporated in the critical asset investment programme.	Incorporate increased resilience measures into asset investment and planning as required. Strengthen coordination with flood management bodies where possible to understand and manage the risks.

Challenges & opportunities for adaptation

We face a number of challenges in adapting to the impacts and effects of climate change ranging from funding, resources, skills, knowledge and information to guidance, regulatory frameworks and external expertise. We have identified key challenges and opportunities to adaptation here.

Funding asset resilience

Consistent with other nationally important infrastructure operators, climate change risks need to be addressed by a greater access to funding. We are a charity and rely on funding from our government grant, our commercial and investment income, boat licencing, partnership funding and public fundraising to maintain and operate the network. Unlike other infrastructure operators, we have a very limited ability to pass on climate-related costs to our users and beneficiaries.

As part of our work for the Forward Look Commission in 2021, we began to explore how much it might cost to adapt the canal network for a future climate. Our work, based on the CCRA and other data sources, suggested we may require additional expenditure of up to £15 million per year through to the year 2100, simply to 'future proof' our critical assets under the 2°C and 4°C warming scenarios. Our estimates were reviewed and broadly accepted by Defra's appointed technical assessors, who recommended that further work is needed in this area.

As our knowledge and data has progressed, and with the experience of more extreme weather events, plus higher costs after two to three years of construction inflation, it is likely that these estimates will have grown significantly. We anticipate that the scale of the increase to fully adapt our network will align with estimates from the Environment Agency and other infrastructure owners and providers.

The Environment Agency's 2021 report on the Impact of Climate Change on Asset Deterioration analysis indicates that maintenance budgets may need an increase of 30% to 80% compared to that presently budgeted. The report looked at a range of waterways assets, such as bridges, embankments and flood gates. Embankments were highlighted as an asset with a high risk of deterioration due to climate change.

Funding short-term operational impacts

As with any asset, the older they become the more maintenance and repairs are required. The ageing of our canal network within an exposed engineering landscape, inflation, and a decrease in government grant, compound the issues that the Trust faces in managing the canal network for a future climate with extreme weather events.

Whilst we carefully plan for the long term to ensure the best use of our funds, an unknown factor – which is rising year on year – is the impact of extreme weather events on our programmes and finances available for planned repairs, and the expertise to deal with these increasingly unexpected, hard-to-predict and often costly events.

We are also seeing acceleration of vegetation growth with both terrestrial and aquatic weeds, requiring increased maintenance and placing more pressure on our resources. Floating weed is carpeting much larger sections of our network than ever and is present for longer periods.

With increasing pressure on the Trust's infrastructure, the total cost of the Trust's work to care for the canal network in 2022/23 rose by over £13.9 million compared with the previous year, and in 2023/24, it rose by a further £17.8 million. This includes emergency response, large-scale repairs and other infrastructure works, day-to-day operations and maintenance and work to mitigate the effects of climate change.

Managing risk as a statutory consultee

As climate change brings more extreme weather, resulting in new and increased risks to our assets, there is a potential for increased liabilities. The Trust's statutory role in the planning system will become even more important in protecting our infrastructure and assets, as well as lives, homes, businesses and much else located in the vicinity of our network.

Guidance & collaboration

Whilst we participate in a range of national and regional technical forums, we recognise there is a need for universally accepted guidance, allowing greater certainty for asset owners around the significant long-term investments in assets. We recommend that where there are existing initiatives and research underway that these continue to receive investment and are accelerated so that they can be made widely available.

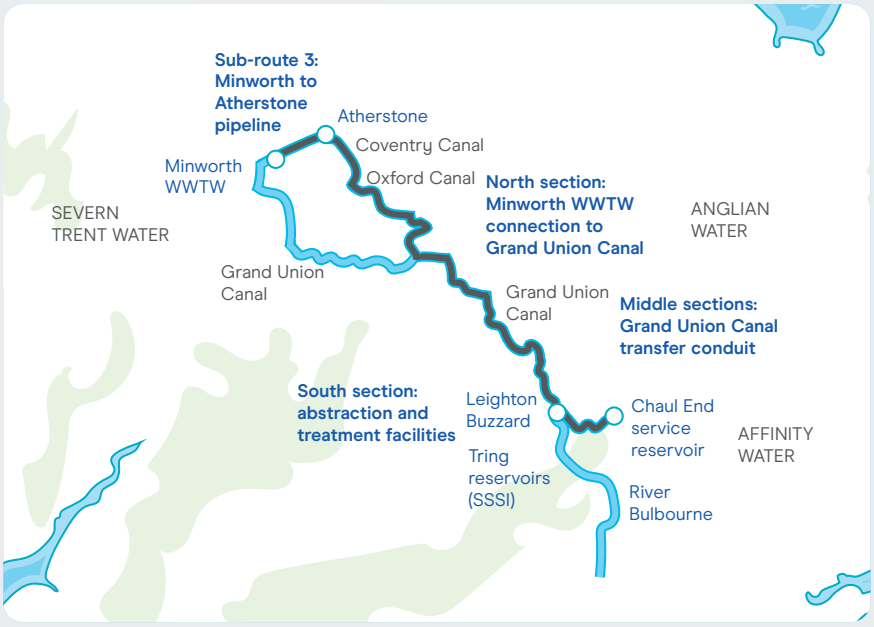
We recognise the value and importance of the ARP reporting process and welcome the opportunity to work in partnership with other similar bodies to resolve this need. The collaboration needs to be wide and include regulatory bodies to ensure that the legal framework and permitting systems keep up with the demands that climate change brings.

Mobilising private investment for adaptation

The UK Climate Change Committee (CCC) has increasingly emphasised the importance of mobilising private investment to fill funding gaps in public infrastructure resilience. While initiatives like the Green Finance Institute's nature-based solutions highlight the potential for private sector involvement, adaptation projects often struggle to attract private capital due to lower immediate returns. For the Trust, pursuing partnerships that leverage private finance, alongside government grants, could provide a pathway to addressing long-term funding needs. However, a clearer framework for incentivising such investments is needed, especially for resilience works where there will be little chance of increased revenue from the intervention.

Grand Union Canal Transfer Project

The Grand Union Canal Transfer Project (GUCT) will be a water transfer project delivered by the Trust and two water companies, Severn Trent and Affinity Water, leveraging historic infrastructure to transfer water across 130 kilometres to supply thousands of homes in South East England. Scheduled for completion by 2032, the project will reduce dependence on vulnerable chalk aquifers and reinforce climate resilience for regional water security; it will help to secure the future of the canals forming the transfer route.



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Canal & River Trust

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Get in touch to discuss opportunities for support and help us to keep our canals open and alive for tomorrow and beyond.

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