Drainage and Wastewater Management Plans (DWMPs)

Technical Summary: Assessing the Impacts of Climate Change

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Version 2

from Southern Water

1. Background

1.1. Purpose

This document is one of several technical summaries that provide more detail around the approaches taken in developing and producing the DWMP. The technical summaries may include technical appendices to provide supporting detail on the assessments and outputs.

In this technical summary, we describe the methods we have adopted in our DWMP to assess the impacts of climate change, especially on flooding as well as storm overflow performance, from our wastewater systems.

This technical summary sets out the gaps in our data and knowledge relating to the impact of climate change on our wastewater treatment processes and the performance and resilience of our assets. It helps us to identify areas for further research and studies to improve our understanding of the future issues.

1.2. Climate Change in context for drainage and wastewater management

The climate is expected to continue to change with annual average temperatures projected to increase, particularly in summer. Winters are projected to be wetter and summers drier although where summer rainfall does occur it is predicted that the intensity of some events will increase. Climate change is projected to result in more extreme weather events, potentially causing or exacerbating periods of drought which, alongside population and economic growth, will impact water availability. Reducing the impact of climate change depends on the success of emission reductions. Carbon and other greenhouse gas (GHG) emissions will continue to be emitted. However, regulations and legislation will likely continue to promote the reduction in emissions through commitments to net zero. The water industry in the UK is aiming to become net zero by 2030.

Most of our wastewater systems have been in service for long time and are designed based on standards which did not account for climate change. The performance of our wastewater systems is likely to be impacted by climate change as they will be exposed to changing conditions and will likely need to operate beyond the historic functional design requirements of the system.

The main impacts of climate change in drainage and wastewater systems are:

1. Increase in rainfall

(a) rainfall runoff above the capacity of the existing system leading to an increase in the risk of flooding and frequency of storm overflow operation.

(b) an increase in the volume of flow arriving at wastewater treatment works means the detention time at the process units could be reduced leading to a lower quality of discharged effluent.

(c) an increase in the rate of flow means the size of debris transported can increase. This can cause quick blinding of screens and premature overflow at CSOs (Combined Sewer Overflows).
(d) the velocity of flow will increase, increasing risk of abrasion and erosion in wastewater systems.

2. Drought/ reduction in rainfall and an increase in temperature

(a) a reduction in flow or long drought periods means the risk of sewer blockage is likely to increase.
(b) a potential increase in septicity and build-up of sulphide which causes odour and corrosion issues.
(c) Wastewater treatment works may struggle to treat septic or highly concentrated influent.
(d) Receiving watercourses may reduce in flow and provide less dilution to treated effluent or spills from overflows leading to higher environmental impact than currently witnessed.

3. Increase in sea-level

Sea level in the UK is projected to raise by 30-34cm by 2050. We have a number of sites along the coast and near major rivers which can be impacted by rising sea levels and an increase in the risk of fluvial (river) flooding. Our resilience assessment identified assets and catchments that may be impacted by coastal and fluvial flooding.

Current observations indicate that the UK is continuing to warm. 2020 was the third warmest year on record for the UK in a series from 1884, and the eighth warmest year for the UK near-coastal sea-surface temperature (SST) in a series from 1875. The most recent decade (2011–2020) has been on average 0.5^{o}C warmer than the 1981–2010 average and 1.1^{o}C warmer than 1961–1990. Annual precipitation has increased across the UK in the last few decades. The most recent decade (2011–2020) has been on average 4% wetter than 1981–2010 and 9% wetter than1961–1990 for the UK overall.

The Met Office UK Climate Projections (UKCP) were updated for the first time since 2009 in December 2018 (UKCP18). The UKCP18 are largely the same as the previous projections where all areas of the UK are projected to be warmer, particularly during the summer months. Rainfall is projected to vary seasonally and at a regional scale, however, the UK is projected to have wetter winters and drier summers. The projected changes in temperature and precipitation for the South East of England by the 2050s (2040-2069), under the RCP8.5 scenario (high emissions scenario) are detailed in Table 1. The 1981-2010 baseline period and the central estimate, representing 'as likely as not' probability of change (50th percentile), was used for the following projections.

Table 1: Future climate projections by the 2050s under the RCP8.5 scenario

Climatic factor	Climate projections
Temperature	Annual mean temperatures are projected to increase by 2.0°C. Summer temperatures are projected to see the largest increase by 2.6°C and winter temperatures by 1.7°C. Mean maximum summer temperatures are projected to increase by 2.9°C.

Precipitation	Annual mean precipitation is projected to decrease by 1.1%. Seasonal variability is projected with a 22.9% decrease in precipitation during summer months and an increase of 11.5% during winter months.

2. Assessing the impacts of climate change

This section describes the methods and procedures we adopted in the DWMP to assess the impacts of climate change on drainage and wastewater management.

2.1. Water UK Guidance

Our approach to assessing the future impacts of climate change in our DWMP follows the guidance set out by Water UK in its Capacity Assessment Framework (CAF).

The Water UK guidance is still based on UKCP09. The principles in the existing Water UK guidance remain largely valid even though UKCP18 is now available. We will continue to adopt and follow the Water UK guidance once it has been updated based on UKCP18.

The published Water UK guidance requires water companies to consider climate change in their modelling of rainfall and wastewater systems by:

> "*applying an uplift of 20% to all design storms (i.e. a 1.2 multiplier should be applied across the full rainfall hyetograph) for assessing the 25-year time horizon. No distinction is made between return periods or between summer and winter design storms. This is based on the High Emissions P50 projection for 2100, scaled down to 2050. Furthermore, no climate change uplift should be applied to design storms for assessing the 5-year time horizon.*
>
> *Sensitivity testing should be carried out by applying +30% and -30% to the 20% climate change uplift for future design storms. This equates to a lower estimate of 14% uplift and an upper estimate of 26% uplift."*

(Definition: A design storm is a hypothetical rainstorm characterised by duration, distribution and intensity, and a hyetograph is a graphical representation of the rainfall distribution over time. A real storm may not behave in this same fashion.)

For sewer catchments where we have a hydraulic model of the system, we have applied an uplift of 20% to design storms that account for the impact of climate change when assessing the long term (2050) planning horizon. As stated in the guidance, we have not made any distinction between summer and winter storms in the application of the climate change uplift.

2.2. Flooding

Flooding is expected to be one the most visible impacts of climate change. It is likely to affect more homes, businesses and infrastructure such as roads and railways.

We have several planning objectives in our DWMP that investigate the risks associated with rainfall and flooding. These are:

(a) PO1: Risk of Internal Flooding to homes and businesses
(b) PO4: Risk of flooding due a 1 in 50 year storm event
(c) PO7: Flood risk due to hydraulic overload (from storm events 1 in 1 year up to 1 in 30 year).

We have described our approach to these risks assessments in the Baseline Risk and Vulnerability Assessment (BRAVA) methodologies.

We applied the standard uplift factor to increase the rainfall by 20% for 2050 when compared to current expected levels of rainfall. This provides us with the expected increase in rainfall volumes by 2050 due to climate change. The rainfall pattern in terms of duration and intensity will be more variable which means the 20% uplift may be seen over a shorter duration in the summer or over a longer duration in winter months. We need to be prepared for the greater variability of weather.

The planning objective for flooding due to hydraulic overload is related to storms for a 1 in 1 year up to a 1 in 30 year event. For 103 of our wastewater systems, we predicted the volume of flood water at each node or manhole and then estimated the number of properties at risk of flooding.

The approach we adopted to estimate number of properties at risk of flooding for a given storm event is based on Ofwat's guidelines - risk of sewer flooding in storm. The estimated number of properties for each return period is used to calculate the annualised number of properties at risk of flooding as described in our BRAVA methodology for flood risk due to hydraulic overload. The annualised number of properties at risk of flooding is calculated by multiplying the number of properties predicted to flood during a given storm event by probability of occurrence of the event and adding numbers for each storm event up to 1 in 30 year.

For 2020 we predicted the annual number of properties at risk of flooding to be around 29,000 out of the 1,933,533 properties modelled. In 2050, the annualised number of properties at risk of flooding is predicted to increase to about 47,000, or nearly double.

We have published maps on our website comparing the 2020 and 2050 predicted flood volumes for a 1 in 20 year storm event for modelled wastewater systems in each of the 11 river basins within our region.

In our BRAVA, we identified the wastewater systems that are at moderate or high risk of flooding now and in the future under expected future climate regimes. This did not include the sensitivity testing of the climate change predictions.

Table 2 provides a summary of flood risk in a 1 in 50 year storm event for each of the 11 river basins in our region. As shown in the table, the number of properties at risk of flooding during a 1 in 50 year storm in our whole region is predicted to increase from 165,000 in 2020 to 212,000 in 2050 which is an increase of 28%.

When assessing future flood risk, we accounted for growth and urban creep alongside the predicted impact of climate change. We have described how we accounted for growth and urban creep in our BRAVA methodology - Flooding due to 1 in 50-year storm event.

Our assessment looked at the combined impacts of the three, but we did not undertake an assessment of the individual impacts. Although growth and urban creep contribute to the increase in risk of flooding, the main contributor is likely to be climate change.

Table 2: Number of properties at risk of flooding

Level 2 Strategic Planning Area	Total No. Properties (Baseline 2020)	Baseline (2020): Total No. of properties at risk of flooding	Future 2050: Total No. of properties at risk of flooding	Baseline (2020): Flooded Properties per 10,000 connections	Baseline (2020): % properties at risk of flooding	Future (2050): Flooded Properties per 10,000 connections	Future 2050 % properties at risk of flooding
Adur & Ouse	311,995	24,379	34,281	781	8%	1099	11%
Arun & Western Streams	184,035	12,318	18,423	669	7%	1001	10%
Cuckmere & Pevensey Levels	146,193	12,225	17,990	836	8%	1231	12%
East Hampshire	273,983	28,092	28,104	1025	10%	1026	10%
Isle of Wight	70,367	8,620	8,620	1225	12%	1225	12%
Medway	390,019	25,029	34,888	642	6%	895	9%
New Forest	64,841	727	1,118	112	1%	172	2%
North Kent	56,570	4,836	6,712	855	9%	1186	12%
Rother	48,378	7,985	8,875	1651	17%	1835	18%
Stour	254,713	22,188	27,272	871	9%	1071	11%
Test & Itchen	239,187	19,092	25,395	798	8%	1062	11%
Regional	**2,040,281**	**165,491**	**211,678**	**811**	**8%**	**1037**	**10%**

2.3. Storm Overflows

We used Time Series Rainfall (TSR) data to predict discharges from storm overflows to assess the impact of climate change on storm overflow performance for modelled catchments. For catchments without models we applied an uplift factor as described in our BRAVA methodology for storm overflows.

TSR is a series of hourly rainfall data covering a hydrological year. It is used to predict storm overflow frequency. Existing TSR was used to predict overflow discharges in 2020. For 2050, the TSR was generated using the UKWIR (UK Water Industry Research) Rainfall Event Duration Uplift ('Redup') tool, which generates future time series rainfall from an existing TSR for a given location.

The 2050 TSR incorporates the impact of climate change by re-profiling rainfall to account for changes in rainfall patterns and intensities. The Redup tool uses a pattern scaling approach based on global mean temperature in the 21st Century. It assumes that the local response of a climate variable is linearly related to the global mean temperature change, with the geographical pattern of change independent of the forcing. Details of the approach we adopted in assessing the predicted frequency of storm overflows are presented in the BRAVA methodology on storm overflows.

The UKWIR Redup tool currently generates rainfall based on UKCP09 projection. The Redup tool is yet to incorporate the UKCP18. UKCP18 uses new emissions scenarios, called Representative Concentration Pathways (RCP). However, there is a great deal of overlap between UKCP09 and UKCP18 projection such that the latest projection is unlikely to significantly change the outcome of our BRAVA assessment.

The modelling prediction for some of our storm overflows differs from the data obtained from our on-site Event and Duration Monitors (EDMs). There are several reasons for this including the uncertainties within the modelling, changes in the condition and performance of the sewer pipes and network, especially where blockages occur from fats, oils, grease, wet wipes and/or ingress of tree roots. Our pollution incident reporting team investigate discharges and validate the EDM data. We can use the data to confirm and validate our modelling of discharges at these storm overflows.

Our Baseline Risk and Vulnerability Assessment (BRAVA) has forecast the impacts of climate change on storm overflows. The 2020 risk assessment indicated that there is a very significant risk in 88 wastewater systems regarding the performance of storm overflows. Specifically, 123 storm overflows have been identified as the cause of the significant risk. A significant risk is where the data from 2017 – 2019 indicates that a storm overflow discharged to freshwater more than 40 times per annum, or 10 times per annum for those discharging to either bathing waters (during the bathing water season) or to shellfish waters. Our BRAVA indicates that the number of storm overflows at very significant risk will increase to 145 by 2050 if no further action is taken.

Table 2: Number of Combined Storm Overflows in each BRAVA risk band

	Freshwater/Others		Bathing Water		Shellfish Water	
BRAVA Risk Band	No. CSO (2020)	No. CSO (2050)	No. CSO (2020)	No. CSO (2050)	No. CSO (2020)	No. CSO (2050)
N/A	459	459	800	784	831	820
0	370	366	147	136	97	106
1	80	82	23	32	7	7
2	70	72	9	27	44	46

(Note: we have 979 storm overflows in total)

2.3 Wastewater Treatment Quality

For this first cycle of the DWMP, our BRAVA assessment for the Planning Objective for Wastewater Treatment: Water Quality Compliance Risk, focused on historical compliance, the potential impact of growth and the risks associated with our assets. We did not assess the impact of climate change on the performance of our wastewater treatment works as further work is required to establish this. Climate change can affect the quality of influent arriving at the works as well as the performance of the treatment process.

During wet periods, the volume of flow arriving at the works will increase in much higher proportion to the total suspended solid (TSS). As such, the influent will be more diluted. The increase in the volume of influent can also lead to reduction in the detention time at the works causing lower quality effluent. In addition, high volume of flows can increase the volume and size of debris arriving at the inlet works leading to increase in the risk of screen blockage and premature overflow of untreated influent to the environment.

On the other hand, a reduction of flow during drought periods can increase the concentration of contaminants and create high-strength influent which is challenging to treat.

Most of our wastewater treatment works involve biological treatment which relies on bacteria and micro-organisms. Extreme weather events are likely to impact the performance of these organisms but the magnitude of this is not known. Generally, micro-organisms are more active and perform better in warmer weather. During colder weather, they slow down. Currently, most sites comparatively have much tighter permits during summer than winter.

In addition to the impact on the performance of micro-organisms, extreme weather events are also likely to affect the dilution factor of the receiving water bodies. Any changes in the dilution factor of receiving water bodies may result in a requirement for more stringent discharge permits.

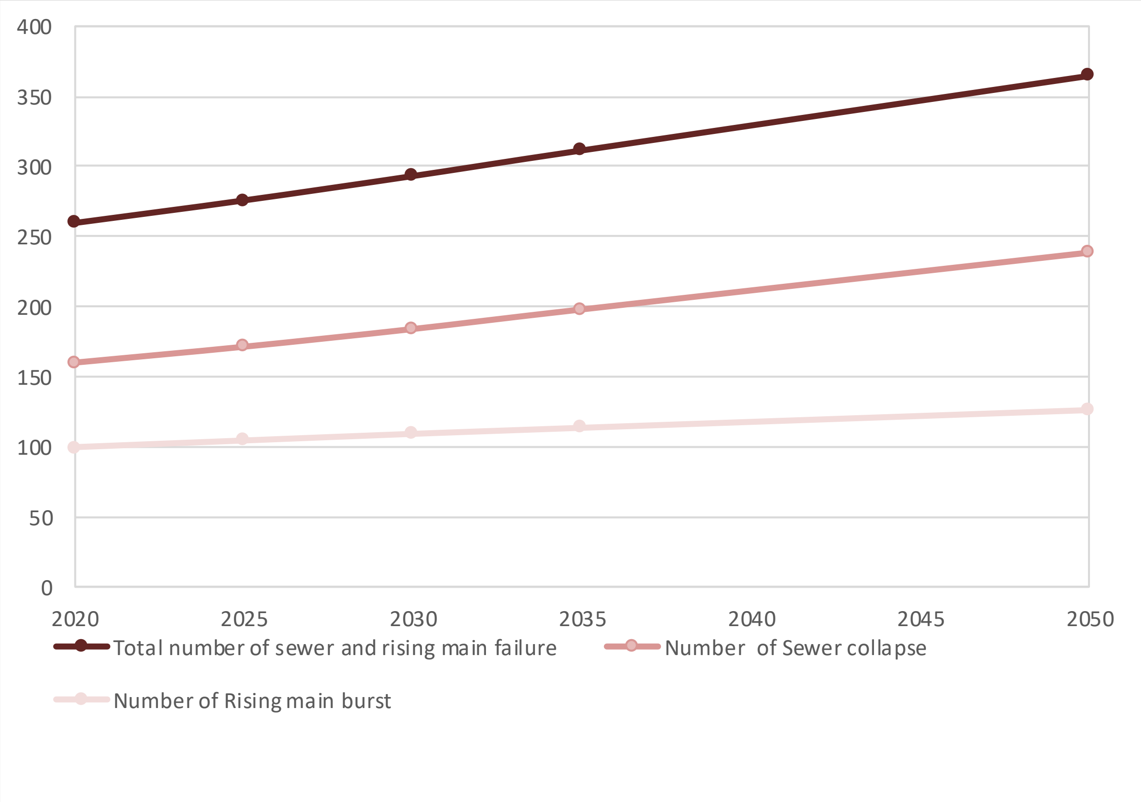
Further investigations and studies are required to assess these risks before we can make the necessary provisions for the future.

2.4 Wastewater Assets

The investment planning modelling suite, Pioneer, has been used to model and predict the deterioration of our assets taking asset age and use into account. Subsequent risk of flooding and pollution associated with the predicted breakdown or failure of an asset has also been quantified.

The deterioration model predicts the risk of sewer collapse or rising main burst based on the type of material the asset is made of and the age of the asset. Figure 1, below, shows the average incidents over the last three years for the baseline year (2020) and predicts the number of incidents there onwards.

Figure 1: Pioneer predication of sewer collapse and rising main bursts within SWS network



We also use Pioneer to predict the likelihood of blockages and the subsequent flooding and pollution risks that the blockages may cause.

Currently, the deterioration models within the Pioneer system do not take climate change into account. This is because the impact of climate change on asset condition is difficult to accurately predict. However, as described in the sections above, the increase in rainfall due to climate change will lead to increased flooding and storm overflow releases.

On the other hand, extreme drought conditions and increases in temperature will increase the risk of corrosion and blockages in sewer pipes. When the flow in the sewer is reduced for long periods and fails to achieve self-cleansing velocity, it could lead to the build-up of fats, oils and greases (FOGs), debris and solids deposition which causes sewer blockages. When organic materials are deposited in a sewer pipe with limited ventilation for a long period, anaerobic condition can develop in the sewer leading to the production of hydrogen-sulphide (H_2S) which can be aggressive and cause corrosion when it converts to sulphuric acid.

Extreme weather conditions are likely to require extremely wide ranges of operating regimes in our pumps and other mechanical assets. For example, standby pumps may be required to operate less frequently in prolonged drought conditions, or continuously during longer periods of sustained winter rainfall, and also cope with rapid onset, intense summer storms. Assets such as standby pumps require modern efficient controls to ensure that they come into service as soon as required and operate to ensure greater reliability and resilience.

3. Summary

Climate change is no longer a future risk. Its effects are being seen now across many sectors, including the water industry, and are predicted to become more severe over time. In this document we have described the methods and approaches we adopted in assessing climate change. We have also highlighted the gaps in data and knowledge in assessing some of the climate change impacts. Further research is required to understand the impact of climate on wastewater asset health and its performance.

The flood risk assessment we undertook is based on 1D network model. A more accurate 2D model will be required to predict the number of properties at risk of flooding. In addition, the rainfall we used to predict the risk of flooding and storm overflow performance is based on UKCP09 projection. In the future it will need to be aligned with the latest projection, UKCP18.

The modelling prediction for some of our storm overflows differ to that recorded by EDM. There are known reasons for this, and further investigation and enhanced modelling is required to increase confidence in future predictions.
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