# WSX23 - Our route to net zero

Business plan
2025-2030

Wessex Water
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# WSX23 – Our route to net zero

*This supporting document is part of Wessex Water's business plan for 2025-2030.*

*Please see'WSX00-Navigation document for where this document sits within our business plan.*

*More information can be found at wessexwater.co.uk*

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# Executive summary

Climate change, caused by greenhouse gas emissions from human activity, is our biggest long-term challenge. Among our responses is our commitment to reduce our own operational carbon emissions to net zero by 2030, and to reduce our total emissions to net zero, including those related to our supply chain emissions, by 2040 at the latest. This is one of the core outcomes within our strategic direction statement.

## Action to reduce our emissions

Our carbon management programme includes a range of actions under the heads of avoidance, optimisation and renewables. These include energy efficiency; generating renewable energy from biosolids, hydro and solar; and the secondary carbon benefits of other activities, such as work to reduce volumes of water and sewage; promote catchment management and nature-based solutions.

Continuing this work plus background decarbonisation of energy will mean that our emissions will fall during 20225-30. While these changes are welcome, they are not sufficient for us to meet our net zero carbon goal.

For this reason, we will need to pursue a wide range of opportunities for cutting carbon that will require additional effort and investment.

*Table 1 Summary of actions to reduce emissions*

| | Base | Standard enhancement | Net zero carbon challenge |
|---|---|---|---|
| **Fossil fuels** | • Reducing natural gas in CHP<br>• Hydrotreated vegetable oil for standby generation | | • Effluent heat recovery to heat digesters |
| **Process emissions** | • Methane monitoring (non-IED sites) | • Covering sludge storage (IED)<br>• Nitrous oxide monitoring | • Nitrous oxide monitoring |
| **Transport** | • Low carbon HGVs<br>• Electric cars & light vans | • Electric vehicle infrastructure | |
| **Electricity** | • Core energy efficiency work<br>• Fine bubble diffused aeration<br>• On-site solar generation<br>• Neighbouring renewable | | |

Alongside, we plan to explore more innovative methods that are not yet sufficiently established or cost-effective to be considered as 'readily available' for implementation during 2025-2030. Technologies of particular interest include advanced thermal conversion methods for treating sewage sludge and capturing carbon in biochar; sewer heat recovery; integration of hydrogen with our activities as an alternative to fossil fuels; algae-based treatment as a lower energy method for phosphorus removal; ammonia stripping for use as a hydrogen carrier and to reduce treatment energy; and techniques to capture or break down nitrous oxide.

We will continue work on more sustainable approaches where carbon is one of a number of elements, e.g., catchment management, nature-based solutions, and tree planting. As well as operational carbon emissions, we know that we must address embodied carbon emissions and we are working towards quantifying whole life carbon as business-as-usual, as a pre-requisite for capital scheme evaluations. As well as facilitating annual reporting, this is needed to drive better management of carbon emissions. This will mean developing a company culture where wholelife carbon is woven into investment decision-making, supported by carbon accounting being business-as-usual for all activities, and part of our engagement with external stakeholders.

# Forecast emissions

Using the specific parameters of the 2025-30 performance commitment, we are forecasting a small reduction in our water supply emissions, and an 11% reduction in our wastewater emissions (on an absolute basis).

*Table 2 Summary of forecast*

| **Operational emissions (t$CO_2$e)** | **2021-22** | **2025-26** | **2026-27** | **2027-28** | **2028-29** | **2029-30** |
|---|---|---|---|---|---|---|
| **Water** | | | | | | |
| Tonnes $CO_2$e | **30,040** | **30,618** | **30,395** | **30,136** | **29,965** | **29,848** |
| Change vs base year | | 578 | 355 | 96 | -74 | -192 (-0.6%) |
| kg $CO_2$e / Ml water distribution input | 241 | 249 | 250 | 250 | 252 | 254 |
| **Wastewater** | | | | | | |
| Tonnes $CO_2$e | **113,984** | **117,244** | **115,651** | **113,185** | **109,486** | **101,666** |
| Change vs base year | | 3,260 | 1,667 | -800 | -4,498 | -12,319 (10.8%) |
| kg $CO_2$e / Ml sewage received | 359 | 336 | 331 | 324 | 314 | 291 |

| **Embodied emissions (t$CO_2$e)** | **2025-26 to 2029-30** | **2023 to 2035** | **2025-26 to 2029-30** | **2023 to 2035** |
|---|---|---|---|---|
| | **Water** | | **Wastewater** | |
| Base | 105,139 | 114,009 | 161,206 | 162,281 |
| Enhancement | 71,454 | 181,875 | 182,316 | 240,511 |
| | **Other** | | **Total** | |
| Base | 26,083 | 51,325 | 557,654 | 761,848 |
| Enhancement | 11,456 | 11,847 | | |

# Reporting emissions

During 2025-30, we will be reporting our emissions each year using three broad methods. Firstly, using the bespoke method defined for the common performance commitments for greenhouse gas emissions (water and wastewater). Secondly, using methods required for statutory corporate reporting; for example, to meet Companies Act reporting using the Taskforce for Climate Related Financial Disclosures framework, and reporting to the Carbon Disclosure

Project. Thirdly, with the parameters of the net zero commitment made as part of the 2019 Public Interest Commitment.

# 1. Introduction

Climate change, caused by greenhouse gas emissions from human activity, is our biggest long-term challenge. The world's climate has already warmed by 1°C above pre-industrial levels and could warm by a further 2-3°C by the end of the 21st century. The level of warming leaves us facing a climate emergency and we must take urgent action if we are to avoid serious consequences.

In the UK, we expect to see warmer, drier summers, milder, wetter winters and more frequent extreme weather events becoming the norm. We must collectively adapt to these future impacts and reduce our greenhouse gas emissions (commonly called carbon emissions).

The Paris Climate Agreement aims to a) hold the increase in the global average temperature to well below 2°C above pre-industrial levels; and b) pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels. The UK Government aims to achieve net zero carbon emissions by 2050 and as part of the 2008 Climate Change Act, has legally-binding carbon budgets, placing a restriction on the amount of greenhouse gases the UK can emit over five-year periods.

Net zero carbon emissions are achieved when greenhouse gas emissions from operational activities have been eliminated or neutralised through the draw-down and storage of carbon from the atmosphere. These emissions are commonly expressed as carbon dioxide equivalent (CO2e) or simply carbon emissions.

Given the critical need to reduce greenhouse gas emissions, external stakeholders – including investors, NGOs and the public – are increasingly expecting businesses to reduce their carbon footprint. The English water companies have committed to achieving net zero operational carbon emissions by 2030. UK Water published a sector-level routemap in November 2020 setting out options for achieving this and our commitments are broadly in alignment.

We aim to be a genuinely sustainable water company, and reducing our carbon footprint is one of the many environmental, social and economic issues that this entails. Decarbonising our activities must connect with other environmental work, linking with our efforts to promote sustainable land use, protect biodiversity and the water environment, improve resource efficiency and reduce air pollution. This in turn will benefit our customers and the communities we serve.

Additionally, the economic and financial rationale for reducing our carbon footprint is becoming more compelling. Renewable energy generation offers financial benefits in terms of sold energy or avoided energy purchase, as well as the subsidies that are offered. Reducing the use of imported electricity and gas, and generating our own energy, can create financial savings. Further, through a performance commitment agreed with Ofwat, we pay customers £19,500 for every kilotonne of carbon dioxide equivalent emissions that exceeds our annual target.

Carbon footprint reporting is required for our annual report to Ofwat; for corporate reporting (e.g. using the Taskforce for Climate-Related Financial Disclosures (TCFD)) and the UK Emissions Trading Scheme.

Our approach to addressing climate change is underpinned by the two main themes of mitigation and adaptation.

Mitigation: the need to drastically reduce greenhouse gas emissions from human activity, to reduce the risk of dangerous climate change.

Adaptation: the need to be resilient to the effects of climate change; in our case, drier summers, wetter winters, and more frequent extreme weather events.

In terms of our mitigation efforts, we are committed to:

- reducing our own operational carbon emissions to net zero by 2030
- reducing our total emissions to net zero, including those related to our supply chain emissions, by 2040 at the latest.

We are fully focused on reducing our own emissions and will build on aspects where we have taken a lead such as waste to energy; nature-based solutions and sustainable land use. We will need an optimal blend of engineered and ‘softer’ non asset-based solutions and will explore new methods, such as environmental markets for scaling-up the most promising methods. Offsetting any remaining, unavoidable emissions would be a last resort and we intend to consult customers and other stakeholders to understand their views.

# 2. Emissions scope, trends, base year

## 2.1. Overview

Our net zero commitment includes our regulated activities for water treatment and distribution, sewage treatment and sludge treatment. The emissions we report are itemised in Table 3. Our multiple annual disclosures during 2025-30 will fit within three broad categories:

- The bespoke method defined for the common performance commitments for greenhouse gas emissions (water and wastewater)
- Statutory corporate reporting, for example, to meet Companies Act reporting using the TCFD framework, and reporting to the Carbon Disclosure Project at the behest of investors
- The parameters of the net zero commitment made as part of the 2019 Public Interest Commitment.

*Table 3 Reporting commitments.*

| | 2025-30 performance commitment | Statutory corporate reporting | Public Interest Commitment (PIC) |
|---|---|---|---|
| **Scope 1** | | | |
| Direct emissions from burning of fossil fuels | ✓ | ✓ | ✓ |
| Process and fugitive emissions (incl. refrigerants) | ✓ | ✓ | ✓ |
| Emissions from vehicle transport (owned or leased) | ✓ | ✓ | ✓ |
| Emissions from land | ✓ | ✓ | |
| **Scope 2** | | | |
| Purchased electricity | ✓ | ✓ | ✓ |
| Purchased heat | ✓ | ✓ | |
| Electric vehicles | ✓ | ✓ | |
| Removal of electricity to charge electric vehicles | ✓ | ✓ | |
| **Scope 3** | | | |
| Business travel and private vehicles | ✓ | ✓ | ✓ |
| Outsourced activities | ✓ | ✓ | ✓ |
| Purchased electricity: extraction to distribution | ✓ | ✓ | ✓ |
| Purchased heat: extraction to distribution | ✓ | ✓ | |
| Purchased fuels: extraction to distribution | ✓ | ✓ | |
| Chemicals | ✓ | ✓ | |
| Disposal of waste | ✓ | ✓ | |
| **Emissions reduction** | | | |
| Exported renewables (generated onsite and exported) | ✓ | ✓ | ✓ |
| Exported biomethane (generated onsite and exported) | ✓ | ✓ | ✓ |
| Insets | ✓ | ✓ | ✓ |
| Offsets | | | ✓ |

## 2.2. Quantification and reporting

We have reported operational carbon emissions since 1998 and used the water industry's standardised Carbon Accounting Workbook published by UK Water Industry Research (UKWIR). since 2007. The workbook is updated annually with emission factors issued by the government and has had periodic updates of sector-specific emission factors from other sources such as research and industry databases.

Our performance commitment base year and forecast conform to Ofwat's definition:

- Greenhouse gas emissions expressed in tonnes $CO_2e$ (carbon dioxide equivalent) and the percentage change since 2021-22. This is also reported as $kgCO_2e$ per megalitre of distribution input (pre-MLE) for water supply, and $kgCO_2e$ per megalitre of volume of wastewater received at sewage treatment works for waste.
- Using the 2022-23 location- based grid emissions factor throughout the period

Nb: we expect to use market-based emissions factors for our PIC reporting, and the most recent location-based grid emissions factor for statutory corporate reporting.

## 2.3. Historical emissions

### Context

Our annual emissions have fallen consistently since 2015 due to reduced carbon intensity of UK-wide electricity generation (as renewable sources have replaced coal) and our own work to improve energy efficiency and renewable energy generation.

Since the mid-1990s our electricity use has increased significantly due to higher quality standards which often requires energy intensive treatment such as mechanical aeration and ultraviolet disinfection. Concerted energy efficiency work has been necessary to prevent even higher energy use.

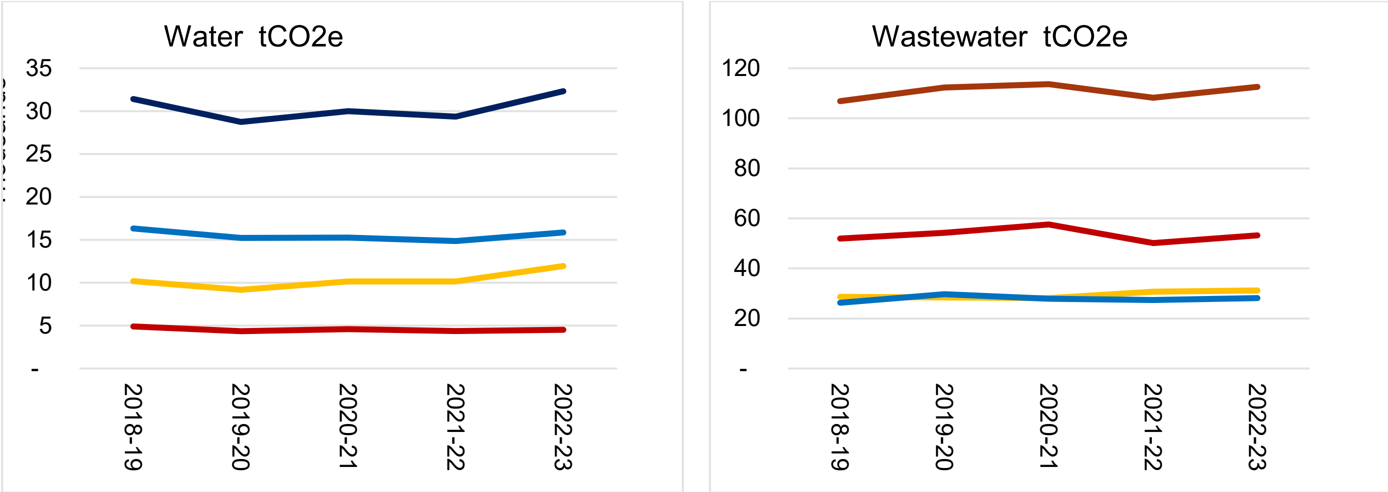
Our electricity consumption is also extremely sensitive to the weather. High rainfall increases the volume of sewage moving through our sewerage network, and heatwaves increase public water demand and the energy required for treating and pumping water.

As electricity decarbonises, there is a growing awareness of the relative importance of process emissions; specifically methane and nitrous oxide from sewage and sludge treatment. These are not measured but estimated, through the use of emission factors that are applied to known quantities such as the tonnage of sludge processed through different methods, and the population served by secondary treatment. Work is underway nationally to better quantify these greenhouse gases, as previous estimates have likely been at the low end of the range. Improving the measurement and control of methane and nitrous oxide is also part of our proposals for 2025-30.

We are confident in the calculation of emissions related to energy and transport. However, emissions of methane and nitrous oxide (within scope 1) are much less certain, as they are estimated by water companies in the absence of direct measurement methods. Work is underway nationally to better quantify methane and nitrous oxide, and initial findings suggest that historically they have been under-estimated. Please see section 4 for more information.

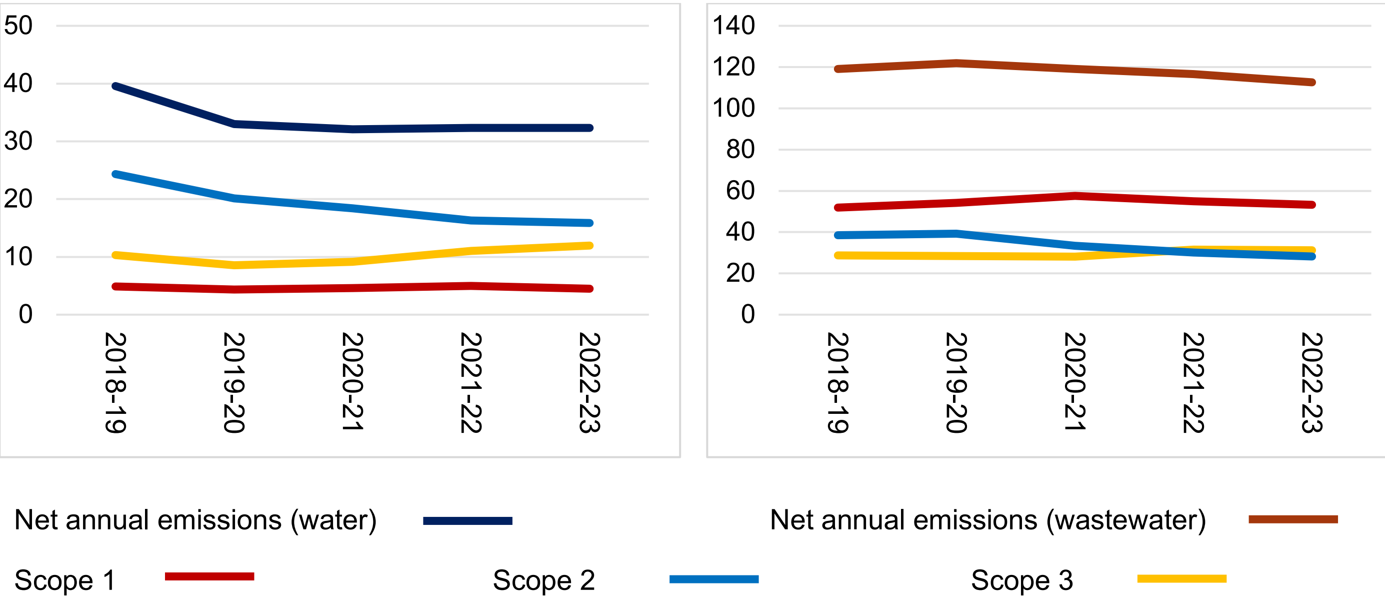
A. Operational emissions (location-based, $ktCO_2e$) using the fixed 2022-23 grid electricity emission factor

*Figure 1 Operational emissions (location-based, ktCO2e) using the fixed 2022-23 grid electricity emission factor*




B. Operational emissions (location-based, $ktCO_2e$) using the moving annual grid electricity emission factor

*Figure 2 Operational emissions (location-based, ktCO2e) using the moving annual grid electricity emission factor*



## Base year (2021-22) emissions

Emissions in 2021-22 were as follows (tonnes $CO_2$ equivalent):

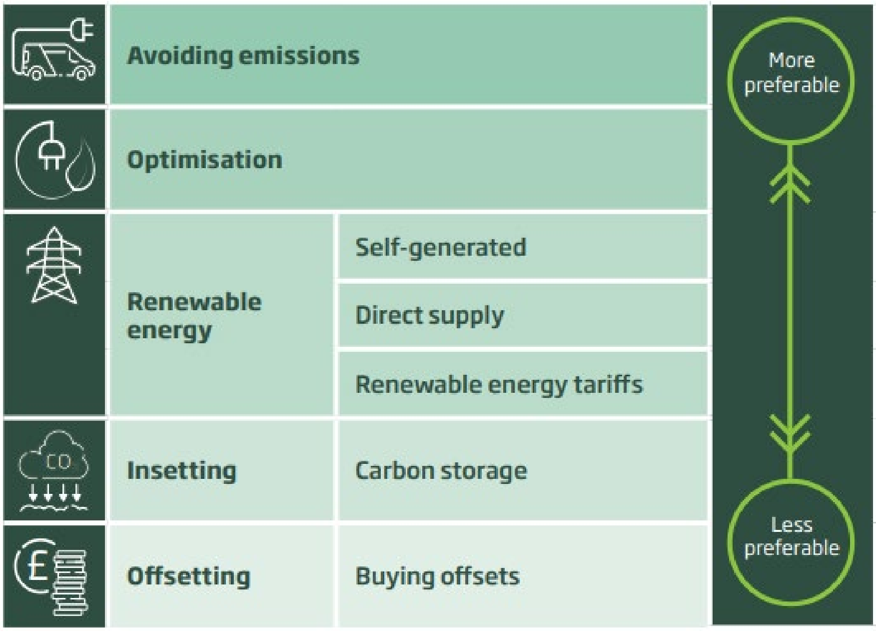
*Table 4 Emissions in 2021-22*

| | Water | Wastewater |
|---|---|---|
| **Scope 1** | **4,977** | **55,015** |
| Direct emissions from burning of fossil fuels (location-based) | 1,043 | 12,858 |
| Process and fugitive emissions (incl. refrigerants) | - | 34,688 |
| Emissions from vehicle transport (owned or leased) | 3,934 | 7,469 |
| Emissions from land | - | - |
| **Scope 2** | **14,860** | **27,440** |
| Purchased electricity (location-based) | 14,860 | 27,440 |
| Purchased heat | | |
| Electric vehicles | | |
| Removal of electricity to charge electric vehicles | | |
| **Scope 3** | **10,203** | **31,529** |
| Business travel on public transport and private vehicles used for company business | 215 | 408 |
| Outsourced activities | 2,056 | 4,089 |
| Purchased electricity: extraction, production, transmission and distribution | 5,240 | 9,672 |
| Purchased heat: extraction, production, transmission and distribution | - | - |
| Purchased fuels: extraction, production, transmission and distribution | 428 | 5,282 |
| Chemicals | 2,264 | 3,976 |
| Disposal of waste (biosolids on third party land) | - | 8,102 |
| **Emissions reduction** | | |
| Exported renewables (generated onsite and exported) | - | - |
| Exported biomethane (generated onsite and exported) | - | - |
| Insets | - | - |
| **Total** | **30,040** | **113,984** |
| **kgCO2e per megalitre** | **241** | **359** |

# 3. Current carbon management work

We have a strong track record of carbon management work. Our Carbon Management Strategy was originally developed in 2001 and has evolved into our routemap to net zero carbon emissions. Our overall approach includes the carbon management hierarchy below:

*Figure 3 Carbon management hierarchy*




The following outlines our carbon management work during 2020-25 within this framework.

## 3.1. Avoidance

### Reducing volumes of water and sewage

Our ongoing programme of leakage reduction and customer demand management is focused on protecting water supplies. This has also reduced energy consumed and our carbon footprint. Leakage reductions achieved during the last 20 years mean that our annual carbon footprint is two kilotonnes less than it would have been.

### Catchment management/nature-based solutions

We have an extensive catchment management programme that promotes farming practices that reduce fertiliser and pesticide use. This in turn has helped us to avoid additional energy and resource-intensive water treatment at specific sites.

### Avoiding transport emissions

Technologies that enable video-conferencing and remote working as an alternative to travelling to other locations are widely used, accelerated in part by the 2020-21 pandemic. More flexible work patterns and improved connectivity will further reduce business mileage and commuting.

Our sister company GENeco has been a pioneer in the introduction of vehicles of different sizes running on biomethane. We have started installation of electric charging points and recently trialled the use of compressed natural gas for large vehicles, instead of diesel.

*Table 5 Innovations in reduction of emissions*

| | | |
|---|---|---|
| Fossil fuel use | • Alternatives to diesel for backup electricity generation e.g. HVO | Early trials |
| | • Lower carbon methods for keeping anaerobic sludge digesters at a warm temperature. | Investigation |
| Process emissions | • Quantifying methane leakage at sewage sludge treatment centres | Early trials |
| Transport emissions | • Electric vehicle charging infrastructure at company sites | Investigation |
| | • Trialling HGVs powered by compressed natural gas and biogas. | Early trials |
| | • Remote working and teleconferencing technologies | BAU, ongoing |
| Reducing volumes of water and sewage | • Reducing leakage by 15% and addressing our customers' water consumption through demand management measures | BAU, ongoing |
| | • Reducing groundwater infiltration to sewers and implementing our stormwater reduction plan | BAU, ongoing |
| Nature and land-based solutions | • Catchment delivery work focused on water quality | BAU, ongoing |
| | • The carbon footprint of constructed wetlands and other nature-based solutions | Investigation |
| Asset maintenance | • Lower carbon methods e.g. trenchless pipe repairs and rehabilitation. | BAU, ongoing |

## 3.2. Optimisation

### Energy efficiency

As we are a major energy user, maintaining the efficiency of equipment at treatment sites and in pumping networks is an important way of controlling energy use. We do this using advanced monitoring and targeting systems, which help us identify sites using more electricity than they should and carrying out focused remedial work as a result.

### Process emissions from sewage and sludge

Nitrous oxide and methane from sewage and sludge treatment are our [second largest] category of emissions, currently accounting for around [a quarter] of our operational emissions. We have been exploring potential methods for monitoring and control of nitrous oxide from sewage treatment. This will be informed by trials in the UK and overseas of systems that combine sensors and data analysis software.

### Transport efficiency

We use route optimisation software to improve the efficiency of journeys and are trialling systems to improve driver behaviour with benefits for safety as well as fuel efficiency.

*Table 6 Innovations in reduction of emissions from transport*

| | | |
|---|---|---|
| Energy efficiency | • Energy efficiency initiatives | BAU, ongoing |
| | • Advanced energy use monitoring and targeting of corrective action | BAU, ongoing |
| Process emissions | • Nitrous oxide monitoring and control systems | Trials |
| Transport efficiency | • Technology to optimise vehicle movements and reduce mileage | BAU / rollout |
| | • Increasing focus on vehicle fuel / electrical efficiency | BAU, ongoing |
| Lower carbon construction materials and methods | • Lower carbon construction materials and methods e.g., low carbon cement / concrete, using concrete for locking-up biochar, offsite and modular build | Trials / rollout |
| | • Developing systems for comparing the whole-life carbon footprint of competing options | Rollout |

## 3.3. Renewable energy

### Energy from waste

Using anaerobic digestion of sewage sludge and food waste, we create biogas that is either used to generate electricity (at five of our sludge treatment centres) or is refined into biomethane (at Bristol and Trowbridge) that can be injected into the gas grid or used as a renewable fuel for transport. We have upgraded digesters at Bristol and Trowbridge sludge treatment centres to a more advanced form that reduces process emissions and increases biogas production. We have conventional digesters at Bournemouth, Poole and Taunton sludge treatment centres.

### Other renewable generation

We operate medium and small-scale hydro turbines at three sites, and we have solar photovoltaic panels on the roofs of our Operations Centre and Sutton Bingham water treatment centre. We are assessing our operational sites and landholding for further solar generation potential as well as suitable candidate sites to take renewable generation from beyond our landholdings.

### Partnerships with third-party renewable energy generators

We host four wind turbines at our water recycling centre in Bristol; these are owned and operated by Thrive Renewables.

*Table 7 innovation in reduction in emissions from operations*

| | | |
|---|---|---|
| Energy from waste | • Optimising existing digesters, in part to maximise gas production | BAU, ongoing |
| | • Export of biomethane at Bristol and Trowbridge | BAU, ongoing |
| | • Heat recovery from sewage pumping stations | Investigation |

| | | |
|---|---|---|
| Other renewable generation | • Sites for solar generation | Investigation |
| | • Partnership opportunities with commercial and community energy developers | Investigation |
| | • Energy crops and other types of biomass for heat generation | Investigation |
| Renewable grid electricity purchase | • Exploring potential power purchase agreements with off-site renewable generators | BAU, ongoing |
| | • Monitoring green energy tariff markets | BAU, ongoing |

## 3.4. Other measures

Carbon insetting involves other emissions-reducing activity within the 'sphere of influence' of a company – often through nature-based solutions, such as tree planting and retention of soil carbon. We are at the early stages of quantifying the carbon storage potential with these types of methods on our own landholding.

We are also looking at opportunities to play a part in the creation of markets for carbon reductions through the promotion of nature-based solutions through our subsidiary company, EnTrade, which is an online platform for collaboration with farmers and landowners.

Carbon offsetting refers to the purchase of carbon credits created by other organisations reducing emissions. We have not undertaken any carbon offsetting to date, and we regard it as the final stage in a hierarchy of actions. It may, however, be necessary to meet our new zero carbon commitment in 2030.

*Table 8 Innovation through carbon offsetting*

| | | |
|---|---|---|
| Land-based measures | • Quantifying carbon flows related to our landholding | Investigation |
| | • Ensuring that our mitigation and landscaping measure maximise carbon capture as part of scheme designs and planning | Planned |
| | • Developing guidance for improving carbon uptake and soil carbon levels on our land | Planned |

# 4. Future work to reduce greenhouse gas emissions

## 4.1. Overview

This section outlines our plans for 2025-30 to reduce our greenhouse gas emissions.

## 4.2. Background emissions reductions

If we were to just continue with current carbon management work, with no additional efforts, we would expect to see our carbon footprint to fall during 2025-30. This will be due to two main factors.

The first is the continuing decarbonisation of grid electricity across the UK, with the commercial grid average emission factor forecast to fall from 0.155 kg $CO_2$ equivalent ($CO_2e$) per kilowatt hour of electricity for the 2024-25 reporting year to 0.072 kg for the 2029-30 reporting year. This would represent a 35 kilotonne CO2 reduction compared with our 2021-22 grid electricity emissions (assuming the same volume of power use).

(See https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/602657/5._Data_tables_1-19_supporting_the_toolkit_and_the_guidance_2016.xlsx )

Secondly, decarbonisation of road vehicles is beginning, with the sale of new petrol and diesel cars and vans to be banned from 2030. As a large user of electricity and road vehicles we will see these changes happening through the supply chain without our direct intervention, although we expect slower progress in decarbonising medium and large vehicles during the same period.

While these changes are welcome, they are not sufficient for us to meet our net zero carbon goal.

For this reason, we will need to pursue a wide range of opportunities for cutting carbon that will require additional effort and investment. These will include some readily-available options, using established methods and known technologies, which have a favourable balance of costs and carbon reduction benefits. Beyond these are more innovative options involving emerging science and technology; these will need to play a part if we are to achieve a net zero carbon position.

## 4.3. Assessing reduction opportunities

### Shortlisting and appraising options

Our main approach to identifying material reduction options for operational emissions was to review known methods, related to each of the categories used in annual reporting:

- fossil fuels - alternatives to gas in CHP engines and diesel-power standby generators
- process emissions – reducing nitrous oxide emissions through process optimisation; methane leakage detection and repair
- transport - alternative propulsion and fuels in cars, vans and medium- and heavy-goods vehicles
- electricity – energy efficiency; additional renewable self-generation and behind-the-meter purchase agreements
- subtractions – options for currently exported renewable energy; carbon removals via biosolids and land.

We have cross-checked against other water-sector specific sources on reducing operational greenhouse gas emissions, notably Jacobs 2022 Net Zero Technology Review commissioned by Ofwat. and the Water UK net zero routemap produced with Mott MacDonald and Ricardo.

The Jacobs review refined a longlist of identified technologies into an ultimate shortlist through a detailed Multi Criteria Analysis (MCA) assessment exercise. Table 9 sets out, for the shortlisted items, our activity to date involving implementation or trials, and our plans for each item during 2025-2030. We will continue with items that we have already implemented and scale-up those where we have started. The following are those that will be added to our programme depending on some pre-conditions:

- N2O setpoint optimisation "Monitoring of N2O and optimisation of existing treatment process to reduce emissions through modifications to existing process control set points such as dissolved oxygen concentration or mixed liquor suspended solids (MLSS), coupled with real time nitrous oxide monitoring to demonstrate reduction from a defined baseline". A likely consequence of our monitoring campaign, albeit dependent on the coherence of the results gathered during monitoring.
- Vacuum methane recovery "Removal and recovery of dissolved methane from digested sludge as it exits the anaerobic digester or from downstream sludge storage." Potential implementation, depending on the outcome of other methane abatement actions required by compliance with the Industrial Emissions Directive (IED).

*Table 9 Net Zero technology review shortlisted items*

| | Our activity to date | Our 2025-2030 plans |
|---|---|---|
| **Burning of fossil fuels** | | |
| **Low-energy drying**<br>Low energy drying methods for sludge or biosolids | Exploration | Ongoing exploration |
| **Heat recovery**<br>Heat recovery from onsite influents / effluents | Exploration | Yes: initial effluent installation at Avonmouth |
| **Process emissions** | | |
| **CH4 monitoring & mitigation**<br>Site wide monitoring and proactive methane mitigation | Early-stage trials of LIDAR | Yes: IED and non-IED sites |
| **Vacuum methane recovery**<br>Recovering methane in sludge using a vacuum within an enclosed tank | | Maybe: potential implementation driven by IED |
| **N2O setpoint optimisation**<br>Process set point optimisation for N2O | | Maybe: following real-time monitoring at largest sites |
| **Real-time N2O control**<br>Real time control for optimisation of nitrous oxide. | Subsequent to installation, data analysis | Yes: implementation at largest sites |

| | | |
|---|---|---|
| **Conversion to nitrifying / denitrifying**<br>Conversion of secondary nitrifying treatment to nitrifying/denitrifying | Only at sites where N reduction is required | Yes: at sites with N permits |
| **Transport** | | |
| **HGVs, biomethane**<br>Heavy transport (e.g. sludge tanker) fuelled by biomethane | Trials of CNG in HGVs | Yes: initial rollout |
| **Electricity** | | |
| **Pump efficiency**<br>Refurbish and optimise pumps | Some pump testing | Yes: ongoing |
| **Membrane aerated biofilm reactor**<br>Membrane aerated biofilm reactor (MABR) for secondary wastewater treatment**.** | | No: not planned as a treatment option |
| **Renewables** | | |
| **Co-digestion**<br>Co-digestion of sewage sludge with other organic materials | Co-*located* food waste digestion, not co-digestion due to regulations | Ongoing separate digestion |
| **AAD EH or APD**<br>Advanced AD - enzymatic hydrolysis | Full scale implementation at Avonmouth and Trowbridge | Yes: ongoing |
| **Advanced AD - thermal hydrolysis**<br>Thermal hydrolysis destroys cell walls and enables the methanogens to convert a greater fraction of solid organic material into methane. | Exploration as an investment option | No: not a priority option for biosolids |
| **Intermediate thermal hydrolysis**<br>Thermal hydrolysis applied to SAS rather than a mix of SAS and primary sludge (PS). | | No: not a priority option for biosolids |
| **Biomethane to grid**<br>Biomethane export to grid | Full scale implementation at Avonmouth, Trowbridge | Yes (but continuing to sell green gas certificates) |
| **Power Purchase Agreements**<br>Onsite, behind the meter renewables, or private wire or corporate PPAs for offsite renewables | Screening sites; invitations to tender | Yes |
| **Other** | | |
| **Water efficiency, leakage reduction**<br>Reduced losses of treated water in networks | BAU leakage reduction plus trials of some innovative methods | Yes: ongoing |
| **Stormwater separation & treatment with NBS**<br>Stormwater separation and treatment with nature-based solutions (e.g. SuDS). | Small scale implementations, trials | Yes: preferred approach where possible |

| | | |
|---|---|---|
| **Biodrying**<br>Biodrying of sludge or biosolids | Historic operational experience. Review underway for 2025 onwards | Review as a precursor for future ATC |
| **Gasification / pyrolysis**<br>Thermal treatment of sludge or biosolids by gasification or pyrolysis | Investigation of options, possible partnerships | Exploration only |
| **Ammonia stripping (liquors)**<br>Stripping ammonia from sludge liquors (air, steam, chemical pH swing) | | Exploration only |

Items that did not make the shortlist were excluded for a number of reasons, e.g. being standard practice already; having marginal net zero benefits; or being at a low technology readiness level and it being unlikely that they can be implemented during 2025-2030. During the next five years – in addition to our planned programme - we will monitor the progress of Items in the latter category as they approach a market-ready position.

The Water UK routemap was developed by considering three possible futures for the sector in the form of pathways towards net zero emissions that involve different combinations of decarbonisation interventions.

*Table 10 Water UK routemap*

| Water UK routemap items | Our activity to date | Our 2025-2030 plans |
|---|---|---|
| **Burning of fossil fuels** | | |
| Divert biogas to boilers to provide heat demand for sludge treatment, stop natural gas to CHP plant | Biogas mainly sent to biomethane plant or CHP | Unlikely preferential use of boilers; other methods to reduce gas use |
| Gas oil replaced by HVO | | Yes: 50% switch by 2030 |
| Hydrogen generators | | Exploration of co-location and fuel switching |
| Electric/ battery powered standby generation to reduce grid imports | Reviewed; no progress due to cost | Exploration only |
| **Process emissions** | | |
| Conventionally digested sludge upgraded to advanced digestion (thermal hydrolysis) | Use of acid-phase digestion instead of thermal hydrolysis | No: thermal hydrolysis not a preferred option for biosolids |
| Alternative treatment - anaerobic treatment / MABR / alternative ammonia removal | | Exploration only |
| Implement monitoring | | Yes: implementation at largest sites |
| Optimisation of current technology to minimise methane emissions | | Yes: dependent on outcome of planned monitoring work |

| | | |
|---|---|---|
| Optimisation of current technology to minimise nitrous oxide emissions | | Yes: dependent on outcome of planned monitoring work |
| Incorporating water sludge into construction materials | No: sludge goes to wastewater network | |
| **Transport** | | |
| Biofuels | Trials on single vehicles | Yes: bio-CNG HGVs introduced at point of replacement |
| EVs | A small number of cars and charging points | Yes: full programme of charging points; electric cars and small vans |
| Hydrogen | | Watching brief |
| Transport - Efficiency | Route planning, driver behaviour | Yes: ongoing |
| **Grid electricity** | | |
| Accelerated leakage reduction | BAU leakage reduction plus trials of some innovative methods | Yes: ongoing |
| Control or analytics upgrades; high efficiency blowers and small pumps | Part of overall energy efficiency programme | Yes: ongoing |
| Reducing power demand - smart control / analytics | Part of overall energy efficiency programme | Yes: ongoing |
| Site electrical rearrangement, for additional CHP power to be used on site rather than exported | | Potential future approach, dependent on main use of biogas |
| Catchment approaches to reduce treatment power | Part of business-as-usual | Yes: ongoing |
| Alternative treatment - MABR | | No: not planned as a treatment option |
| Government-led water labelling associated with Building Regulations & minimum standards | | Outside our control |
| Replacing ageing equipment with modern equivalents | Part of business-as-usual | Yes: ongoing |
| Rainwater harvesting to reduce wholesome water demand. | Small localised interventions | Yes: part of Drainage and Wastewater Management Plan |
| **Renewables** | | |
| Hydropower – dam head and run of river | Installations at three sites | Yes: ongoing, but no additions planned |
| Solar | A small number of installations | Yes: upscaled programme at company sites |

| | | |
|---|---|---|
| Wind | Hosted at Avonmouth | No additional generation planned |
| **Natural sequestration** | | |
| Tree planting | Phase-in to larger programme | Yes: upscaled programme |
| Grassland restoration | Biodiversity work on our own land; catchment work | Yes: ongoing |
| Peatland restoration | | Not applicable |
| **Admin** | | |
| Energy efficiency | BAU as part of facilities management | Yes: ongoing |
| Energy management | BAU as part of facilities management | Yes: ongoing |
| Fossil fuel alternatives | | Maybe: as part of HVO for standby |
| Onsite generation | Discrete sites e.g. Operations Centre solar | Ongoing at current sites; exploration for future expansion |

Items identified for exploration in 2025-30 are set out section 4.

## 4.4. Summary of planned interventions

Table 11 summarises the new items that we propose, and the proposed spend category for each:

*Table 11 Summary of planned interventions*

| | Water / wastewater | 2029/30 $tCO_2e$ reduction | Spend category |
|---|---|---|---|
| **Fossil fuels** | | | |
| Reducing natural gas in CHP | Wastewater | 2,107 | Base |
| Effluent heat recovery to heat digesters | Wastewater | 730 | Enhancement (net zero challenge) |
| Hydrotreated vegetable oil for standby generation | Both | 1,764 | Base |
| | | | |
| **Process emissions** | | | |
| Methane monitoring (non-IED sites) | Wastewater | - | Base |
| Covering sludge storage (IED) | Wastewater | 2,983 | Enhancement (IED) |
| Nitrous oxide monitoring: sites with other enhancement drivers | Wastewater | 1,978 | Enhancement (standard) |

| | | | |
|---|---|---|---|
| Nitrous oxide monitoring: other sites | Wastewater | 892 | Enhancement (net zero challenge) |
| **Transport** | | | |
| Low carbon HGVs | Wastewater | 1,330 | Base |
| Electric vehicle infrastructure | Both | - | Enhancement (M&G) |
| Electric cars & light vans | Both | 1,508 | Base |
| **Electricity** | | | |
| Core energy efficiency work | Both | 1,667 | Base |
| Fine bubble diffused aeration (FBDA) - Avonmouth | Wastewater | 2,268 | Base |
| FBDA - other sites | Wastewater | 286 | Base |
| On-site solar generation | Both | 1,243 | Base |
| Neighbouring renewable energy private wire | Wastewater | 5,493 | Base |

In addition to the above, it is possible that we will introduce vacuum extraction of methane from sewage sludge storage. This is an innovative solution; its implementation depends on IED requirements and the efficacy of other solutions that we plan to implement to achieve IED compliance. This, and all of the items above would contribute to the achievement of our performance commitment.

Outside our performance commitment, we aim to achieve our target to achieve net zero operational carbon emissions by 2030 through a combination of market-based reporting (using the inventory in place in 2021 at the time of the commitment), buying renewable grid electricity, and offsetting residual emissions, which we anticipate being circa 50,000 tonnes in 2030.

The following sections provide details on our proposals for 2025-30. These are items that build upon existing activities that have carbon benefits, or while new to us are using readily available technology that has already been proven at scale.

**Low carbon innovation – effluent heat recovery**

**The underlying issue or opportunity being addressed**

Since 2018 our use of natural gas has resulted in approximately 10,000 tonnes CO2 emissions in an average year. The largest use is to run combined heat and power engines at Avonmouth sludge treatment centre.

**What have we done to date?**

In the past we used biogas from anaerobic digesters to generate electricity, via combined heat and power engines with the exhaust heat from the engines helping maintain the correct operating temperature in the digesters. Since 2014, at Avonmouth sludge treatment centre we diverted sewage-derived biogas from the CHP engines to the production of biomethane, which is exported to the local gas grid. To compensate we have imported additional natural gas to run the CHP engines. This maintains the exhaust heat output required by the digesters and produces electricity to run the site.

**What is the innovation we propose for 2025-30?**

We propose to install a 2MW heat pump that draws heat from the treated effluent downstream of the secondary treatment process at Avonmouth water recycling centre. This would supply heat to the mesophilic anaerobic digesters' hot water circuit by as much as 50 degrees Celsius, reducing the need to use the CHPs and an associated boiler as a heat source. This is a technology that is readily-available but is an innovation in the context of the water sector.

Source: IPT

**What are the expected benefits?**

It is estimated that the heat provided would offset around 10 GWh of natural gas per year, saving around 1.8 kt $CO_2$e. With the additional electricity required to run the heat pump, the net $CO_2$ saving would be around 0.7 kt $CO_2$e per year.

We believe that this overall approach presents good value, deriving renewable from a plentiful onsite source and reducing exposure to external energy markets, while sustaining the use of current digester assets. Operational savings would pay back the initial investment comfortably within the 2025-2030 period.

## 4.5. Reductions from base maintenance

### 4.5.1. Fossil fuels: use of hydrotreated vegetable oil for standby generation

**Context**

We employ standby generators at treatment works and other locations as a business continuity measure, i.e. to provide back-up electricity for treatment works or pumping stations in the event of power cuts. These generators are powered by diesel, and while they are not used frequently, their resulting greenhouse gas emissions are 3.0 to 3.5 kilotonnes $CO_2$ per year. Consequently, we have been exploring options to provide power backup that do not involve fossil diesel. We have considered two main options. Firstly, large battery installations, either through an own and operate model or lease arrangements; and secondly, continuing with existing engines but using a non-fossil fuel such as hydro-treated vegetable oil (HVO) as an alternative to conventional diesel.

**Proposal**

At present, battery installations are expensive, and we do not consider them to financially viable at the small and medium sites where standby generators are often sited. We are also concerned about the embodied carbon of battery units and their longevity, particularly given the potential for short actual run times before they need to be replaced or decommissioned.

We propose substituting conventional fossil diesel with hydrotreated vegetable oil. This can be used with existing generators as a direct substitute for fossil diesel and has a ten-year shelf life, reducing the need for regular changing of unused fuel. It can be viewed as a flexible option in this regard. While other companies in the UK are embracing HVO as a diesel substitute, at present it is not produced in the UK, so there are potential supply challenges. For this reason we propose phasing into a 50% switch by 2030, rather than 100% substitution. Concerns have also been raised about traceability and the sustainability of the source material from which HVO is produced.

The additional opex is based on a 10% price premium (see for example https://yournrg.co.uk/ ) and current diesel prices.

*Table 12 HVO and diesel*

| | | Both services |
|---|---|---|
| Capex £m: not applicable | Total opex £m: 0.269 | Totex 2025-30 £m: £0.269 |
| Annual $tCO_2e$ saving by 2030: 1,764 | | |

### 4.5.2. Fossil fuels: reducing use of natural gas in CHP engines

**Context**

The main use historically of biogas from anaerobic digesters has been to generate electricity, via combined heat and power engines. The exhaust heat from the CHP engines is in turn used to maintain the correct operating temperature in the digesters.

Since 2014, at Avonmouth sludge treatment centre we diverted sewage-derived biogas from the CHP engines to the production of biomethane, which is exported to the local gas grid. To compensate we have imported additional natural gas to run the CHP engines for two purposes, namely a) to maintain the exhaust heat output required by the digesters and b) to produce electricity as a substitute for imported grid electricity, based on their relative prices.

**Proposal**

During 2017-18 to 2018-19, average natural gas input to the Avonmouth CHP engines was 33 GWh. During 2019-20 to 2021-22, this increased to 47 GWh on average. This proposal simply involves reducing the gas input to the CHP engines by approximately 14 GWh to the 2017-18 to 2018-19 level. It would require additional grid electricity import to compensate, but there would be a net CO2 reduction.

Forecast opex savings are based on our best estimates for future gas and electricity prices using information from a panel of energy consultants that we use.

*Table 13 Natural gas reduction – Avonmouth CHP*

| | Wastewater | |
|---|---|---|
| Capex £m: not applicable | Total opex £m: -£0.392 | Totex 2025-30 £m: -£0.392 |
| Annual tCO2e saving by 2030: 2,107 | | |

### 4.5.3. Process emissions: regular methane monitoring at sludge treatment centres to assist corrective maintenance work

**Context**

The majority of the sludge that we generate is treated in anaerobic digesters. These are not perfectly sealed systems, and the post-treatment storage units at our sludge treatment centres are unenclosed. As energy and transport decarbonises, process and fugitive emissions will account for a growing proportion of our total emissions. In our 2021-22 base year, methane emissions from sewage sludge treatment amounted to 11.3 kt CO2e, based on the UKWIR carbon accounting workbook.

To date the main regulatory drive to reduce methane leaks at sludge facilities has not been focused on climate change mitigation; instead it has been primarily focused on the Industrial Emissions Directive and b) Dangerous Substances and Explosive Atmospheres. Quantification of methane emissions from sludge treatment is through calculations in the UKWIR Carbon Accounting Workbook (CAW), based on tonnage of sludge processed through different treatment methods. Specifically, there are individual emission factors for a) acid phase AD, b) thermophilic AD, c) conventional digesters (with enclosed or unenclosed digestate storage).

This method is a high-level, top-down way to quantify this issue, which do not account for the actual age or condition of the assets. We believe that more detailed site-specific quantification is needed to have a better picture of the overall issue, as well as indicating locations where subsequent corrective actions can be carried out.

**Proposal**
A monitoring programme is included in our IED schedule for digester sites. Details on this can be found in WSX18 *Bioresources strategy and investment.*

Alongside, we propose a programme of methane monitoring at sludge treatment centres that are not covered by IED (i.e. sites that don't include anaerobic digesters). This new activity will help us better quantify emissions, through monitoring and analysis of methane levels by the company's process scientists. It will also be an enabler for corrective maintenance work.

While there is currently a limited number of market-ready solutions in this field, we envisage two broad methods: firstly, pole-mounted LIDAR cameras and secondly mobile detection devices. We already have some experience of the former, having carried out a short initial trial at Avonmouth of LIDAR leak detection equipment in 2022. Engaging the equipment and service provider has helped to generate estimate of the cost of equipment and installation for an expanded programme during 2025-30. Overall, we consider this to be a flexible solution, which does not involve long-term fixed installations. Rather, it is a temporary programme of quantification to build up picture about each site being assessed.

Looking ahead, we envisage the emergence of digital twin and predictive analytics methods that obviate the need for continuous monitoring, but instead provide probabilistic estimates based on known factors. However, these methods will only work if prior monitoring has been caried out through projects such as this one.

At present, we do not know the level of methane emission reduction that will result from this monitoring activity. For this reason we have not entered a reduction estimate in our projections. However, this activity is a critical enabler for targeting subsequent methane reduction interventions, and will further refine our understanding of the unit cost of process emission reduction. As such, we can not yet claim to have a robust understanding of the cost-benefit relationship, but future investment will be more robust based on the findings from this project.

Other issues related to the ability to report emissions reductions as a result of this work:
- monitoring may reveal significantly higher or lower emissions than those assumed via the CAW
- the CAW itself will need to evolve past the current high-level, rigid emissions factors to reflect situations where leak detection and repair investment has been carried out.

*Table 14 Methane monitoring activity costs*

| | Wastewater | |
|---|---|---|
| Capex £m: £0.224 | Total opex £m: £0.125 | Totex 2025-30 £m: £0.349 |
| Annual CO2 saving by 2030: Unknown | | |

### 4.5.4. Transport: electric cars and vans – phase-in

**Context**

We have assessed the viability of using electric vehicles (EV) as part of our strategy to reduce operational carbon emissions. At this time the alternative fuel technology is deemed suitable for us to move to EVs for company cars and small vans and a partial transition for larger vans. The other vehicles in the fleet may transition during the AMP if technology developments mean suitable options become viable.

**Proposal**

We have assessed two options. Firstly, all vehicle replacement being with conventional internal combustion engine vehicles; secondly, replacement of light vans and company cars with electric versions, and partial transition for large vans.

Our assessment indicates the second option has a higher totex cost and embodied carbon emission due to the EV options having a higher capex than internal combustion engine equivalent. However, we have chosen to proceed with option 2 due to the benefit of lower operational carbon emissions – a 1.5 kilotonne saving - outweighing the higher upfront impacts. Further information is provided in WSX10 Maintaining our services.

### 4.5.5. Transport: lower carbon heavy goods vehicles (HGVs)

***Context***
Our fleet transport emissions averaged 11 kt $CO_2$e over the last five years, around a 40% of which is attributable to HGVs. Government policy is for the sale of new diesel HGVs to end in 2040.

***Proposal***
During 2025-30, we propose trialling of HGVs running on bio-CNG. We propose introducing these vehicles on a phased basis as part of the natural replacement cycle. Focusing on vehicles with large annual mileage such as sludge cake trucks, the gradual introduction of ten such vehicles each travelling 100,000 miles per year would offer 1.3kt CO2 saving by 2030. This project will build on a short trial of two vehicles carried out in 2022.

**Need for enhancement investment**
Average emissions from our HGV fleet are around 4 kilotonnes of CO2 per year, accounting for just under 40% of our total fleet emissions. Most of the visible effort to decarbonise transport is currently focused on cars and light vans, given the 20030 date for ending the sale of new diesel and petrol vehicles in those categories. However, Government policy also includes ending the sale of new diesel HGVs in 2040, and we e consider it to be important to test the available options that would fit our operational environment. Moreover, we need to find emissions reductions across our portfolio of assets in order to minimise residual operational emissions in line with our 2030 goal. As we would be acquiring a new bespoke asset we are designating this investment as an enhancement.

**Best option for customers**
The most important criterion for operational vehicles is their ability to perform reliably within our operational setting. A specific requirement for HGVs is to be able to transport heavy loads over uphill sections of road, and achieve long continuous hours of operation. Low carbon vehicles will therefore need to be sufficiently powerful and robust. The fuels used will need to be widely available, and preferably involve quick refuelling.

We have started looking at a range of options:
a) electric HGVs do not have sufficient power for the loads that we require.
b) bio-CNG is a relatively well-established option, and we have the benefit of a bio-CNG refuelling station operated by a third party in Avonmouth. Companies using bio-CNG include Lidl, Royal Mail, Amazon and Warburtons.
c) HVO can be used as a direct substitute for diesel (as noted in 5.3.1) and is starting to be used by other HGV operators such as Royal Mail. The main concern is about its availability.
d) Hydrogen powered vehicles may be suitable for heavier loads, but this is a relatively expensive option at present, the refuelling infrastructure is sparse and most available hydrogen is not renewably sourced.

Consequently we favour bio-CNG at present, and will also be open to testing HVO pending its availability.

**Cost efficiency**
It is estimated that vehicles of this type would incur a premium of £30,000 each at the point of purchase. However there are opex savings available from using bioCNG, with estimates of it being 30-40% cheaper than conventional diesel.

*Table 15 Hydrogen powered vehicle cost*

| | Wastewater | |
|---|---|---|
| Capex £m: £0.300 | Total opex £m: -£0.339 | Totex 2025-30 £m: -£0.039 |
| Annual CO2 saving by 2030: 1,330 | | |

### 4.5.6. Electricity: energy efficiency

**Context**
As we are a major energy user, maintaining the efficiency of equipment at treatment sites and in pumping networks is an important way of controlling energy use. We do this using advanced monitoring and targeting systems, which help us identify sites using more electricity than they should and carrying out focused remedial work as a result. Meanwhile, investment to upgrade water and wastewater networks and treatment sewage treatment in order to improve the water environment, drinking water quality and resilience tends to act as an upward pressure on energy use. We forecast that the 2025-2030 programme will increase electricity use by circa 30GWh in the absence of efficiency work.

**Proposal: overall energy efficiency programme**
We propose a continuation and expansion of energy efficiency initiatives, drive by higher energy costs as well as by net zero carbon aims. This would include a portfolio of small to medium scale energy efficiency projects overseen by process scientists, with one leading this activity in each geographic division. This work is likely to focus on energy efficiency opportunities primarily at water recycling centres (WRCs), including installing of improved monitoring and replacement of less efficient mechanical equipment. Overall we aim to achieve a 6.4 GWh cumulative saving by 2030, which translates to a 1,667 $CO_2e$ saving at the 2022-23 grid emissions factor.

This programme is inherently flexible: it is able to respond to variables such as the performance of pumps and treatment processes, which can change the priority ranking of any given option. Forecast financial savings are based on projections used by our energy team, informed by external energy consultants.

*Table 16 Energy efficiency initiatives cost*

| | | Both services |
|---|---|---|
| Capex £m: £4.400 | Total opex £m: -£2.864 | Totex 2025-30 £m: £1.536 |
| Annual CO2 saving by 2030: 1,667 | | |

**Proposal: fine-bubble diffused aeration at Avonmouth and three medium to large water recycling centres**
Fine-bubble diffused aeration (FBDA) involves the production of very small air bubbles, which are dispersed via a grid of diffusers within secondary treatment chambers, thereby improving oxygen transfer through wastewater. This allows less energy to be used for oxygen transfer compared with conventional coarse aerators. FBDA can be retrofitted within existing sewage treatment structures, and we have previously installed the technology at a small number of medium scale WRCs with reasonable payback times. FBDA has being considered previously for the sequencing batch reactors (SBR) at Avonmouth WRC previously, but has not proceeded due to the compliance implications of reduced capacity with SBR tanks being taken out in sequence for FBDA installation. However, the increased treatment capacity that will be gained mid-way through 2025-2030, with the current expansion programme, will allow current SBRs to be taken out of use temporarily for fitting FBDA arrays, without risking site compliance.

Quantification of the scheme costs and benefits is based on a comprehensive 2014 technical report produced by an independent third party (Stantec) that assessed the capex and opex of a number of options, ranging from replacement of the control system only, to installation of FBDA with reconfiguration of blowers. The option chosen involves replacement of jet aeration with FBDA and optimisation of the control system. We have inflated Stantec's 2014 costs and benefits assessment of this option to current values for the purpose of this submission. Beyond Avonmouth, FBDA has been identified as a suitable intervention at three medium sized WRCs: Chippenham, Palmersford and Wimborne. We do not have equivalent detailed analysis of costs and energy savings for FBDA implementation at these sites, but have drawn on the conclusions of the 2014 Stantec work to produce indicative figures based on the surface area of the aerated chambers in use.

Savings: at Avonmouth we aim to achieve a 8.7 GWh cumulative saving once the scheme is complete, which translates to a circa 2,300 $tCO_2e$ saving at the 2022-23 grid emissions factor. Across Chippenham, Palmersford and Wimborne we aim to achieve a 1.1 GWh cumulative saving once the scheme is complete, which translates to a circa 290t $CO_2e$ saving at the 2022-23 grid emissions factor.

Our mitigation of the principal uncertainties (scheme delivery costs, actual energy savings and future electricity prices) will centre on our experience of delivering capital schemes and energy efficiency projects in general and FBDA schemes in particular.

*Table 17 FBDA costs, Avonmouth*

| | Wastewater | |
|---|---|---|
| Capex £m: £4.700 | Total opex £m: -£5.395 | Totex 2025-30 £m: -£0.695 |
| Annual CO2 saving by 2030: 2,268 t | | |

*Table 18 FBDA costs, other sites*

| | Wastewater | |
|---|---|---|
| Capex £m: £0.873 | Total opex £m: -£0.418 | Totex 2025-30 £m: £0.455 |
| Annual CO2 saving by 2030: 286 t | | |

### 4.5.7. Electricity: solar photovoltaics (PV) hosted at Wessex Water sites

**Context**
To date, the large majority of our renewable energy generation has been via biogas from anaerobic digestion of sewage sludge; medium and small-scale hydro turbines at three sites; and solar photovoltaic panels on the roofs of our Operations Centre and Sutton Bingham water treatment centre. Marked improvements to the economics of solar energy has improved the feasibility of this option.

**Proposal**
We aim to expand our use of electricity from solar PV, generated at our own sites. Having considered various arrangements for this, our preferred approach is to invite third parties to build, own and operate solar PV installations on our land, and for us to take the electricity directly for onsite use. This offers opportunities for opex savings, as well as the additionality of new renewable onsite electricity displacing grid electricity imports.

Looking across all our sites, we identified 36 that are technically suitable (e.g. energy generation potential and having immediate onsite use of the power), and would also be suitable from a local planning perspective. We then commissioned DNV to carry out an independent review of the shortlisted sites. A mathematical model was applied to 36 sites to determine the potential or optimum size of PV arrays, potential cost savings, forecast power output, and indicative PV system layout for each site. All 36 sites were deemed technically feasible, but we propose to exclude small scale roof mounted systems which would require high power purchase agreements. Consequently we propose progressing at 26 sites, with a water : wastewater split of 31:69. Combined, we estimate that these will displace 4.75 gigawatt hours of imported grid electricity each year. Regarding delivery, we expect to award tenders at the start of 2025-2030 with construction occurring in the first two years of the period.

*Table 19 Solar PV costs*

| | | Both services |
|---|---|---|
| Capex £m: £0.100 | Total opex £m: -£2.940 | Totex 2025-30 £m: -£2.840 |
| Annual CO2 saving by 2030: 1,243 | | |

### 4.5.8. Private wire from neighbouring renewable energy

**Context**
There are opportunities to power our sites with renewable energy from neighbouring electricity generation.

**Proposal**
Some of our sites are sited close to renewable electricity generation owned by third parties. We will actively explore opportunities to buy the power generated for our own operational use, via ‘private wire’ arrangements. As these would not involve the creation of a new asset there would be no capex associated with this option, and we would seek arrangements with a neutral opex position also. We aim to use circa 20 GWh annually through these arrangements by 2030, which translates to a circa 5,500t $CO_2e$ saving at the 2022-23 grid emissions factor.

*Table 20 Neighbouring renewable energy*

| | | Both services |
|---|---|---|
| Capex £m: n/a | Total opex £m: £0 | Totex 2025-30 £m: £0 |
| Annual tCO2 saving by 2030: circa 5,500 | | |

### 4.5.9. Other: renewable electricity purchase

Even with increasing self-generation and 'behind the meter' power purchase agreements, we expect our grid electricity consumption to remain in excess of 210 GWh during 2025-30, which translates to around 41,000 tonnes $CO_2e$ at the 2022-23 grid emission factor.

We will seek to contract with grid electricity suppliers for the supply of renewable energy backed by REGOs (renewable energy guarantees of origin). We are aware that this does not fit with the location-based reporting approach specified for the 2025-2030 performance commitment, so this would only be applied for corporate reporting (e.g. TCFD reports) and for our net zero target, using market-based reporting methods.

## 4.6. Reductions from enhancement

These options would not be considered as base maintenance as they the creation of new assets. Where carbon reductions are taking place in the context of an enhancement scheme that is underpinned by another driver (e.g. improving the quality of rivers and coastal water) we categorise the investment as 'standard enhancement'. Where the primary driver is greenhouse gas emissions reduction, i.e. they do not occur alongside investment to meet another 'standard' enhancement requirement, we propose the intervention be categorised in the net zero carbon challenge.

### 4.6.1. Fossil fuels: alternative, low carbon heating of anaerobic digesters

**NET ZERO CARBON CHALLENGE**

**Context**
The main use historically of biogas from anaerobic digesters has been to generate electricity, via combined heat and power engines. The exhaust heat from the CHP engines is in turn used to maintain the correct operating temperature in the digesters. Since 2014, at Avonmouth sludge treatment centre we diverted sewage-derived biogas from the CHP engines to the production of biomethane, which is exported to the local gas grid. To compensate we have imported additional natural gas to run the CHP engines for two purposes, namely a) to maintain the exhaust heat output required by the digesters and b) to produce electricity as a substitute for imported grid electricity, based on their relative prices.

**Proposal**
We propose to install a 2MW heat pump that draws heat from the treated effluent downstream of the secondary treatment process at Avonmouth water recycling centre. This would supply heat to the mesophilic anaerobic digesters' hot water circuit by as much as 50 degrees Celsius, reducing the need to use the CHPs and an associated boiler as a heat source.

It is estimated that the heat provided would offset around 10 GWh of natural gas per year, saving around 1.8 kt $CO_2$e. With the additional electricity required to run the heat pump, the net $CO_2$ saving would be around 0.7 kt $CO_2$e per year.

**Need for enhancement investment**
Most gas at Avonmouth is used for CHP engines to produce electricity (to power site). Previously this has been cheaper than buying grid electricity, with the CHP providing heat for maintaining the temperature of anaerobic digestors. However, with increasing gas prices and the falling carbon intensity of grid electricity, the economic and environmental cases for this are less compelling now. If electricity needs to be imported to power the site, the carbon footprint will become much less in the years ahead, i.e. likely falling to less than 0.1 kg CO2 / kWh by 2030, compared with >0.4 kg CO2 / kWh when we started to use significant quantities of natural gas for power generation.

We will continue to need a heat source for anaerobic digestors; heat demand has been steadily around 23 GWh thermal for the last three years. We aim to do this in a way that reduces our scope 1 fossil fuel emissions, as well as reducing the volume of UK Emissions Trading Scheme allowance that we are required to purchase.

**Best option for customers**
We envisage generating some of the necessary heat from gas CHP engines, at around 14 GWh thermal per year. The natural gas required for this would be about 31 GWh/year, around the levels seen in 2017-18 – this change would be delivered through base maintenance.

However, we also see the potential for further gas use reduction through effluent heat recovery; specifically, taking heat from the high volumes of treated effluent exiting the sequencing batch reactors. This is an innovative renewable energy method which would involve the creation of new physical assets. As the primary driver for doing this is greenhouse gas emission reduction, we consider this to be a suitable submission for the net zero carbon challenge.

The remaining heat requirement of around 10 GWh/year can be supplied by the envisaged heat pump. No boilers would be required for any additional heat requirements. The heat recovery equipment will be source from M&E sector vendors, using standard procurement processes. Potential cost savings are linked to the reduced gas consumption (minus the additional electricity required to run the heat pump); our estimates of monetary savings are based on related forecasts of energy prices and an estimate of ongoing maintenance costs.

**Cost efficiency**

Project costs estimates have been informed by a quote from a company specialising in heating and cooling systems (IPT-Technology) based on their GeoCube heat pump. Estimated savings are based on our measurements of gas, electricity and heat flows in relation to our CHPP equipment and the digesters, and the forecasts of future energy costs.

We believe that this overall approach presents good value, deriving renewable from a plentiful onsite source and reducing exposure to external energy markets, while sustaining the use of current digester assets. Operational savings would pay back the initial investment comfortably within the 2025-2030 period. The principal uncertainties relate to actual future energy prices (and therefore savings) and downtime for maintenance. The main mitigation is the processes we apply routinely in the management of mechanical and electrical equipment assets.

The estimated net carbon benefit of this option is 0.7 kilotonnes CO2 equivalent per year.

*Table 21 GeoCube heat pump costs*

| | Wastewater | |
|---|---|---|
| Capex £m: 1.079 | Total opex £m: - £4.769 | Totex 2025-30 £m: - £3.690 |
| Annual CO2 saving by 2030: 730 | Cumulative totex / cumulative tCO2e (y5) - £1,264 | |

*Table 22 GeoCube analysis*

| | Requirement | See section | Comment |
|---|---|---|---|
| **A1.1.1 Need for enhancement investment** | | | |
| A | Is there evidence that the proposed enhancement investment is required (i.e. there is a quantified problem requiring a step change in service levels)? This includes alignment agreed strategic planning framework or environmental programme where relevant. | 1 | The need to reduce our carbon footprint, contributing to UK carbon budgets linked to some cost savings.<br>No specific regulatory drivers related to gas use. |
| B | Is the scale and timing of the investment fully justified, and for statutory deliverables is this validated by | - | Quantification through government emission factors via UKWIIR CAW |

| | | | |
|---|---|---|---|
| | appropriate sources (for example in an agreed strategic planning framework)? | | |
| C | Does the proposed enhancement investment or any part of it overlap with activities to be delivered through base, and where applicable does the company identify the scale of any implicit allowance from base cost models? | 4.5, 4.6 | Effluent heat recovery involves new assets; other complementary work to reduce gas use will be delivered through base. |
| D | Does the need and/or proposed enhancement investment overlap or duplicate with activities or service levels already funded at previous price reviews (either base or enhancement)? | - | No |
| E | Is the need clearly identified in the context of a robust long-term delivery strategy within a defined core adaptive pathway? | WSX03 3.8 | Work to reduce gas use is within the core pathway |
| F | Where appropriate, is there evidence that customers support the need for investment (including both the scale and timing)? | - | Support for emissions reduction in general |
| G | Is the investment driven by factors outside of management control? Is it clear that steps been taken to control costs and have potential cost savings (e.g. spend to save) been accounted for? | 1 | Investment driven by corporate net zero aims, informed by national policy<br><br>No steps taken so far to control costs; standard procurement processes would apply<br><br>Evaluation of costs savings through technical supplier quote and energy price forecasts |
| **A1.1.2 Best option for customers** | | | |
| A | Has the company considered an appropriate number of options over a range of intervention types (both traditional and non-traditional) to meet the identified need? | 4.5 | Options: reducing gas use to recent lower levels, and installation of effluent heat recovery to heat the digesters are complementary options. |
| B | Has a robust cost–benefit appraisal been undertaken to select the proposed option? Is there evidence that the proposed solution represents best value for customers, communities and the environment over the long term? Is third-party technical assurance of the analysis provided? | 4.6.1 | Cost-benefit appraisal: semi-robust, i.e. based on market prices for energy and quoted prices for heat pump installation<br><br>The option pays back within five years and therefore offers value for customers.<br><br>Technical assurance of the analysis has not been provided by an independent third party i.e. beyond a potential technology supplier. |
| C | In the best value analysis, has the company fully considered the carbon impact (operational and embedded), natural capital and other benefits that the options can deliver? Has it relied on robustly calculated and trackable benefits when proposing a best value option over a least cost one? | - | The carbon impact has been calculated based on forecast changes to gas and electricity use. Wider natural capital benefits have not been assessed |

| | | | |
|---|---|---|---|
| D | Has the impact (incremental improvement) of the proposed option on the identified need been quantified, including the impact on performance commitments where applicable? | - | Improvements of the proposed option have been quantified using UK emissions factors, as used in the UKWIR CAW. |
| E | Have the uncertainties relating to costs and benefit delivery been explored and mitigated? Have flexible, lower risk and modular solutions been assessed – including where forecast option utilisation will be low? | 4.6.1 | Uncertainties mainly related to the reliability of equipment that we are not very familiar with (but has been proven in other sectors) No mitigation is offered at this stage. |
| F | Has the scale of forecast third party funding to be secured (where appropriate) been shown to be reliable and appropriate to the activity and outcomes being proposed? | - | Not applicable |
| G | Has the company appropriately considered the scheme to be delivered as Direct Procurement for Customers (DPC) where applicable? | - | Not applicable |
| H | Where appropriate, have customer views informed the selection of the proposed solution, and have customers been provided sufficient information (including alternatives and its contribution to addressing the need) to have informed views? | - | Customers have not been consulted on this specific option |
| **A1.1.3 Cost efficiency** | | | |
| A | Is it clear how the company has arrived at its option costs? Is there supporting evidence on the calculations and key assumptions used and why these are appropriate? | 4.6.1 | Option costs have been calculated, based on supplier quote – for supply, installation and maintenance. |
| B | Is there evidence that the cost estimates are efficient (for example using similar scheme outturn data, industry and/or external cost benchmarking)? | - | There are too few of these installations in our sector to judge whether the cost estimate is efficient |
| C | Does the company provide third party assurance for the robustness of the cost estimates? | - | No |
| ***Need for enhancement model adjustment*** | | | |
| D | Is there compelling evidence that the additional costs identified are not included in our enhancement model approach? | - | Not applicable |
| E | Is there compelling evidence that the allowances would, in the round, be insufficient to account for evidenced special factors without an enhancement model adjustment? | - | Not applicable |
| F | Is there compelling econometric or engineering evidence that the factor(s) identified would be a material driver of costs? | - | Not applicable |
| **A1.1.4 Customer protection** | | | |

| | | | |
|---|---|---|---|
| A | Are customers protected (via a price control deliverable or performance commitment) if the investment is cancelled, delayed or reduced in scope? | - | Delivery is factored into our performance commitment level |
| B | Does the protection cover all the benefits proposed to be delivered and funded (e.g. primary and wider benefits)? | - | Yes |
| C | Does the company provide an explanation for how third-party funding or delivery arrangements will work for relevant investments, including how customers are protected against third-party funding risks? | - | Not applicable |

### 4.6.2. Process emissions: nitrous oxide monitoring and control measures

**Context**
Nitrous oxide ($N_2O$) is formed during secondary treatment of sewage as a by-product when incoming ammonia is converted by microbes to nitrate, and with conversion of nitrate to nitrogen gas if there is a denitrifying stage. Once released, $N_2O$ has a global warming potential of 298 times that of carbon dioxide over a 100 year period. As energy and transport decarbonises, process and fugitive emissions will account for a growing proportion of our total emissions.

**Proposal**

## STANDARD ENHANCEMENT: 7 SITES

## NET ZERO CARBON CHALLENGE: 13 SITES

Having started to investigate the monitoring of $N_2O$ emissions, we wish to enact a company-wide monitoring campaign during AMPP8. We propose starting with the largest water recycling centres (WRCs) where secondary treatment mainly takes place through aeration processes, as these are more amenable to measurement than sites with trickling filters. As our 20 largest WRCs of this type account for around 63% of the population we serve we consider this to be a cost-effective approach, i.e. starting with the sites that are likely to have the greatest overall impact.

Investigatory monitoring will take place for two years, with the default technology being sensors that measure $N_2O$ in solution in the aqueous phase. Two years of continuous monitoring will help us better understand the cause-effect relationships at specific sites of the variables noted above and $N_2O$ formation, while also allowing us to see the degree to which $N_2O$ spikes can be prevented and whether levels observed at other times can be reduced. After two years of monitoring at the first tranche of sites, rigs will be de-mounted, moved and re-assembled at other WRCs to repeat the exercise.

We are also aware of the emergence of data-led solutions, which can reduce or eliminate the need for permanent physical monitoring at WRCs, once the principal causes of $N_2O$ formation at each site has been established through monitoring campaigns. We will engage the suppliers of these solutions as part of this exercise with a view to data led optimisation in the medium to long term.

We propose two types of sites, and two corresponding enhancement funding streams

- Seven sites where enhancement investment is planned for 2025-2030 where the driver is another service improvement e.g. improved water quality in rivers of estuaries. The nitrous oxide monitoring in these cases will be classed as standard enhancement.
- Thirteen sites where there is no other enhancement requirement, which means that net zero carbon is the primary driver. For this block we are bidding to the net zero challenge.

**The need for enhancement investment**
To date, there has been little incentive to address $N_2O$ emissions beyond the fact of it being a greenhouse gas. It is not covered by environmental regulation, there is no cost driver (unlike energy and fuels), nor any obvious commercial opportunities. We are pursuing this enhancement investment now because it is the right thing to do for the environment and we foresee greater stakeholder scrutiny of this specific issue in future.

There are considerable uncertainties about the true level of methane and nitrous oxide emitted from sewage and sludge treatment processes arise from them. These are not measured directly because of how they arise, e.g. diffusing into the air from tanks and filters in which sewage is treated, or from anaerobic digesters that are not fully-sealed. Instead, UK water companies estimate these emissions via a standard method, using a few emissions factors that have remained largely the same for around fifteen years.

Currently the emissions of $N_2O$ are estimated using a standardised method (the UKWIR CAW) based on the population served, and assumptions of a) the average nitrogen load per person in sewage and b) the amount of incoming nitrogen converted to $N_2O$. Using this calculation method, our emissions during the last five years have been just under 20,000 t $CO_2$e per year. While this approach has served the purpose of annual reporting, it does not differentiate by process type or operating conditions. However, there is now a facility for reporting companies to input their emissions based on their own monitoring; this proposal will help us provide data specific to Wessex Water, and to then start to manage-down our emissions. The water companies recognise the shortcomings of this estimation method, and are reviewing it in the light of evolving science and the availability of new technology that enables some degree of measurement.

In 2019, the Intergovernmental Panel on Climate Change revised and quadrupled its standard assumption for the amount of incoming nitrogen converted to $N_2O$). For Wessex Water, if this conversion factor were to be applied top-down our $N_2O$ emissions would increase from to circa 80 ktCO2e. Even with the emissions factors in the current UKWIR CAW, $N_2O$ from sewage treatment is likely to be the largest single aspect of our operational greenhouse gas emissions. Consequently, we are aware of the need to better quantify the issue at site level as a precursor and enabler for corrective action, and to reduce reliance on high-level estimates. For now, monitoring work is underway that will help better quantify nitrous oxide emissions at UK water recycling centre and we expect a revised set of emissions factors in the future, at which point we will need to revise our overall carbon footprint calculation. Overall, this is rapidly becoming one of our largest emissions liabilities.

With this project, analysis of N2O levels would be added to tasks of current process scientists. The majority of the project cost involves the purchase of equipment including monitoring rigs, sensors and calibration kit.

**Best option for customers**
Two broad methods have been identified for carrying out this work, both of which require secondary treatment taking place in aerated chambers of liquid (e.g. activated sludge plants, sequencing batch reactors), rather than where biofilm grown on a solid media (e.g. stone trickling filters). The preferred method involves the placement of probes directly into the sewage being treated – this is the most commonly used method where trials have been carried out in the UK; there is single dominant supplier (Unisense) of the probes for this option. A second available method involves domed hoods that float on the surface, with gas sensors in the ceiling of the dome. need to look at relative costs; would be outlined in enhancement case;

As this is a new, developing area of work, neither the costs nor the benefits are well established and the supply chain is relatively small. Current emissions estimates are at a very broadly estimated, and true values may vary widely; through this project we seek be in a position to better quantify our emissions. As such we cannot yet claim that the current cost-benefit assessment is robust. However, any future investment in corrective action or management practices will be more robust based on the findings from this project. Moreover, we are seeing entrants to this field from the arena of big data, digital twins and predictive analytics / machine learning – see for example the ongoing innovation challenge being run by Spring. We will learn from these approaches during 2025-2030, as they offer the prospect of managing sewage treatment to minimise nitrous oxide based on modelling and the use of proxy measurement, rather than continuous real-world measurement of nitrous oxide itself.

In terms of the actual emissions benefits that we envisage, we are drawing on monitoring of N2O emissions using dedicated sensors by some wastewater utilities. Some of this information has been assembled in the first two phases of the UKWIR project on process emissions, which has looked for evidence from around the world. There is also early monitoring of N2O emissions underway among some UK wastewater companies. This is helping to build understanding the circumstances leading to high chronic levels of $N_2O$ or acute spikes. Anecdotally, subsequent control measures often leads to reductions of around one quarter to one third. However, there are a number of variables at play, including dissolved oxygen levels and their stability, flow, biological load and the time of year.

For the purpose of this proposal, our estimates of potential emission reductions are summarised in Table 22:

*Table 23 Estimates of potential emission reductions*

| | % of total population equivalent served | Emissions to be addressed | % reduction assumed | Emissions reduction |
|---|---|---|---|---|
| **Sites covered by standard enhancement** | 43% | 7.9 | 25% | 1.978 |
| **Sites covered by net zero carbon challenge** | 19% | 3.68 | 25% | 0.920 |

We will be able to identify at the end of this work what emissions reduction could be achieved or sustained through future management of the WRCs monitored during the 2025-2030 assessments. It will also help us estimate savings from WRCs that have not been monitored but have similar processes. We also understand that some WRCs may be more complicated than others, e.g. those (such as Avonmouth) with sequencing batch reactors where the water level rises and falls constantly as an inherent part of the treatment process, Nevertheless, the approach we advocate here is flexible as we are not proposing long-term fixed installations; instead, this project involves temporary calculation to build up picture about each WRC which should enable more accurate emissions calculation based on this 'ground truthing'.

**Cost efficiency**

The cost involved for installation and monitoring well understood; we have quotations from the technology supplier and local installers of monitoring rigs. We expect some variability for the installation cost at sites that are more complicated. We will seek opportunities for efficiencies and competitive quotes on a per-unit basis with a larger volume of installation. We have also included added assumptions around the time required carry out site visits and calibrate sensing tools.

At present, we have not assessed potential cost savings from reducing nitrous oxide emissions. In the future, with a better understanding of the costs and benefits of this activity, we will be able to better compare N2O reduction with other monetised reduction and the cost to offset residual emissions as part of our corporate commitment. However, we are fully aware that this would not count towards the common performance commitment for 2025-30.

### a. Standard enhancement

*Table 24 Standard enhancement*

| | Wastewater | |
|---|---|---|
| Capex £m: £0.506 | Total opex £m: 0.346 | Totex 2025-30 £m: £0.852 |
| Annual tCO2 saving by 2030: 1,978 | Cumulative totex / cumulative tCO2e (y5) £216 | |

### b. Net zero carbon challenge

*Table 25 Net zero carbon challenge*

| | Wastewater | |
|---|---|---|
| Capex £m: £0.831 | Total opex £m: £0.538 | Totex 2025-30 £m: £1.370 |
| Annual tCO2 saving by 2030: 892 | Cumulative totex / cumulative tCO2e (y5) £771 | |

*Table 26 Project analysis*

| | Requirement | See section | Comment |
|---|---|---|---|
| **A1.1.1 Need for enhancement investment** | | | |
| A | Is there evidence that the proposed enhancement investment is required (i.e. there is a quantified problem requiring a step change in service levels)? This includes alignment agreed strategic planning framework or environmental programme where relevant. | 1 | N2O is becoming a major component of total emissions. There are no regulatory or legislative driver; company action is voluntary and based on reducing environmental harm |
| B | Is the scale and timing of the investment fully justified, and for statutory deliverables is this validated by appropriate sources (for example in an agreed strategic planning framework)? | - | Quantification through UKWIR CAW. This relies on high level assumptions; this project is needed to provide better data |
| C | Does the proposed enhancement investment or any part of it overlap with activities to be delivered through base, and where applicable does the company identify the scale of any implicit allowance from base cost models? | 4.6.2 | Analysis of N2O levels to be added to tasks of process scientists |
| D | Does the need and/or proposed enhancement investment overlap or duplicate with activities or service | - | No |

| | | | |
|---|---|---|---|
| | levels already funded at previous price reviews (either base or enhancement)? | | |
| E | Is the need clearly identified in the context of a robust long-term delivery strategy within a defined core adaptive pathway? | WSX02 3.8 | Yes, this monitoring and control is part of our core pathway |
| F | Where appropriate, is there evidence that customers support the need for investment (including both the scale and timing)? | - | Support for emissions reduction in general |
| G | Is the investment driven by factors outside of management control? Is it clear that steps been taken to control costs and have potential cost savings (e.g. spend to save) been accounted for? | 4.6.2 | External factors: in part, i.e. the re-appraisal of wastewater emissions by IPCC<br><br>Cost estimates are based on quotes for equipment and rig installation. Potential cost efficiencies with a larger volume programme,<br><br>Future savings: not apparent as N2O emissions specifically are not yet monetised. |
| **A1.1.2 Best option for customers** | | | |
| A | Has the company considered an appropriate number of options over a range of intervention types (both traditional and non-traditional) to meet the identified need? | 4.6.2 | Two broad methods: liquid probes (dominant method) and gas hoods |
| B | Has a robust cost–benefit appraisal been undertaken to select the proposed option? Is there evidence that the proposed solution represents best value for customers, communities and the environment over the long term? Is third-party technical assurance of the analysis provided? | 4.6.2 | This is a developing area. The cost-benefit equation is not yet robust, but future investment will be more robust based on the findings from this project. Other alternative methods are in development e.g. digital twins, predictive analytics. Evidence of best value is limited by the lack of UK real-world emissions data. Third party technical assurance of the solution has not been provided. |
| C | In the best value analysis, has the company fully considered the carbon impact (operational and embedded), natural capital and other benefits that the options can deliver? Has it relied on robustly calculated and trackable benefits when proposing a best value option over a least cost one? | 4.6.2 | A provisional estimate of emissions savings has been made. Wider natural capital benefits would relate to impacts on atmospheric regulating services. |
| D | Has the impact (incremental improvement) of the proposed option on the identified need been quantified, including the impact on performance commitments where applicable? | - | Potential improvements are based on the addressable emissions based on population served by WRCs |
| E | Have the uncertainties relating to costs and benefit delivery been explored and mitigated? Have flexible, lower risk and modular solutions been assessed – including where forecast option utilisation will be low? | - | The main uncertainties: true emission levels; responsiveness to management interventions; variability of installation costs. |

| | | | |
|---|---|---|---|
| | | | This is a flexible solution being based on temporary calculation work. |
| F | Has the scale of forecast third party funding to be secured (where appropriate) been shown to be reliable and appropriate to the activity and outcomes being proposed? | - | Not applicable |
| G | Has the company appropriately considered the scheme to be delivered as Direct Procurement for Customers (DPC) where applicable? | - | Not applicable |
| H | Where appropriate, have customer views informed the selection of the proposed solution, and have customers been provided sufficient information (including alternatives and its contribution to addressing the need) to have informed views? | - | Customer views on this specific issue and solution have not been sought. |
| **A1.1.3 Cost efficiency** | | | |
| A | Is it clear how the company has arrived at its option costs? Is there supporting evidence on the calculations and key assumptions used and why these are appropriate? | 4.6.2 | Quotes from service providers (equipment, installation) |
| B | Is there evidence that the cost estimates are efficient (for example using similar scheme outturn data, industry and/or external cost benchmarking)? | 4.6.2 | This activity is at a relatively early stage. Equipment providers are very limited. |
| C | Does the company provide third party assurance for the robustness of the cost estimates? | - | Not for this specific activity. |
| ***Need for enhancement model adjustment*** | | | |
| D | Is there compelling evidence that the additional costs identified are not included in our enhancement model approach? | - | Not applicable |
| E | Is there compelling evidence that the allowances would, in the round, be insufficient to account for evidenced special factors without an enhancement model adjustment? | - | Not applicable |
| F | Is there compelling econometric or engineering evidence that the factor(s) identified would be a material driver of costs? | - | Not applicable |
| **A1.1.4 Customer protection** | | | |
| A | Are customers protected (via a price control deliverable or performance commitment) if the investment is cancelled, delayed or reduced in scope? | - | Not applicable in this instance |
| B | Does the protection cover all the benefits proposed to be delivered and funded (e.g. primary and wider benefits)? | - | Not applicable |

| | | | |
|---|---|---|---|
| C | Does the company provide an explanation for how third-party funding or delivery arrangements will work for relevant investments, including how customers are protected against third-party funding risks? | - | Not applicable |

### 4.6.3. Process emissions: reductions related to the Industrial Emissions Directive.

**ENHANCEMENT - BIORESOURCES**

**Context**

As noted previously, the anaerobic digesters we use to treat sewage sludge are not perfectly sealed systems, and the post-treatment storage units at our sludge treatment centres are unenclosed. The Industrial Emissions Directive is requiring extensive investment as sludge treatment centres, including the covering of secondary sludge storage.

**Proposal**

Our proposals for covering digestate storage are covered in WSX18 *Bioresources strategy and investment.* The costs of this work are submitted separately through the Bioresources programme; i.e. they are not being submitted under a greenhouse gas emissions heading.

We estimate that the greenhouse gas emissions savings will amount to 2,983 tonnes $CO_2e$ with all storage tanks covered. This is based on the conversion factor used in the UKWIR CAW, i.e. 8kg methane emitted per tonne dry solid in unenclosed secondary storage. This is then multiplied by 25 for the global warming potential of methane, and applied to the forecast tonnage in dry solids of raw sludge to be processed in conventional digestion.

### 4.6.4. Transport: Installation of EV charging infrastructure

**ENHANCEMENT (M&G)**

***Proposal***
In line with the trend of decarbonisation happening first for lighter vehicles, we propose to invest in the infrastructure necessary for running electric cars and smaller vans. Electric vehicles would not be zero carbon given the requirement for additional grid electricity; however with the reducing carbon intensity of grid electricity the carbon benefits of this intervention will increase over time. For now we are projecting a 1.4 kilotonne saving based on a 60% reduction from the baseline LGV emissions of 2.3 kt.

The costs of this work are submitted separately through the Management and General enhancement programme; i.e. they are not being submitted under a greenhouse gas emissions heading.

***Context***
Our transport emissions averaged 11 kilotonnes over the last five years and we are looking at ways to decarbonise our vehicle fleet. Cars and smaller vans (LGVs) account for around one fifth of our vehicle CO2 emissions, medium goods vehicles account for around 43%, and heavy goods vehicles (HGVs) for around 37%.

National policy is for the phase-out of new petrol and diesel cars and vans by 2030, and new diesel HGVs by 2040. From 2035 an outright ban on cars and vans that produce emissions from the tailpipe will be implemented.

Our 2021 route map to net zero operational carbon sets out actions we need to take to achieve net zero operational carbon by 2030. This will involve a combination of both readily available and innovative technologies and ways of working. Increasing the use of lower carbon transport is a key element required to meet this target.

*Table 27 extract from 'Our Route map to Net Zero'*

| | |
|---|---|
| Avoiding transport emissions | **From 2020**<br>• Investing in infrastructure to enable the transition to electric and other non-fossil fuel vehicles.<br>• Starting to use electric cars and vehicles on a regular basis.<br>• Trialling HGVs powered by compressed natural gas and biogas.<br>• Wide use of homeworking and teleconferencing technologies.<br>**2025-30**<br>• Programmed roll-out of appropriate electric cars and vans and associated infrastructure.<br>• Integration of lower carbon HGVs. |
| Transport efficiency | **2020-30**<br>• Further use of technology to optimise vehicle movements and reduce mileage.<br>• Increasing focus on vehicle fuel / electrical efficiency. |

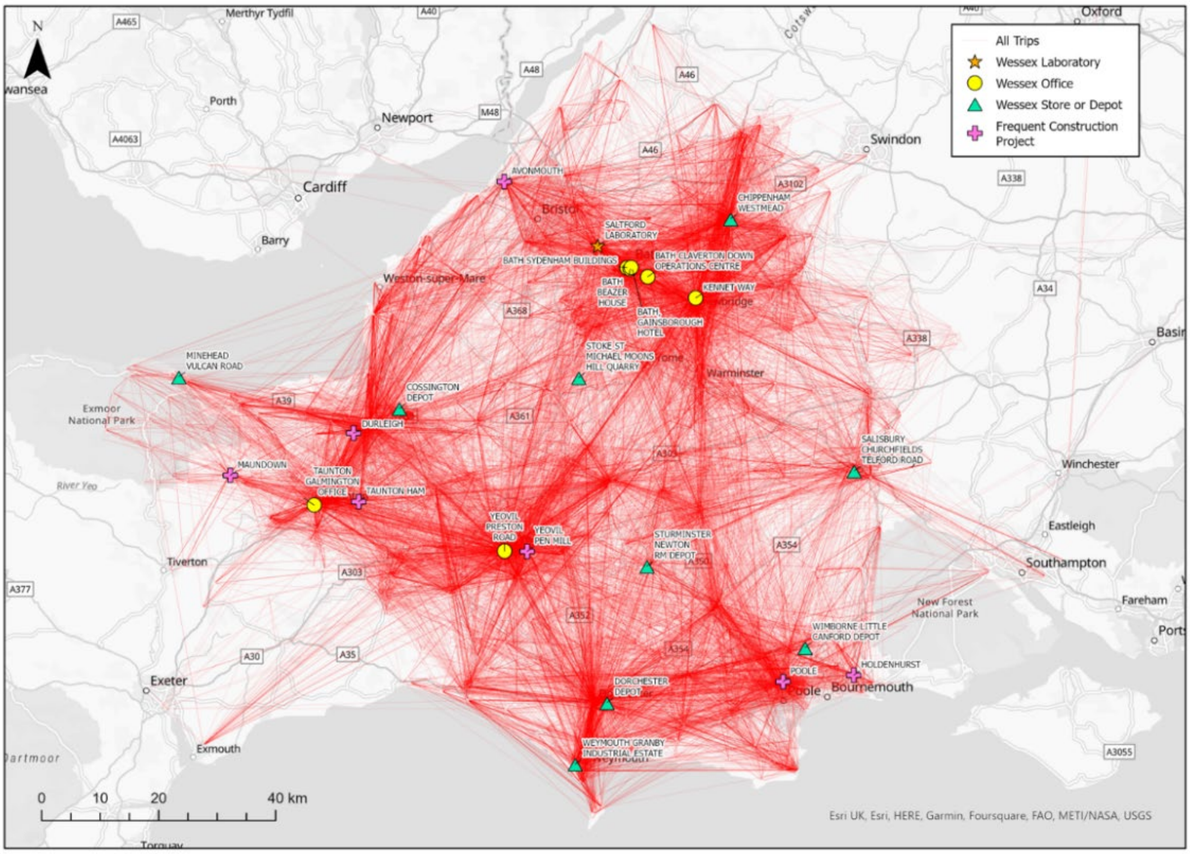
To mitigate national policy measures and support meeting our operational net zero goals we are proposing to install electric vehicle (EV) charging infrastructure to serve our changing fleet. Early on in our approach we identified that the current EV technologies available would not be suitable for our larger van fleet that tow or HGVs. Therefore, the focus of this proposal will be on our small van fleet and a small proportion of the large van fleet. As of 2021 our vehicles fleet comprised 360 company cars, 450 small vans, 525 large vans and 70 HGVs. All studies were based on this fleet profile.

## Highlighting the need

With the government restriction on the purchase of ICE vehicles, we have to consider a wholesale fleet change. The government guidance on which vehicles will be suitable from 2030 is limited, which steers us towards a fully electric small to medium sized van fleet. Van manufacturers have embraced fully electric vehicles but there are very few hybrid or plug in hybrid van options. Large vans that need to tow have not been included due to the available options due to the towing capacity required. For example, a sewerage jetting unit weighs in at 1.5t and currently there are no electric vans on the market that can tow this weight.

To assess our EV infrastructure needs at Wessex Water we commissioned Stantec to carry out a study and review of our needs. Stantec analysed data from 343 van vehicle trackers to understand the journeys carried out, their relationship to Wessex Water key site, and to develop an approach to charging. From the two months of data the 343 small/medium sized vans undertook a total of 68,000 trips, illustrated below.

*Figure 4 Vehicle tracker illustration*




Based on the journeys and distance travelled around 50% of the vehicles would need to be charged between two and four times per week. Some of the fleet would need very infrequent charging whilst others would need more than seven charges per week.

*Figure 5 Vehicle tracker summary*

One of the main factors around the frequent charging needs is the reduced range of electric vans. Stantec supplied details of small electric vans and their expected range in the study (see right). The Worldwide Harmonised Light Vehicle Test Procedure (WLTP) does not take into account real world usage and carrying a load so vehicle ranges are often over estimated when compared to real world applications. Also, rapid charging capability only charges vehicles to between 70-80% of full charging capacity, further impacting the possible range. Additionally to ensure good asset life from electric vehicles, battery management needs to be considered. DC fast charging only has a detrimental impact on battery lifespan. EV batteries need to be charged via an AC charger incrementally to maintain their lifespan.

| **Small Vans** | WLTP (Miles) | Lowest range* | 70%** of range |
|---|---|---|---|
| Renault Kangoo E-Tech | 186 | 115 | 81 |
| Peugeot e-Partner | 171 | 105 | 74 |
| Toyota Proace City | 168 | 105 | 74 |
| **Medium Vans** | | | |
| Volkswagen ID.Buzz Cargo | 256 | 160 | 112 |
| Mercedes eVito | 92 | 60 | 42 |
| Maxus eDeliver 3 (LDV) | 151 | 95 | 67 |
| Vauxhall Vivaro Electric | 205 | 125 | 88 |
| Toyota Proace Electric | 205 | 125 | 88 |
| **Large Vans** | | | |
| Fiat E-Ducato | 175 | 110 | 77 |
| Iveco eDaily | 186 | 115 | 81 |
| Maxus eDeliver 9 (LDV) | 185 | 115 | 81 |
| Ford E-Transit | 196 | 120 | 84 |

* Based on Kangoo figures – 43mph, 5 degrees C, Fully laden, non ec
** Rapid charge to 80% / Min charge 10%
Figures don't allow for towing

As the EV fleet grows accessibility to charging infrastructure will necessitate changes to staff scheduling and management, ensuring the best possible operational efficiency. From the data available Stantec calculated that the average achievable distance after a charge for small/medium sized vans is 80 miles.

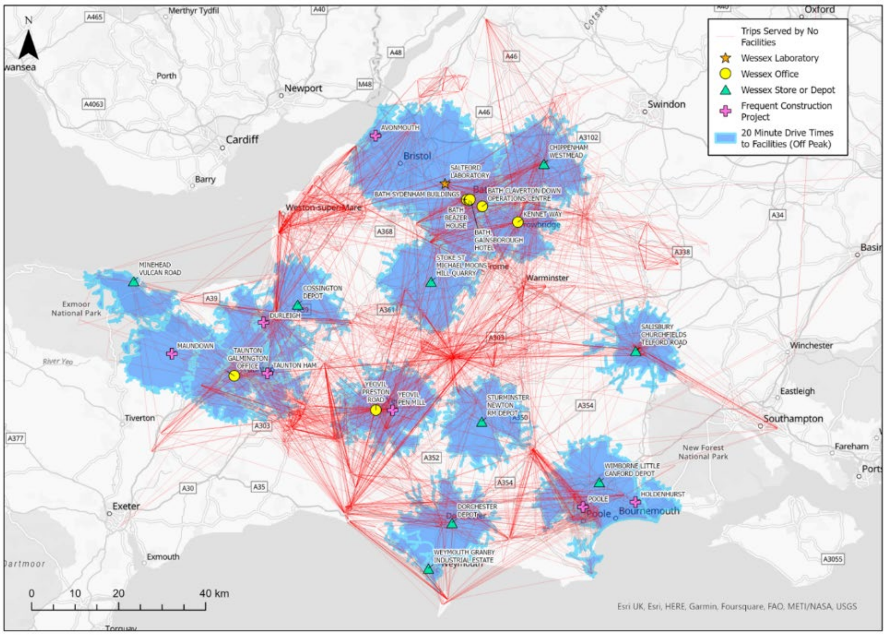
## Understanding the risk

The move to electric vehicles will impact on productivity, primarily due to the length of time taken to charge rather than simply filling up at a fuel station.

The study investigated how many journeys could be met by infrastructure at one of 24 of our key sites, with a sub-20 minute diversion to and from the routes captured in the two-month period. It concluded that

- 79 vehicles would have all their charging needs met, with no change to the existing journey.
- 214 vans would need to divert their journeys by up to 20-minutes each way
- 50 vehicles would not be served with the diversion times being over 20-minutes each way (see right, red lines).

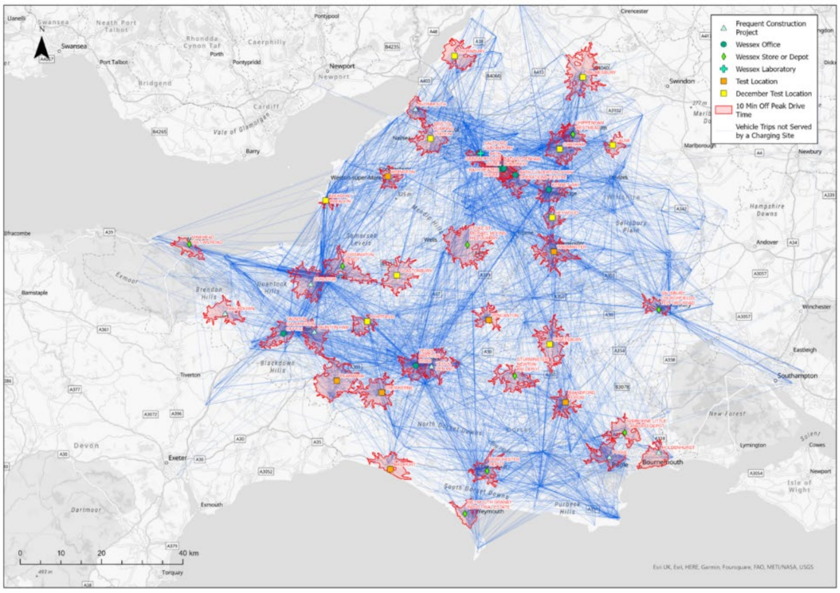
*Figure 6 Charging point illustration, 24 sites*




An alternative model was tested with charging points at 17 additional sites (a total of 41), and a 10-minute each way diversion to the charging infrastructure. In this scenario:

- 111 of the vehicles would have all their charging needs met with no change to the existing journey.
- 131 vans would need to divert their journeys by up to 10-minutes each way
- 101 of the vehicles would not be served at all with the diversion times being over 10-minutes each way (see right).

*Figure 7 Charging point illustration, 41 sites*




This evidence shows that there will be a drop in productivity related to the increase in EV vans with vehicles spending more time diverting and waiting to charge. The use of public infrastructure and home charging has also been considered to mitigate the change. This brings a number of additional challenges around legal responsibility, accessibility, public perception and charging efficiency.

The recent government study (https://www.gov.uk/government/statistics/electric-vehicle-charging-device-statistics-april-2023/electric-vehicle-charging-device-statistics-april-2023) of EV charging highlights that although accelerating, the infrastructure roll out is not sufficient to meet Wessex Water's fleet needs. As of July 2023 there are 45,737 charging devices at 26,805 locations across the UK (Source: https://www.zap-map.com/ev-stats/how-many-charging-points). Of these, only 20% are rapid and ultra-rapid chargers which would be needed to maintain productivity. Our operating region has only 7% of the national charging infrastructure or 44 chargers per 100,000 of population, with fewer than 11 rapid chargers per 100,000 of population.

Relying on this network for fleet charging would significantly increase unproductive time, and risk increased customer complaints and negative perception if our vehicles delayed customers from accessing chargers. Moreover, charging at public charging infrastructure would not ensure operational efficiency. According to zap-map.com in June 2023 the average price for EV charging ranged between 49p/kWh using slow / fast chargers (3-22kW) to 75p/kWh using rapid / ultra-rapid chargers (25-100+kW). As our energy tariffs currently substantially lower than this, using public infrastructure for the majority of our charging needs would not be efficient.

Home charging vans has also been considered; this presents several issues:

- Employees without off-street parking would be automatically excluded.
- If a home charger were to be installed by Wessex Water, the liability of ensuring the home electrics is compliant would fall on the company, in many cases this would make the installation unviable.
- If an employee leaves the company it would not be cost effective to remove the charger, so the asset would need to be written off.
- The installation of a charger at an employee's home would also be classed as a taxable fringe benefit that some employees may not be happy with.

Details relating to the challenge of home charging can be found in this article: https://www.automotive-fleet.com/10192592/a-new-asset-class-for-fleet-managers-home-ev-chargers.

For the reasons above Wessex Water will need to carry out further studies into home charging.

## Mitigating the risk

In our management and general (M&G) capital maintenance plan we have proposed that around 60% of our small van fleet will be upgraded to EV. This is based on our standard renewal rate where small vans are replaced every five years. We also propose that 19% of our large van fleet is also updated to EV, and 50% of the large van fleet will be replaced using ICE vehicles. This is based on our standard renewal rate of seven years for large vans and the inability for EV vans to tow the capacities required for standard business operations. Based on these proposals we will have in excess of 350 EV vehicles by the end of 2025-2030. Our proposal is that in excess of 90% of these will have access to corporate EV charging infrastructure by 2030.

Stantec approached the Electricity Distribution Network Operators (DNO) to assess the cost of additional capacity and connection at the initial 24 sites highlighted in the study. National Grid provided costed estimates for each site; Scottish and Southern Energy provided a fixed estimate regardless of the site location. Only a proportion of the DNO cost estimates will be included in these costs. This is due to the high-level nature of these estimates and likely changes in legislation relating to how DNO's are able to charge for offsite reinforcement of the grid.

While Stantec recommend that further studies are required to identify the best size and locations of chargers, they proposed some initial high-level approaches.

e) Up to 90% of the EV fleet having access to charging infrastructure and a lower productivity impact. This assumes 10-minute diversion each way to charger, 40 sites with dual high-voltage DC chargers, and 22 sites with lower voltage AC chargers

This is the medium cost approach with the associated ongoing operational maintenance cost. This option would need further assessment to assess suitable locations for charging infrastructure to minimise the productivity impact.

f) Up to 95% of the EV fleet with access to charging infrastructure and a lower productivity impact. This assumes 10-minute diversion each way to charger, 40 sites with dual high-voltage DC chargers, 22 sites with lower voltage AC chargers, and 101 home chargers

This is the highest cost approach with the highest ongoing operational maintenance cost. Due to issues relating to installation, maintenance and liability of home chargers, the installation of home chargers will need further assessment. This is the recommended option as this proposal minimises lost productivity when travelling to charging infrastructure.

g) In excess of 70% of the EV fleet with access to charging infrastructure; with a higher productivity impact. This assumes a 20-minute diversion each way to a charger, 22 sites with dual high-voltage direct current (DC) chargers, and 22 sites with lower voltage alternating current (AC) chargers

This is the lowest cost approach with the lowest ongoing operational maintenance cost. Given the likely pace of roll out this approach, we consider this an appropriate balance of meeting the EV infrastructure requirements and minimising the impact on productivity. More EV infrastructure will be required in AMP9 to support the growth of the EV fleet following the ICE ban in 2030. It is also likely that other options will become available to support the large van fleet that have to tow.

Therefore, we propose the highest cost option to meet in excess of 95% of the EV fleets charging needs and to conduct further studies in 2025-2030 on how best to deliver the fleet requirements given the estimates provided by Stantec. The proposed sites, charger types and numbers are subject to change.

*Table 28 electric vehicle infrastructure*

| | | Both services |
|---|---|---|
| Capex £m: 9.534 | Total opex £m: 0.053 | Totex 2025-30 £m: 9.587 |
| Annual CO2 saving by 2030: n/a - enabling activity | Cumulative totex / cumulative tCO2e (10 year) n/a - enabling activity | |

*Table 29 electric vehicle analysis*

| | Requirement | See section | Comment |
|---|---|---|---|
| **A1.1.1 Need for enhancement investment** | | | |
| A | Is there evidence that the proposed enhancement investment is required (i.e. there is a quantified problem requiring a step change in service levels)? This includes alignment agreed strategic planning framework or environmental programme where relevant. | 4.6.4 | Government legislation changes |
| B | Is the scale and timing of the investment fully justified, and for statutory deliverables is this validated by appropriate sources (for example in an agreed strategic planning framework)? | 4.6.4 | Government legislation change 2030 |

| | | | |
|---|---|---|---|
| C | Does the proposed enhancement investment or any part of it overlap with activities to be delivered through base, and where applicable does the company identify the scale of any implicit allowance from base cost models? | 4.6.4 | No |
| D | Does the need and/or proposed enhancement investment overlap or duplicate with activities or service levels already funded at previous price reviews (either base or enhancement)? | 4.6.4 | No |
| E | Is the need clearly identified in the context of a robust long-term delivery strategy within a defined core adaptive pathway? | 4.6.4 | Targeting Government legislation change 2030 |
| F | Where appropriate, is there evidence that customers support the need for investment (including both the scale and timing)? | n/a | n/a |
| G | Is the investment driven by factors outside of management control? Is it clear that steps been taken to control costs and have potential cost savings (e.g. spend to save) been accounted for? | 4.6.4 | Yes |
| **A1.1.2 Best option for customers** | | | |
| A | Has the company considered an appropriate number of options over a range of intervention types (both traditional and non-traditional) to meet the identified need? | 4.6.4 | Yes |
| B | Has a robust cost–benefit appraisal been undertaken to select the proposed option? Is there evidence that the proposed solution represents best value for customers, communities and the environment over the long term? Is third-party technical assurance of the analysis provided? | 4.6.4 | Yes, Stantec report |
| C | In the best value analysis, has the company fully considered the carbon impact (operational and embedded), natural capital and other benefits that the options can deliver? Has it relied on robustly calculated and trackable benefits when proposing a best value option over a least cost one? | 4.6.4 | Yes |
| D | Has the impact (incremental improvement) of the proposed option on the identified need been quantified, including the impact on performance commitments where applicable? | n/a | |
| E | Have the uncertainties relating to costs and benefit delivery been explored and mitigated? Have flexible, lower risk and modular solutions been assessed – including where forecast option utilisation will be low? | 4.6.4 | Yes |
| F | Has the scale of forecast third party funding to be secured (where appropriate) been shown to be reliable and appropriate to the activity and outcomes being proposed? | 4.6.4 | Yes |
| G | Has the company appropriately considered the scheme to be delivered as Direct Procurement for Customers (DPC) where applicable? | n/a | |
| H | Where appropriate, have customer views informed the selection of the proposed solution, and have customers been provided | n/a | |

| | | | |
|---|---|---|---|
| | sufficient information (including alternatives and its contribution to addressing the need) to have informed views? | | |
| **A1.1.3 Cost efficiency** | | | |
| A | Is it clear how the company has arrived at its option costs? Is there supporting evidence on the calculations and key assumptions used and why these are appropriate? | 4.6.4 | Yes |
| B | Is there evidence that the cost estimates are efficient (for example using similar scheme outturn data, industry and/or external cost benchmarking)? | 4.6.4 | Yes - Stantec |
| C | Does the company provide third party assurance for the robustness of the cost estimates? | 4.6.4 | Yes - Stantec |
| ***Need for enhancement model adjustment*** | | | |
| D | Is there compelling evidence that the additional costs identified are not included in our enhancement model approach? | n/a | Not applicable |
| E | Is there compelling evidence that the allowances would, in the round, be insufficient to account for evidenced special factors without an enhancement model adjustment? | n/a | Not applicable |
| F | Is there compelling econometric or engineering evidence that the factor(s) identified would be a material driver of costs? | n/a | Not applicable |
| **A1.1.4 Customer protection** | | | |
| A | Are customers protected (via a price control deliverable or performance commitment) if the investment is cancelled, delayed or reduced in scope? | n/a | n/a |
| B | Does the protection cover all the benefits proposed to be delivered and funded (e.g. primary and wider benefits)? | n/a | n/a |
| C | Does the company provide an explanation for how third-party funding or delivery arrangements will work for relevant investments, including how customers are protected against third-party funding risks? | n/a | n/a |

## 4.7. Feasible: potential delivery through other drivers

### 4.7.1. Vacuum extraction of methane

As noted earlier, one of the requirements of our IED work is to addressing methane emissions from digestate, which we will undertake by coverage of secondary sludge storage.

One of the high-scoring technologies noted by Jacobs in its 2022 Net Zero Technology Review for Ofwat is recovery of the methane from digestate using a vacuum system within an enclosed tank. As Jacob report notes, methane recovered in this way can be blended with the bulk biogas that has been collected from the digester, and the additional methane is approximately equal to the energy required to sustain the process. This also reduces further emission of methane downstream of digestion – although the scale of that problem will vary from site to site – and potentially from digestate at the point of land application.

We have received a quote for this work from the leading supplier of the technology (Eliquo) as part of the IED programme. However, it is not yet clear whether this will be a requirement of our IED, therefore we remain at the exploratory stage.

We are also part of the net zero hub trial led by Severn Trent and supported by the Ofwat innovation competition, which includes Eliquo's Elovac technology. Even if we do not implement vacuum recovery during 2025-2030, we will draw on this project for potential implementation post-2030, plus the experience from other water and sewerage companies that are trialling vacuum recovery.

## 4.8. Feasible but not selected

### 4.8.1. Wind: new on-site self-generation

In the leadup to this submission we have revisited the possibility of *additional* wind turbines sited on our land, either owned and operated by ourselves, or owned and operated by a third party with electrical output consumed on-site.

For evidence regarding this option, we have the 2006 findings from an independent third-party company that is expert in the planning issues for wind power development. This considered the costs and benefits of a single wind turbine Weston Super Mare WRC, on one corner of site, and serves an indicative case for cost estimates and on-site utilisation of power generated. The financial profile of new wind development is not dissimilar now, being around £1.5m per MW installed, and while the benefit of avoiding grid electricity would include the avoidance of distribution charges.

A site such as Weston-super Mare could support a single turbine. If sized at 3 MW capacity, it would generate around 6.5 GWh per year, avoiding 1,700t $CO_2e$ at the 2022/23 grid emission factor.

This option is eminently feasible; however, we have not selected it for this business plan submission. The main reason is the delivery risks associated with wind development in the Wessex Water region, especially regarding local planning and wildlife conservation constraints. We do not believe that any of our sites are sufficiently advanced on these issue in relation to wind development that we can expect successful delivery during 2025-2030.

### 4.8.2. Retaining green gas certificates, relating to exported biomethane.

We export biomethane to the local gas grid at Avonmouth STC and Trowbridge STC, displacing fossil gas in the process. This equates to nearly 26,000 tonnes of avoided $CO_2e$ emissions. Our non-appointed business (Wessex Water Enterprises) sells the associated green gas certificates, generating revenue for the wider group. However, the sale of green gas certificates means that we are not able to subtract the $CO_2$ reduction benefit of the exported biomethane from our reported emissions.

We have decided not to forego the income from the sale of green gas certificates; therefore we are not presenting this as a planned emissions reduction solution for 2025-2030.

### 4.8.3. Sewer heat recovery at one or more major pumping stations

In 2019 GENeco commissioned a third-party consultant report into the feasibility of deploying wastewater heat recovery technology in combination with water-source heat pumps at a large sewage pumping station in Bath to capitalise on the renewable heat potential. The concept involved heat being supplied as low temperature hot water via a district heat network to a nearby housing development for space heating and domestic hot water. The report included a preliminary conceptual design and costing to support any subsequent development of a business case and project plans.

The report concluded that a 3MW sewer heat recovery system at the pumping station could provide in the region of 3.24 GWh of heat. This would be supplemented by gas heating to meet the housing development’s hot water requirements.

We are not proposing this solution within the 2025-2030 business plan, because of uncertainty about our ability deliver this project at this location (or an equivalent elsewhere) in the next five years.

### 4.8.4. Advanced thermal conversion of biosolids

There is growing concern about the ‘standard model’ for sewage sludge treatment and disposal i.e. anaerobic digestion or lime stabilisation, followed by reuse on farmland within the boundaries set by regulation and the safe sludge matrix. The principal concerns relate to nutrient leaching, novel contaminants such as PFAS and microplastics, and emissions of methane and nitrous oxide.

Regarding potential solutions, the emergence of advanced thermal conversion (ATC) techniques is of particular interest for addressing these issues. From a greenhouse gas emissions, the potential to turn biodegradable organic material into forms of stable carbon such as a biochar is of particular interest. Biochar is widely recognised for its potential for greenhouse gas removal as the carbon it contains would remain inert over several decades at least. As well as a method for emissions reduction and carbon capture (and thereby compensating for residual emissions), it can have agronomic benefits - although sewage sludge derived biochar is not yet certified for reuse in agriculture.

In the last two years we have been looking more closely at (ATC) technologies more closely, and in the early stages of this business plan we scoped out trials of three in particular – pyrolysis, hydrothermal carbonisation and supercritical water oxidation. These give rise to different solid outputs - biochar; a coal-like slurry; and small quantities of ash respectively. Each technologies is innovative in our context, as they have not yet been proven at scale in the UK for processing sewage sludge. We considered these as a means of providing additional capacity in 2025-2030 to accommodate increasing sludge volumes due to population growth and phosphorus removal. This would also allow technology trials to be undertaken to help develop further solutions at PR29. However, upon review of the scale of investment required for ATC; the risk of solutions not being reliable; and the lack of a regulatory driver, we decided to not progress unilaterally with ATC trials in 2025-2030. We will instead engage with the wider industry to undertake a collaborative, industry-wide ATC trial, to minimise the risks borne by a company acting on its own.

## 4.9. Exploration, research and other complementary activities during 2025-30

### 4.9.1. Exploration

As technologies that are already widely used will not get us to a net zero carbon position, we need to explore more innovative methods that are not yet sufficiently established or cost-effective to be considered as ‘readily available’ for implementation during 2025-2030. There is a growing list of options in this category, some of which were profiled in the 2022 Jacobs review of net zero technologies and the Water UK net zero routemap. Over the next few years we will maintain a watching brief over these, and in some cases we will carry out closer investigations or take part in trials – either in a lead role or as partners. Technologies of particular interest include:

- Advanced thermal conversion (ATC) methods for treating sewage sludge and capturing carbon in biochar (as noted in 4.8.4)
- Sludge drying, included low-energy drying / dewatering, as a precursor to ATC
- Sewer heat recovery
- Integration of hydrogen with our activities as an alternative to fossil fuels
- Algae-based treatment as a lower energy method for phosphorus removal
- Ammonia stripping / capture for use as a hydrogen carrier and to reduce treatment energy
- Other alternative sewage treatment methods e.g. anaerobic treatment, membrane aerated biofilm reactors
- Techniques to capture or break down nitrous oxide, such as the methods being tested in the Severn Trent Net Zero Carbon Hub project, in which we are a partner.
- Electric / battery powered standby generation.

### 4.9.2. Development of our own work

There are also a number of water and wastewater management practices where we need to develop further evidence of their interplay with greenhouse gas emissions. This will mean supplementing high-level national estimates with data from our own projects and interventions. These include:

- Data from our own projects on the net carbon benefits of more sustainable rainwater management e.g. SUDS, rainwater harvesting – and their comparison with conventional network storage and storm tanks in carbon terms
- Better understanding the carbon dimension of catchment management, wetlands and other nature-based solutions; in terms of both their own emissions, their potential for carbon capture, and their avoidance of emissions from more conventional network and treatment approaches
- Putting whole-life carbon benchmarks and targets into place for capital schemes and implementation of lower wholelife carbon options and materials where possible
- Working with our supply chain to understand their carbon footprint and putting in place plans to reduce this.

Alongside these activities we will continue work on more sustainable approaches, and implement other initiatives, where carbon is one of a number of elements. These include:

- Working with farmers on retention of soil carbon, e.g., through restoration of grassland, as part of the wider suite of catchment-based interventions
- Tree planting, which will offer a long-term carbon benefit – especially in the 2040s and 2050s.
- Further use of technology to optimise vehicle movements and reduce mileage.

### 4.9.3. Carbon offsetting

While buying carbon offsets is at the bottom of the hierarchy, we cannot rule it out. Even with full pursuit of the options available to us, we are likely to have residual emissions in 2030, especially related to nitrous oxide and methane emitted from sewage and sludge treatment. This is true under all forms of carbon accounting, whether corporate carbon accounting with a growing inventory of items (especially in scope 3); or a fixed-in-time reporting *as per* the initial commitment made in 2019 as part of the Public Interest Commitment.

Carbon offsetting is not counted in our performance commitment calculations. If we buy carbon offsets it would be for corporate net zero goals, not for complying with the performance commitment.

If offsetting were an unavoidable way to achieve a net zero position in 2030, we would favour schemes that offered benefits for biodiversity and local communities as well as carbon reduction, such as nature-based projects in our region, or more innovative approaches such as those involving coastal wetlands and marine vegetation. Either way, we would look for projects and providers offering verified carbon offsetting with good permanence.

We will also engage with our customers and other stakeholders on the topic of carbon offsetting to understand their viewpoints.

# 5. Funding emissions reduction

This section summarised our view of how net zero carbon proposals are best allocated for funding from base expenditure, standard enhancement investment and the net zero carbon challenge during 2025-30

## 5.1. Base maintenance

*Table 30 Base maintenance*

| | Emission scope | Capex 2025-30 £m | Total opex 2025-30 £m | $tCO_2e$ reduction 2030 vs 2021-22 |
|---|---|---|---|---|
| **Supply** | | | | |
| HVO instead of diesel | 1 | - | 0.027 | 176 |
| On-site solar generation | 2 | 0.035 | -0.911 | 385 |
| Core energy efficiency work | 2 | 0.880 | -0.573 | 333 |
| Carbon offset purchase (year 5) | Net | - | 0.595 | Residual |
| | | | | |
| **Waste** | | | | |
| Reducing natural gas in CHP | 1 | - | -0.392 | 2,107 |
| HVO instead of diesel | 1 | - | 0.242 | 1,588 |
| Methane monitoring (non-IED sites) | 1 | 0.224 | 0.125 | n/a |
| Low carbon HGVs | 1 | 0.300 | -0.339 | 1,330 |
| Core energy efficiency work | 2 | 3.520 | -2.291 | 1,334 |
| FBDA - Avonmouth | 2 | 4.700 | -5.395 | 2,268 |
| FBDA - other sites | 2 | 0.873 | -0.418 | 286 |
| Neighbouring renewable private wire | 2 | - | - | 5,493 |
| On-site solar generation | 2 | 0.065 | -2.029 | 858 |
| Carbon offset purchase (year 5) | Net | - | 4.875 | Residual |

Nb. Replacement of petrol and diesel cars and light vans lands within the Management and General submission provides a 1,508 CO2e reduction.

## 5.2. Standard enhancement

*Table 31 Standard enhancement*

| | Emission scope | Capex 2025-30 £m | Total opex 2025-30 £m | $tCO_2e$ reduction 2030 vs 2021-22 | £ totex / cumulative tCO2e reduced |
|---|---|---|---|---|---|
| **Waste** | | | | | |
| Nitrous oxide – 7 sites with other enhancement drivers | 1 | 0.506 | 0.346 | 1.978 | 216 |

Nb. Outside this submission are two relevant programmes:

- Installation of electric vehicle charging infrastructure within the Management and General Enhancement submission; this does not have a direct emissions reduction, but is an enabler for emissions reduction from the EVs noted in 5.1.
- Covering sludge storage, driven by the Industrial Emissions Directive is within the Bioresources Enhancement programme. This is estimated to provide a 2,983t CO2e benefit.

## 5.3. Enhancement: net zero carbon challenge

*Table 32 Enhancement: Net Zero challenge*

| | Emission scope | Capex 2025-30 £m | Total opex 2025-30 £m | $tCO_2e$ reduction 2030 vs 2021-22 | £ totex / cumulative tCO2e reduced |
|---|---|---|---|---|---|
| **Waste** | | | | | |
| Effluent heat recovery – Avonmouth | 1 | 1.201 | -4.769 | 0.730 | - 1,264 |
| N2O monitoring & control – 13 sites without other enhancement drivers | 1 | 0.831 | 0.538 | 0.892 | 771 |

# 6. Future emissions: forecasts

As set out previously we will be making multiple parallel annual disclosures of our greenhouse gas emissions during 2025-30. This is already happening and will likely increase in volume and complexity.

## 6.1. Forecast performance commitment levels

The tables below show our forecast based on the specific parameters for the 2025-30 performance commitment.

*Table 33 Forecast, 2025-30 performance commitment, water*

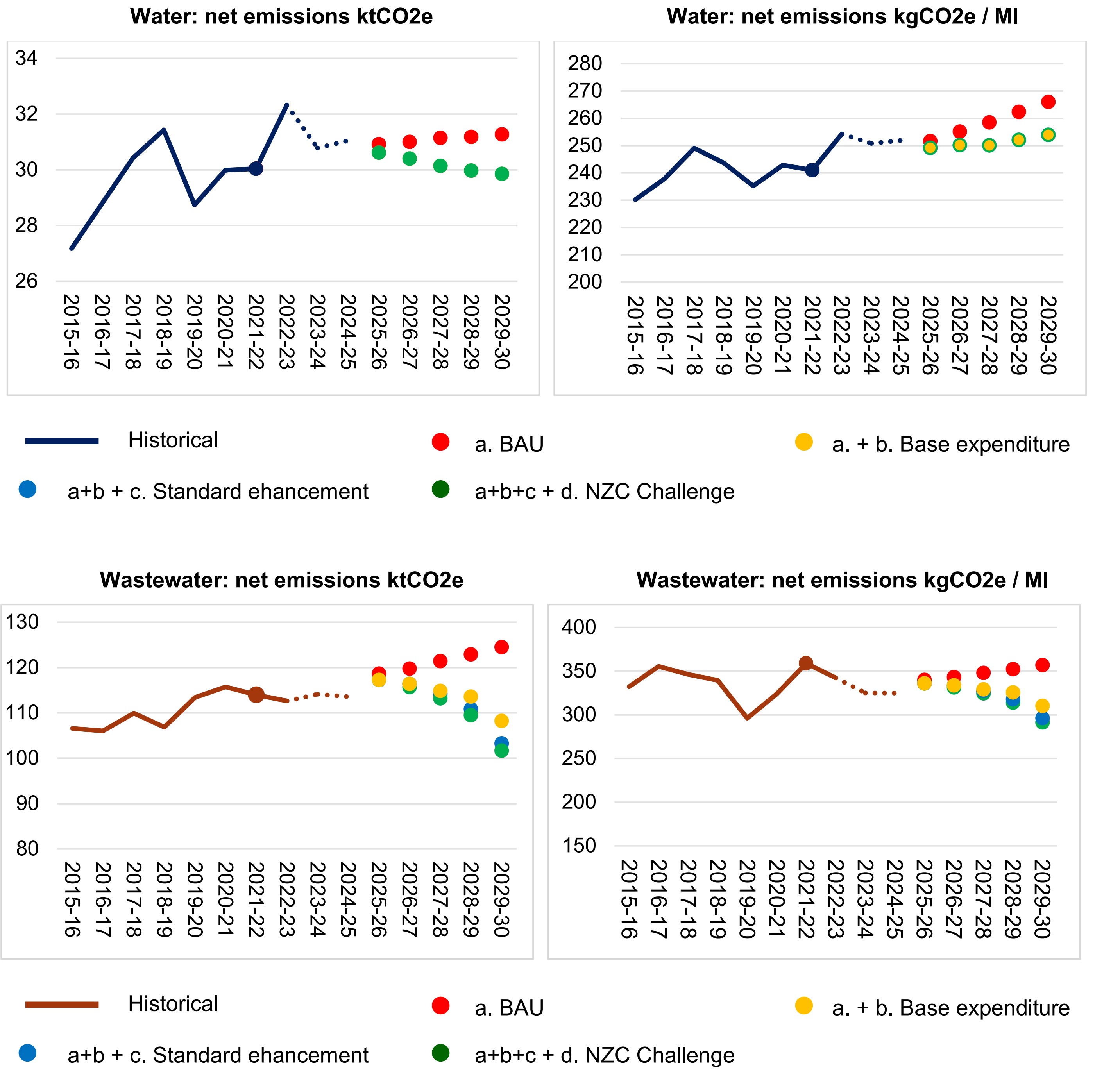
| **Water** | 2021-22 | 2025-26 | 2026-27 | 2027-28 | 2028-29 | 2029-30 |
|---|---|---|---|---|---|---|
| Tonnes $CO_2e$ | **30,040** | **30,618** | **30,395** | **30,136** | **29,965** | **29,848** |
| Change vs base year | | 578 | 355 | 96 | -74 | -192 (-0.6%) |
| kg $CO_2e$ / Ml water distribution input | 241 | 249 | 250 | 250 | 252 | 254 |
| Emissions with base maintenance | | 30,618 | 30,395 | 30,136 | 29,965 | 29,848 |
| Emissions with base maintenance and standard enhancement | | 30,618 | 30,395 | 30,136 | 29,965 | 29,848 |
| Emissions with base maintenance, standard enhancement and net zero challenge | | 30,618 | 30,395 | 30,136 | 29,965 | 29,848 |

*Table 34 Forecast, 2025-30 performance commitment, wastewater*

| **Wastewater** | 2021-22 | 2025-26 | 2026-27 | 2027-28 | 2028-29 | 2029-30 |
|---|---|---|---|---|---|---|
| Tonnes $CO_2e$ | **113,984** | **117,244** | **115,651** | **113,185** | **109,486** | **101,666** |
| Change vs base year | | 3,260 | 1,667 | -800 | -4,498 | -12,318 (10.8%) |
| kg $CO_2e$ / Ml sewage received | 359 | 336 | 331 | 324 | 314 | 291 |
| Emissions with base maintenance | | 117,244 | 116,381 | 114,862 | 113,602 | 108,249 |
| Emissions with base maintenance and standard enhancement | | 117,244 | 116,381 | 114,209 | 110,805 | 103,288 |
| Emissions with base maintenance, standard enhancement and net zero challenge | | 117,244 | 115,651 | 113,185 | 109,486 | 101,666 |

Forecast trends are show in the graphs below.

*Figure 8 forecast trends*




Opportunities for absolute emissions reduction are more numerous and evident on the wastewater side of our business, and it is unsurprising that greater reductions from base plus enhancement are envisaged for the latter. The rising profile of normalised water supply emissions is due to the expected reduction in water distribution input, which will have a disproportionate effect on the $CO_2e$ / Ml calculation.

## 6.2. Other reporting

There is a growing expectation that companies provide as comprehensive a picture as possible in their corporate reporting, which in practice will mean a larger number of scope 3 items (as per the Greenhouse Gas Protocol) than reported in the past. For 2022-23 TCFD reporting we included the same items as were added to the scope 3 inventory for the annual performance report to Ofwat. However, unlike the 2025-30 performance commitment we will use the grid electricity emission factors for each respective year (i.e. the location-based UK grid average) for TCFD reporting and similar.

The inventory of items making up our (PIC) reporting will remain as it was at the time and forms the boundary and content of our net zero commitment to 2030. We will also use market-based reporting for our PIC reporting. Our estimate of our residual emissions in 2030 is 50-55 kilotonnes $CO_2e$.

# 7. Embodied carbon

## 7.1. Introduction

As well as operational carbon emissions, we know that we must address embodied carbon emissions. These are associated with a) building materials (e.g., concrete, cement, steel, aggregates) and other aspects of our construction programme (sometimes referred to as capital carbon) and b) consumables such as treatment chemicals, IT equipment and clothing. Currently, the full extent of our embodied carbon footprint is not known but we are making progress in quantification, although we know that the calculations involved often carry many assumptions and estimates. For example, the carbon footprint of one tonne of steel or cement can vary substantially depending on the types of energy used, the place where it was manufactured, the distance it has travelled to reach us, and the mode of transport used.

While emissions on a per unit basis should decrease over time as heavy industry and manufacturing decarbonises, this could be a relatively slow process as cement, steel, chemicals and manufacturing are recognised as sectors that will have difficulty reducing their carbon footprint. Furthermore the extensive capital programme set out in the business plan is likely to give rise to significant embodied carbon emission, purely as a function of its scale. Nevertheless we are committed to reducing our total emissions to net zero, including those related to our supply chain emissions, by 2040 at the latest. This will be ten years ahead of the UK's commitment to achieve net zero carbon emissions by 2050. It will also mean challenging assumptions about the best ways to carry out investment for customers, our communities, and the water environment.

## 7.2. Quantification

### 7.2.1. Overview of method

We are working with Mott MacDonald to embed a process for quantifying whole life carbon as business-as-usual., as a pre-requisite for capital scheme evaluations and wholelife emissions reductions. We are estimating emissions from capital projects is on a cradle-to-build basis. The procedure began with a "bottom-up" assessment of the carbon footprint of individual capital schemes for PR24 business plan preparation, using company information and Mott MacDonald's Moata carbon portal. In each case, this calculates the carbon footprint of specific assets and components. This produced a detailed assessment of carbon / cost intensity ratios for categories of capital schemes which were applied to the top 80% of schemes by expenditure during 2022-23. For schemes covered by the remaining 20% of expenditure, an average carbon / cost intensity ratio was applied. Combined, these methods produced the embodied carbon related to each scheme category.

This method provides a good start. It offers good coverage including multiple projects from each of the four workstreams, encompassing both capital maintenance and enhancement works, with carbon / cost intensities derived from real Wessex Water asset and activity data. The scope of the carbon model data used is considered of good quality and attempts to cover a full cradle-to-build asset boundary. The datasets used are industry recognised and relevant to UK construction, and our partner Mott MacDonald is fully engaged with recognised standards such as PAS 2080, CESSM4:2013. More detail of our assessment of our current methodology is given below.

**Strengths**

**Coverage:** 74% of 2022/23 spend was assessed in accordance with the methodology, covering multiple projects from each of the four workstreams. Carbon / cost intensities were derived from real asset and activity data.

**Scope:** the carbon model data used is considered of good quality and attempts to cover a full cradle-to-build asset boundary. The datasets used are industry recognised and relevant to UK construction.

**Methodology:** All of the carbon emissions were assessed on the basis of real asset and activity data. For routine maintenance items, real data for representative schemes was used. There can therefore be a reasonable amount of confidence that the overall figures are meaningful and reflective of the true situation.

**Engagement:** there was internal engagement with project leads. Mott MacDonald assisted in this engagement, and is fully engaged with recognised standards such as; PAS 2080, CESSM4:2013.

**Weaknesses**

**Scope:** carbon models need further review against latest design specification and construction approaches and to improve their alignment with cost models. The build part of the carbon models also relies on both CESMM4 data (which was last updated in 2013) and some uplift assumptions based on review of a small sample of historic projects. The allocation of cost data to capital and purchased goods and services needs further refinement to ensure allocated costs reflect the same scope boundary of the carbon models.

**Methodology:** currently, carbon emission estimates across all project blocks are based on extrapolation, which could under- or overestimate emissions.

**Engagement:** engagement with external stakeholders on carbon reduction plans has been limited to date.

**Opportunities**

**Coverage:** data coverage would improve significantly if carbon assessment were carried out on live 2020-2025 projects. This would allow hotspot analysis, better inform decision-making and potentially reduce the whole-life carbon of existing and new infrastructure.

**Scope:** engagement with the supply chain would lead to more confidence in the data and greater refinements to the current set of carbon models over time.

**Methodology:** the company is moving towards carbon emissions being assessed routinely for all projects, which will improve accuracy in future reporting year

**Engagement:** PAS 2080:2023 encourages asset owners to influence carbon management up and down the supply chain and incentivise carbon reduction.

**Threats**

**Coverage:** there is a risk that projects are carried out without additional carbon assessment. Also, that assessments are carried out only to satisfy regulatory requirements, with insufficient focus on carbon management.

**Scope:** significant up-front work is needed to improve the scope and accuracy of the carbon models. A major focus on improving data could mean less time and resources for actively pursuing carbon reduction.

**Methodology:** over- and underestimates could mean that the true level of emissions or potential reductions could be hidden or misinterpreted. Consequently, a plan is in place to improve data capture on live capital schemes.

**Engagement:** supply chain engagement that is limited, or undertaken without clear strategic direction or the ability to motivate action in the supply chain, would hinder short- and long-term emissions reductions.

### 7.2.2. Base position (2022-23)

2022-23 capital project embodied emissions were 47,636 $tCO_2e$, split as follows:

*Table 35 Base position 2022-23*

<table>
<tr><td>Capital Maintenance</td><td>Water supply infra</td><td>20,097</td><td rowspan="4">24,548</td></tr>
<tr><td>Capital Maintenance</td><td>Water supply non-infra</td><td>1,411</td></tr>
<tr><td>Enhancements</td><td>Water supply infra</td><td>2,604</td></tr>
<tr><td>Enhancements</td><td>Water supply non-infra</td><td>436</td></tr>
<tr><td>Capital Maintenance</td><td>Wastewater infra</td><td>6,227</td><td rowspan="4">23,088</td></tr>
<tr><td>Capital Maintenance</td><td>Wastewater non-infra</td><td>5,476</td></tr>
<tr><td>Enhancements</td><td>Wastewater infra</td><td>,291</td></tr>
<tr><td>Enhancements</td><td>Wastewater non-infra</td><td>9,094</td></tr>
</table>

Greenhouse gas emissions related to purchased goods and services (including management and general schemes; desktop studies and investigations; and a set proportion of all capital projects to account for design and consultant fees), were estimated based on a top-down approach using the Scope 3 evaluator tool Quantis SUITE 2.0. 2022-23 emissions related to purchased goods and services were as follows (tCO2e):

*Table 36 (tCO2e)*

| Water | Wastewater | Total |
|---|---|---|
| 3,482 | 11,355 | 14,837 |

## 7.3. 2025-2030 forecast

The tables below summarise our estimates for 2025-29, and the full programme including schemes starting early or completing during the AMP9 period.

*Table 37 2025-2030 Forecast, water*

<table>
<tr><th colspan="2"></th><th>2025-29</th><th colspan="5">2023-34</th></tr>
<tr><td rowspan="2">Capital Maintenance</td><td>Infra</td><td>95,860</td><td rowspan="2">105,139</td><td rowspan="4">176,593</td><td>104,730</td><td rowspan="2">114,009</td><td rowspan="4">295,884</td></tr>
<tr><td>Non-infra</td><td>9,279</td><td>9,279</td></tr>
<tr><td rowspan="2">Enhancement</td><td>Infra</td><td>69,680</td><td rowspan="2">71,454</td><td>99,362</td><td rowspan="2">181,875</td></tr>
<tr><td>Non-infra</td><td>1,774</td><td>82,513</td></tr>
</table>

*Table 38 Forecast, wastewater*

<table>
<tr><th colspan="2"></th><th colspan="3">2025-29</th><th colspan="3">2023-34</th></tr>
<tr><td rowspan="2">Capital Maintenance</td><td>Infra</td><td>65,034</td><td rowspan="2">161,206</td><td rowspan="4">343,522</td><td>65,034</td><td rowspan="2">162,281</td><td rowspan="4">402,792</td></tr>
<tr><td>Non-infra</td><td>96,172</td><td>97,247</td></tr>
<tr><td rowspan="2">Enhancement</td><td>Infra</td><td>24,054</td><td rowspan="2">182,316</td><td>24,101</td><td rowspan="2">240,511</td></tr>
<tr><td>Non-infra</td><td>158,262</td><td>216,410</td></tr>
</table>

*Table 39 Forecast, other*

| | 2025-29 | 2023-34 |
|---|---|---|
| Capital Maintenance | 26,083 | 51,325 |
| Enhancement | 11,456 | 11,847 |

The totals for the entire programme are 557,654 tonnes during 2025-29, and 761,848 tonnes during 2023-34.

The schemes with the largest estimated embodied emissions (>5,000 tonnes $CO_2e$) are as follows:

**Water**

*Table 40 water*

| | |
|---|---|
| 641 Supply maintain leakage (current costs) | 56,520 |
| 1110 WRMP24 - PCC Plan 7 | 53,397 |
| 1500 Supply distribution (infra) - base (excl. leakage) | 30,470 |
| 425 Supply Appearance Taste Odour | 8,870 |
| 877 Supply disinfection improvements | 7,315 |
| 1102 WRMP24 - leakage Plan 7 | 6,184 |

**Wastewater**

*Table 41 wastewater*

| | |
|---|---|
| 1481 Sewerage Base spend AMP8 | 65,034 |
| 1128 AGP031 – Water recycling centres CM | 62,319 |
| 2029 Avonmouth WRC - AMP 7 FFT increase & DWF exceedance | 15,658 |
| 1476 Sludge storage resilience - 9x sludge barns | 13,231 |
| 1869 AMP7 safety improvement works at Avonmouth BC | 10,142 |
| 1465 IED improvements at Avonmouth BC | 9,512 |
| 653 WINEP - Nitrogen Removal - Poole Harbour - Poole WRC | 9,000 |
| 651 WINEP - Nitrogen Removal - Poole Harbour - Dorchester WRC Grey Solution | 7,130 |
| 1129 AGP022 - INFRA Sea Outfalls CM | 7,083 |
| 1466 IED Improvements at Berry Hill BC | 7,253 |

| | |
|---|---|
| 1468 IED Improvements at Taunton BC | 6,295 |
| 459 DWMP - Capacity and separation schemes to reduce hydraulic flooding Scenario 1a | 5,301 |
| 462 DWMP - Total Pollutions Core option 2b | 5,205 |

**Both**

| | |
|---|---|
| 663 Fleet & Plant Replacement Plan excl. sludge vehicles | 11,597 |
| 659 Laboratory Equipment Investment Option 1 | 6,748 |
| 479 Decarbonised Fleet Infrastructure - additional Wessex Water charging (90% can charge) | 5,547 |

The 2025-29 embodied carbon of other investment lines (i.e. management and general) is estimated at 26,083 tCO2e from maintenance and 11,456 from enhancement.

## 7.4. Better managing embodied emissions

Our approach to managing wholelife carbon must evolve further and become more closely integrated with investment choices. This has a number of aspects, many of which are found in the recommendations of UKWIR's 2022 publication, Calculating wholelife / totex carbon (22/CL/01/32).

**Company culture and practice**

- making wholelife carbon assessment a routine part of investment decision-making and out challenge processes with carbon accounting being business-as-usual for all activities.
- ensuring that embodied carbon assessment is not only carried out for reporting requirements, but to also drive better management of carbon emissions.

**Building the right thing**

- Using multi-criteria analysis of options, as has been implemented with the EDA system used for this business plan.
- Increasing use of lower carbon intensity options, including greater deployment of nature-based solutions where they are evidentially better than conventional engineered methods.

**Working with others**

- establishing greenhouse gas emissions as a key metric in our procurement process
- increasing our understanding of which supply chain emissions we can influence and the most effective ways to do this.
- working with the supply chain to increase confidence in product emissions data and carbon models, and to explore opportunities to carbon savings.
- greater engagement with the full range of external stakeholders on carbon management goals and the emissions impacts of different options to improve service and the water environment.

**Improving modelling and assessments**

- reviewing the carbon models we use against latest design specification and construction approaches and to improve their alignment with cost models.
- assessing as-built projects and live projects through bill of quantity information, which will enable hotspot analysis and better inform decision-making.
- increasing precision in estimation of emissions from purchased goods and services.
- Moving toward any top-down application of carbon / cost intensities being the exception.

To enable a more systematic approach across all these aspects, we are looking at developing a corporate carbon management process in line with PAS2080:2023 (with formal accreditation being an option). As a starting point we are working with Mott MacDonald to develop work packages that are based on a gap analysis against

PAS2080:2016. This has five main strands: a) development of the capital carbon catalogue; b) linking the carbon catalogue to existing investment tools; templates for carbon reporting and schemes moving through internal gateways; d) engagement with business leadership and the supply chain; e) contributing to major investment programme deadlines.

# 8. Other aspects of this work

## 8.1. Challenges

Alongside the options set out above for achieving net zero carbon are a number of other issues that will come into play – some of which could add complexity while others could speed-up progress. Either way, decarbonising our work is unlikely to be a predictable, linear process.

Firstly there are opportunities and 'tailwinds'

- rapid decarbonisation of grid electricity, and gradual decarbonisation of fuels and transport; may technologies are already readily available.
- wider technological innovations approaching maturity and scalability e.g. predictive analytics, biochar, hydrogen; ammonia recovery as way to reduce treatment energy while producing a hydrogen carrying substance.
- low carbon concrete and steels, where 'grey' solutions are required.
- growth and mainstreaming of nature-based solutions.

However, we also face some challenges, 'headwinds' and uncertainties.

- estimations of nitrous oxide and methane emissions could be recalibrated significantly upwards.
- accounting additions: chemicals; sludge to land; fossil-fuel extraction, production, distribution.
- significant additional construction carbon: related especially to WINEP, storm overflows, and water supply resilience.
- additional energy use as a consequence of regulated investment.
- demonstrating robust cost-effective and scalable advanced thermal conversion of sewage sludge.

**Working with others**

We will not be able to decarbonise in isolation. Collaboration and positive relationships with other businesses and organisations will be crucial for our decarbonisation work, and we will need to draw on the expertise and assistance of many others if we are to succeed. Partnership working has always been a feature of all aspects of our work, and we already have strong links with many other sectors of the economy. This includes energy, transport, communications, construction, engineering, advanced technology and data, agriculture and environmental services. We are also firmly embedded within the region that we serve and have close links with local authorities, community groups and other local interests. Partnerships are also critical for issues such as carbon reduction where rapid change and new approaches are needed. To this end we will be working closely with innovators, developers of new technologies and researchers, as well as other water companies and companies in the supply chain and other organisations with which we are already linked.

**Regulation**

We are required to bring about a large range of improvements for customer service, drinking water quality and the wider water environment. Meeting tighter standards has often resulted in additional energy consumption or the use of carbon-intensive materials for creating new infrastructure. As regulation is often focused on specific objectives, any additional greenhouse gas emissions caused by this work has often seemed to be a peripheral consideration. Looking ahead, there will need to be a more joined-up view and open dialogue with regulators to promote the lowest carbon options.

**Enabling technology**

We are broadly optimistic about the role technology and innovation will play in the years ahead. Through technological improvements we have already seen sharp reductions in the cost of renewable energy generation and energy storage. We expect to see this trend continue; and more activity around topics such as hydrogen for energy storage and replacing gas and diesel. We are also increasingly seeing the potential for digitalisation and data-led innovations, which offer a lot of promise for operating water mains, sewers and water and sewage treatment in the most efficient way possible. We look forward to working with other businesses and the research community for putting new low carbon technologies into practice.

**Climate change adaptation**

Addressing climate change will mean adapting to the effects of climate change as well as eliminating our own contribution as much as we can. Climate change will affect us through ‘stresses’ - changes that gradually apply more pressure over time - and ‘shocks’ in the form of extreme weather events such as heatwaves, droughts, intense storms and prolonged rainfall. While shock events such as these have happened in the past, climate change is a ‘threat multiplier’ that increases risks. So, extreme weather events that are considered possible but unusual by today’s standards will occur more frequently and to a greater intensity in future.

In response we have developed a climate change adaptation plan because some effects of climate change are already happening, and we must be prepared for the impacts on our activities. Our plan outlines the main climate-related risks that we face and the work that we are carrying out in response. We produced an updated report on our adaptation plans and work in 2021.